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### Prevalence and Modelling of Complication of Diabetes and Its Risk Factors in District Dir Lower Khyber Pakhtunkhwa

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#### Abstract

*In this study prevalence of complication in type 2 diabetes and its associated factors are identified. Two stage cluster sampling method is used to select sample of diabetic patients from the District Dir Lower Khyber Pakhtunkhwa. Structure interview schedule is developed to capture necessary information from the selected patients. Binary logistic regression model is used to investigate risk factors of complication of diabetes. Moreover, 95% confidence interval (CI) for population proportion for each complication is calculated. Analysis revealed that major complication of diabetes are autonomic dysfunction (15%) and foot ulcer (11%). Further, 55% of diabetics have no complication. Also, major risk factors to the complication are obesity, lack of exercise, positive family history of diabetes and hypertension.*

**Keywords:** Complication, Type 2 Diabetes, Binary Logistic Regression Model, Autonomic Dysfunction, Foot Ulcer.

#### Introduction

Type 2 Diabetes mellitus (T2DM) is one of the most vital public health problems in the Glob. The prevalence of diabetes in the world in 2021 was estimated to be 10.5% (536.6 million people), rising to 12.2% (783.2 million) in 2045 (Sun et al., 2022; Bhutta et al., 2022). Approximately 75% people with diabetes live in low- and middle-income countries; and the burden of DM in Sub-Saharan Africa (SSA) increased by 126.4% between 1990 and 2017, due to increased sedentary lifestyles, unhealthy diets, and ageing (Gouda et al., 2017). Pakistan has an estimated 33 million diabetics, the third largest diabetes population in the world. Moreover, 11 million Pakistani adults have impaired glucose tolerance, while approximately 8.9 million adults with diabetes remain undiagnosed (Sun et al., 2022).

Diabetes mellitus type 2 (DMT2) has chronic complication which increases diabetic mortality. These complications also affect the quality of life of the subject and incur heavy burdens to the health care system (Papatheodorou et al, 2018). DMT2 is a major cause of blindness, renal failure, cardiovascular disease, stroke and lower limb amputation. About 2.8% of Rwanda's 12.95 million people were estimated to be living with DM by 2016 (World Health Organisation, 2016).

Obirikorang et al. (2016) studied the complication of diabetes. They select 630 diabetic patients from hospital and found the complications; hypertension 223(35.4 %), neuropathy 184 (29.2 %), hypoactive sexual arousal 160(25.4 %), arousal disorder 135(21.5 %), eye diseases 112(17.7 %), heart disease 58(9.2 %), and renal disease 34(5.4 %). Iradukunda et al. (2021) identified the risk factors associated with diabetes; alcohol intake, smoking, obesity and family history of diabetes. In their study major complications of T2DM are found; Hypertension (50.4%), acute hyperglycemic state (24%), nephropathy (23.6%), and stroke (15.4%). Akhtar et al. (2022) carried a study to explore the prevalence of foot ulcers and their associated factors among diabetic patients. They used multistage cluster random sampling procedure to perform a cross-sectional analysis in the study area. They found significant risk factors of complication of diabetes (foot ulcer) are; age, duration of diabetes, and gender. Khuwaja et al. (2004) detected retinopathy, nephropathy, neuropathy in diabetic patients. According to Haider and Obidullah (1981) prevalence of major complications are ischemic

heart disease retinopathy, nephropathy, neuropathy, hypertension and cataracts. Waris et al. (2021) study the complication of diabetes and its associate knowledge, attitude and practices in Karachi Pakistan. Younis et al. (2018) studied the prevalence of foot ulcer to diabetes patients.

Diabetes type 2 is one of the growing diseases throughout the world. Its chronic complication affects the quality of life and makes permanent disable many people of the Globe. Many studies have been done on the risk factors and its chronic complication to DMT2 in world as well as in Pakistan. A study of prevalence and risk factors of DMT2 is carried before in this area by Akhtar et al. (2016). But unfortunately, District Dir Lower, an important historical and populist area of Khyber Pakhtunkhwa province, is deprive from the study of complications of DMT2. This study is done in that important district of the province to identify major complication of DMT2, and to estimate prevalence of diabetic patients having specific complication.

**Material and Method**

A structure interview schedule is developed to capture information regarding demographic characteristics, diabetic related characteristic and complication. The interview schedule is modified after pilot survey accordingly. Two stage cluster random sampling method is used to identify the sample from the population. Six clusters (populist places in the study area), from the study area are selected; Chakdara, Ouch, Talash, Temergarah, Khal, Samer Bagh of district Dir lower. In the second stage villages are selected from the already selected clusters. Subjects have age 25 and above are included in the study. Complication is detected from observation and by studying patient medical chart.

**Statistical Analysis**

The percentage and proportion with 95% confidence interval are used to present the data of complication of diabetes. To investigate the individual risk factor in complication of diabetes, binary logistic regression model is used. The dependent variable is complication or no complication of diabetes to an individual patient. The dependent variable is coded as 1 if the complication exists to a subject, and 0 when no complication found in the patient. Similarly other variables are coded accordingly. For subset selection of predictor variable, Akaiki information criteria is used.

**Results**

The study consists of 100 patients out of which 54 were male and 46 were female. The diabetic patient included in the study is belonging to six populist areas of District Dir Lower. Overall, 55 of the 100 DMT2 subjects (55%) have no recognized complications. While 45 (45%) suffered from at least one diagnosed chronic complication. Specific complication along with number of diabetic patients is shown in Table 1. The Table reveals that major complication of diabetes is autonomic dysfunction (15%). The 2<sup>nd</sup> and 3<sup>rd</sup> major complication of T2DM is foot ulcer (11%), and eye disease (6%) respectively. Other complications of T2DM are nephropathy (4%), charcot joints (1%), cerebrovascular disease (4%), cardiovascular (1%), sexual dysfunction (1%) and peripheral vascular (1%).

**Table 1. Prevalence of the Complication of Diabetes type 2.**

<b>Complication</b>	<b>Number of Patient</b>	<b>Percentage</b>	<b>Cumulative percentage</b>
No complication	55	55	55
Eye disease	06	06	61
Nephropathy	04	04	65
Foot ulcers	11	11	76
Charcot joints	01	01	77
Autonomic dysfunction	15	15	92
Sexual dysfunction	01	01	93
Cardiovascular	02	02	95
Peripheral vascular	01	01	96
Cerebral vascular disease	04	04	100
Total	100		

The proportion of diabetic persons in population is estimated through 95% confidence interval in Table 2. The major complication autonomic dysfunction is presented in 8 to 22 percent of diabetic in the population. The foot ulcer is existed in 5 to 17 percent and eye diseases are in from 1 to 10 percent of diabetic in population.

**Table 2. Proportion of complication of T2DM and 95% confidence lower limits and upper limits**

S. No	Complication	Proportion	Lower bound	Upper Bound
1	<b>No complication</b>	<b>0.55</b>	<b>0.45</b>	<b>0.65</b>
2	Eye disease	0.06	0.01	0.11
3	Nephropathy	0.04	0.00	0.08
4	<b>Foot ulcers</b>	<b>0.11</b>	<b>0.05</b>	<b>0.17</b>
5	Charcot joints	0.01	0.01	0.03
6	<b>Autonomic dysfunction</b>	<b>0.15</b>	<b>0.08</b>	<b>0.22</b>
7	Sexual dysfunction	0.01	0.01	0.03
8	Cardiovascular	0.02	0.01	0.05
9	Peripheral vascular	0.01	0.01	0.03
10	Cerebral vascular disease	0.04	0	0.08

The analysis reveals that risk factors to complication of diabetes in the study area are obesity, exercise, positive family history and hypertension. Table 3 consists of number of diabetes patient having risk factors of complication of diabetes. Further, the table reveals that most of the patient has positive family history of diabetes (54%). Also 45% of patient is obese, and 23% of the patient has hypertension. Further, 38% of the patient is doing exercise regularly.

**Table 3. Characteristic of diabetic patient.**

S.No	Characteristics	Number of diabetic patients
1	Obesity	45%
2	Exercise	38%
3	Family history of DM2	54%
4	Hypertension Tension	23%

**Modelling of the diabetes and risk factors**

Modelling is a statistical procedure through which we can check the significance and predict the dependency of one or more than one independent variable (s) on one dependent variable. In this particular study we have a categorical dependent variable which is binary and we can't use classical linear regression model. In such a situation, we can use binary linear regression model (Agresti, 2002).

The response variable is presence or absence of complication in diabetic patient, which is coded as '1' for presence of chronic diseases and '0' for absence of such disease.

For a binary response variable Y and an explanatory variable X, let

$\Pi(x) = P(Y = y / X = x) = 1 - P(Y = 0 / X = x)$ , The logistic regression model is

$$\Pi(x) = \frac{\exp(\alpha + \beta x)}{1 + \exp(\alpha + \beta x)} \tag{1}$$

Equivalently, the log odds, called the logit, has the linear relationship

$$\text{Logit} [\Pi(x)] = \log \frac{\Pi(x)}{1 - \Pi(x)} = \beta_0 + \beta x \tag{2}$$

Here  $\beta$  showed the strength of relationship between explanatory variable X and log odd ratio. Its sign shows the nature of relationship i.e either it is positive relationship or negative relationship (Agresti, 2002). Taking anti log both sides of (2) we get

$$\frac{\Pi(x)}{1 - \Pi(x)} = e^{\alpha} e^{\beta x}$$

Now the intercept term  $e^{\alpha}$  is the odd ratio when X equal to zero, and  $\beta$  is slope (Logistic Regression, Lecture notes).

**Selection criteria for Predictor variable**

For the selection of best suitable model we use Akaike information criterion. Akaike information criterion's formula is give below,

$$AIC = 2 \ln(L) - 2K$$

Where,

K = number of parameter in statistical model

L= maximized value of the likelihood function for the estimated model

We can also calculate AIC using RSS as under

$$AIC = n \left[ \ln \left( \frac{RSS}{n} \right) \right] + 2k.$$

In this study, five risk factors are included; family history, exercise, obesity, hypertension and smoking. Akaike Information Criterion (AIC) is calculated to detect those independent variables

having more explanatory power. The AIC of the four explanatory variables; family history, exercise, obesity and hypertension is small than other combination. Therefore, we run the Binary Logistic Model for only these variables.

**Table 4. Selection of best fitted model through Akaike information criterion**

Models	K	Loglikelihood	AIC
f/h*	2	-64.733	133.466
f/h+exercise	3	-59.435	124.870
f/h+exercise+smk	4	-58.663	125.326
f/h +smkng+htn**	4	-61.689	131.378
f/h +smkng+htn+exercise	5	-56.052	122.104
f/h+htn+exercise	4	-56.761	121.522
<b>f/h+htn+exercise+obesity</b>	<b>5</b>	<b>-52.888</b>	<b>115.776</b>
f/h+htn+exercise+obesity+smoking	6	-52.053	116.106

\*f/h is family history, htn\*\* is hypertension.

Estimated coefficient of binary logistic regression along with standard error and P-value are in Table 5. Estimated logistic regression reveals that chronic complication of T2DM has positive relation with obesity, family history and hypertension while it has negative relation with exercise.

**Table 5. Result of Binary Logistic Regression Model**

Covariate	Coefficient	Standard error	P value
Constant	-0.87710	0.49711	0.078
Obesity	0.56665	0.47400	0.232
Exercise	-1.64460	0.54123	0.002
Fh	1.29653	0.54662	0.009
Htn	0.45321	0.54662	0.407

**Discussion**

Autonomic dysfunction is the major complication of DMT2 in District Dir Lower. Most of the diabetic patients (15%) have autonomic dysfunction. This result match to Obirikorang et al. (2016) who also identify the autonomic dysfunction (neuropathy) as the complication of diabetes.

Another major complication of DMT2 is foot ulcer in the study area. Eleven percent of the diabetic patients have foot ulcer. This finding match to Akhtar et al. (2022) and Younis et al. (2018).

The other complication in the study area is; eyes problems, nephropathy, cerebrovascular, cardiovascular, sexual dysfunction and peripheral vascular. Most of these complications of diabetes are found by Obirikorang et al. (2016).

The results of binary logistic regression show that; obesity, positive family history and hypertension are positive related with complication of diabetes. Thus, diabetic patient having these characteristics have high risk of chronically diseases. This result match to Iradukunda et al. (2021) who identify the obesity and positive family history as risk factors of diabetes.

**Conclusion**

Chronic diseases due to diabetes is exist in District Dir lower. Autonomic dysfunction and foot ulcer are major complication of diabetes in the study area. The study can be extended by taking more sample from the population.

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