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DISCRIMINATING DIABETIC PATIENTS OF SOME RURAL AND URBAN AREAS OF BANGLADESH: A DISCRIMINANT ANALYSIS APPROACH

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Summary

The present analysis was conducted in the American International University of Bangladesh using the data collected from 900 respondents. Among the respondents 70.6 percent are diabetic patients. Finding reveals that the largest percentage of patients is of the age group ≥ 50^+ years. About 34 percent patients are suffering from Type II diabetes and among them 63.3 percent are in the age group ≥50^+ years. Higher prevalence rates of diabetes are observed among farmers and retired persons. The diabetic patients are discriminated from non-diabetic respondents due to the variables age, residence and work type. Most important variables for discriminating diabetic patients are age, education and work-type.

Introduction

Diabetes is a disease characterized by excessive urination which is caused by insufficient insulin production or lack of responsiveness to insulin. The impact of insufficient insulin production is hyperglycemia. Thus, diabetes mellitus is a major and growing health problem in most countries and an important cause of prolonged disease and early death since insulin is essential to process carbohydrate, fat and protein [1]. Insufficient insulin production is associated with health problem such as gangrene, blindness, kidney failure, health failure, prolonged ill health and death due to vascular diseases [2 – 5]. The risk factors for cardiovascular disease are glucose and lipid abnormalities and the prevalence of this disease is a major factor due to diabetes in both developed and developing countries [6].

Nearly 80% of people with diabetes live in low and middle income countries [4]. Diabetes is prevalent among 10% people of Bangladesh and according to the international Diabetes Federation, the prevalence will be 13% by 2030 [4]. However, no na-

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tionally representative, epidemiological study of the prevalence of diabetes and its risk factors has been carried out in the country. People are also not aware, especially the rural people, of the disease and the factors responsible for the disease.

There are mainly two types of diabetes, Type I and Type II. Type I diabetes may be caused by an autoimmune response and it is insulin dependent diabetes. Insulin is produced in the pancreas by the beta cells of the islets of Langerhans. Absence or destruction or loss of these cells causes an absolute deficiency of insulin leading to Type I diabetes. Type II diabetes is a heterogeneous disorder and the patients of this type of diabetes have insulin resistances their beta cells lack the ability to overcome this resistance. Whatever be the type of the disease, complications arise due to the disease. There are 3 major categories of complications and these are (a) acute, complications, (b) long-term complications, and (c) complications caused by associated autoimmune diseases. Acute compilations include hypoglycemia, hyperglycemia, and death during diagnosis.

People, even the government, are not aware of the complication and as a result, the factors responsible for the disease are not well identified. The aim of this paper is to identify the socio-demographic variables responsible for diabetes among some people of rural and urban Bangladesh. The important factors responsible for diabetes can be identified by discriminant analysis, where the respondents are discriminated by the presence or absence of the diabetes. Discriminant analysis is also done among the diabetic patients by the type of diabetes.

Methodology

The analytical results are obtained from a sample of 900 persons among Bangladesh. Among the respondents, 635 are diabetic patients and 265 are non-diabetic people. The data are collected by postgraduate students of first and second - semester of 2014-2015 of American International University-Bangladesh. This group of students is doctors/nurses working in different hospitals/ clinics. Some of them are involved in health services in both urban and rural areas. They have collected information from the working places/neighbors according to their convenience through pre-designed and pre-tested questionnaires. Five hundred forty four people are interviewed by this group of students. Another 200 students of different disciplines are randomly selected from the university and they are asked to collect information from their parents/guardians. This latter group of students has collected information from 400 persons. But 44 filled-in questionnaires are found incomplete and these are discarded from the analysis. Finally, the analysis is done using the data of 900 persons.

The questionnaire contains questions related to socio-demographic characteristics of each person. Questionnaire also contains questions related to the stage of disease, treatment stage of disease, precaution against the disease and the stage of complications of the disease. The information regarding blood sugar level and blood pressure level are also collected according to the latest measurement by doctors/diagnostic centers. The diabetic patients are also discriminated by the type of disease. Data are classified for diabetic and non-diabetic people and accordingly association of diabetes and socio-demographic variables of respondents are studied. Significant association is determined by chi-square test with p-value < 0.05. The respondents are discriminated by the diabetic and non-diabetic respondents to identify the variables which are more important for diabetes. The importance of the variable is decided by largest correlation coefficient of the variable and discriminant score [7 - 8]. The statistical analysis is done by using the SPSS [version 17.0] and MATLAB.

The discriminant analysis is done using the variables residence, age, sex, education, occupation, type of work, and income. Here sex, occupation, residence, and type of work are nominal variables. Thus, we have transferred all the variables in nominal form by assigning numbers.

Results

Among 900 respondents sampled 635 are diabetic patients (70.6%). Since objective of the study is not an estimate of prevalence rate, the investigated variables are classified by prevalence of diabetes and by other socioeconomic characteristics. The classified results are shown in tabular form and the classified results are used to test the independence of any two characters.

As shown in table 1, the prevalence of diabetic patients is 78.3% among urban people and 21.7% among rural people. Prevalence of diabetes according to residential origin is significantly higher in urban area at the univariate analysis (p-value < 0.001). This finding is similar with the finding observed at national level [9], where more urban people are diabetic patients (67.8%) compared to non-diabetic patients.

Among the respondents 58.9% are males and 71.1% of them are diabetic. Among females 69.7% are diabetic patients. The differentials in prevalence of diabetes according to sex are not statistically significant (p- value= 0.65, Table 2).

In different studies [9, 11-13] it is reported that prevalence of diabetes is higher among the middle aged and among older people. In this study also it is seen that among 52.9% of respondents in the age group ≥ 50^{+} years 81.1% are diabetic (Table 3).

Prevalence of diabetes	Residential Origin		Total n (%)
	Rural n (%)	Urban n (%)	
Yes	138 (21.7)	497 (78.3)	635 (70.6)
No	29 (10.7)	236 (89.3)	265 (29.4)
Total	167 (18.6)	733 (81.4)	900 (100)

Table 1:
Distribution of respondents by the prevalence of diabetes and residential origin.

Prevalence of diabetes	Residential Origin		Total n (%)
	Male n (%)	Female n (%)	
Yes	377 (71.1)	258 (69.7)	635 (70.6)
No	153 (28.9)	112 (30.3)	265 (29.4)
Total	530(58.9)	370 (41.1)	900 (100)

Table 2: Distribution of respondents according to sex and prevalence of diabetes.

Prevalence of diabetes	Age groups (in years)				Total n (%)
	<25 n (%)	25-40 n (%)	40-50 n (%)	over 50^{+} n (%)	
Yes	7 (36.8)	62 (50)	180 (64.1)	386 (81.1)	635 (70.6)
No	12 (63.2)	62 (50)	101 (35.9)	90 (18.9)	265 (29.4)
Total	19 (2.1)	124 (13.8)	281 (31.2)	476 (52.9)	900 (100)

Table 3: Distribution of respondents according to age and prevalence of diabetes.

The prevalence rate is significantly lower among the lower aged group of respondents ($p<0.001$). This finding is consistent with that observed globally.

It has been reported [9, 13] that positive association exists between diabetes and level of education. It has also been reported [1] that there is significant association between level of education and pre-diabetes. In the present study also significant association is observed between prevalence of diabetes and level of education (p-value ≤ 0.001). More than 62% of (Table 4) respondents are at least graduated and among them 64.8% are affected by diabetes. The results indicate that there is negative association between prevalence of diabetes and level of education. Similar findings are also observed in some developed and developing countries [9,13].

There are 4.3% agriculturists in the sample and prevalence rate of diabetes among them are higher (87.2% Table 5). Largest prevalence rate is observed among employees of private organizations. The second higher prevalence rate is observed among retired persons. The higher prevalence rate among these two groups of people may be due to non-involvement with physical labors/ activities. In the sample, a good number of people (18.9%) work without any physical labor. This proportion among diabetic patients is 0.268 (Table 7). The prevalence rate is expected to be higher among them. The differentials in prevalence rate according to respondent's occupation are statistically significant as p-value ≤ 0.01.

Prevalence of diabetes	Level of education					Total n (%)
	Illitterate n (%)	Primary n (%)	Secondary n (%)	Graduate n (%)	Post-graduate n (%)	
Yes	30 (83.3)	73 (88)	167 (76.6)	240 (66.3)	125 (62.2)	635 (70.6)
No	6 (16.7)	10 (12)	51(23.4)	122 (33.7)	76 (37.8)	265 (29.4)
Total	36 (4)	83 (9.2)	218 (24.2)	362 (40.2)	201 (22.4)	900 (100)

Table 4: Distribution of respondents according to level of education and prevalence of diabetes.

Prevalence of diabetes	Occupation						Total n (%)
	Agriculture n (%)	Business n (%)	Govt. Service n (%)	Private Service n (%)	Retired n (%)	Housewife n (%)	
Yes	34 (87.2)	151 (72.2)	101 (65.6)	130 (62.8)	85 (76.6)	134 (74.4)	635 (70.6)
No	5 (12.8)	58 (27.8)	53 (34.4)	77 (37.2)	26 (23.4)	46 (25.6)	265 (29.4)
Total	39 (4.3)	209 (23.2)	154 (17.1)	207 (23.0)	111 (12.3)	180 (20.0)	900 (100)

Table 5:
Distribution of respondents according to occupation and prevalence of diabetes.

It has already been mentioned that 70.6% respondents are diabetic patients. These respondents are classified by their type of diabetes and according to their age (Table 6) and type of work they do (Table 7). A good number (269 out of 635) of patients do not know their type of diabetes.

Only 20.8% are suffering from Type I diabetes and 47.7% of them are in the age group over 50 years old. This differential by age and type of diabetes is significant as ($p \leq 0.01$). The study indicates that most of the patients are suffering from Type II diabetes. This result is similar to that observed in a separate study [1].

Higher proportion of diabetic patients is doing physical labor and 27.5% of them are suffering from Type II diabetes. The corresponding figure among the patients who are not doing work with physical labor is 40.6. There is significant differences in the proportions of respondents suffering from diabetes according to the type of work they do ($p \leq 0.01$).

Results of Discriminant Analysis by Disease

The importance of the inclusion of variables in the discriminant analysis is studied by 1- r^2 as shown in Table 8. None of these values is low and hence all the seven variables are included in the analysis. The discriminant coefficients are shown in Table 9 below. The results indicate that the variable age has the highest discriminating power followed by educa-

Type of diabetes	Age group (in years)				Total n (%)
	<25 n (%)	25-40 n (%)	40-50 n (%)	over 50+ n (%)	
I	3 (2.3)	20 (15.8)	46 (34.8)	63 (47.7)	132 (20.8)
II	3 (1.4)	25 (11.6)	51 (23.7)	136 (63.3)	215 (33.8)
III	0 (0.0)	2 (10.5)	3 (15.8)	14 (73.7)	19 (3.0)
Unknown	1 (0.4)	15 (5.6)	80 (29.7)	173 (64.3)	269 (42.4)
Total	7 (1.1)	62 (9.8)	180 (28.3)	386 (60.8)	635 (100.0)

Table 6: Distribution of respondents according to their age and type of diabetes.

Type of diabetes	Type of works				Total n (%)
	Only official work n (%)	Office work with physical labor n (%)	Physical labor n (%)	Work without physical labor n (%)	
I	40 (24.7)	22 (16.7)	33 (19.3)	37 (21.8)	132 (20.8)
II	63 (38.9)	36 (27.3)	47 (27.5)	69 (40.6)	215 (33.8)
III	5 (3.1)	4 (3.0)	4 (2.3)	6 (3.5)	19 (3.0)
Unknown	54 (33.3)	70 (53.0)	87 (50.9)	58 (34.1)	269 (42.4)
Total	162 (25.5)	132 (20.8)	170 (26.9)	170 (26.8)	635 (100.0)

Table 7: Distribution of diabetic patients according to their type of diabetes and type of work.

tion, sex and residence. The importance of the variables is also observed from the study of the correlation coefficients of the variables with discriminant score [8 - 9]. The correlation coefficients in descending order are shown below in Table 10. The function is found highly significant by Bartlett's [10] test ($p<0.001$). The test indicates that diabetic and non-diabetic respondents are significantly different. The important variable for discrimination is age followed by education and residence. This result is observed from the study of correlation coefficients of the variables and discriminant score.

Discrimination by Type of Diabetes

The diabetic patients are classified by type of diabetes. In total there are 635 diabetic patients. Among them 132 are of Type-1 diabetes, 215 are of Type-II diabetes, 19 has said that they are of Type III diabetes and 269 are unaware about their type of diabetes. Thus, we have classified the patients into 4 groups and identified them by 1, 2, 3 and 4 respectively. The multivariate analysis of variance shows that the mean vectors of four groups of patients by type are significantly different (Wilk's ^ = 0.919, F= 2.555, $p \leq 0.01$). The discriminant analysis also shows that the 3 discriminant functions are significantly different ($p \leq 0.01$). The results are shown in Table 11. The pooled within- groups correlations between discriminating variables and the standardized canonical discriminant functions are shown in Table 12.

The first function discriminates well among groups of patients and the variables age and education and residence are important to discriminate among pa-

Variable	Wilk's ^	F	d.f	p-value	$1-r^2$
Residence	0.984	14.603	1, 898	0.00	0.769
Age	0.926	71.634	1, 898	0.00	0.924
Sex	1.000	0.206	1, 898	0.65	0.531
Education	0.971	26.634	1, 898	0.00	0.619
Occupation	1.000	0.007	1, 898	0.93	0.628
Work type	0.989	9.908	1, 898	0.00	0.731
Income	0.997	2.343	1, 898	0.13	0.821

Table 8: Results showing the importance of inclusion of variable in the discriminant analysis.

Variable	Constant	Age	Education	Residence	Work type	Income	Sex	Occupation
Coefficient	-1.431	1.079	-0.443	-0.220	0.055	-0.046	-0.235	0.053

Table 9: Discriminant coefficients of different variables.

Variable	Age	Education	Residence	Work type	Income	Sex	Occupation
Correlation coefficient	0.845	-0.515	-0.382	0.314	-0.153	-0.045	0.009

Table 10: Correlation coefficients with discriminant score.

tients of different types of diabetes. The second function discriminates well and the important variables for discrimination are age, income and occupation. The third function discriminates well among different groups of patients of different types and the variables age, education, residence and sex are very important to discriminate well.

Discussion and conclusion

Higher prevalence rate of diabetes is observed among male respondents. Higher educated people are less affected by diabetes. Prevalence rates of diabetes are higher among illiterate, primary educated and secondary level educated people. The prevalence rates of diabetes are higher among farmers and retired persons and the prevalence rate is lower among the lower aged respondents. Among the respondents 26.8% are not doing any physical labor and 40.6% of them are suffering from Type II diabetes. This percentage is obviously higher compared to the percentages of other groups of respondents.

Among the diabetic patients 60.8% are in the age group over 50 years old. This result is similar to that observed in a different work [1].

Data reported indicates that among the diabetic patients most of them are from urban area. This result is similar as is observed in another study [9]. This is probably due to the fact that we were mainly interested to study the factors important for diabetes and accordingly

Variables	Coefficients of functions		
	1	2	3
Constant	-3.338	-0.226	-7.629
Age	1.007	-0.581	0.416
Education	-0.723	0.009	0.563
Residence	0.869	0.063	1.813
Work type	-0.245	0.050	0.341
Income	0.254	0.486	-0.130
Sex	0.368	1.193	0.541
Occupation	0.029	-0.352	-0.067

Table 11: Discriminant coefficients of different variables.

Variables	Functions		
	1	2	3
Age	0.654*	-0.463	0.192
Education	-0.425	0.142	0.619*
Residence	0.104	0.170	0.802*
Work type	0.040	-0.100*	0.062
Income	0.317	-0.695*	0.167
Sex	0.218	0.380*	-0.014
Occupation	0.195*	-0.074	0.133
** Largest absolute correlation between variable and discriminating function.*			

Table 12: Correlation coefficients with discriminant score.

mostly diabetic patients were investigated. Age is significantly associated with diabetes. The discriminant analysis also indicates that age is an important factor to discriminate the diabetic and non-diabetic people. These findings are similar as are observed around the world [13]. In particular, two studies conducted in China and India confirmed this data [14, 15].

The discriminant analysis indicates that diabetic patients and non-diabetic people are significantly different according to socio-demographic variable. The variable age is the most important variable for discrimination followed by education and residence. Akter et al also observed that residence is an important factor in distinguishing diabetic and non-diabetic people [9].

Education is significantly negatively associated with prevalence of diabetes. This is may be due to more awareness of the higher educated people about the health hazard of diabetes. The inverse association between diabetes and education are also observed in both developing and developed countries [13, 16- 18].

Occupation and income are important components of socioeconomic status of people. In this study both the variables are found significantly associated with diabetes. Higher prevalence rate is observed among retired persons and among persons involved in work without physical labor. In some studies socioeconomic status and diabetes are inversely associated .The risk of diabetes is increased with the increase of socioeconomic status [12 -14, 19- 20]. Our findings are similar with the findings mentioned above.

Most of the findings reported here are consistent with the findings by other research workers in Bangladesh, India and Pakistan [15, 21, 22]. Some of the social factors associated with the prevalence of diabetes are identified by Chi-square test as is usual process used in other studies in Bangladesh, China and India [14, 15, 21]. In this paper discrimination of diabetic and non-diabetic people is done to identify the most important social factors responsible for diabetes. Similar findings are observed in both type of analysis. Some of the risk factors are age, education, work type and residence. The prevalence rate of diabetes are more among the aged and retired persons.

Diabetes is a serious problem of health hazard in Bangladesh. However the challenge of this health problem can be tackled by (a) incorporating some techniques to investigate the people occasionally to check the health condition of them and accordingly they can be advised to take care of health, (b) encouraging all adults and retired persons to participate at blood screening program so that they can be alerted against the health hazard of diabetes, (c) encouraging the people, especially among urban area to do some sorts of physical activities. The public health authority can play a decisive role for the above steps.

References:

1. Rahaman, M., Islam, J. Problems with diabetes and awareness to its control: Experienced from Diabetes Patients of Rajshahi City Corporation in Bangladesh. 2007. Available online at: http// ispub.com/1jh/8/1/9402.

2. International Diabetic Federation (IDF). Diabetes atlas (Second edition), Brussels. The International Diabetes Federation. 2003. http//www.world diabetes foundation.org.

3. Lozano, R., Naghvi, M., Foreman,K., et al. Global and regional mortality from 235 causes ofdeath for 20 age groups in 1990 and 2010: a systematic analysis for the global Burden of disease study 2010. Lancet 2012, 380,2095-2128.

4. Murray,CJL.,Vos,T., Lozano,R, et al. Disability-adjusted life years for 291 disease and injuries in 21 regions, 1990-2010, a systematic analysis for the Global Burden of disease study 2010. Lancet 2012, 380,2197-2223.

5. Arunachalam, S. and Gunasekaran, S. Diabetes research in India and China today; From literature based mapping to health-care policy. Current Science 2002, 82,No.9,1086-87.

6. Prakashchandra, RD and Naidoo, DP. Glycaemic control profile in diabetic patients: A sub-analysis of the phoenix lifestyle project. Euromediterranean Biomedical Journal 2016, 11(05):33-39.

7. Dillon, WR. and Goldstein, M. Multivariate Analysis. Methods and Applications, John Wiley and Sons 1984, New York.
8. Norusis, MJ. SPSS/PC+ Advanced Statistics™ 4.01 BM PC/XT AT and PS/2,Illinois,1990.
9. Akter, S., Rahman, MM., Abe, S. K., Sultana, P. Prevalence of diabetes and prediabetes and their risk factors among Bangladeshi adults: a nationwide survey. Bulletin of the World Health Organization 2014, 92:204-213A.
10. Barltett, MS. Multivariate analysis. Jour. Roy. Stat. Soc. 1947, B, 9, 176-197.
11. International Diabetes Federation (IDF). Diabetes atlas, 6th ed. (Internet). Country estimates table 2011. The International Diabetes Federation 2012.
12. Rahim,MA., Hussain, A., Azad Khan, et al. Rising Prevalence of Type II Diabetes in rural Bangladesh: a Population based study. Diabetes Research and Clinical Practice 2007, 77,300-5.
13. Calamusa, G., Amodio, E., Costantino, C. et al. Body mass index and factors associated with overweight and obesity: A crosssectional study of adult subjects living in a small city of Western Sicily (Italy). Italian Journal of Public Health 2012, volume 9(3) Pages: e7539.
14. Yang W.Lu, Weng J, Jia W, Ji L, Xiao J. et al. China National Diabetes and Metabolic Disorders Study Group, et al. Prevalence of diabetes among men and women in China. N Engl J Med 2010, 362:1090 –1101.
15. Ramchandran A, Snehalata C, Kapur A , et al. Diabetes Epidemiology Study Group in India (DESL) et al. High prevalence of diabetes and impaired glucose tolerance in India: National Urban Diabetes Survey. Diabetologia 2011, 44:1094-1101.
16. Duc Son LN, Kusama K, Hung NT, et al. Prevalence and risk factors for diabetes in Ho Chi Minh City, Vietnam. Diabet Med 2004, 21:371-376.
17. Borrell LN, Dallo FJ, White K. Education and diabetes in a racially and ethnically Diverse population. Am J Public Health 2006, 96:1637-1642.
18. Mokdad AH, Ford ES, Bowman BA, et al. Prevalence of obesity, diabetes, and obesity related health factors. JAMA 2001, 289:76-79.
19. Ahsan HN, Islam MZ, Alam MB, et al. Prevalence and risk factors of Type 2 diabetes mellitus among Secretariat employees of Bangladesh. J Med 2011, 12:125 –130.
20. Bhowmik B, Afsana F, My Diep L, et al. Increasing prevalence of Type 2 diabetes in a rural Bangladeshi population: a population based study for 10 years. Diabetes Metlab J 2013, 37:46 –53
21. Abu sayeed M, Ali L, Hussain MZ, et al. Effect of Socioeconomic risk factors on the difference in prevalence of diabetes between rural and urban populations in Bangladesh. Diabetes Care 1997, 20:551-555.
22. Shera AS, Rafique G, Khawaja IA, Baqai et al. Pakistan National Diabetes Survey: Prevalence of glucose intolerance and associated factors in Baluchistan province. Diabetes Res Clin Pract 1999, 44:49-58.