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Risk Factors for Diabetes Mellitus: A Population Based Study

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Abstract

The present study tried to examine the risk factors associated with diabetes in Bangladesh utilizing information recorded for 14113 diabetic patients registered at Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders (BIRDEM) during 2003. Multinomial Logistic Regression is applied to estimate the relative risk of various explanatory variables used in the model. Younger cohort, uneducated people, rural population, people with low body mass index (BMI), people having diabetes in the family and males are found to be associated with higher risk of developing both moderate and severe diabetes condition. An indication of early onset of the disease is observed which is of major concern. Preventive measures should be taken immediately to address the epidemic. Otherwise, the economic and the human cost of this disease will unbearable for a poor country like Bangladesh.

I. Introduction

Diabetes is at present considered as an epidemic for its increasing prevalence all over the world. Wild et. al. (2004) provides estimates of the global prevalence of diabetes for the year 2000 and the projections for the year 2030. This report uses prevalence data for adults ($\geq$ 20 years of age) derived from studies in a number of countries and the estimates obtained were extrapolated to other countries using a combination of criteria including geographical proximity, ethnic, and socioeconomic similarities. Considering obesity and physical activity will remain constant in developed countries and urbanization will account for those in the less developed countries, the total number of people with diabetes in this report is projected to rise from 171 million (2.8%) in 2000 to 366 million (4.8%) in 2030. Although diabetes is now a global health problem, developing countries, minority groups, and disadvantaged communities in industrialized countries are facing the greatest risk (King et. al., 1993). The ten countries estimated to have the highest number of people with diabetes in 2000 and 2030 are listed in Global prevalence of Diabetes (2004) and Bangladesh appears in the lists for both the years. Moreover, from the bottom of the list in 2000 with 3.2 million people with diabetes, Bangladesh is projected to rank the 7th with 11.1 millions in 2030.

Diabetes is a serious disease with multiple complications which accounts for a significant number of deaths worldwide. World Health Reports (World Health Organization: The World Health Report 2003, Geneva. World Health organization, 2003) estimated 987,000 deaths from diabetes in the world in 2002 which was 1.7 percent of total world mortality. However, individual with diabetes most often die of cardiovascular and renal disease and thus mortality from diabetes is seriously underestimated. Therefore, mortality attributable to diabetes could be expected to be much higher. Roglic et. al. (2005) tried to estimate the global number of excess deaths due to diabetes in the year 2000 and yielded an estimate of excess global mortality attributable to diabetes that is three times higher than the estimates given in the international statistical reports mostly based on death certificates. The excess global mortality attributable to diabetes in the year 2000 was estimated to be 2.9 million deaths, equivalent to 5.2 percent of all deaths. Excess mortality attributable to diabetes accounted for 2-3 percent of death in the poorest countries (Roglic, 2005). Roglic (2005) further suggested that in most developing countries almost one in ten deaths in economically productive individuals aged 35-64 years can be attributable to diabetes. With the projected number of people with diabetes in the coming years, the burden this disease will impose on a poor country like Bangladesh will be unbearable. Identification of the risk factors responsible for diabetes in this country is, therefore, utmost important for rational planning and taking immediate preventive measures.

The increasing prevalence of diabetes around the world is found to be associated with various risk factors such as population growth, aging, urbanization, increasing prevalence of obesity, physical inactivity, smoking, alcohol consumption, race, family history and so on. Some of these factors are related to food habit and life style while the others are biological. In addition, there are some socioeconomic factors such as education, economic condition which might be indirectly associated with the development of diabetes. The degree of strength of association between diabetes and the various risk factors, however, varies over different parts of the world especially; there might be a difference between the developed and the developing countries. In the developed countries increasing life expectancy and obesity are considered as the prime reasons for the increasing prevalence of diabetes while in recent years in many developing countries including Bangladesh, obesity is not still a major problem.

The prevalence of diabetes in Bangladesh and the associated risk factors have been studied by a number of authors. Hussain et al. (2006) found age, sex, and waist/ hip ratio to be important risk factors for the occurrence of type-2 diabetes in rural Bangladesh. Sayeed et al. (2004) also observed increased age, higher WHR and higher socioeconomic class, to be associated with glucose intolerance in urban and rural Bangladesh. Although a number of studies regarding diabetes have been carried out in Bangladesh, advanced statistical techniques were applied only in a few of them. For example, Singh et. al. (1999) applied an algorithm for estimating parameters of the multi-state model for reverse and repeated transitions to longitudinal data on diabetes mellitus collected at a diabetes hospital in Bangladesh. In the present study a multivariate statistical model named Multinomial Logistic Regression analysis is carried out to identify the possible risk factors.

II. Data and Methods

The data for the present study come from BIRDEM (Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders) which is a muli-sectoral health care delivery centre founded by then

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national professor of Bangladesh Mohammad Ibrahim in Dhaka in 1980. It is the largest health complex in Bangladesh, with almost all types of clinical and diagnostic facilities (Banglapedia, National Encyclopedia of Bangladesh, p.226). People diagnosed to have diabetes are usually referred to BIRDEM from all corners of Bangladesh. During registration a number of demographic and socioeconomic information such as age, sex, family income, education, occupation, area of residence, height, weight, calculated BMI, systolic and diastolic blood pressure are recorded for each patient. Two-sample oral glucose tolerance (OGTT) of each patient is undertaken to confirm diabetes (Khanam et. al., 2008). The present study utilizes the records of 14113 patients registered at BIRDEM during the year 2003.

At first, bivariate analysis was conducted to examine the association between diabetes and different risk factors. Then, Polytomous Logistic Regression analysis was performed to identify the variables that are likely to increase the risk of developing diabetes in Bangladesh. Polytomous, better known as Multinomial Logistic Regression model is an extension to Logistic Regression to handle responses that take more than two categories. The response variable in the present study corresponds to the diabetic patients divided into three categories. Patients with IGT≤11.1 are considered as normal and are coded 0 which is used as the reference category. Diabetic patients producing IGT>11.1 are further divided into two groups. Patients with IGT between 11.2-20 are considered as moderate diabetic patients and are coded 1. Patients with IGT ≥21 are considered as severe diabetic patients and are coded 2.

For the 14113 patients, if we let Y be a polytomous response variable, than we will have Y=0, 1, 2. In this case, we will have two logit functions; one for Y=1 versus Y=0 and the other for Y=2 versus Y=0. The explanatory variables utilized in the present study include Age, Gender, BMI, Heredity, Place of Residence and Education. Wealth index although included in the bivariate analysis was excluded from the multivariate model as it was not significant. Blood pressure and occupation are also excluded from the analysis because they contained too many missing values. Odds Ratios are used to explain the relative contribution of various factors used in the model to the development of diabetes in Bangladesh.

III. Results and Discussion

The results of bivariate and multivariate analyses are given in Table 1 and Table 2, respectively. It is found from Table 1 that all factors that we considered have significant association (p=0.000) with the diabetes mellitus. The results in Table 2 are discussed below.

The effect of age on diabetes is well known and may be related to increasingly impaired β-cell function with age (Scheen, 2005). King and Rewers (1993) observed the prevalence of diabetes to rise with age in all the populations in which age-specific data were examined. Hussain et. al. (2006) in his study in rural Bangladesh found diabetes prevalence to increase with increasing age both for males and females. Sayeed et. al. (2004) also observed similar results in the Hill Tracts of Bangladesh. The present study, however, showed some disagreement with the above mentioned studies. Here the middle aged people are found to be more likely to develop both moderate and severe diabetes compared to their older counterparts. In this study people aged <30 years are taken as the reference category. A comparison with this category reveals that the risk of developing both severe and moderate diabetes is four times higher in subjects aged 30-55 years while for the older cohort the risk is 2.7 times higher in moderate group and 3 times higher in severe group. This might indicate a shift in the set at risk of developing diabetes from older to younger age cohorts in Bangladesh. Kwon et. al. (2008) in his study also observed the relative change in the increased prevalence of diabetes in Korean men to be greater in the younger birth cohorts. Kwon et. al. (2008) argued that older generations may be slower in adopting new lifestyles and likely to maintain their old food habit and physical activities and thus has lower risk of developing diabetes compared to their younger generations.

Urban population is found to be associated with increased risk in both the categories of diabetes. These people are 1.3 times more likely to develop moderate or severe diabetes compared to their rural counterparts. The rural/urban differential in the prevalence of diabetes in developing countries is well documented in the literature and has been attributed to lifestyle factors associated with the higher socio-economic living in urban areas (Illangasekera, 2004). Rural people are primarily engaged in agriculture or related activities. Also, they are not provided with equal urban facilities of transport, water, gas etc and thus have more physical movement which might have lowered their risk of developing diabetes. However, people from rural areas are less likely to attend for health checkup, which might underestimate the strength of the association between diabetes and area of residence.

As mentioned earlier, obesity is considered as a prime determinant of diabetes, particularly in the developed countries (Roglic et al. 2005). Recent U.S. studies considered obesity as a major factor for the increase in both the prevalence and incidence of diabetes (Mokdad et. al., 2000; Gregg et. al. 2004). Kwon et. al. (2008) also considered obesity as the major cause of the diabetic epidemic in Korea in recent years. However, as mentioned by Kwon (2008) obesity may not have the same implications for all the ethnic groups for various reasons such as their different body structures. In Bangladesh different studies produced results regarding relation between obesity and diabetes that contradicts each other. Khanam et. al. (2008), for example, considered obesity as an important contributory factor for the increased prevalence and early onset of diabetes in Bangladesh during the period 1995-2005. Hussain et al (2006), on the contrary, didn't observe any association between BMI and diabetes in his study in rural Bangladesh. The present study also, failed to associate obesity with the development of diabetes. Obesity and overweight are measured as BMI≥30 and BMI≥25, respectively. In the present study, however we have a very few individuals with BMI≥30. Therefore, the

two categories are combined together and people with BMI≥25 are considered as 'overweight'. Individuals with BMI ≤ 18.5 are considered as 'underweight' and those in the middle are considered as 'normal' with which the other two categories are compared.

Table. 1. Percentage distribution of some independent variables with 3 categories of Diabetes Mellitus

Variables	Normal	Moderate	Severe	P-value
Gender				
Male	51.4	53.7	56.5	0.000
Female	48.6	46.3	43.5	
Area of residence				
Rural	29.3	33.8	41.3	0.000
Urban	70.7	66.2	58.7	
Heredity				
Yes	54.2	49.1	40.7	0.000
No	45.8	50.9	59.3	
Age Category				
<30 years	6.0	6.1	10.0	0.000
30-55 years	70.5	75.5	71.5	
55+ years	23.4	18.4	18.5	
Education Level				
< SSC	65.1	68.0	78.0	0.000
SSC+HSC	27.1	25.5	18.2	
Higher	7.8	6.5	3.8	
Economic Status				
Poor	19.4	17.4	18.8	0.000
Middle Class	53.3	55.0	51.2	
Rich	27.3	27.6	30.0	
Body Mass Index				
Normal	49.7	50.9	59.7	0.000
Under weight	4.3	4.9	13.2	
Over weight	46.0	44.2	27.1	

Table. 2. Multinomial logistic regression coefficients for categories of diabetes mellitus by different risk factors

	Moderate			Severe		
Variables	Coefficient	Odds ratio	P-value	Coefficient	Odds ratio	P-value
Gender						
Male	0.309	1.362	0.000	0.430	1.537	0.000
Area of residence						
Urban	0.285	1.330	0.000	0.265	1.303	0.000
Heredity						
Yes	0.491	1.635	0.000	0.716	2.046	0.000
Age Category						
30-55 years	1.441	4.227	0.000	1.408	4.008	0.000
55+ years	1.102	3.009	0.000	0.988	2.686	0.000
Education Level						
SSC+HSC	0.040	1.041	0.640	- 0.377	0.686	0.000
Higher	- 0.148	0.862	0.296	- 0.773	0.462	0.000
Body Mass Index						
Under weight	0.774	2.168	0.000	1.510	4.525	0.000
Over weight	0.255	1.290	0.000	- 0.318	0.727	0.000

-2log Likelihood=1604.78 (p-value=0.000).

The present study observed the underweight patients to be more associated with severe diabetes. As revealed in the present study, the underweight individuals are 4.5 times more likely to have severe diabetes compared to those with normal BMI, while for moderate patients the observed odds ratio is 2.2. The overweight patients showed a negative relation with diabetes in the severe group and a positive association in the moderate group, indicating that overweight patients are less likely to have severe diabetes and are more likely to have moderate diabetes compared to those with normal weight.

Male/female differential in diabetes is observed in many studies. Hussain et al (2006) observed females to have higher prevalence of diabetes in all age groups compared with males with wider difference in the older age groups (>50 years). This, however, contradicts with the present findings. Among the severe diabetic patients males are 1.5 times more likely to develop the disease compared to females. Among the moderate patients, similar result is observed. In this category also, males are associated with higher risk of developing the disease compared to their female counterparts although the odds ratio (1.4) is little less than that in the severe group. However, Bangladeshi women are less likely to attend for routine health checks and their actual conditions might be underestimated.

Heredity appeared to be a significant risk factor for the development of diabetes in Bangladesh. The effect is more significant for severe diabetic patients. People with diabetes in the family are associated with two times higher risk of having severe diabetes than those without having a family history of diabetes. The corresponding odds ratio in the moderate group, although a little less (1.6) than that in the severe group, is also highly statistically significant.

Education, although not directly related to the development of diabetes, it might operate through other direct determinants such as food habit and life style. Educated people are more likely to be aware of the disease and the likely risk factors and would try to avoid them. In the present study also, education is found to reduce the risk of development of diabetes in both the categories. The effect is, however, statistically significant only for the severe diabetic patients. The strength of association between diabetes and education increases with an increase in the level of education. For instant, patients with education up to higher secondary level is 0.7 times less likely to develop the disease while for people with higher education the odds ratio reduces to 0.5, which implies that they are half as less likely to develop the disease as those with no formal education.

IV. Conclusion

An attempt is made in this study to examine the variation in the severity of diabetes among patients registered at BIRDEM in relation to some selected determinants employing Polytomous Logistic Regression. The major drawback of this study is that only the diabetic patients are registered at BERDEM and consequently, the reference group is selected from the patients. However, BIRDEM is the only source of getting reliable information regarding this disease in Bangladesh. The other alternative is to conduct individual level study in particular areas which would not only be very expensive, but also, might not represent the whole Bangladesh. Like most other parts of the world, diabetes in Bangladesh has become a serious disease and cause of other life threatening diseases. Since there is no health registration system in Bangladesh, no reliable statistics of the prevailing situation of this disease in this country is available.

Khanam et. al. (2008), however, compared the diabetic patients registered at BIRDEM during 1995 to those registered during 2005 and identified an increase in the prevalence of diabetes in the female, rural and poor class people during that period. They further identified an early onset of this disease. The present study also witnessed that most of the diabetic patients belong to relatively younger age category, which is of major concern. Bangladesh is an over populated country with a very poor economy. The health care system and disease awareness in this country are also at very low level. If the Number of people affected by diabetes reaches the projected 11.1 millions in 2030, the human and economic costs of this disease will be enormous. Preventive measures should be taken to address this epidemic immediately which calls for the identification of the factors associated with the rapid development of this disease. Such an attempt is made in this study with the best possible available data. Almost all the variables considered showed significant association with both moderate and severe diabetic patients. Only the impact of education on moderate diabetic patients was not statistically significant. The strength of association between various factors is found to be of similar degree for both moderate and severe patients except for BMI. Among the various factors studied some are biological and thus might not be removed, but a knowledge and consciousness about those factors might delay the onset and improve the quality of life of those already have diabetes. An increase in the level of formal education will help people to be aware of the disease and the risk factors associated with it.

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