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Susceptible Factors of Type-2 Diabetes in a Population of Bangladesh

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Abstract Diabetes is a buzzing word nowadays in Bangladesh as well as the world. The prevalence and incidence of type-2 diabetics is also increasing in Bangladesh. Secondary data is used in this study. It is anticipated that most patients will fall in the age range of 20-75 years. All patients, who are newly detected diabetes patients, from the year of 2012 of the BIRDEM General hospital in Bangladesh are requested to fill up a form of the Patients History Sheet. The study use bivariate analysis and a multiple regression analysis considering fifteen risk factors as covariates controlling one by one and two hours before fasting blood glucose of type-2 diabetic patients as a response variable. After controlling one by one fifteen risk factors, it is examined that there is relationship between age and type-2 diabetes. Moreover, fifteen models are considered by controlling individual outcomes to find out the confounding factors. Physical activities, occupation, family history of diabetic patients, Systolic Blood Pressure (SBP) (>140mm Hg), and Diastolic Blood Pressure (DBP) (<70 mm Hg) are confounders for the association of diabetes and age among Bangladeshis. None of the model showed the significant effect of sex, marital status, number of family members and smoking status on the relationship.

Keywords Risk Factors, Fasting Blood Glucose, Controlling Covariates, Confounding Factors

1. Introduction

In 2010, the International Diabetes Federation (IDF) estimated that 5.7 million (6.1%) and 6.7 million (7.1%) of people living in Bangladesh is suffering from diabetes and impaired glucose tolerance (IGT) respectively. It is indicated that the prevalence of diabetes in Bangladesh in populations aged 20-79 years is 6.6%. By 2030, that number of diabetic population is expected to rise to 11.1 million. This explosion in diabetes prevalence will place Bangladesh among the top seven countries in terms of the number of people living with diabetes in 2030. [1] Evidence suggests that type-2 diabetes can effectively be prevented. Recent research has shown that about 65% of type-2 diabetes can be prevented by adopting appropriate life style i.e. increasing physical activity and preventing obesity in Europe and America. Type- 2 diabetes is associated with modifiable (body weight, exercise, diet) and non modifiable (heredity, aging) risk factors. Modifiable risk factors reported to be associated with type-2 diabetes are being overweight, [2-5] low physical activity, [6-8] high dietary fat intake, [9-11] and low fiber intake. [12,13]

There are top 7 Risk Factors for type-2 Diabetes. The number one risk factor for type-2 diabetes is obesity; others are Sedentary Lifestyle, Unhealthy Eating Habits, Family History and Genetics, Increased Age, High Blood Pressure and High Cholesterol, History of Gestational Diabetes. [14] Diabetes is known to be associated with multiple CHD risk factors, including hypertension, dyslipidemia, and abnormalities in hemostasis and cardiac function. [15] All of these are most consistent risk factor of diabetes. [2, 3][16-20] In addition, Area of residence (Urban/Rural) has been considered as a risk factor. [21, 22] Besides these risk factors, another one is Economic status, e.g. higher family income had significantly higher prevalence of type-2 diabetes than that with lower income. [20, 21][23-25]

Though in these studies an interaction was found with high income family while in another study it was not, where findings suggest type-2 diabetes may be quite common in Mexican-American youths and adults from a lower than from a higher socioeconomic status. [26-29] Similarly, Sex is another risk factor where in one study; females are more affected than males. [29,30] This finding is in accord with some findings, while it differs with others, e.g. the prevalence of diabetes is higher in men than women. [22][24] For inconsistencies results it is obligated to re-examine these factors, i.e. further investigation of whether men or women are vulnerable is required. Furthermore, Cigarette smoking may be an independent, modifiable risk factor for noninsulin-dependent diabetes mellitus. [31,32] Apart from cigarettes, however, few published studies have investigated in regards to Education level, [33] Occupation [30] as susceptible factors.

As the risk factors for type 2 diabetes are likely to differ in different population and places; [34] therefore, considering above scenario, it is important to address these issues and to determine the risk factors of various parameters affecting diabetes in Bangladesh. In fact, our study will suggest the possible reasons, i.e. risk factors for the high incidence of diabetes among Bangladeshis. In the literature of international and local studies, it has been shown that couple of risk factors are associated with the occurrence of type-2 diabetes, and we would like to do further investigation about other risk factors which are still not explicitly quantitatively studied. Consequently, the findings of this research will open the new avenues in diabetes prevention for all individuals at risk through the identification of risk factors, which is essential to the successful implementation of primary prevention programs.

2. Materials and Methods

The Study is conducted on the base of data which have been collected form of the Patients History Sheet record. All patients from the year of 2012 of the BIRDEM GENERAL HOSPITAL in Bangladesh were requested to fill up a form of the Patients History Sheet. Participants are included in the study if they are diabetic patients. The analysis of this paper comprises the information of 15095 diabetes patients aged 20-79.

Initially it was anticipated that most patients would fall in the age range of 20-79 years. Data were collected from programmers within the Instructional Technology Integration and Development section under the Division of Instructional Innovation and Assessment.

For the analysis, some characteristics of diabetes patients, i.e. sex (male, female), age in years (< 31,31-50 and 50+ years), marital status (yes, no), area of residence (urban, rural), education level (<SSC, SSC/HSC/equivalent, graduate/higher), occupation (HW, employed, unemployed), patient's body mass index (BMI) (<18.5, 18.5-24.99, 25.0-29.99 and 30+ kg/m2), No of family members (1-4, > 4), Family expenses i.e. Economic status(rich, middle class, poor), Smoking habit (yes, no), past family history about Diabetes (no, yes), Diastolic Blood Pressure (DBP) (<70. 70-90, >90), Systolic Blood Pressure (SBP) (<120, 120-140, >140), physical activities (>60 minutes, 60-120 minutes, >120 minutes) and no. of children (1-2, >2) are considered as outcomes variables.

Bivariate analysis is used to test the association between the categorical variables by applying the chi square test. But the bivariate analysis does not allow for quantification or testing the strength of the risk factors of diabetic patients among selected variables. For that reason, multiple regression analysis is used to quantify the individual effect of outcome variables (sex, age, marital status, area of residence, education level, occupation, patient's body mass index (BMI), no. of family members, Family expenses i.e. Economic status(rich, middle class, poor), Smoking habit, past family history about Diabetes (no, yes), Diastolic Blood Pressure (DBP), Systolic Blood Pressure (SBP), physical activities, and no. of children) with diabetes as a dependent variable in different models. In this analysis, Fasting Blood Glucose (FBG) level (6.1 mmol/l) i.e. having diabetes is considered as the dependent variable.

3. Results

Amongst the chosen diabetic patients from BIRDEM 15095 diabetes patients aged 20-79, 49.9% were male and 51.1% were female respectively.

Table 1. Frequency of education level with gender

	Sex	Number	% of total
<SSC degree	Male	3634	24.1
	Female	5709	37.8
SSC/HSC/equivalent	Male	2173	14.4
	Female	1297	8.6
Graduate/higher	Male	1733	11.5
	Female	549	3.6
Total	Male	7540	50
	Female	7555	50

Table 2. Past family history with gender frequency distribution

	Sex	Number	% of total
No	Male	4610	30.2
	Female	4130	27.1
Yes	Male	3003	19.7
	Female	3511	23.0
Total	Male	7613	49.9
	Female	7641	50.1

Table 3. Class in society with gender frequency distribution

	Sex	Number	% of total
Rich	Male	316	2.1
	Female	334	2.2
Middle	Male	5297	35.7
	Female	4908	33.1
Poor	Male	1809	12.2
	Female	2184	14.7
Total	Male	7422	50
	Female	7426	50.0

Table 4. Diastolic Blood Pressure (DBP) with gender frequency distribution

DBP	Sex	Number	% of total
<70	Male	1054	6.9
	Female	904	5.9
70-90	Male	5516	36.2
	Female	5681	37.3
>90	Male	1034	6.8
	Female	1043	6.8
Total	Male	7604	49.9
	Female	7628	50.1

Table 5. Systolic Blood Pressure (SBP) with gender frequency distribution

SBP	Sex	Number	% of total
<120	Male	5132	33.7
	Female	5082	33.4
120-140	Male	2028	13.3
	Female	2024	13.3
>140	Male	438	2.9
	Female	525	3.4
Total	Male	7598	49.9
	Female	7631	50.1

Table 6. Body Mass Index (BMI) with gender frequency distribution

BMI	Sex	Number	% of total
<18.5	Male	526	3.5
	Female	461	3.1
18.5-24.99	Male	4273	28.5
	Female	3290	21.9
25-29.99	Male	2232	14.9
	Female	2759	18.4
30 and above	Male	441	2.9
	Female	1028	6.8
Total	Male	7472	49.8
	Female	7538	50.2

Table 7. Frequency distribution with location and age range with gender

			Sex	Number	% of total
Rural	Age	<31 years	Male	402	3.3
			Female	711	5.8
		31-50 years	Male	3585	29.2
			Female	3682	30.0
		>50 years	Male	2291	18.7
			Female	1603	13.1
Total			Male	6278	51.1
			Female	5996	48.9
Urban	Age	<31 years	Male	89	3.3
			Female	158	5.8
		31-50 years	Male	3585	29.2
			Female	3682	30.0
		>50 years	Male	2291	18.7
			Female	1603	13.1
Total			Male	6278	51.1
			Female	5996	48.9

Table 8. Age range with the gender frequency distribution

		Sex	Number	% of total
Age	<31 years	Male	510	3.3
		Female	911	6.0
	31-50 years	Male	4340	28.5
		Female	4747	31.2
	>50 years	Male	2752	18.1
		Female	1970	12.9
Total	Total	Male	7602	49.9
		Female	7628	50.1

Results from the analysis show that higher percentage (68.9%) of the diabetic patients has education levels less than SSC degree, where males were 24.1% and females were 37.8%. In this study, 68.8% of the total diabetic subjects (35.7% male, 33.1% female) were found to belong to the middle socioeconomic class; only 4.3% and 26.9% were found to belong to rich and poor socioeconomic class respectively. The highest prevalence of diabetes was observed significantly among the middle socioeconomic class and the lowest prevalence was observed significantly among the rich socioeconomic class respectively.

Increased prevalence of diabetes was observed with increased SBP. Medium DBP (70-90 mmHg) showed a significant association with diabetes. Higher percentage (59.7%) of Diabetic patients was observed in the age group of 31-50 years, where male was 28.5% and female was 31.2%.

Identifying Confounding variables:

Confounding is a bias introduced by the imbalanced distribution of extraneous risk factors among comparison groups. The issue of assessing confounding effects has been discussed in several papers [36-40]. It has been recognized that there are multiple risk factors for the disease of interest, type-2 diabetes. But typically we want to focus on the casual effect of only one factor ‘age ’; hereafter this factor is called the “exposure”. In this setting, other risk factors for the disease are considered only because they might be confounders- that have substantially changed the effect estimate- rather than being of direct interest. The goal is then to study the effect of the exposure on disease, ‘‘controlling’’ or ‘‘adjusting’’ for the others.

A stepwise variable selection approach using multiple regression analysis is used in following Table 9 for assessing the confounding variables. Because Regression models are a flexible way of investigating the separate or joint effects of several risk factors for disease or ill health. These factors may include exposures and confounders of the exposure-disease relationship. In general, a regression coefficient for a factor in a model estimates the effect of an increase of one unit in that factor; if all other factors in the model stay unchanged and assuming the model assumptions are correct.

For assessing the relationship between the exposure 'age' and diabetics, therefore, in model-1(Table 9) only age variable is considered as a covariate. Then to study this relationship, while allowing for the effects of physical activities, model-2 is considered.

FBG=a+b.age+r model-1

FBG=a+b.age+c.physical activities+r model- 2

Table 9 shows output of estimates of regression coefficient with p values from significance tests (5% and 10 % level of significance) from fitting model(1-15) to the data. In each test, the null hypothesis is that the true value of the coefficient is zero. If b were zero, then age would have no effect on FBG. Here, the test strongly suggests that b is positive i.e the unadjusted regression estimate in model-1(Table 9) indicates that there is a strong positive relationship between diabetes i.e fasting blood glucose level and age. It assumes that mean FBG increases by a fixed amount (estimated as 1.104 m in model-1) for every year of age. The term r is a random component assumed to vary from person to person. Inclusion of this term in the model allows for the fact that people of the same age are not all the same: their individual FBG values will vary about the mean for that age (model-1). Random variation is unpredictable but, overall, it can be described by a statistical distribution. With continuous variables such as FBG, the random component is often assumed to have a Normal distribution with a mean of zero.

The effect of age diabetes remains large and highly statistically significant, when the effect of physical activities is controlled for in model-2. Additionally controlling for housewife's occupation in model-3 has little influence on the strength of the relationship between age and diabetes. Up to the model-6, when family past history, SBP, and DPB are additionally controlled, the relationship of age and diabetes remains statistically significant. Therefore, it is worth to mention that after observing all models in table-9, models 1 to 6 showed significant association with type-2 diabetics and age considering physical activities, occupation, family past history, SBP, and DPB as confounders of the relationship. Interestingly, from model-7 to model-15, result showed a negative relationship of age with type-2 diabetics but it is insignificant.

Table 9. Multiple regression: risk factors were selected stepwise in different models taking type 2 diabetes as a dependent variable

Risk factors	Model 1	Model 2	Model3	Model4	Model5
Age (<31 years †) 31-50 years >50 years	1.104 (.165) * 1.405(.175) *	.94(.174) * 1.21(.184) *	.623(.200) * .968(.212) *	.615(.200) * .983(.212) *	.596(.201) * .952(.213) *
Physical activities ‡ (60-120 min †) <60min		-.085(.174)	-.101(.198)	-.097(.198)	-.094(.198)
>120 min		-0.587(.614)	-1.40(.75) **	-1.35(.75) **	-1.35(.75) **
Occupation (Housewife †) Employed			-.313(.110) *	-.332(.110) *	-.336(.110) *
Unemployed/Pensioner			.472(.196) *	.408(.197) *	.399(.197) *
Family past history (no †) Yes				-.565(103) *	-.560(.103) *
SBP (<120 †) 120- 140					-.256(.119) *
>140					.030(.212)

Table 9. continued

Risk factors	Model 6	Model 7	Model 8	Model 9	Model 10
Age(<31years †) 31-50 years	.558(.20) *	.245(.199)	.245(.199)	.251(.200)	.228(.235)
50 years	.937(.21) *	.645(.21) *	.631(.212) *	.654(.213) *	.575(.259) *
Physical activities ‡ (60-120 min †) <60min	-.136(.198)	-.118(.195)	-.125(.195)	-.139(.196)	-.217(.272)
>120 min	1.25(.75) **	1.012(.765)	1.018(.764)	.987(.764)	1.953(1.50)
Occupation(Housewife †) Employed	-.341(.11) *	-.461(.109) *	-.291(.220)	-.283(.221)	-.051(.237)
Unemployed/Pensioner	0.37(.02) **	-.154(.197)	.017(.269)	.025(.270)	-.101(.446)
Family past history (no †) Yes	-.54(.103) *	-.266(.10) *	-.269(.103) *	-.269(.103) *	-.323(.124) *
SBP (<120 †) 120- 140	-.070(.128)	.074(.126)	.074(.126)	.082(.126)	.026(.149)
>140	.366(.243)	.371(.240)	.328(.240)	.320(.240)	.557(.280) *
DBP(70-90 †) <70(DBP)	.648(.167) *	.39(.167) *	.400(.166) *	.423(.167) *	.613(.235) *
>90(DBP)	-.352(.17) *	-.130(.171)	-.114(.171)	-.111(.171)	-.237(.209)
BMI(18.5-24 †) <18.5		-3.72(.23) *	-3.669(.23) *	-3.703(.23) *	-3.65(.296) *
24-30		1.195(.11) *	1.200(.11) *	1.198(.11) *	1.26(.137) *
30 +		-1.25(.18) *	-1.266(.18) *	-1.275(.18) *	-1.65(.19) **
Sex (Male †) Female			.199(.219)	.205(.220)	.114(.312)
Family member(1-4 †) 4 +				-.088(.102)	.154(.134)
number of children(1-2 †) 2 +					-.338(.151) *

Table 9. continued

Risk factors	Model11	Model12	Model13	Model14	Model15
Age (<31 years †) 31-50 years	-.281(.239)	-.346(.254)	-.393(.259)	-.279(.26)	-.335(.262)
>50 years	.597(.267) *	.66(.282) *	.709(.29) *	.53(.289) **	.633(.291) *
Physical activities ‡ (60-120 min †) <60min	-.223(.278)	-.020(.311)	.008(.313)	.121(.315)	.188(.316)
>120 min	-.88(.1.685)	-.67(1.689)	-1.36(1.818)	-1.75(1.813)	-1.75(1.811)
Occupation(HW †) Employed	-.042(.246)	.032(.260)	.020(.265)	.047(.265)	.290(.280)
Unemployed/Pensioner	-.087(.468)	-.014(.474)	.078(.482)	-.157(.265)	-.039(.486)
Family past history (no †) Yes	-.33(.128) *	-.298(.14) *	-.24(.137) **	-.184(.139)	-.107(.140)
SBP (<120 †) 120- 140 (SBP)	-.021(.155)	-.024(.160)	.055(.163)	.023(.164)	.052(.164)
>140 (SBP)	0.555(.29) **	.508(.30) **	.620(.307) *	.547(.309) *	.591(.309) **
DBP(70-90 †) <70(DBP)	.614(.247) *	.51(.275) **	.607(.281) *	.539(.282) **	.559(.282) *
>90(DBP)	-.179(.216)	-.095(.224)	-.144(.228)	-.164(.230)	-.168(.230)
BMI(18.5-24 †) <18.5	-3.898(.31) *	-3.97(.32) *	-4.02(.325) *	-3.685(.33) *	-3.726(.33) *
24-30	1.282(.14) *	1.21(.148) *	1.25(.15) *	1.15(.15) *	1.128(.15) *
30 +	-1.64(.195) *	-1.60(.21) *	-1.58(.209) *	-1.43(.212) *	-1.41(.212) *
Sex (Male †) Female	.119(.321)	.160(.341)	.288(.349)	.246(.153)	.232(.350)
Family member(1-4 †) 4 +	.145(.139)	.105(.144)	.098(.146)	.060(.147)	.088(.148)
number of children(1-2 †) 2 +	-.33(.16) *	-.34(.16) *	-.318(.165) *	-.305(.166) **	-.214(.168)
Matital status(married †) Unmarried	.346(.906)	.745(.990)	.642(1.015)	.958(1.013)	1.074(1.012)
Smoking status (No †) Yes		.127(.381)	-.007(.387)	-.101(.389)	-.113(.389)
Area(Rural †) Urban			32(.18) *	.150(.188)	.037(.191)
Socioeconomic Status(Poor †) Rich				-.864(.35) *	-.62(.36) **
Middle				-1.15(.16) *	-1.017(.17) *
Education(<SSCdegre †) HSC					-.56(.194) *
Graduate/higher					-.764(.30) *

† Reference category, ‡ physical activities are equivalent to walking "X" min/24 h (excluded from models 1), * 5% level of significance, ** 10% level of significance

4. Discussion

Table 1 shows the frequency of education level with gender. Higher percentage (68.9%) of the diabetic patients has education levels less than SSC degree, where males were 24.1% and females were 37.8%. About 23% (14.4% male, 8.6% female) and 15.1% (11.5% male, 3.6% female) diabetic patient were found to have an educational level of SSS/HSC/equivalent and graduate/higher studies respectively.

Table 2 shows a comparison between positive and negative family history of the diabetics. Out of 15254 subjects, (42.7%) were found to have a positive family history of diabetes, of which 19.7% was male and 23% was female. It was also found from the studies that subjects (57.3%) have negative family history of diabetes, of which 30.2% was male and 27.1% was female.

Table 3 depicts the distribution of subjects by socioeconomic class. In this study, 68.8% of the total diabetic subjects (35.7% male, 33.1% female) were found to belong to the middle socioeconomic class; only 4.3% and 26.9% were found to belong to rich and poor socioeconomic class respectively. The highest prevalence of diabetes was observed among the middle socioeconomic class and the lowest prevalence was observed among the rich socioeconomic class respectively.

Table 4 shows the distribution by diastolic blood pressure (DBP) with gender frequency distribution. Table 5 shows the distribution of subject by systolic blood pressure (SBP). Both diastolic blood pressure (DBP) and systolic blood pressure (SBP) were investigated for their association with diabetes. Increased prevalence of diabetes was observed with increased SBP. Medium DBP (70-90 mmHg) showed a significant association with diabetes, the percentage being which was found 73.5% (where 36.2% male, 37.3% female) whereas the percentages were found to be 12.8% and 13.6% for the group of <70 mmHg and >90 mmHg respectively. On the other hand, a comparison between groups of SBP <120 mmHg, 120-140 mmHg and >140 mmHg, showed a higher prevalence in the group <120 mmHg (67.1%), as compared to the groups of >140 mmHg (6.3%) and 120-140 mmHg (26.6%).

Table 6 shows the distribution subjects by index (BMI). In the subjects under study 50.4% (male 28.5%, female 21.9%) diabetics had BMI 18.5-24.9, whereas 6.6% diabetics had BMI <18.5, 33.3% had BMI 25-29.99 and 9.7% had BMI >30.

Table 7 represents the percentage distribution of diabetic patients by living area. Diabetes was found higher (59.2%) in both urban and rural populations for age ranges 31-50 years. There were very few diabetic patients (9.2%) in the age range <31 years, having 3.3% male and 5.8% female population.

Table 8 shows the age range with the gender frequency distribution. Higher percentage (59.7%) of Diabetic patients was observed in the age group of 31-50 years, where male was 28.5% and female was 31.2%. About 31.0% (18.1% male, female 12.9%) and 9.3% (male 3.3%, female 6.0%) diabetics were found in the age group of >50 years and <31 years respectively.

The result of association between type 2 diabetes among some selected socio-economic, demographic, and health consciousness related characteristics of diabetic patients have been demonstrated in Table 9. Table 9 reveals the fifteen numbers of models created by controlling one by one factors to get the idea about confounding. In model-1(Table -9) it was found that the type-2 diabetic patients are significantly belonged in the middle (31-50 years) and older age group (>50 years). It was also observed in other studies that prevalence of diabetes was associated with increasing age [35].From the Table 9 in model -3, it is also found that age, controlling physical activities and occupation of the respondents, is significantly associated with the type 2 diabetes of diabetic patients. So, here occupation has been revealed as a confounding. Not only that, physical activities more than 120 minutes is also significantly associated with type-2 diabetes. It was identified that unemployed/pensioner and past family history are significantly associated with an increase in diabetes. Interestingly, from model-10 to model-14, more than two numbers of children showed a negative relationship with type-2 diabetics.

After observing all models in Table 9, sex, marital status, number of family members, smoking status was not found significant association with type-2 diabetics for none of the models. In addition, occupation, family past history, physical activities, SBP, and DBP can be considered as potential confounders because these factors confounded the effect of the strength of the relationship between diabetes and age.

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