Research Article

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Diabetes in a disaster prone coastal population of Bangladesh

Abstract

Background and aims: A substantial number of studies estimated the prevalence of diabetes in different ethnic groups and geographical sites in Bangladesh. There was no such report on the coastal population. This study addressed the prevalence of diabetes and to determine the diabetes related risks among the coastal people.

Methods: This study was conducted in six coastal districts (Barisal, Borguna, Vola, Pirojpur, Potuakhali and Jhalukathi) at 32 different coastal communities. All people over 18y were considered eligible. Social, clinical and family history was taken. Heights, weight, waist- and hip-girth were measured. Resting blood pressure was recorded. Fasting blood glucose and lipids were assessed.

Results: The crude prevalence of T2DM of both sexes was 8.8% (95% CI, 8.15–9.45) and IFG was 10.0% (95% CI 9.31–10.69). Compared with the poor the middle (OR=1.36, CI, 1.18–1.57) and the rich classes (OR=1.80, CI, 1.50–2.16) had excess risk for diabetes. The participants with known family history of diabetes had higher risk (OR=2.90, CI, 2.54–3.31) than those with negative or unknown history. Based on logistic regressions of different models, irrespective of sex, higher social class of known diabetic family and higher quartiles of age, BMI, WHR and WHtR were proved to be the independent risk factors for diabetes.

Conclusions: The coastal population showed higher prevalence than the Bangladeshi rural and indigenous people. The rich social class, family history of diabetes and advancing age were the independent risk factors for developing diabetes. Both general and central obesity were found to have equal risk. Further study may be undertaken to confirm our study findings and to determine other unexplored risks like less physical activities, unhealthy dietary habit or psychosocial stress rendering the coastal people more susceptible to metabolic disorder and diabetes.

Keywords: coastal population, diabetes prevalence, risk factors

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Abbreviations: BADAS, bangladesh diabetes samity; BMI, body mass index; BP, blood pressure; DBP, diastolic blood pressure; IFG, impaired fasting glucose; NFG, normal fasting glucose; SBP, systolic blood pressure; T2DM, type2 diabetes mellitus; SD, standard deviation; UC, union council; WHO, world health organization; WHR, waist to hip ratio; WHTR, waist to height ratio; CI, confidence interval

Introduction

Of the highly alarming trend of non-communicable diseases (NCD), type 2 diabetes mellitus (T2DM) is common throughout the world and particularly in the south-east Asian region.[1] In the year 2000, 171million were estimated having diabetes. This number is increasing and projected to 366million by 2030. It is also estimated that most significant increase will occur in developing countries.[1] T2DM affects elderly people in the developed countries, whereas, in the developing and least developing countries, more and more younger people are affected.[2] In Bangladesh also we have the same experience.[3] Rising prevalence of T2DM has been found in the native population of both rural and urban areas.[4–7] There were studies conducted to assess diabetes prevalence in the indigenous people[8,9] and in the childhood population.[10] Interestingly, there was no study in the coastal area though Bangladesh has a large population in coastal area encircled by the Bay of Bengal. These people maintain their livelihood on fishing and agriculture facing disaster like cyclone, tidal waves and floods causing hundreds of deaths and injuries several times a year. Their farming land remained inundated by saline water for weeks or even months rendering them a difficult living environment. Considering the hard and strange lifestyle of a vast coastal population this study was undertaken to determine the prevalence of diabetes and the risks related to diabetes.

Subjects and methods

The study protocol was submitted to and approved by the Ethical Review Committee of the Bangladesh Diabetes Association (BADAS). The study was conducted at 32 different geographical sites in different coastal communities in coastal districts of Barisal, Borguna, Vola, Pirojpur, Potuakhali and Jhalukathi.[10] The community participation was made possible by involving the elected members of the local government body of Union Councils (UC) and social and religious leaders. The teachers and students of sixteen secondary schools, five primary schools, five Madrasahs (religious schools) volunteered. In addition, four UCs and two colleges took part in the study. The study began discussing local leaders, the teachers and the students about the proposed study. They were informed about the objectives and the procedural details of the investigations. They helped preparing the list of the eligible (=>18y) participants. Informed consent was taken from those who agreed to participate. They were advised to attend a specified venue in the next morning with an overnight fast. According to the list each participant was interviewed about occupation, education, income, illness (present or past), medication and family-history of diabetes, hypertension (HTN), stroke and coronary heart diseases (CHD).

Measurements of height, weight, and waist- and hip-girth were taken with light clothes and without shoes. The weighing tools were calibrated daily by known standard weight. Blood pressure was taken after 10min rest with standard cuffs, fitted with mercury sphygmomanometer. Taking an aseptic measure five ml of fasting blood sample was collected for estimation of fasting blood glucose (FBG mmol/l) and lipids (mg/dl), total cholesterol [t-chol], triglycerides [TG], low-density lipoprotein [LDL], high-density lipoproteins [HDL]. These collected samples were transported in an iced box and refrigerated. Finally, biochemical tests were carried out in BIRDEM central Lab. Plasma glucose was measured by glucose oxidase-peroxidase method using Technicon M-II auto-analyzer. To reduce the cost, a randomized sample was drawn (n=225) for the estimation of Chol, TG and HDL by auto-analyzer (Hitachi-704) using enzymatic method. The coefficient of variation (CV) was allowed ≤5%. We used WHO diagnostic criteria (1999) for IFG and T2DM.[11] The cut-offs of NFG, IFG and T2DM diabetes were taken <5.6, 5.6–6.9 and ≥7.0mmol/l, respectively. We categorized hyperglycemia as abnormal fasting glucose (AFG=IFG+T2DM)) when fasting blood glucose level exceeded 5.6mmol/l. Body mass index was calculated (BMI=weight in kg/height in met sq). Waist-to-hip (WHR) and waist-to-height (WHtR) ratios were measured for the assessment of central obesity.

Statistical analyses

The comparisons of characteristics (mean with standard deviation) were shown between men and women; and between subjects with and without hyperglycemia (AFG). The prevalence rates according to sex, social class and family history were given in percentages with 95% confidence interval (95% CI). The *Chi-sq* test estimated the association of AFG with age, sex, social class and obesity. Logistic regression estimated the effect of risk factors (sex, age, social class, BMI, WHR and WHtR) in different models with different combinations taking AFG as a dependent variable. Family history of diabetes was also included in the models. The quantitative variables (age, BMI, WHR, WHtR) were transformed into quartiles (Q1, Q2, Q3, Q4) and entered in the regression analyses where the Q1 was taken as a reference category. All statistical tests were considered significant at a level of ≤5%. SPSS version 20.0 was used.

Results

A total of 8500 were enlisted. Of them, 7096 (m/f =2650/4446) participated in the study. The response rate was 83.4%. The comparisons of biophysical characteristics between men and women were shown in Table 1. The men had significantly higher height, weight, waist-girth, WHR, SBP, DBP, FBG (for all p<0.001) and TG (p=0.02); whereas, the women had significantly higher BMI (p<0.001), T-Chol (p=0.02), HDL (p=0.01) and LDL (p=0.003). Again, these characteristics were compared between subjects with FBG <5.6 (NFG) and FBG ≥5.6mmol/l (AFG) in Table 2. The AFG group had significantly higher age, BMI, WHR, WHtR, SBP, DBP and FBG (for all p<0.001); whereas, there was no significant difference in lipid variables though LDL was found significantly higher in the NFG group (p<0.05). The prevalence rates [with 95%CI] of T2DM and IFG are shown according to sex, social class and family history of diabetes (Table 3). The crude prevalence of T2DM both sexes was 8.8% [8.15-9.45]. For the males, it was 11.3% [9.92-12.28] and for the females it was 7.4% [6.64-8.16]. The prevalence of IFG of both sexes was 10.0%[9.31-10.69]. The prevalence of IFG in males was 11.2%[10.01-12.39] and that of females was 9.3%[8.46-10.14].

Thus, the prevalence of abnormal fasting glucose (AFG=T2DM+IFG: FBG>5.6mmol/l) was 19.1%(95% CI 18.17 -20.03). The prevalence of AFG in male participants was 22.7%[21.07-24.33] and in female was 16.9%[15.78–18.02] (not shown in the table). Compared with female participants the males had significantly higher prevalence of IFG, T2DM and also AFG. Regarding social class, significantly higher prevalence was found in the middle and in the rich than in the non-affluent class (chi-sq=53, p<0.001) (Table 3). The prevalence of both IFG and T2DM was found increasing with increasing quartiles (quartile 1 through quartile 4: for all, p<0.001) of age, BMI, WHR and WHtR (Figure 1). Binary Logistic Regression estimated the individual risk (age, sex, social class, BMI, WHR, WHtR) contributing to develop abnormal fasting glucose (AFG), which was taken as a dependent variable (Table 4). Different risk factors as independent variables were entered in different models (Table 4: model 1 to 4). Three risk variables (sex, family history and social class) were entered in the regression-equation in model-1. The quartiles of age, BMI and WHtR were entered in the subsequent models: age in model-2, BMI in model-3, WHtR in model-4).

Table1 Comparison of biophysical characteristics between male (n=2650) and female (n=4446) participants

Variables	Men		Women		p‡
	Mean	SD†	Mean	SD	
Age(y)	48.2	16.2	41.1	13.8	<0.001
Height(cm)	162.7	6.9	150.9	6.19	<0.001
Weight(kg)	58.3	10.8	51.7	10.5	<0.001
Waist(cm)	75.2	10.6	73.6	10.5	<0.001
Hip(cm)	83.6	7.9	85.8	8.5	<0.001
Body mass index (BMI)	22	3.6	22.6	4.1	<0.001
Waist-to-hip ratio(WHR)	0.898	0.076	0.857	0.078	<0.001
Waist-to-height ratio(WHtR)	0.463	0.065	0.488	0.071	<0.001
Systolic BP(mmHg)	121.4	20.8	117.3	21.3	<0.001
Diastolic BP(mmHg)	78.8	11.7	76.8	11.7	<0.001
Fasting blood glucose (mmol/L)	5.4	2.2	5.2	1.8	<0.001
CHO.(mg/dl)	197	58.7	216.1	65.6	0.024
TG*(mg/dl)	178.6	125.9	146.6	74.7	0.02
HDL*(mg/dl)	42.2	10	45.9	11.4	0.01
LDL*(mg/dl)	119.1	47	140.8	59.7	0.003

*For cholesterol, Tg, HDL and LDL a randomized sample of 102 male and 122 female participants

†SD, standard deviation

‡ P, after unpaired t-test

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Considering the four models taking different combination of risk factors it was revealed that the male participants with family history of diabetes had excess risk for AFG. Higher social class (upper middle and rich) had significant risk as compared with the poor class. Higher quintiles of age, BMI and WHtR were also proved to have excess risk. Finally, when all the risk factors were entered in Model-4, the estimated risk (OR, 95% CI) for men (OR 1.29, 1.12–1.49), diabetic family (OR 2.76, 2.40–3.16), higher social class (OR 1.34, 1.10–1.63), advanced age of quartile-4 (OR 3.67, 2.92–4.60), highest quartile (model-3) of BMI (OR 2.57, 2.08–3.17) and highest quartile of WHtR (OR 2.98, 2.40–3.69) were proved significant.

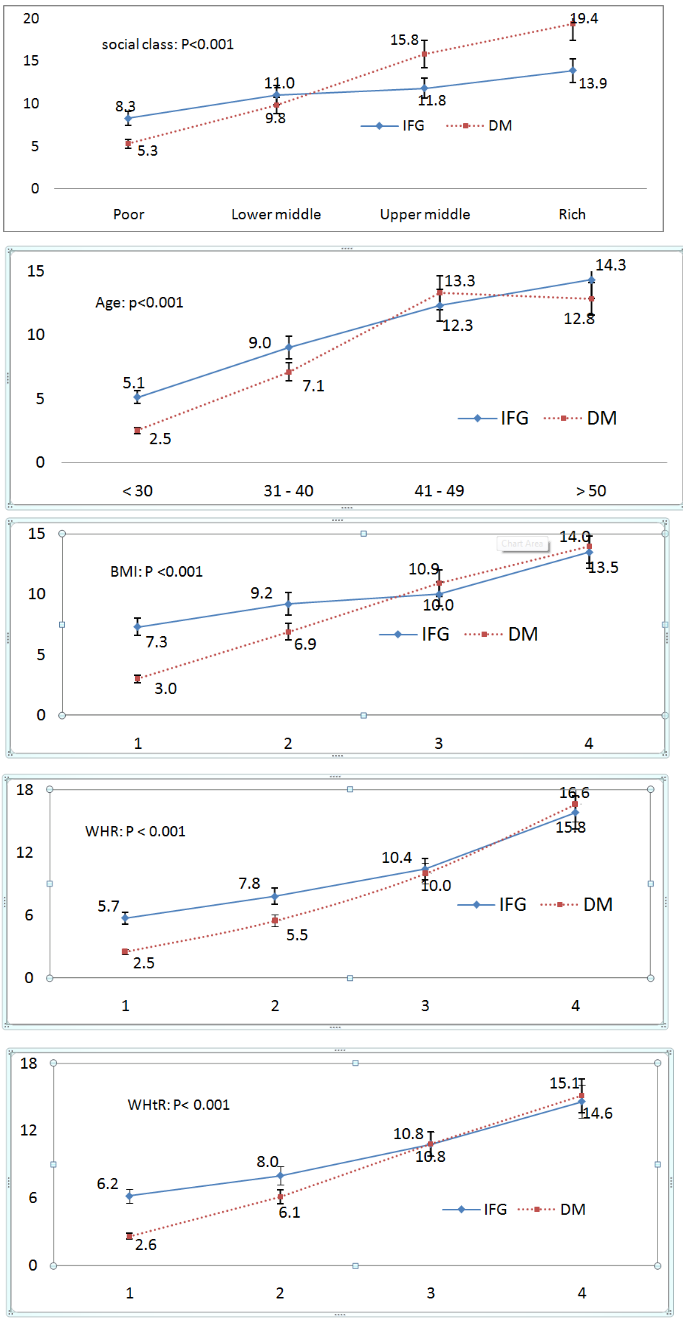

Figure1 Prevalence (%) with 95% CI of IFG and DM according to social class; and quartiles of age, BMI, WHR and WHtR. The X axis: 1 to 4 indicates Quartiles of BMI, WHR and WHtR. The Y axis indicates prevalence rate in percentages.

Table 2 Comparison of characteristics between subjects with normal fasting glucose (NFG: FBG<5.6 mmol/l, n=5840) and with abnormal fasting glucose (AFG: FBG =>5.6 mmol/l, n=965)

Variables	NFG: FBG<5.6mmol/l		AFG: FBG>=5.6mmol/l		p‡
	Mean	SD†	Mean	SD	
Age(y)	42.9	15.2	49.6	13.3	<0.001
Body mass index	22.1	3.9	23.7	3.9	<0.001
Waist-to-hip ratio	0.87	0.08	0.92	0.08	<0.001
Waist-to-height ratio	0.47	0.07	0.51	0.07	<0.001
Systolic B (mmHg)	117	21	128	21	<0.001
Diastolic BP(mmHg)	77	11	81	11	<0.001
Fasting blood glucose(mmol/L)	4.6	0.5	9.1	3.6	<0.001
CHOL*(mg/dl)	219	59	202	64	ns
TG*(mg/dl)	147	75	167	111	Ns
HDL*(mg/dl)	44	9	44	11	ns
LDL*(mg/dl)	146	60	124	52	<0.05

*--Randomized sample, 62 in the NFG and 160 in the AFG group

†SD, standard deviation

‡ P, after unpaired t-test

Table 3 Prevalence (%) with 95% confidence interval (CI) of IFG and DM by sex and social class.

Characteristics	n	IFG%(95% CI)	DM%(95% CI)
Sex			
Both	7265	10(9.31 - 10.69)	8.8(8.15 - 9.45)
Male	2702	11.2(10.01 - 12.39)	11.1(9.92 - 12.28)
Female	4563	9.3(8.46 - 10.14)	7.4(6.64 - 8.16)
Social class			
Poor	3103	8.3(7.33 - 9.27)	5.3(4.51 - 6.09)
Lower middle	2902	11(9.86 - 12.14)	9.8(8.72 - 10.88)
Upper middle +Rich†	1055	11.8(9.85 - 13.75)	15.8(13.6 - 18.0)
Family history of DM			
No or not known	5450	9.2(8.43 - 9.97)	4.7(4.14 - 5.26)
Yes	1818	12.6(11.07 - 14.13)	21 (19.13 - 22.87)

Parenthesis indicates 95% CI. The male participants had significantly higher prevalence of IFG and DM (for all p<0.001)

†Number of Rich was very few (n=36) and merged with upper middle class. The middle and rich class had significantly higher hyperglycemia than that of non-affluent class (p<0.001). The participants who confirmed diabetes among the first degree relatives had significantly higher prevalence of both IFG and DM than those who had no such family history

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Table 4 The risk variables in different models in the binary logistic regression taking hyperglycemia (AFG: FBG>5.6mmol/l) as a dependent variable

Risk Factors	Model-1		Model-2		Model-3		Model-4	
	OR	95% CI‡	OR	95% CI	OR	95% CI	OR	95% CI
Sex	1.3	1.14-1.47	1.04	0.90-1.19	1.13	0.98-1.30	1.29	1.12-1.49
F=1, M=2								
FHDM†	2.9	2.54-3.30	2.01	2.54-3.33	2.71	2.36-3.11	2.76	2.40-3.16
No=1, yes=2								
Social class*								
I	1	-	1	-	1	-	1	-
II	1.32	1.11-1.57	1.26	1.06-1.50	1.27	1.09-1.48	1.06	0.89-1.27
III	1.8	1.50-2.17	1.84	1.53-2.22	1.39	1.14-1.69	1.34	1.10-1.63
Age								
Quartile 1			1	-	1	-	1	-
Quartile 2			1.18	1.00-1.39	1.29	1.10-1.52	1.19	1.01-1.41
Quartile 3			2.04	1.70-2.45	2.28	1.89-2.76	1.99	1.65-2.39
Quartile 4			4.5	3.60-5.61	4.68	3.74-5.85	3.67	2.92-4.60
BMI								
Quartile 1					1	-		
Quartile 2					1.46	1.23-1.73		
Quartile 3					1.69	1.41-2.03		
Quartile 4					2.57	2.08-3.17		
WHtR								
Quartile 1							1	-
Quartile 2							1.42	1.21-1.68
Quartile 3							2.07	1.72-2.49
Quartile 4							2.98	2.40-3.69

‡CI, confidence interval; †FHDM, family history of diabetes

*Social class, I- poor, II-middle class, III-middle+rich; Number of Rich was very few (n=36) and merged with upper middle class

Discussion

This epidemiologic study on diabetes in a coastal area is the first of its kind in Bangladesh and unique in the sense that it was conducted in a large population widely spread over 32 communities at different geographical sites in six districts. These areas are separated by estuaries and not easily accessible. The investigation team had to face endangered boat travel from one place to the other. Sometimes, they had to postpone programmed travel because of adverse weather condition. However, the coastal people were cooperative and did extend their help in all respects. The UC members, the social and the religious leaders, the school authorities, the teachers and the students volunteered actively in disseminating information of the diabetes screening and making the lists of participants. Additionally, they helped organizing the reception and maintaining discipline of the participants while arrived at venue in the morning.

Despite a remotest area inhabited by rural and coastal people the response rate was satisfactory (83.4%). The prevalence of diabetes (8.8%) in the coastal population is higher than that of rural native (~5%) and rural indigenous (6.6%) but lower than urban (11.2%) population.[5,6,8,9] The prevalence of IFG simulates the diabetes prevalence. For comparison, there are few studies on the diabetes prevalence among the coastal people. The prevalence of diabetes in coastal people was reported 16% in Karnataka and 11.5% in Fujian,[13,14] higher than this study. In China, it was reported that both awareness and the prevalence were higher in the coastal province than in the interior.[14] We had no assessment of awareness so it could not be compared. Obviously, these studies indicate that the coastal people are more prone to develop diabetes or AFG irrespective of ethnic origin or geographical site or economic status. It is not clear why these coastal populations have greater risk. Possibly, these people are chronically exposed to disastrous and hostile natural environment like cyclone and other tropical storm, which lead to psycho-social stress and AFG, eventually leading to T2DM. Life style (physical activities, dietary habit) might have some contribution, which we could not investigate. The family history of diabetes was found to be an independent risk factor in Chinese coastal people,[14] which is very much consistent with this study. As regards other risk factors like age, sex, social class, obesity (BMI, WHR, WHtR) are significantly related to diabetes, which are consistent with the past studies in Bangladesh.[6,8,10] However, in this study, higher BMI, WHR and WHtR were proved to have equal risk for diabetes. In contrast, our previous studies showed that only higher WHR and WHtR (and not higher BMI) was found to be associated with diabetes.[6,15] It may be noted that BMI is the measure of general obesity; whereas, WHR and WHtR are the measures of central obesity. Most of the studies showed that central obesity was found related to diabetes and insulin resistance.[16] In this study, both general obesity and central obesity showed equal risk though WHtR was proved to be the most important predictor for diabetes.

Conclusions

The study concludes that the prevalence of diabetes in the coastal population is higher than that of the rural and indigenous people. Higher social class, family history of diabetes and advancing age were the independent risk factors for diabetes. Both general and central obesity were proved to be important risk factors for diabetes. Further study may be undertaken to confirm these findings and to determine other unexplored risks like physical activities, dietary habit or psychosocial stress which might have influenced the coastal people to develop diabetes.

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Conflict of interest

Author declares that there is no conflict of interest.

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