Diabetic retinopathy and visual impairment in disaster prone coastal population of Bangladesh

**M. Abu Sayeed[1], AH Syedur Rahman[2], Md. Hazrat Ali[2],
Mir Masudur Rhaman[1], J Ashraful Haq[1] and Akhter Banu[3]**

[1]Department of Community Medicine, Ibrahim Medical College (IMC), Dhaka; [2]Department of Ophthalmology, Bangladesh Institute of Research and Rehabilitation in Diabetes and Endocrine Metabolic Disorders (BIRDEM); [3]Institute of Nutrition and Food Science (INFS), University of Dhaka

Abstract

Background and objective – Disaster prone coastal population has least accessibility to health care and very little is known about the prevalence of diabetes, diabetic retinopathy (DR) and visual impairment. This study addressed the prevalence of visual impairment and DR and risk factors related to DR among population residing in disaster prone areas of Bangladesh.

Methods: Thirty-two coastal communities in six coastal districts were purposively selected. All coastal people of age 18 years or more were considered eligible. Investigations included clinical history, anthropometry (height, weight, waist- and hip-girth), blood pressure and fasting blood glucose (FBG). The participants with hyperglycemia (FBG ≥ 5.6mmol/l) were undertaken for eye examination. Visual acuity was measured bilaterally using the Snellen chart. An Early treatment diabetic retinopathy study (ETDRS) cut out chart with E Optotypes was used.

Results: A total of 7567 participants volunteered and 1540 had hyperglycemia (FBG ≥ 5.6mmol/l). Of the hyperglycemic participants, 1214 (91.7%) participated for complete eye examination. Visual impairment of any type was found in 14.1%, any type cataract in 27.8% and any type DR in 18%. The participants of advancing age of higher social class and higher central obesity had excess risk for developing DR. The participants with known family history of diabetes also had greater risk. Compared with the group having FBG 5.6 – 6.9mmol/l those having FBG >6.9mmol/l had significant risk for DR (OR 3.11, 95%CI 2.04 – 4.76).

*Conclusion***:** The study concludes that visual impairment and cataract of any type is almost comparable with other coastal populations. The coastal people had higher prevalence of DR compared to rural population from other areas of Bangladesh and it was also higher than global estimate. The persons with higher age from higher social class with higher central obesity had excess risk for DR. The risk of DR increased with increasing hyperglycemia. Further study may be undertaken to confirm these findings.

Introduction

Of the alarming trend of non-communicable diseases (NCD), type 2 diabetes mellitus (T2DM) is common throughout the world and more alarming in the south-east Asian region [1]. A global estimate of diabetes in the year 2000 was 171 million. This figure is likely to be more than double (366 million) by 2030; and most significant

Address for Correspondence:
Prof. M. Abu Sayeed, Department of Community Medicine, Ibrahim Medical College, 122 Kazi Nazrul Islam Avenue, Shahbag, Dhaka-1000. email: sayeed@imc.ac.bd

increase will occur in the developing countries [1]. T2DM affects elderly people in the developed countries, whereas, in the developing and least developing countries, younger people are more affected [2]. We have the same experience in Bangladesh [3]. Additionally, the prevalence of micro-vascular complications is common in these populations [4-6]. Of the micro-vascular sequels, diabetic retinopathy (DR) was found to be the most disabling complications as it results into loss of vision. A community based study in Sri Lanka reported that more than one-fourth (27.4%) of the diabetic patients had DR [7]. This report indicates that the most diabetic people are prone to develop DR and eventually blindness. For Bangladesh, several population based studies reported the increasing trend of T2DM [8-10]; but there was no community based study on DR. This study addressed the prevalence and risk of DR at the community level in a disaster prone coastal population of Bangladesh.

Material and methods

The study protocol was approved by the Ethical Review Committee of the Diabetic Association of Bangladesh (BADAS).

Study area and population. A disaster prone population of coastal area was purposively selected. A total of 32 geographical sites [18 secondary schools, 5 primary schools, 5 Madrasahs (religious schools) including 4 Union Councils] were selected purposively in six coastal districts of Barisal, Borguna, Vola, Pirojpur, Potuakhali and Jhalokathi. The study areas were reported elsewhere [11] and is shown in Fig 1 and 2. The investigations at community level started on 17th September 2013 and ended on 12th May 2014. At the start, we made contact with the teachers and the students of the selected institutions. We discussed the proposed study with them informing the objectives and the investigation procedure in detail. All parents, guardians, neighbors and relatives of the students and teachers were invited to participate. All villagers of age 18 years or more were considered eligible. The students and teachers volunteered to inform the villagers about the study. Additionally, volunteers prepared the list of the interested participants. Informed consent was taken from each

participant and was advised to attend the investigation site in the next morning with an overnight fast the algorithm of the study is shown in Fig 3.
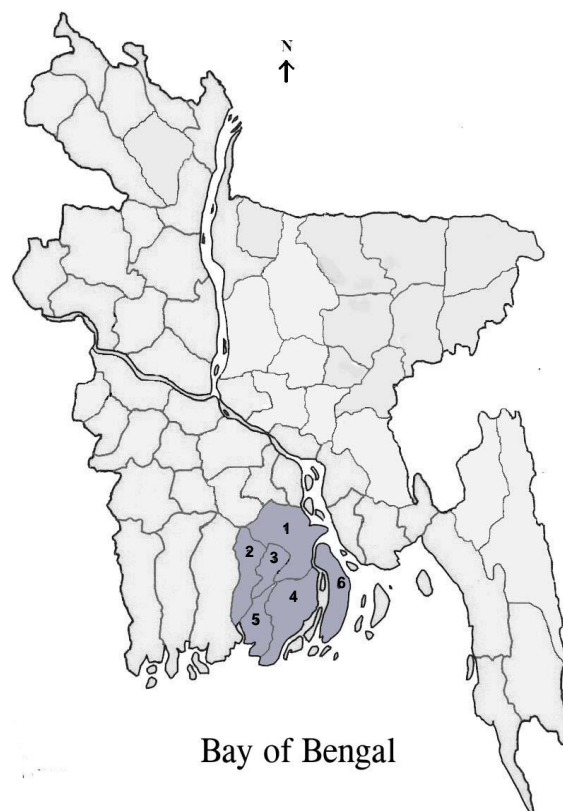

Fig.1: *Map of Bangladesh showing the location of six coastal districts included in the study [11]*
Note: *1–Barisal, 2–Pirojpur, 3–Jhalokhati, 4–Patuakhali, 5–Barguna, 6–Bhola*

Interviewing, measurement of anthropometry and blood pressure: In the morning, the participant was interviewed about occupation, education, income, illness (present or past) and medication. Interview on family-history included diabetes, hypertension (HTN), stroke, coronary heart diseases (CHD), peripheral vascular disease (PVD), foot-ulcer and leg amputation. The anthropometric measurements were height, weight, waist- and hip-girth. Body mass index (BMI = weight in kg / height in met sq.) and waist-to-hip ratio (WHR = waist / hip) were calculated. Blood pressure was measured after 10 min rest with standard cuff, fitted with mercury sphygmomanometer. A mean of the two measures was accepted.
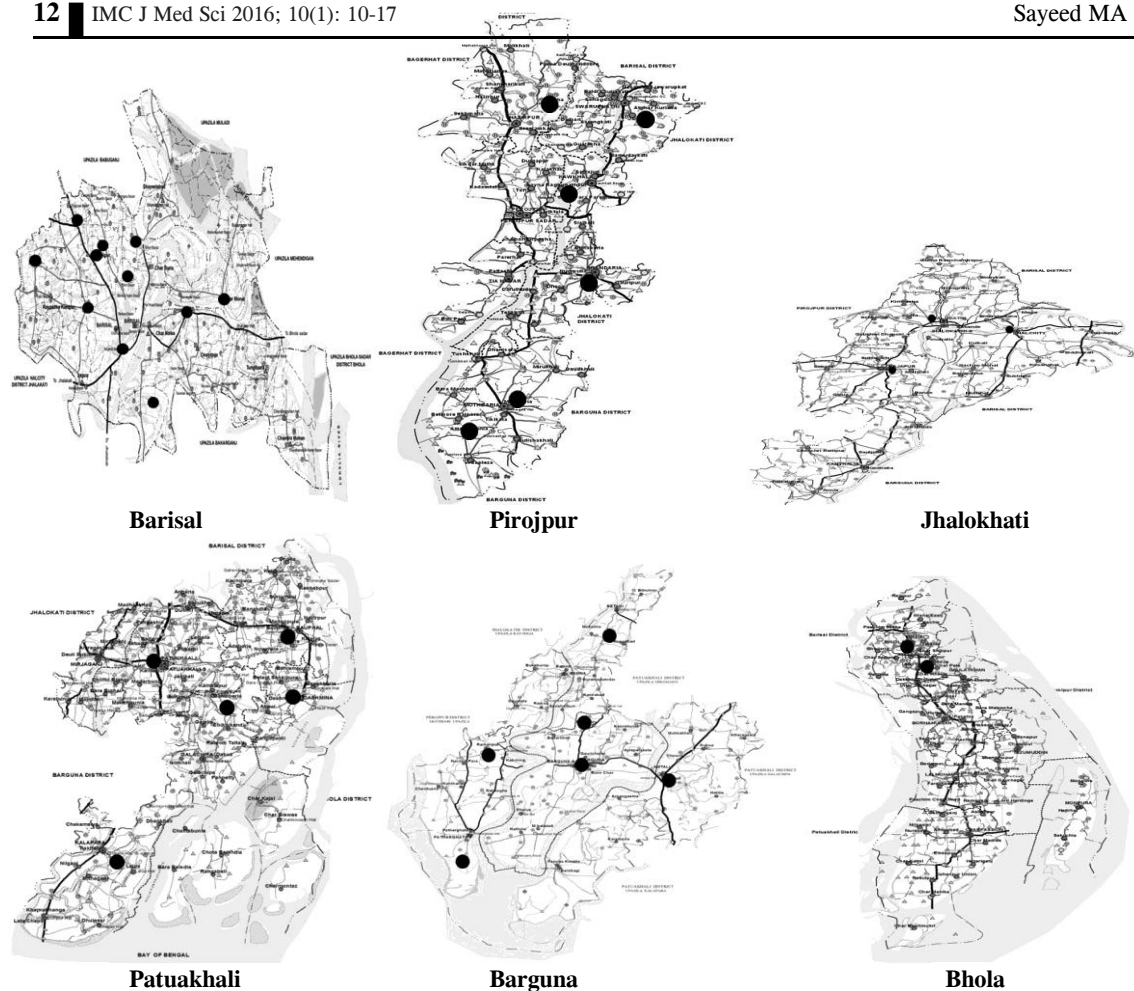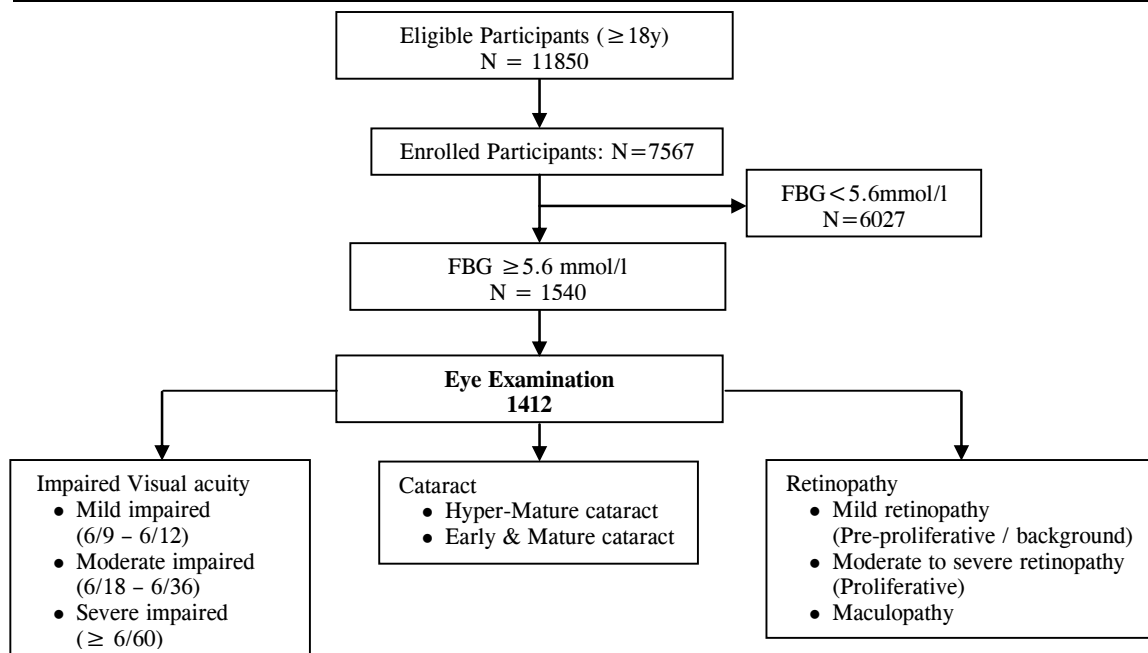
Fig.2: *Map showing the study sites in each coastal district. Each Dot (●) indicates location of study site [11]*

Collection of blood sample: Taking an aseptic measure five ml of fasting blood sample was collected for estimation of fasting blood glucose (FBG mmol/l) and lipids (total cholesterol [T-chol], triglycerides [TG], low-density lipoprotein [LDL] and high-density lipoproteins [HDL]). Finally, biochemical tests were carried out in BIRDEM laboratory. 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 T-chol, TG and HDL by auto-analyzer (Hitachi-704) using enzymatic method. The coefficient of variation (CV) was allowed ≤5%. While collecting blood sample a drop of blood was taken on a hemo-glucotest strip (*One Touch select sample, Lifescan*) for rapid

assessment of FBG [12]. We used ADA and WHO diagnostic criteria for hyperglycemia and predicting diabetes [13,14]. The participants, who showed FBG ≥5.6 mmol/l, were referred to ophthalmologist for eye examination (Fig 3). The participants presented with eye complaints, irrespective of glycemic status, were also referred.

Eye examinations: This included visual acuity test and fundoscopy by a two-member team of the ophthalmologists. Both ophthalmologists had the experience of eye examination in the department of ophthalmology at BIRDEM hospital. It may be noted that BIRDEM, a national referral center for endocrine disorders, where these ophthalmologists examine about 100 diabetic patients daily for the diagnosis of DR.

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┌─────────────────────────────┐
│ Eligible Participants (≥ 18y)│
│         N = 11850           │
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              │
              ▼
┌─────────────────────────────┐
│ Enrolled Participants: N=7567│
└─────────────────────────────┘
              │                    ┌──────────────────┐
              ├───────────────────▶│  FBG < 5.6mmol/l  │
              │                    │     N = 6027      │
              ▼                    └──────────────────┘
┌─────────────────────────────┐
│      FBG ≥ 5.6 mmol/l        │
│         N = 1540            │
└─────────────────────────────┘
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┌─────────────────────────────┐
│      Eye Examination        │
│           1412              │
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Impaired Visual acuity	Cataract	Retinopathy
• Mild impaired (6/9 – 6/12) • Moderate impaired (6/18 – 6/36) • Severe impaired (≥ 6/60)	• Hyper-Mature cataract • Early & Mature cataract	• Mild retinopathy (Pre-proliferative / background) • Moderate to severe retinopathy (Proliferative) • Maculopathy

Fig-3: *Algorithm of the study*

Visual acuity was measured bilaterally using the Snellen chart. An early treatment diabetic retinopathy study (ETDRS) cut out chart with E Optotypes was used [15]. Torch light and pinhole were also used [16]. The cause of visual impairment (cataract, refractive error and retinopathy) was identified [16, 17]. Then the pupil was dilated by using 1% Tropicamide and the fundus was examined with direct ophthalmoscope [18]. Diabetic retinopathy (DR) was diagnosed and classified according to classification of DR and diabetic macular edema [19]. The study findings on DR have been modified for easy presentation: (a) Pre-proliferative – microaneurysms with or without intraretinal hemorrhages; (b) proliferative – neovascularization with or without Vitreous/preretinal hemorrhage; (c) Diabetic macular edema (maculopathy) – any thickening or lipid exudates in the macula [20].

Statistical analyses

The prevalence rates of cataract, impaired visual acuity and diabetic retinopathy according to sex, family history and social class were given in percentages with 95% confidence interval (CI). The biophysical characteristics were shown in mean with standard deviation. We used unpaired t-test for comparison of characteristics between participants with and without retinopathy. For assessment of risk odds ratio (OR) with 95% CI were used. SPSS version 20 was used for all analyzing qualitative and quantitative data. Less than 0.05 was considered significant.

Results

According to eligibility criteria (age ≥ 18y), as mentioned above, a total of 11,850 were found eligible (Fig 3). Of them, 7567 (63.85%) took part in the investigation. The prevalence of hyperglycemia (FBG ≥ 5.6 mmol/l) was found in 1540 (20.4%). Of them, 1412 (91.7%) volunteered eye examination. The prevalence (with CI) of cataract, impaired visual acuity and diabetic retinopathy was 27.8 (25.57 – 30.23), 14.1 (12.28 – 15.92) and 17.9 (15.90 – 19.90), respectively (Table 1).

The prevalence of DR according to sex, social class and family history were shown in table 2. The prevalence of DR was significantly higher among those who had known diabetic member in their first degree relatives than those who had no known diabetic member in their families. Regarding social class, the affluent participants had

significantly higher DR than their non-affluent counterparts. Compared with the women the men had higher frequency though not significant.

Table-1: *Prevalence [% (95% CI*)] of cataract, impaired visual acuity and retinopathy (n=1412)*

Cataract	n	% (95% CI)
a. No Cataract	1018	72.1 (69.77–74.43)
b. Cataract		
Early + Mature	256	18.1 (16.1–20.1)
Hyper-mature	138	9.8 (8.25–11.25)
Total cataract	394	27.9 (25.57–30.23)
Visual acuity		
a. Normal (6/6)	1213	85.9 (84.08–87.32)
b. Impaired		
Mild (6/9-6/12)	103	7.3 (5.95–8.65)
Moderate (6/18-6/36)	53	3.8 (2.8–4.8)
Severe (=>6/60)	43	3.0 (2.1–3.9)
Total impaired	199	14.1 (12.28–15.92)
Diabetic Retinopathy		
a. Absent	1158	82.0 (84.0–82.0)
b. Present		
Mild (pre-proliferative / background)	170	12 (10.31–13.69)
Moderate to severe (proliferative)	44	3.1 (2.20–4.00)
Maculopathy (macular edema)	40	2.8 (1.94–3.66)
Total diabetic retinopathy	254	17.9 (15.90–19.90)

CI* - confidence interval

Table-2: *Prevalence [% (95% CI*)] of retinopathy according to sex, family history (n=1412) and social class (n=1377)*

Variables	n	% (95% CI*)
Sex		
(n: men/women= 585/827)		
Men	126	21.5 (17.67–24.83)
Women	128	15.5 (13.03–17.97)
Family history of diabetes		
(n: Absent/Present= 833/579)		
Absent (or not known)	113	13.6 (11.29–15.91)
Present	141	24.4 (20.91–27.89)
Social class		
(n: Non affluent/affluent= 480/897)		
Non affluent (poor)	63	13.1 (10.08–16.12)
Affluent (middle and rich)	184	20.5 (17.85–23.15)

CI* - confidence interval

Table-3: *Comparison of characteristics between participants with and without retinopathy*

Characteristics	No retinopathy n=617		Retinopathy n=145		
	Mean	SD†	Mean	SD	p‡
Age (y)	47.7	13.4	52.4	12.8	0.001
BMI	23.6	3.9	23.6	3.5	.917
WHR	0.896	0.081	0.925	0.072	0.001
WHTR	0.507	0.072	0.523	0.061	.010
SBP (mmHg)	127.4	21.9	129.8	24.2	.238
DBP (mmHg)	81.8	12.6	81.9	11.1	.921
FBG (mmol/l)	6.8	3.1	8.9	4.5	0.001
Chol (mg/dl)*	221	69	189	48	.030
TG (mg/dl)*	176	122	150	82	.323
HDL (mg/dl)*	46.2	10.4	44.5	11.4	.468
LDL (mg/dl)*	139.9	59.6	114.6	41.5	.047

† SD – standard deviation; ‡ p after unpaired t-test; * - a randomized sample size (n = 225)

Table-4: *Prevalence (%) and Risk factors estimated for retinopathy*

Risk variables	%	OR†	95% CI*)	p
Sex				
Women	18.5	1	–	
Men	19.8	1.09	0.75–1.57	*0.66*
Social class				
Poor	14.0	1	–	
Middle + Rich	21.1	1.54	1.01–2.35	*.047*
Family history of diabetes				
Absent or not known	15.5	1	–	
Present	23.1	1.52	1.05–2.20	*.028*
Glycemic status(FBG, mmol/l)				
NFG (<5.6)	12.7	1	–	
IFG (5.6 – 6.9)	13.3	1.05	0.61–1.81	*.850*
DM (>6.9)	31.3	3.11	2.04–4.76	*.000*
Age quartile (y)				
Quartile 1 (<30)	9.9	1	–	
Quartile 2 (<31 – 40)	12.9	1.35	0.58–3.17	*.485*
Quartile 3 (<41 – 55)	19.8	2.25	1.03–4.94	*.043*
Quartile 4 (>55)	26.4	3.27	1.48–7.19	*.003*
BMI quartile				
Quartile 1 (<19.5)	15.6	1	–	
Quartile 2 (<19.6 – 21.9)	18.0	1.19	0.61–2.33	*.618*
Quartile 3 (<22.0 – 24.8)	22.3	1.55	0.82–2.92	*.178*
Quartile 4 (>24.8)	18.6	1.23	0.66–2.32	*.515*
WHR quartile				
Quartile 1 (<0.81)	12.1	1	–	
Quartile 2 (<0.82 – 0.87)	12.2	1.01	0.48–2.13	*.982*
Quartile 3 (<0.88 – 0.93)	21.4	1.98	1.03–3.79	*.040*
Quartile 4 (>0.93)	23.8	2.28	1.22–4.23	*.009*

†OR – odds ratio

*CI – confidence interval

Table 3 showed the comparisons of biophysical characteristics between participants with and without DR. The participants with DR had significantly higher age ($p < 0.001$), higher central obesity (WHR $p < 0.001$; and WHtR $p = 0.01$), higher fasting FBG ($p < 0.001$). Interestingly, there was no significant difference in general obesity (BMI $p = 0.917$). Even more interesting is that the participants with DR had significantly lower total cholesterol ($p = 0.03$) and lower low-density lipoprotein (LDL $p = 0.047$).

The risk factors related to DR was shown in Table 4. Compared with the non-affluent, the affluent participants had higher risk (OR 1.54, 95% CI, 1.01 – 2.35). Likewise, the participants from known diabetic family had greater risk (OR 1.52, CI, 1.05 – 2.20) than their counterparts having no known diabetes in their families. The participants with diabetes had excess risk (OR 3.11, CI, 2.04 – 4.76) than those with normal (NFG) or impaired fasting glucose (IFG). For an increasing age, higher the quartiles greater is the risk. Similarly, higher is the central obesity (WHR) more is the risk (Table 4); whereas, general obesity (BMI) was found to have no effect on DR.

Discussion

This is the first study, which addressed the prevalence of DR and visual impairment in a coastal population. Some socio-demographic and biophysical risk factors were also assessed. Two important aspects of the study are worth mentioning. Firstly, the study population has least access to health care services and diagnostic facilities. Secondly, the study areas are mostly inaccessible due to inconvenient communication and precarious weather condition. We had some advantages. We could refer the persons with cataract to nearby centers for surgery organized and maintained by Fred Hollow Foundation. The local people especially teachers and students were very much cordial. They actively and sincerely volunteered the study in every step (carrying message to the villagers from house to house and making list of the participants and taking them to the investigation site.

There are few published studies on the prevalence of visual impairment and cataract among coastal population for comparisons. Patil S et al reported very high prevalence of impaired visual acuity (33.0%) and cataract (82.4%) in Sindhudurg district on the western coastal strip of India [21]. They reported high prevalence among coastal population may be due to higher age group (>50y) they studied.

So far available a population based study of Bangladesh showed that overall prevalence of DR was 5.4% among the rural people of age 30 years or older [22]. Our study demonstrated that compared with the rural people of other areas of Bangladesh, the coastal people had increased prevalence of DR. An estimated global prevalence of 'any DR' was found 6.96% (95CI, 6.87-7.04) [23]. Thus, the global estimate also indicates that the coastal people are more susceptible for developing DR. A 'Singapore Eye Study' among the migrant Indians (age >40y) reported that the prevalence of DR was 10.5% (95% CI, 9.3-11.8) [24]. This finding also showed that our study population bears greater risk for DR.

With regard to risk factors, we found persons with advancing age, higher class with family history of diabetes had excess risk for DR. These findings are consistent with other studies [20 – 23]. In contrast, the Singapore study [24] observed that lower income and living in smaller houses were associated with vision threatening DR.

An interesting finding was that the level of total cholesterol and LDL-cholesterol was found significantly lower in those who had no DR than those who had. The findings indicate that these lipid fractions appear to be protective against DR. The explanation is not known.

We had some limitations. The sampling technique was a purposive one. We could not include dietary habit (salt, fruits and vegetables), physical activities and housing status. We could not afford two important but relevant investigations like hemoglobin A_{1c} and stereoscopic digital photography.

Conclusion

We conclude that the prevalence of visual impairment and cataract is comparable with other studies; whereas, the prevalence of DR among the

coastal people was higher than that of the rural Bangladeshis and also higher than global estimates and Indian migrants. The persons with higher age from higher social class with higher central obesity had excess risk for both diabetes and DR. Further study may be undertaken to confirm the study findings and if found consistent then the coastal people need an urgent Eye Care facilities for the prevention of visual impairment and blindness.

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