Prevalence of Diabetes Mellitus and Associated Cardiovascular Risk Factors among the Santal (Tribal) Population of Dinajpur

*Islam MN,[1] Hossain MA,[2] Islam MN[3]

The present descriptive cross sectional study was conducted on the Santals population of Dinajpur District, Bangladesh to find the prevalence of diabetes mellitus, prediabetes state and cardiovascular risk factors associated with them. Mean age of the subjects was 39.8 ± 12.8, range from 18-75 years. The male to female ratio was roughly 3:4. Of the 316 subjects, 7% reported that diabetics, 25.3% did not have diabetes and 67.7% did know whether they had diabetes. On blood glucose analysis, 92.1% was found non-diabetic, 4.4% had impaired glucose tolerance (IGT), 2.5% had diabetes and 0.9% impaired fasting glucose (IFG). Cardiovascular risk factors were hypertension 11.1%, diabetes and prediabetes 17%, dyslipidaemia 21.5%, smoking 34.5% and alcoholism was 13%. Neither age nor sex was associated with diabetic and prediabetic status (p = 0.586 and 0.328 respectively). Dyslipidaemia was significantly higher in the diabetic and prediabetic group (48.8%) than that in non-diabetic group (19.9%) (p = 0.001). Although prevalence of diabetes is not much higher yet, it may increase to an alarming proportion unless measure is taken to reduce the prevalence IGT and IFG. Measures should also be taken to reduce the incidence of dyslipidaemia, smoking and alcoholism.

[Dinajpur Med Col J 2015 Jul; 8 (2):112-119]

Key words: Diabetes mellitus, Santal population, Dinajpur

Introduction

Diabetes mellitus (DM) is now recognized as a major chronic public health problem throughout the world (WHO, 1994). It is associated with increased morbidity, mortality, and cost thereby. This disease is becoming an increasing threat to the world's health service. Formerly described as a "disease of affluence", it is now evident that (owing to demographic changes, cultural transition and population aging) diabetes is a problem of developing countries as well as affecting a wide range of ethnic and economic groups.[1] It is estimated that currently diabetes mellitus (DM) accounts for 5.2 % of all deaths worldwide.[2] The number of people with DM is expected to be doubled from 175 million in 2000 to 353 million in 2030.[3] The largest increase is expected to occur in developing countries, with 305 million individuals likely to have DM by 2030.[3] Recently "global estimates of diabetes prevalence" clearly indicates that there is an overall increase of diabetes prevalence in the developing countries especially in South-East Asian countries.[4] An increasing trend of Diabetes registration in all the referral centers in Bangladesh is reported in recent years. Diabetes has been found to be more prevalent in Urban than in rural population.[5,6,7]

1. *Dr. Md. Nurul Islam, Assistant Professor, Department of Biochemistry, Dinajpur Medical College, Bangladesh. inuruldr@yahoo.com*
2. *Dr. Md. Anowar Hossain, Lecturer, Department of Biochemistry, Dinajpur Medical College, Dinajpur*
3. *Dr. Md. Nazrul Islam, Assistant Professor, Department of Biochemistry, Dinajpur Medical, College, Bangladesh*

**For correspondence*

Migrant Indians in different parts of the world have shown a higher risk of type-2 diabetes which is attributed to changed living conditions and environmental factors.[8,9,10] Urbanization and urban migration have been established as a risk factor for an increased incidence of diabetes. The trend has been authenticated by the World Health Organization (WHO).[1,11]

The prevalence of DM in adult varies markedly between different population, e.g. 2.6 % in Nigeria, 18 % in Mauritius and more than 50% in Pima Indians in the US.[12] Tribal or aboriginal population show an accelerated increase of diabetes worldwide .[13] Very high prevalence of diabetes has been found among the natives of America, Alaska, Canada and the aborigines of Australia.[15,16,17] These tribes and aboriginals exhibited a high prevalence of metabolic syndrome as well.[18] Similar findings were also reported among the tribal populations from northern Sudan, the United Arab Emirates and Taiwan.[19] Very little information is available in the literature regarding the prevalence of diabetes among tribal population living in south-east Asian countries including Bangladesh.

Bangladesh is a land of mixed ethnicity. After Chakma, Marma and Garo, Santal's are the important tribal populations of Bangladesh. Total number of tribal population of Bangladesh is 1410169 which are less than 1% of the total population, comprising more than 30 different ancestries. In Rajshahi division there are about 363451 tribal populations and among them Santal population is 188359.[20,21] In santals a total of 12 clans are found. They are: Hansduk, Murmu, Hembron, Soren, Kisku, Tudu, Marndi, Baski, Besra, Chonre, Puria and Bedea. They have their own language, culture and social pattern's, which are clearly distinct from those of other tribes. Agriculture is there main source of livelihood. Their principle food items are rice, fish and vegetable. They also eat crabs, pork, chicken, beef and meat of squirrels, jute spinach (nalita), wild potatoes, fruits, roots of young shoots, flowers, mashroom, eggs of ducks, chickens, birds and turtle. Most of the Santals are animist. Haunting and collecting foods from forest were their primitive economic activities. Liquor distilled from putrefied rice called hadia or (pachai) is their favorite drink. They are excessively addicted to tobacco, alcohol and wines prepared locally by themselves. They cannot think of performing any religious or social ceremony without drinking wine.

The Santal of Bangladesh today can be seen going through an identity crisis for a verity of reasons. They are not able to put concerted efforts to face the rapidly changing situation. Whatever changes seem to have taken place due to outside pressure, promotion of education, and some initiatives taken by the Church, they do not reach out to the bulk of the Santal population, living in the rural villages scattered around the countryside. As the time passes on, Santals are becoming more and more marginalized – struggling for mere survival without having any proper direction to move forward or improve their life situation. According to Professor Hossain, "The social solidarity and homogeneity of the ethnic minority of Santals are weakening and disintegrating. In effect, culturally, they are in transitional state. The Santals today face transition from the sovereignty of the isolated village to the complexities of modern politics, bureaucracy, and money economy.[22]

Few studies have so far been conducted among the tribal population on the prevalence of diabetes and cardiovascular risk factors. Some studies have been done on the tribal population of hill tracts in Chittagong and Mymensingh but no study has been carried out in Santal population of Dinajpur yet.

Considering these issues we undertake this study to assess the prevalence of diabetes and cardiovascular risk factors among the Santal population of Dinajpur district in the Northwestern belt of Bangladesh.

Methods

This descriptive cross sectional study was carried out from July 2007 to June 2008 in the Department of Biochemistry, Dinajpur Medical College, Dinajpur and Dinajpur Diabetes and Shasthasheba Hospital. Study population was the adult Santal (Trival) of Dinajpur district of 18 years and above and both sexes. Pregnant women, severe comorbidity and subject using oral contraceptives, steroid and herbal medicine were excluded from the study. The sample size of 384 was calculated taking the level of estimated prevalence of diabetes among tribal population is 5% Using 95% confidence interval. Out of 384 subjects 68 did not attend the center and. 316 subjects included in the study.

Data was collected by a pretested survey questionnaire. Subjects with known diabetes were asked to stop oral hypoglycemic agent regimens for 3 days and insulin 24 hour before participation. Informed consent was obtained from each subject who agreed to participate in the study. Each subject was asked to report at a selected investigation site after an overnight fast of at least 12 hours. Each participant was interviewed for detail demographic profile and relevant history and comorbidity was noted. Anthropometric measurement, blood pressure , and fasting plasma glucose (FPG) were obtained by using appropriate tools and techniques. BMI was calculated using formula, BMI= Weight (kg)/[Height (m)]^2.Waist girth was measured by placing a plastic tape horizontally midway between twelfth rib and iliac crest in the midaxillary line. Similarly, the hip was measured by taking the extreme end posteriorly and the symphysis pubis anteriorly. Blood pressure was taken after a 10-min rest with standard cuffs for adults fitted with a mercury sphygmomanometer. Fasting venous blood (5 ml) was collected by vene puncture with the subjects lying supine in a quiet room for FPG, total cholesterol, HDL cholesterol, triglyceride (TG). In the same way venous blood was collected again 2hours after taking 75 g of glucose (dissolved in 300 ml of water) for the estimation of blood glucose level. After 10-15 minutes of collecting blood sample, it was centrifuged for 5 minutes at 3000 rpm to obtain serum. Serum was frozen at -45^0C till analysis. Blood pressure was measured in sitting position, with calf at the level of the heart. After 10 minutes of rest a second reading was taken. Recorded Korotkoff sound I (the first sound) and V (the disappearance of sound) denoted the systolic blood pressure (SBP) and diastolic blood pressure (DBP), respectively (according to WHO-IHS).Serum glucose, lipid profile creatinine and other biochemical parameters were analyzed by automated analyzer **(ABX Laboratories, France)** by using appropriate standard method.

Data were processed and analyzed using SPSS (Statistical Package for Social Sciences). The test statistics used analyze the data were descriptive statistics, Chi-square or Fisher's Exact Probability Test. The level of significance for each analytical test was set at 0.05 and $p < 0.05$ was considered significant.

Results

The findings derived from data analyses shown (Table I) that the mean age of the subjects was 39.8 ± 12.8 years and the youngest and oldest participants were 18 and 75 years old respectively. The male to female ratio was roughly 3:4.In terms of occupation nearly three-quarter (73.7%) of the subjects was day labourers. Level of education shows that about 40% was illiterate, 48.1% was

primary level educated, 12% was below SSC and 0.3% HSC level educated. Majority (87.7%) of the subjects had concrete-tin shaded house. Over three-quarter (78.8%) of the subjects had monthly family income 3000 or below 3000 Takas. Stratification of subjects by number of family members shows that 36.1% had 3 – 4 members, 37.3% 5 – 6 members and 17.4% 7 or more than 7 members. Of the 316 subjects, 7% reported that diabetics, 25.3% did not have diabetes and 67.7% did know whether they had diabetes. Likewise 6.3% reported that their 1st degree relatives had diabetes, 26.3% did not have any family history of diabetes and 67.4% was unaware about family history of diabetes. On blood glucose analysis, 92.1% was found non-diabetic, 4.4% had impaired glucose tolerance (IGT), 2.5% had diabetes and 2.0% impaired fasting glucose (IFG). Cardiovascular risk factors analysis revealed that 7.9 % subjects had hypertension, 5.3% had diabetes/prediabetic, 21.5% dyslipidaemia and 16.6%. had waist-hip ratio > 0.9. Alcohol consumption and smoking were unusually higher (13 % and 34.5 % respectively). Very few subjects (1.2%) were however, found to be overweight and obese.

Neither age nor sex was associated with diabetic and prediabetic status (p = 0.571 and 0.381 respectively) Table II. Dyslipidaemia was significantly higher in the diabetic and prediabetic group than that in non-diabetic group (p = 0.006) Table-III. Hypertension, smoking habit waist-hip ratio (WHR) and alcohol consumption were almost homogeneously distributed between diabetic and non-diabetic groups (p = 0.920, p = 0.689, p = 0.479 and p = 0.250 respectively) Table III. Dyslipidaemia was mainly contributed by high level of total cholesterol and triglycerides in the diabetic and prediabetic group compared to those in non-diabetic group but statistically not significant (p=0.198 and p=0.054 respectively)Table IV.

Table I: Base line characteristics of the study subjects (n=316)

Characteristics	n(%)
Age	Mean age, 39.6 ± 12.8 years
	Range(18-75 yrs)
Sex	
Male	135(43)
Female	181(57).
Male :Female	3:4
Occupation	
Day laborer	233(73.7)
Sedentary worker	2(0.6)
House worker	57(18.1)
Others	24(7.6)
Education	
Illiterate	125(39.6)
Primary	152(48.1)
Below SSC	38(12)
HSC and above	01(0.3)
Socioeconomic status	
≤3000(TK)	278(78.8)
3000-5000(TK)	16(5.1)
≥5000(TK)	51(16.1)
Familiy history of diabetes	19(6.3)
Yes	26.3(84)
No	213(67.4)
Don't Know	
Blood sugar	
IFG	05(2.0)
IGT	14(4.4)
Diabetic	08(2.5)
Non diabetic	289(92.2)
Cardiovascular risk factors	25(7.9)
Hypertension	17(5.3)
Diabetic and pre diabetic	68(21.5)
	109(34.5)
Dyslipidemia	41(13.0)
Smoking	52(16.6)
Alcohol consumption	4(1.2)
WHR	
BMI	
Lipid profile	
Raised total cholesterol	41(27.88)
	03(2.04)
Raised LDL cholesterol	05(3.4)
	19(12.92)
Low HDL	
Raised triglyceride	

Table II: Association of age and sex with diabetes and prediabetes (n = 316)

Demographic characteristics	Group		p
	Diabetic and prediabetic (n = 17)	Non-diabetic(n = 299)	
Age (yrs)			
≤ 40	05(4.03)	70(70.79)	0.571
> 40	12(12.79)	229(228.03)	
Sex			
Male	09(7.29)	126(127.74)	0.381
Female	08(9.74)	173(171.26)	

P value based on Chi-square test

Table III: Association between cardiovascular risk factors and diabetes and peripatetic State (n=316)

Cardiovascular risk factors	Group		p
	Diabetic and prediabetic (n =17)	Non-diabetic (n = 299)	
Hypertension			
Yes	6(5.81)	102(102.19)	0.9203
No	11(11.19)	197(196.81)	
Dyslipidaemia			
Present	13(6.35)	105(111.65)	0.0006*
Absent	4(10.65)	194(187.35)	
WHR			0.4792
(> 0.9)	8(9.4)	132(133.4)	
<0.9	9(7.59)		
		167(165.59)	
BMI (≥ 25 kg/m^2)			0.1425
≥30	7(9.9)	177(174.1)	
<30	10(7.1)	122(124.9)	
Smoking habit			0.6891
Yes	12(11.75)	197(197.76)	
No	5(7.6)	102(101.24)	
Alcohol consumption			0.2505
Yes	14(11.89)	207(209.11)	
No	3(5.11)	92(89.89)	

P value based on Chi-square test, *significant

Table IV: Association between serum lipid and diabetes and prediabetes (n=316)

Lipid profile	Group		p
	Diabetic and prediabetic (n = 17)	Non-diabetic (n = 299)	
Raised total cholesterol			0.1983
(> 200 mg/dl)	13(6.99)	182(175.99)	
(≤200 mg/dl)	4(10.01)	117(123.01)	
High LDL			0.689
(>150 mg/dl)	9(9.97)	173(172.21)	
(≤150 mg/dl)	8(7.21)	126(126.79)	
Low HDL			0.7641
(< 40 mg/dl)	10(9.41)	165165.59)	
(≤ 40 mg/dl)	7(7.59)	134(133.41)	
Raised TG			0.0544
(> 200 mg/dl)	14(10.22)	176(179.78)	
(≤ 200 mg/dl)	3(6.78)	123(119.22)	

P value based on Chi-square test

Discussion

Diabetes mellitus is a metabolic disorder, the underlying mechanism of which is still unsettled and it is debated whether impaired β-cell function or insulin resistance is the primary pathogenic mechanism. Many investigators believe that insulin resistance precedes β-cell dysfunction and it is the primary genetic factor, while β-cell dysfunction is a late phenomenon due to exhaustion after years of compensatory hyper secretion .[23]

The debate is complicated by the fact that there is considerable racial variation in insulin secretion and sensitivity and also, a number of lifestyle and nutritional factors may modulate both the phenomena. One of the widely recognized strategies to unravel the pathophysiology of a disease is to study its natural history, and early and intermediate stages of the disease process are invaluable tools for such studies.

A total of 316 apparently healthy subjects age

18 or above were randomly selected and included in the present study. Out of 316 subjects 135 (43%) were male and 181(57%) were male to female ratio was 3:4. The study conducted by Rahman et al. showed a similar male female ratio.[24] The mean age of the study subjects, male and female was 39.6 ± 12.8 years. In the present study day labourers formed the main bulk (73.3%) with illiteracy rate about 40%. Sayed et al observed the similar findings that about 75% of the subjects to be illiterate. [25] In terms of monthly family income, over three-quarter (78.8%) of the subjects had income 3000 or below 3000 Takas, 5.1% 3000 – 5000 Takas and the rest 16.1% more than 5000 Takas.

In our study, 8 out of 316 subjects (2.5%) were diabetic, 3(0.9%) had IFG (impaired fasting glucose), 14(4.4%) had IGT (impaired glucose tolerance). Sayeed et al detected the crude prevalence of diabetes 6.6 % and IFG 8.5% among the tribal people of Khagrachari Hill Tracts of Bangladesh.[25.] Another study carried on urban and rural people in Bangladesh has reported 2.3% diabetes in tribal population of Bangladesh.[26] Systolic blood pressure had a marginal association with diabetes based on only FBG level in rural people. They however, did not find any association between BMI and diabetes. In our studies none of these variables was found to be associated with diabetes or prediabetes. Sayeed and his associates in an attempt to find the prevalence diabetes among the tribal people of Khgrachari Hill Tracts, Bangladesh showed that both tribal and non-tribal people carries equal risk of developing diabetes.[25] They found advancing age, higher income level and increased central obesity as the independent risk factors for developing diabetes. Several other studies demonstrated similar findings indicating that regardless of ethnicity this metabolic disease increases with higher income and affluent life style.[27,28,29] Interestingly none of these factors was found to have any influence on the development diabetes or prediabetes state in the present study. However, some important observations on dyslipidaemia and obesity deserve mention. Dyslipidaemia demonstrated their significant presence in the diabetic and prediabetic population compared to the non-diabetic population, although BMI and WHR did not have any effect on diabetes. Subjects with raised cholesterol and raised triglycerides were significantly prone to develop diabetes, IFG and IGT. But high LDL (>150 mg/dl) and low HDL (< 40 mg/dl) was rarely observed in both diabetic and non-diabetic groups. Sayeed and his associates (1997) observed that highest quartile of BMI in nontribal Bangladeshis had highest risk of diabetes, whereas in tribal population, neither BMI nor WHR was found to be associated with diabetes.[30] They also observed that tribal hyperglycemic subjects had significantly higher level of total cholesterol and triglycerides level, while non-tribal hyperglycemic subjects had lower total cholesterol and higher HDL. These differences in lipid profile between tribal and non-tribal Bangladeshis suggests that unlike non-tribal Bangladeshis, insulin resistance might be an important contributor to diabetes among the Sandals tribe.

Another important finding that might be attributed to high prevalence of dyslipidaemia in diabetic and prediabetic group is alcohol consumption which was observed to be unusually higher in our study population (76.6%). However, caution is advised to consider it as a contributor to high prevalence of dyslipidaemia in the diabetic and prediabetic group, as no significant difference was observed between the diabetic and non-diabetic groups in terms of prevalence of alcohol consumption (84% vs. 75.9%, $p = 0.361$).

Conclusion

This study addressed the prevalence of diabetes and prediabetes among Santal population of Northern District of Bangladesh. The prevalence of diabetes was observed to be 2.5%. However, together with IFG and IGT it is higher than the previous studies (7.8%). In the present study dyslipidaemia was observed to be significantly higher in the diabetic and prediabetic group compared to their non-diabetic counterpart. Alcohol consumption was inappreciably higher which might be due to custom prevailing in this tribal group. This high alcohol consumption might be attributed to high prevalence of dyslipidaemia. The findings of the study suggest that further nation wide study with large sample size should be conducted to validate the findings of the present study and also to formulate a health care plan for this tribal population in order to reduce incidences of diabetes, prediabetes state, dyslipidaemia, smoking habit and alcohol consumption.

References

1. King, H, Aubert RE, Herman WH. Global burden of diabetes l995-2025.Prevalence numerical estimation and projection. Diabetes care. 1998; 21: 1414-1431.
2. Roglic G, Unwin N, Bennett PH, Mathers C, Tuomilehto J, Nag S, Connolly V, KingH. The burden of mortality attributable to diabetes: realistic estimates for the year 2000. Diabetes Care. 2005; 28:2130-2135.
3. Yach D, Dtuckler D , Browneel KD. Epidemiologic and economic consequences of the global epidemics of obesity and diabetes. Nat Med. 2006;12:62-66.
4. King H, Rewers, M, WHO adhoc Diabetes Reporting Group. Global estimates for prevalence of diabetes mellitus and impaired glucose tolerance in adults. Diabetes Care, 1993 16,157-177.
5. Ramachandran A, Snehalath, C, Dharmaraj D, Viswanathan M, 1992. Prevalence of glucose intolerance in Asian Indians. Urban–rural difference and significance of upper body adiposity', Diabetes Care.1992; 15:1348-1355.
6. Mbanya JCN, Ngogang J, Salah J., Minkoulou E, Balkau B, 1997. Prevalence of NIDDM and impaired glucose tolerance in a rural and urban population in Cameroon. Diabetologia. 1997 ;40:824-829.
7. Al-Nuaim AR, 1997. Prevalence of glucose intolerance in urban and rural communities in Saudi Arabia. Diabetic Medicine.1997;14(7): 959-602.
8. Ramachandran A, Snehalatha C, Dharmaraj D, Viswanathan M. 1992. Prevalence of glucose intolerance in Asian Indians. Urban–rural difference and significance of upper body adiposity', Diabetes Care.1992;15:1348-1355.
9. Mather, H.M, Keen H. The Southhall diabetes survey: prevalence of known diabetes in Asians and Europeans. Br Med J. 1985;291:1081-1084
10. Tailor R, Zimmet P. Migrant studies in diabetes. In : Mann, HI, Pyorala, K , Teuscher A, Diabetes in Epidemiologic Perspective. Churchill Livingstone, Edinburgh.1983;58-79.
11. World Health Organization (WHO) Consultation .Definition, Diagnosis and Classification of Diabetes Mellitus and its complications. Part 1: Diagnosis and Classification of Diabetes Mellitus, Report of a WHO Consultation. Geneva: World Health Organization, 1999.
12. King H, Rewers M, WHO adhoc Diabetes Reporting Group. Global estimates for prevalence of diabetes mellitus and impaired glucose tolerance in adults .Diabetes Care. 1993; 16:157-177.
13. Rasmussen SS, Glumer S, Sandbaek A, Lauritzen T, Borch- Johnsen K.Progression from Impaired Fasting Glucose and Impaired Glucose Tolerance to

diabetes in a high-risk screening programme in general practice: the addition study, Denmark, Diabetologia. 2000; 50: 293-297.
14. Rock M. Sweet blood and social suffering: rethinking cause-effect relationships in diabetes, distress, and duress. Med Anthropol. 2003; 4(22):131–17.
15. Greenlund KJ, Valdez R, Casper ML, Rith-Najarian S. Croft JB 1999. Prevalence and correlates of the insulin resistance syndrome among Native Americans: the Inter-Tribal Heart Project. Diabetes Care. 1999; 22:441–447.
16. Hoehner CM, Greenlund KJ, Rith-Najarian S, Casper ML. McClellan WM. Association of the insulin resistance syndrome and microalbuminuria among nondiabetic native Americans: the Inter-Tribal Heart Project.J Am Soc Nephrol, 2002; 1:1626–1634.
17. Pioro MP, Dyck RF, Gillis DC. Diabetes prevalence rates among First Nations adults on Saskatchewan reserves in 1990: comparison by tribal grouping, geography and with non-First Nations people.'Can J Public Health, 1996;87:325–328.
18. Rowley KG, Iser DM, Best JD, O'Dea K, Leonard D, McDermott R. Albuminuria in Australian Aboriginal people: prevalence and associations with components of the metabolic syndrome. Diabetologia. 2000;43:1397–1403.
19. Chen HD, Shaw CK, Tseng WP, Chen HI, Lee M. Prevalence of diabetes mellitus and impaired glucose tolerance in Aborigines and Chinese in eastern Taiwan. Diabetes Res Clin Pract. 1997;38:199–205.
20. Bangladesh Bureau of Statistics (BBS) 2001. Statistical Pocket Book of Bangladesh. Singha AC, Ed. Statistical Division, Ministry of Planning, Government of the People's Republic of Bangladesh. 2001.
21. Bangladesh Bureau of Statistics(BBS), 1991. Statistical Pocket Book of Bangladesh, Singha AC.Ed. Dhaka, Bangladesh, Statistical Division, Ministry of Planning, Government of the People's Republic of Bangladesh. 1991.
22. Hussain A, Rahim MA, Azad Khan AK,Vaaler S .Type 2 diabetes in rural and urban population: diverse prevalence and associated risk factors in Bangladesh. Diabetic Medicine.2005;22: 931-936.
23. Katsilambros N, Tentolouris N. 2003. Type 2 diabetes: an overview. In: John C. Pickup and Gareth Williams, Eds, Textbook of Diabetes, 3rd ed. Blackwell Science. 2003 ; 4.1-4.19.
24. Rahman H , Samira HH, Lahiry S, Biswas KB, Islam R. Ali L. 2003. Prevalence of Diabetes Mellitus among a Tribal Population (Rakhaiyans) in the South-Coastal Belt of Bangladesh. Diab Endocr J. 2003; 31(1): 9-11.
25. Sayeed MA, Khan AR, Banu A, Hussain MZ . Diabetes and Impaired Fasting Glycemia in the Tribes of Khagrachari Hill Tracts of Bangladesh. Diabetes Care.2004; 27: 1054-1059.
26. Hussain A, Rahim MA , Azad Khan AK, Vaaler S.Type 2 diabetes in rural and urban population: diverse prevalence and associated risk factors in Bangladesh.' Diabetic Medicine. 2005 ;22: 931-936.
27. Pan X, Li G, Hu Y, Wang JX, Yang WY, An ZX, Hu ZX, Lin J, Xiao JZ, Cao HB, Liu PA, Jiang XG, Jiang YY, Wang JP, Zheng H, Zhang H, Bennett PH, Howard BV. Effect of diet and exercise in preventing NIDDM in people with impaired glucose tolerance: the Da Qing IGT and Diabetes Study. Diabetes Care.1997; 20:537–544.
28. Astrand PO. Physical activity and fitness: physical activity and carbohydrate metabolism. Am J Clin Nutr.1992;55:1231S-65S.
29. Lovejoy Di, Girolam M . Habitual Dietary intake and insulin sensitivity in lean and obese adults. Am J Clin Nutr.1992;55: 1174-79.
30. Sayeed MA, Hossain MZ, Banu A, Rumi MAK, Azad khan AK . Prevalence of diabetes in a suburban population of Bangladesh. Diab Res Clin Pract.1997; 34:149-55.