To identify the risk factors for high prevalence of diabetes and impaired glucose tolerance in Indian rural population

Sudha S. Deo[1], Avinash Zantye[2], Rajashree Mokal[3], Shilpa Mithbawkar[3], Sujata Rane[3], Kalpana Thakur[4]

[1]Sr. Research Scientist, [2]Diabetologist, [3]Sr. Research Assistant, [4]Social Worker. Sir Hurkisondas Nurrotumdas Medical Research Society, Raja Ram Mohan Roy Road, Girgaum, Prarthna Samaj, Mumbai - 4000 04. Zantye Hospital, Malwan, Sindhudurg, Maharashtra, India

AIM: The present study was undertaken to determine the prevalence of diabetes in the rural population and to identify the major risk factors that may be the cause for increase incidence in rural population.

METHODOLOGY: A study population comprising of 1022 individuals in the Malwan area of Sindhudurg district of Maharashtra, age >20 years were selected for investigation. These individuals were analyzed for their biochemical parameters by Standard Randox kits. Both fasting blood glucose and post 2-hour glucose after 75 gm of powdered glucose intake were analyzed. Baseline clinical data like height, weight and blood pressure as well as family history were recorded by the standard methods.

RESULTS: The prevalence of diabetes (i.e., fasting blood glucose) as per the WHO criteria was 9.3% while it was 8.9% per ADA criteria. The prevalence according to 2-hr post-glucose blood glucose was 9.3%. The prevalence of IGT was 2.25% in subjects <50 years and 1.12% in subjects >50 years. IGT values also increase with increasing age and BMI. The accepted normal fasting and 2-hr post glucose blood glucose values are <6.1 mM/l and <7.8 mM/l. From our studies (N = 1022) we found the mean fasting glucose blood glucose was 5.31 ± 1.99 mM/l while 2 hr post glucose, blood glucose increased to 5.66 ± 4.09 mM/l. The mean fasting glucose in 95 diabetic individuals was 9.37 ± 4.43 mM/l and the 2 hrs post glucose blood glucose was 14.85 ± 8.51 mM/l, which was found to be highly significant.

CONCLUSION: It was observed that the mean blood glucose in diabetic patients was 9.37 ± 4.43 mM/l with a prevalence rate of 9.3% which is highly significantly in the rural population. Compared to the general risk factors found in the urban populations we found that the increase in age and BMI could be the risk factors. Further studies focused on the genetic predisposition to diabetes need to be done.

KEY WORDS: Rural, diabetes, survey.

Introduction

The global prevalence of type 2 diabetes (DM) is expected to rise to double in 2025. With urbanization occurring rapidly there is increased risk of diabetes in the younger age group. It is observed that India and other countries in Asia have also been experiencing an increase in the prevalence of type 2 diabetes and cardiovascular disease. In the seventies, migrant Asian living in different parts of the world has shown a higher prevalence of diabetes then other ethnic groups living in the same countries. This was attributed to the changes in the environmental factors such as increased affluence that may unmask a genetic or racial tendency for diabetes.[1]

The prevalence of type 2 DM in urban Indian adults has increased from < 3% in 1970s to >12% by 2000, while that in rural population has increased to almost 7%. It is observed that India has the largest number of diabetics than any other country. It is predicted that by 2025 India will harbor more than 60 million diabetic patients and that cardiac diseases would be the leading cause of death i.e., 1 out of 4 individuals will be an Indian diabetic in

Correspondence to **Sudha S. Deo**, Sir Hurkisondas Nurrotumdas Medical Research Society, Raja Ram Mohan Roy Road, Girgaum, Pratma Samaj, Mumbai - 400,004, India

the world while 3 out of 4 will be from the developing countries.[2]

It is observed that this increased percentage has been ascribed to the rapid changes in the demographic, nutritional as well as the socioeconomic factors i.e., transition phase. The inverse relationship of birthweight and the risk of diabetes and metabolic syndrome could be applied as one of the factors. It has been observed that mothers in rural India are small and are thought to be undernourished because of low BMI. Indian babies are the smallest in the world and that 1/3 of the Indian population have low birth weight of < 2.5 kg. It is thus possible that maternal and fetal undernutrition could contribute to the epidemic of diabetes in urban Asian countries. The urban Indian babies are better nourished than those of rural population.[3-5] It is observed that if the mean birth weight is between 2.6-2.9 kg the subject population is found to have 5 times greater susceptibility to diabetics. Studies showing increasing trend in the number of diabetics in the urban and rural Indians during the last 5 years is shown in Table 1.

Going through all the above epidemiological studies, we thought it best to do some more surveys in the rural areas and compare the data with the urban values. It would be very important to find the risk factors that would help us to curb the increased prevalence of this disease. Hence, a study was undertaken in the Malwan area, a coastal region of Sindhudurg district of Maharashtra state to find out the major risk factors that contribute to increase in the prevalence of diabetes.

Malwan is a small town with a scanty population situated 500 km away from Mumbai and about 150 km from Goa. The area population is 150/sq km. The two main areas Tarkali and Devbag are occupied by people of the lower and middle lower income group. Their staple diet and their lifestyle was different than that of the urban population. A total of 1044 individuals were selected, of which 1022 took part in the camp and their ages ranged from 20-70 years.These were from the two main centres Tarkali and Devbag.

Table 1: Epidemiological data of diabetes surveys

Year	Authors	Place (Region)	% Prevalence	
2000	Zarger *et al*	Kashmir (North U)		6.1
2001	Ramchandran *et al*	National (U)		12.1
2001	Misra *et al*	New Delhi (North U)		10.5
2001	Mohan *et al*	Chennai (South U)		12.1
2001	Kuty *et al*	Kerala (South U)		12.4
2003	Sayeed *et al*	Bangladesh (R)		4.3
2004	Iyer *et al*	Dombivili (U)	IGT	12.4;
			WHO	4.01
			ADA	7.5
2004	Yagnik *et al*	Pune (U)	ADA	3.6
			WHO	4.3,
2004	Sadikot *et al*	Indian population (U) (R)	U-	4.6,
			R-	1.9

U-urban, R-rural

Compared to sedentary life style of urban population the rural population followed a more laborious work habits in their daily life, including agriculture, fishing, poultry and cow herding. Vast majority of Indian population resides in the rural areas and have very little access to health care facilities. This study was therefore undertaken to study the risk factors in Malwan area, as one of the observations was the regular use of insulin in a large percentage of diabetics in that area.

Methodology

A total of 1022 individuals of the Malwan area situated in Sindhudurg district of Maharashtra state comprising of 469 males and 553 females were screened for their biochemical parameters. Their age ranged from 20-70 years. All the subjects underwent the oral glucose tolerance test with pre and post 2 hour collections of blood after intake of 75 gm of glucose. A fasting glucose value of 6.7 mM/l was taken as a normal tolerance limit. The routine biochemical marker studies included triglyceride, cholesterol, HDL-cholesterol, as well as height, weight and waist measurements. Blood pressure also included the systolic and diastolic pressures. Impaired glucose tolerance was also detected when post glucose was found to be greater than ≥ 140 mgm% and < 200 mgm% according to WHO criteria. Fasting glucose ≥ 110 mgm% and < 126 mgm% indicated impaired fasting glucose. All these tests were conducted using Randox kits from USA and the results read on the spectrophotometer. Insulin levels were detected by the routine radioactive kits from BARC and the insulin values were calculated after taking the readings on the Gamma Counter. The data was then analysed using the student 't' test.and the HOMA IR values.

Results

From Table 2, it is observed that as the age increases the number of individuals showing signs of diabetes also increases and hence the percentage of individuals showing diabetes thus increases. The mean glucose levels thus increases showing a significant correlation of increased percentage of diabetes (P<0.001).

Table 3 depicts the differences in the NGT, IGT and DM subjects showing the changes with respect to BMI, the age and ratio in the percentage of male versus the female. According to WHO as well as the ADA criteria there is no significant change in the percentage of these values in any of the group. Thus from our studies it is obvious that diagnosis can be made by any of the criteria.

Table 4 shows prevalence of impaired fasting glucose as well as impaired glucose tolerance test. The overall percentage in T2DM was around 9.3% being similar in male and female.

From the Table 5 it is observed that out of 1022 screened, the history of DM was found in 66 individuals showing prevalence rate of 9.3% while the incidence rate being 4.7%. Similarly patients with HT showed increased prevalence with 40.1% and incidence rate of 27.3%. Thus it is obvious that the prevalence of IFG, IGT and T2DM does not depend on the family history of DM and hypertension. Similarly there is no difference in prevalence rate in males and females. No significant correlation has been found which shows consistency in results when compared to the data presented by Ramchandran *et al*. (1997)

From Table 6 it can be observed that age specific prevalence of T2DM, IFG as well as IGT showed an increasing trend with the increase in age.

The levels of cholesterol, systolic blood pressure, fasting plasma glucose in females is found to be slightly higher in the female rural population than the males. There is significant difference in the male and female values for waist as well as for HOMA IR (P<0.001).

Table 2: Distribution of diabetes according to age and quantization of glucose levels

Age (years)	Number	% of diabetes	Mean glucose mM/l ± SD
21-30	4/236	1.69	4.77 ± 0.79
31-40	9/287	3.1	4.99 ± 1.22
41-50	24/187	12.8	5.77 ± 3.11
51-60	30/178	16.8	5.68 ± 2.13
≥ 61	28/134	20.9	5.84 ± 2.23

Discussion

A study conducted by Diabetes Research Centre in Chennai, India reported a prevalence of diabetes to be about 5.9% in semi-urban areas which is midway between urban (11.6%) and the rural (2.4%).[6] A recent survey in a rural area in 2003 showed indications of transition in the lifestyle of rural population and striking increase in the rate of prevalence of diabetes was noted (6.3%).[7-9] Similarly, a study conducted in 13 rural villages of Thailand about 500 km from Bangkok

Table 4: Prevalence of type 2 DM impaired fasting glucose and impaired glucose tolerance according to WHO criteria

Gender	No.	IFG %	IGT %	T2DM
Male	449	23 (4.9)	9 (1.9)	43 (9.2)
Female	553	20 (3.6)	10 (1.8)	52 (9.9)
Total	1022	43 (4.2)	19 (1.85)	95 (9.3)

Table 5: Prevalence of DM according to family history and hypertension (HT) and their link to prevalence of IGT, IFG and DM

	IFG N=43	IGT N=19	DM N=95
F/H DM - None	39	17	83
F/H DM - Yes	4	2	12
F/H HT - None	38	16	84
F/H HT - Yes	5	3	11

Table 6: Age specific prevalence of T2DM, IFG and IGT

	21-30 yrs	31-40 yrs	41-50 yrs	51-60 yrs	≥ 61 yrs
M	106	125	89	79	70
F	130	162	98	99	64
Total	236	287	187	178	134
T2DM					
M	0 (0.01)	5 (4)	8 (8.99)	14 (17.7)	16 (22.8)
F	4 (3)	4 (2.5)	16 (10.3)	16 (16.2)	12 (18.7)
Total	4 (1.7)	9 (3.1)	24 (12.8)	30 (16.8)	28 (20.4)
IFG					
M	4 (3.8)	5 (4)	6 (6.7)	1 (1.3)	7 (10)
F	2 (1.5)	6 (3.7)	4 (4.1)	5 (5.0)	3 (4.7)
Total	6 (2.5)	11 (3.8)	10 (5.3)	6 (3.4)	10 (7.5)
IGT					
M	1 (0.9)	3 (2.4)	3 (3.3)	1 (1.3)	1 (1.4)
F	1 (0.77)	6 (3.7)	2 (2)	0 (0)	1 (1.56)
Total	2 (0.185)	9 (3.1)	5 (2.6)	1 (0.5)	2 (1.5)

Figures in the parenthesis are percentages

Table 3: Demographic data in normal glucose tolerant, IGT and DM cases

Group	WHO criteria			ADA criteria		
	Age	BMI	M/F	Age	BMI	M/F
Normal glucose tolerance NGT (869)	41.7 ± 13.8	21.37 ± 3.99	397:472	41.7 ± 13.8 (N=888)	21.39 ± 4.01	404 : 484
Impaired glucose tolerant IGT (19)	42.84 ± 11.3	22.21 ± 11.3	9:10	-	-	-
Diabetes mellitus DM (95)	54.13 ± 11.6	23.85 ± 4.26	43:52	54.23 ± 11.54 (N=91)	23.86 ± 4.14	42:49

Table 7: Complete profile of the investigations carried on 1022 individuals of the rural population

	Males (N = 469)	Females (N = 553)
Age yrs	43.82 ± 0.67	42.97 ± 0.25
FPG mM/l	5.31 ± 0.1	5.32 ± 0.08
2h PG mM/l	5.5 ± 0.19	5.32 ± 0.08
F Insulin mM/l	113.41 ± 3.7	107.85 ± 3.11
S Chol mM/L	5.02 ± 0.05	5.16 ± 0.05
S TG mM/l	1.35 ± 0.03	1.17 ± 0.03
S.HDL mM/L	1.21 ± 0.01	1.32 ± 0.01
BMI Kg/m2	21.55 ± 0.16	21.78 ± 0.19
Systolic BP mm Hg	126.67 ± 0.92	127.7 ± 0.9
Diastolic BP mm Hg	80.2 ± 0.5	79.4 ± 0.5
WHR	0.89 ± 0	0.80 ± 0
Waist	78.78 ± 0.49	69.4 ± 0.5
HOMA IR	4.61 ± 0.2	4.41 ± 0.16

showed prevalence of diabetes around 6.7%. This high prevalence was attributed to aging, increased BMI as well as decreased physical activity.[10,11] Rural population of Malaysia showed an increased prevalence rate from 3.9 to 12.2% over a study period of 10 years.[12] That in Bangladesh showed prevalence of diabetes to be 4.5% and prevalence of impaired glucose tolerance (IGT) being about 7.7% which showed an association with BMI.[13] Surveys from Pakistan showed prevalence of DM to be between 11-17% and IGT about 25%.[14] Our study shows that the incidence rate is 4.7% while the prevalence is 9.3%.

Studying the socioeconomic risk factors on the differences in the prevalence of diabetes between rural and urban populations in Bangladesh, the prevalence of type 2 diabetes with age adjusted to 30-64 years and the percentage prevalence of 7.97% with 95 CI in the urban and 3.84% with 2.6 CI in the rural population. Adjusting for age, sex, social class the prevalence of type 2 diabetes, there was no significant differences in the rural population. Increased age, higher socioeconomic class and higher WHR were proven to be independent risk factors for glucose intolerance in either area.[15-17]

From our data we observed the increasing trend of diabetes in the older age group. It is known that the prevalence of diabetes increases with increasing family history of diabetes. The prevalence of diabetes among offspring with one diabetic parent was 36% which increased to 54% with positive family history. A study conducted showed prevalence rate of 62% and risk of 73% when both parents had diabetes.[18,19]

A number of factors contribute towards the increase in the risk of diabetes but there may be a marked difference in the rural and the urban population.[20-22] Type 2 diabetes. The main factors being:

1) *Socioeconomic influences:* Low educational status and the lack of health care facilities in the rural areas delay the diagnosis of diabetes until severe complications develop. More than 70% of diabetic subjects remain undiagnosed in these areas. Studies in India showed a low prevalence of diabetes and were found to be low in the lower income group than the wealthier groups. This being due to high level of physical activity and the lower consumption of refined foods by the poorer people. People residing in Malwan were less educated and were found to be in the lower income group.
2) *BMI:* It is observed that people of the lower socioeconomic status had lower BMI. In the higher socioeconomic groups diabetes, obesity, dyslipidemia and central obesity, especially in the females.
3) *Effect of Urbanization:* Urbanization leads to unhealthy lifestyle changes which adversely affect the metabolic changes. The prevalence of diabetes seems to increase two fold higher in urbanized areas in India then the rural. This was due to the development of industries and the lifestyle changes.
4) *Racial disposition*: There is higher incidence of glucose intolerance in our migrant Asian Indians when compared to local population.
5) *Familial Aggregation:* High prevalence of diabetes in the first degree relatives as well as vertical transmission through more than two generations is commonly seen in Asians Indians. The prevalence of diabetes increases with increasing family history of diabetes. According to literature, it is seen that obesity and upper body adiposity show familial aggregation. The same is reverse in the rural population where laborious work helps to lower the incidences of obesity and central obesity. It is seen that Indians have a genetic phenotype characterized by low body mass index, but high upper body adiposity, and high body fat percentage as well as high level of insulin resistance. With a high genetic predisposition and the high susceptibility to overcome environmental conditions the Indian population faces a high risk for diabetes and its associated complications.

Our findings suggest that the obesity, especially central obesity is related to the prevalence of type 2 diabetes as the BMI showed significant association. Future studies need to be conducted to determine whether genetic predisposition can be one of contributing factors to the increased incidence in the rural population.

Acknowledgements

The authors wish to thank the Director, Dr. Mrs. Meena P. Desai and the Management of the Sir H. N. Medical Research Society for granting us the permission to conduct this project and the funds to make this project a success. Authors also thank Dr. Mrs Rosalind Marita-Ex Scientist for the intial work up of this project and the local people of Malwan district to make the arrangement for conducting the camp and the staff of the Medical Research Society for their help in the conduct of this project.

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