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Original Article

Diabetes Sweeping Rural Areas: Findings from Community Based Study in Rural Agra, India

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ABSTRACT

Introduction: The International Diabetes Federation (IDF) showed that nearly 7 crore people in India were suffering from diabetes in 2015 and this number is projected to be 12.5 crore by 2040. India's economic boom has been accompanied by a dramatic upsurge of diabetes. Globalization of unhealthy lifestyles are closing the gap between urban and rural diabetes. So it has become important to estimate the diabetes prevalence and risk factors in rural Agra, India where no community based data was available. **Material and Methods:** This community based cross-sectional study was carried out in rural Agra from June 2013 to 2014. The sample size was calculated to 1209. Data was collected using a structured and pre-tested questionnaire while fasting blood glucose measured with the help of Glucocard - Vital Glucometer. The data was compiled and statistically analyzed using SPSS-22 software. **Results:** The prevalence of Diabetes Mellitus in rural Agra was found to be 7% with a *diagnostic gap of 37%*. Prevalence of Diabetes was observed significantly associated with the age, occupation and socioeconomic status. Prevalence of Diabetes Mellitus was significantly more in people with higher Body mass index (13.3%), centrally obesity (10.3%) and higher Waist Hip Ratio (8.4%) than with normal BMI (4.4%) , non-obese (4.2%) and normal WHR category (1.6%). On multiple logistic regression age, hypertension, BMI and WHR contribute as risk factors for developing Diabetes mellitus. **Conclusion:** As evident from findings diabetes is becoming common in rural population also, adding to the problem is poor awareness. Health care systems should be strengthened for early detection and effective treatment of disease.
Key words: Diabetes, Prevelance, Risk factors, Diagnostic gap, Prevalence, Body mass index.

INTRODUCTION

Diabetes mellitus as called madhumeha (sweet urine disease) has its citation thousands of year back in "charaka samhita".[1] Present in every country and affecting millions around globe, Kelly west often called father of diabetes epidemiology labeled it as epidemic way back in 1921.[2] WHO with diabetes as World health day theme in 2016 highlighted this growing problem stating *"422 million people have diabetes around the world. That's almost four times than in 1980!!"* India has around 65 million diabetics (Lancet 2016)…40 % of Delhiites are diabetic (ET health news Aug 2016)…five out of the top 10 largest-selling drugs in the country are now anti-diabetes (AICOD July 2016)…prevalence of adult diabetes in India was recorded at 9.5% in 2015 against a global average of 9% (global nutrition report 2016)…all these news are a grim reminder of the growing incidence of lifestyle diseases in developing countries.

The International Diabetes Federation (IDF) showed that nearly 7 crore people in India were suffering from diabetes in 2015 and if changes in lifestyle and food habits are not made this number will be 12.5 crore by 2040. This paper, based on data from 751 studies, showed that the prevalence of diabetes has increased 80% in women and more than doubled in men in the country.[3] India's economic boom has been accompanied by a dramatic upsurge of diabetes. Some issues are troubling country -double burden problem (it is housing maximum stunted children and at 7 crore, India is among top 3 countries with highest diabetic population), distressing fact that now it is appearing even at lower BMI and lower age,[4] though Universal health coverage (UHC) is fuelling but data shows cardiovascular disease patients in India spent 30% of their annual family income on related healthcare.

These figures in millions and doubling rate is quite alarming, same as the risk factors as the *so called status symbol tags are now becoming stress symbols*. Ever growing threat of over nutrition, obesity and diabetes, rapid cultural and social changes, ageing population, increasing urbanization, dietary changes, reduced physical activity and unhealthy behaviors. Globalization of unhealthy lifestyles are closing the gap between urban and rural diabetes. Nearly 68.84% of India resides in rural areas (census 2011). Recent figures showed surprisingly increased rates in rural areas. The prevalence in rural areas of the Chandigarh, Tamil Nadu, Maharashtra and Jharkhand, was 8.3%, 7.8%, 6.5% and 3% respectively.[5] Lack of area specific data in state of Uttar Pradesh and wave of westernization lifestyles and food engulfing people in rural area also,

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it has become important to measure the prevalence, socio-demographic factors and risk factors associated with it.

MATERIAL AND METHOD

This study was carried out in the field practice area of rural health training center (RHTC) Saiyan, attached to Department of community medicine, S.N. Medical College, Agra from July 2013 to July 2014. Due to familiarity with the area and frequent visits we selected four by random sampling villages from Saiyan block. Four villages were selected by random sampling and all population above 30 years presented on the day of survey and willing to participate were taken for the study. House to house survey was done. The total number of subjects thus surveyed from four villages was 1209. Data was collected using a structured and pre-tested questionnaire. The questionnaire was translated into the local language. The subjects were briefed about the procedure of the investigation and a repeat visit was made on the consecutive day early in the morning to measure fasting capillary blood glucose with the help of Glucocard-Vital Glucometer. Physical activity was measured using International Physical Activity Questionnaire (IPAQ). Activities are classified as vigorous and moderate physical activities. The total duration of physical activity, per week, is calculated to the nearest minute; metabolic equivalents (MET) are calculated. The data was compiled and statistically analyzed using SPSS-22 software.

Definitions and Diagnostic Criteria: Diabetes Mellitus was defined on criteria laid by WHO i.e. Fasting Plasma Glucose ≧126 mg/dl, for Impaired Fasting Glucose (IFG) =110-125 mg/dl and known Diabetics under treatment.[6]

RESULTS

The prevalence of Diabetes Mellitus in rural Agra was found to be 7%. Almost one third (2.7%) were newly diagnosed while the remaining were known diabetics; *thus giving a diagnostic gap of 37%.* (Table 1). The standardized prevalence (standardized with census 2011 population) of Diabetes Mellitus was calculated to be 7.7%. Prevalence of Diabetes was observed significantly associated with the age, occupation, socioeconomic status. The difference is statistically significant between all groups combined and laborers of participants. Diabetes is not choosing caste as it was found insignificant. The prevalence of diabetes was highest in class I statistically significant difference between class I and class IV & V. (Table 2,3,4)

Prevalence of Impaired fasting glucose was found to be 6.4% using WHO criteria and almost four times (26.6%) using ADA criteria. (Table 5) Prevalence of Diabetes Mellitus was more in People with higher BMI (13.3%), centrally obesity (10.3%) and higher Waist Hip Ratio (8.4%) than with normal BMI (4.4%), non-obese (4.2%) and normal WHR category (1.6%). (Table 6,7,8,9) Among Hypertensives, diabetes was found to be higher as compared to normotensive and the difference is statistically significant. (Table 10). Prevalence of diabetes decreased significantly from 10.7% among those with low physical activity to 4.4% among those having vigorous activity. (Table 11) Variables significant in univariate analysis were included for multiple logistic regression-age, hypertension, BMI and WHR contribute as risk factors for developing Diabetes mellitus in this study. (Table 12)

DISCUSSION

India, the second most populous country of the world, has been severely affected by the global diabetes epidemic. There is clear evidence to show that diabetes prevalence is rapidly increasing, both in urban and rural India. This study for rural Agra found prevalence of diabetes mellitus to be 7.0% which is in accordance with a multicentric study, ICMR-INDIAB (2011) which reported prevalence as 6.5%, 7.8% and 8.3% in rural areas of Maharashtra, Tamil Nadu and Chandigarh respectively but much lower prevalence (3.0%) in Jharkhand housing majority of labor population.[5] While slightly lower figures were seen in Gupta *et al.* (2010), Ahmad *et al.* (2011) and Majgi SM *et al.* (2012) among rural population of Tamilnadu (5.9%), Kashmir (6.05%) and Puducherry (5.8%) respectively, may be because of inclusion of lower age group (≥20 years).[7,8,9]

Baridalyne *et al* in 2008 found prevalence of 3.9% in rural north India may be due to inclusion of younger age group, smaller sample size and study being conducted *almost seven years back.*[10] Goa and Karnataka have more diabetic (10.3% and 10.5% respectively) in rural areas which could be due to entirely different socio-cultural milieu.[11,12] A rural hospital based study in Haryana reported a very high prevalence (18.43%) of Diabetes.[13]

WHO and ADA (American Diabetes Association) follow same fasting blood sugar criteria (≥126 mg/dl) but have different cut-off value for Impaired Fasting Glucose (WHO recommends >110 mg/dl whereas ADA's cut-off value for IFG is >100 mg/dl). Thus prevalence of Impaired fasting glucose was found to be 6.4% using WHO criteria and almost four times (26.6%) using ADA criteria. Similar prevalence (25.2%) was found Adopting ADA criteria (25.2%).[14]

Anjana *et al.* (2011) reported the prevalence of IFG among 20 years and above as 4.4% to 4.7%, lower than present study, the prime factor might be inclusion of lower age group. Despite lower age of the subjects (≥20 years), they reported higher prevalence from Maharashtra and Chandigarh (7.6 and 10.9% respectively), which perhaps reflects the variation of sociocultural attributes favoring Diabetes in these states. Vijaykumar *et al.* (2009) adopting ADA criteria reported a lower prevalence of IFG (5.1%), but higher prevalence of Diabetes (12.5%) in rural Kerala.[15] Higher prevalence (11.1%) of IFG was reported in Kashmir valley in age group 20-40 year, many of whom might be in early transition phase for becoming diabetic in future.[14]

The present study showed significant increase in prevalence of Diabetes Mellitus (p-0.002) with the age of study subjects ,this finding is comparable to other studies.[5,8,9,12,16,17] *There was no diabetic from 30-39 years of age* and a small drop reported from 65-70 years , peaks till 60-69 age group. On regression analyses age is found to be significant risk factor similar to Anjana *et al.* (2011). Males (8.6%) were more diabetic than females (5.7%) but difference is statistically insignificant. Contrary some studies reported a higher prevalence among males.[4,12,13] However population based multicentric studies NUDS (2001) and PODIS (2004) reported similar prevalence in males and females.[18,19] But more diabetic females were found by Bhalerao *et al.* (2014) and Vaz *et al.* (2011).[20,21] *So conclusive gender wise pattern cannot be established.*

Education is not influencing the prevalence of Diabetes. Similar results were obtained from a cohort study among industrial workers by.[22] In urban India and many western studies had reported lower prevalence of Diabetes among more with educated groups.[22,23.24] This subtly points towards the different stages of NCD epidemic in which these countries lie- In the west due to better health education the more educated groups have already adopted life style conducive to avert Diabetes whereas, India is lagging behind as low education status may influence the lesser awareness, lesser opportunity for prevention/control, hence it may take a few more decades for India to witness this change.

The present study as in some other studies,[9,25,26] found occupation to be significantly associated with the prevalence of DM .This association of diabetes with occupation could be due to combined effect of physical activity and work related stress. Then the Prevalence showed a significant difference between class I and class IV and V (p=0.04). Similarly Vaz *et al.* (2011) in Goa found highest prevalence in class II while the lowest prevalence upper lower class IV.

Table 1: Prevalence of diabetes and IFG (Impaired fasting glucose) among Study Subjects

Fasting Blood Sugar Status	Hyperglycemic N=162(13.4%)			Normoglycaemic	Total
	Diabetes Mellitus n=85(7.0%)		Impaired Fasting Glucose		
	Known diabetic	Newly diagnosed			
N	53	32	77	1047	1209
(%)	4.4	2.6	6.4	86.6	100

Table 2: Age wise Prevalence of Diabetes Mellitus and Impaired Fasting Glucose in study subjects

Age	Hyperglycemic				Normoglycaemic		Total
	Diabetes Mellitus		Impaired Fasting Glucose				
	N	%	N	%	N	%	
30-39	0	0	8	2.4	322	97.6	330
40-49	16	5.0	24	7.3	286	87.8	326
50-59	32	12.1	24	9.0	208	78.8	264
60-69	25	14.2	11	6.2	140	79.6	176
≥70	12	10.7	10	8.9	91	80.6	113
Total	85	7.0	77	6.4	1047	86.6	1209

χ^2=56.4, df=4, p=0.001

Table 3: Distribution of Diabetic and IFG Study Subjects as per their Occupation

Occupation	N	Diabetes Mellitus		Impaired Fasting Glucose	
		n	%	n	%
Service/ Professional	100	10	10	10	10.0
Shop-owner/ Business	31	3	9.7	2	6.4
Farmer	185	18	9.7	6	3.2
Laborer	288	12	4.1	20	6.9
Unemployed /Retired	140	12	8.5	6	4.2
Housewife	465	30	6.4	33	7.0
Total	1209	85	7.0	77	6.4

χ^2=4.74, df=1, p=0.029

Table 4: Distribution of Diabetic and IFG Subjects as per their Socio-Economic Class

Socio-Economic Class	N	Diabetes Mellitus		Impaired Fasting Glucose	
		N	%	n	%
Upper (I)	56	8	14.2	4	7.1
Upper Middle (II)/Lower Middle (III)	109	6	5.5	12	11.0
Upper Lower (IV)/Lower (V)	1044	71	6.8	61	5.8
Total	1209	85	7.0	77	6.4

χ^2=4.73, df=1, p=0.03

Table 5: WHO Vs ADA Diagnostic Criteria for Impaired Fasting Glucose (IFG)

Age	Impaired Fasting Glucose (IFG)			
	WHO		ADA	
	N	%	n	%
30-39	8	2.4	60	18.1
40-49	24	7.3	104	31.9
50-59	24	9.0	68	25.7
60-69	11	6.2	51	28.9
≥70	10	8.8	39	34.5
Total	77	6.4	322	26.6

Table 6: Association between Diabetes Mellitus and BMI of the subjects (WHO criteria)

Diabetic status BMI	N	Diabetes Mellitus		Impaired Fasting Glucose	
		N	%	N	%
<18.5(Underweight)	319	12	3.8	17	5.3
18.5-24.9(Normal)	537	26	4.8	20	3.7
25-29.9(Overweight)	279	41	14.7	22	7.9
30-34.9(Obesity 1)	64	6	9.3	14	21.8
≥35 (Obesity 2)	10	0	0	4	40.0
Total	1209	85	7.0	77	6.4

Fischer test=35.5, df=4,p<0.0001

Table 7: Association between Diabetes Mellitus and BMI of the study subjects (Asian criteria)[122]

Diabetic status BMI	N	Diabetes Mellitus		Impaired Fasting Glucose	
		N	%	N	%
<18.5(Underweight)	319	12	3.7	17	5.3
18.5-22.9(Normal)	455	18	3.9	20	4.3
23-24.9(Overweight)	138	16	11.6	4	2.8
≥25 (Obese)	297	39	13.1	36	12.1
Total	1209	85	7.0	56	6.4

χ^2=32.8, df=1, p=0.0001

Table 8: Association between Waist Circumference (WC) and Diabetes among Males and Females

Diabetic status Waist Circumference		Diabetes Mellitus	Impaired Fasting Glucose	Normal	Total (%)
Males	Normal	24(6.6)	11(3.0)	331(90.4)	366(67.0)
	High	23(12.8)	20(9.0)	137(76.2)	180(33.0)
	Total	47(8.6)	31(5.6)	468(85.8)	546(100)
Females	Normal	4(1.3)	14(4.8)	276(93.9)	294(44.3)
	High	34(9.2)	32(8.7)	303(82.1)	369(55.7)
	Total	38(5.7)	46(7.2)	579(87)	663(100)

Male (p=0.005), Female (p=0.0001)

Table 9: Association of Waist Hip Ratio (WHR) with Blood Sugar Status of Males and Females

Diabetic status WHR		Diabetes Mellitus	Impaired Fasting Glucose	Normal	Total (%)
Males	Normal	4(2.4)	5(3.0)	155(94.6)	164(30.0)
	High	43(11.2)	26(6.8)	303(79.0)	382(70.0)
	Total	47(8.6)	31(5.6)	468(85.7)	546(100)
Females	Normal	0(0)	4(4.7)	80(14.0)	84(13.0)
	High	38(6.6)	42(7.2)	499(86.0)	579(87.0)
	Total	38(5.7)	46(7.0)	579(87.3)	663(100)

Fisher test=12.7 df=1 p=0.0001 Fisher test=6.03 df=1 p=0.014(??)

Table 10: Association of Hypertension and Diabetes Mellitus in Study Subjects

Diabetic status Blood Pressure	Diabetes Mellitus	Impaired Fasting Glucose	Normal	Total (%)
Normal	16(18.8)	27(35.0)	473(47.2)	516(42.7)
Pre-hypertension	27(31.8)	32(41.6)	378(36.1)	437(36.1)
Hypertension	42(49.4)	18(23.4)	196(18.7)	256(21.2)
Total	85(100)	77(100)	1047(100)	1209(100)

χ^2= 45 .0 df – 1 p-value=0.00001

Table 11: Association of Physical Activity with Diabetes Mellitus Status of Study Subjects (International Physical Activity Questionnaire)

Physical Activity	N	Diabetic		Impaired Fasting Glucose	
		N	%	N	%
Low	412(34.0)	44	10.7	29	9.4
Moderate	616(51.0)	33	5.3	41	6.6
Vigorous	181(15.0)	8	4.4	7	3.8
Total	1209(100)	85	7.0	77	6.4

χ^2=12.7 df=1 p=0.001

Table 12: Logistic Regression Analysis of Risk Factors for Diabetes Mellitus

Variable	Odds ratio	CI (95%)		p-value
		Lower	Upper	
WHR	2.780	1.490	5.188	0.001
Age	1.984	1.193	3.298	0.008
BMI	1.797	1.070	3.020	0.027
Hypertension	1.752	1.032	2.973	0.038
Physical activity	0.623	0.385	1.008	0.054
Family History	2.158	0.820	5.680	0.119
WC	1.394	0.699	2.782	0.346

Early diagnosis and treatment is important to reduce morbidity and mortality in non-communicable diseases. *Diagnostic gap of 37% was calculated* (Prevalence of diabetes mellitus was 7%, of these 2.6% are newly diagnosed while the remaining are known diabetic). Ahmad *et al*. (2011) and Deepthi R *et al*. (2013) found a gap of 33% and 46%. Anjana *et al*. (2011) multicentric study reported diagnostic gap of more than 50% perhaps due to larger sample size of study.[5,12,18]

Insight into risk factors is important for the prevention. The present study showed that BMI is a significant independent predictor of development of diabetes. *It also supported the evidence that among Asians, even at lower BMI, there were higher odds (3.8) of diabetes* and the prevalence shows a marked difference among those having high BMI (12.6%) as compared to those having normal BMI (3.8%). WHR an index of central obesity was significantly associated with increase in prevalence of DM. Prevalence of diabetes mellitus is also found to increase with increasing WHR and WC. Chances of having diabetes mellitus are found to be 2.8(odds ratio) times and 5.8 (odds ratio) times higher respectively with higher WC and WHR which in conformity with the study of Ohlson *et al* and Rathod *et al* (2014). Some other studies also found similar findings in relation to age, BMI, WHR, WC.[26,27] Ahmad *et* al (2011) stated that evidences both from prospective and cross-sectional studies suggest obesity to be strongly linked to Diabetes.

Prevalence of diabetes decreased significantly from 10.7% among those with low physical activity to 4.4% among those having vigorous activity. Kokiwar *et al*. (2007) and Majgi *et al*. (2012) reported same in rural Maharashtra and Puducherry.[9,28] Contrary Raghupathy *et al*. (2007) in rural Vellore found no association, the difference obviously is because of younger study subjects (26-32 years)-an age not prone to become diabetics.[29] However this significance faded under multivariate analysis (p=0.054) (odd's ratio is 0.6) reflecting physical activity is not an independent risk factor for diabetes mellitus.

The present study depicts that Hypertension is significantly associated with Type II Diabetes mellitus. Around 49% of diabetic are hypertensive, 31.8% prehypertensive and only 18% were normotensive. Odds of having hypertension among Diabetic is calculated as 1.72 thus depicting higher chances of hypertension in diabetics. Anjana *et al*. (2011) and some other studies also alarmed hypertension as important risk factor.[25,30,31] However, with IFG no such association was observed.

Asian Indians have an ethnic susceptibility to Type II diabetes and a high familial aggregation of the disease. Similarly present study showed significantly higher prevalence of diabetes among those with positive family history (40%) as compared to those with no family history (6.7%). Odds of diabetes with family history are 3.2-times compared those without family history of diabetes. Ramachandran A *et* al. (2001) Vaz *et al*. (2011) *and* B. Valliyot *et al*. (2013) also found significant association with family history.[19,21,25] Unhealthy eating contributes largely to obesity. According to WHO diets consumed in South East region typically energy dense, high in saturated fatty acids and low in fruits and vegetables, which are established risk factor for the development of type II diabetes mellitus. But no association was found with servings of fruits and vegetables also same fining by B. Valliyot *et al*. (2013) in his case control study.

Study is limited by sample size as number of villages selected may not represent total population. The confounding variables whether known or not known are inevitable in any analytical study. A possibility of recall bias in the family history of diabetes cannot be ruled out due to the inadequate literacy levels of the rural population.

CONCLUSION

As evident from findings diabetes is becoming common in rural population also, adding to the problem is poor awareness. Health care systems should be strengthened for early detection and effective treatment of disease. NPCDCS (National program for control of diabetes, cancer and stroke) has focused on awareness generation for behavior and lifestyle changes, screening and early diagnosis, treatment and referral to higher facilities for appropriate management for non-communicable diseases (recently ASHA is being deployed for the screening of diabetes and hypertension).

WHO calls for multi-sectoral, population-based approaches to help reduce risk factors for diabetes in the general population and recommends healthy eating and physical activity from an early age to prevent type 2 diabetes later in life. Importantly, regulation of marketing, trade and agricultural policies to promote healthier eating is also proposed. Prevention is of utmost importance, but for the millions of diabetics managing their disease must remain the priority. WHO's report recommends a multidisciplinary approach with patient education, medication, and consistent follow- up.

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CONFLICTING INTEREST

Nil

ABBREVIATION USED

BMI: Body mass index; **WHR:** Waist Hip ratio; **WC:** Waist circumference; **IFG:** Impaired Fasting Glucose; **ADA:** American diabetes association.

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