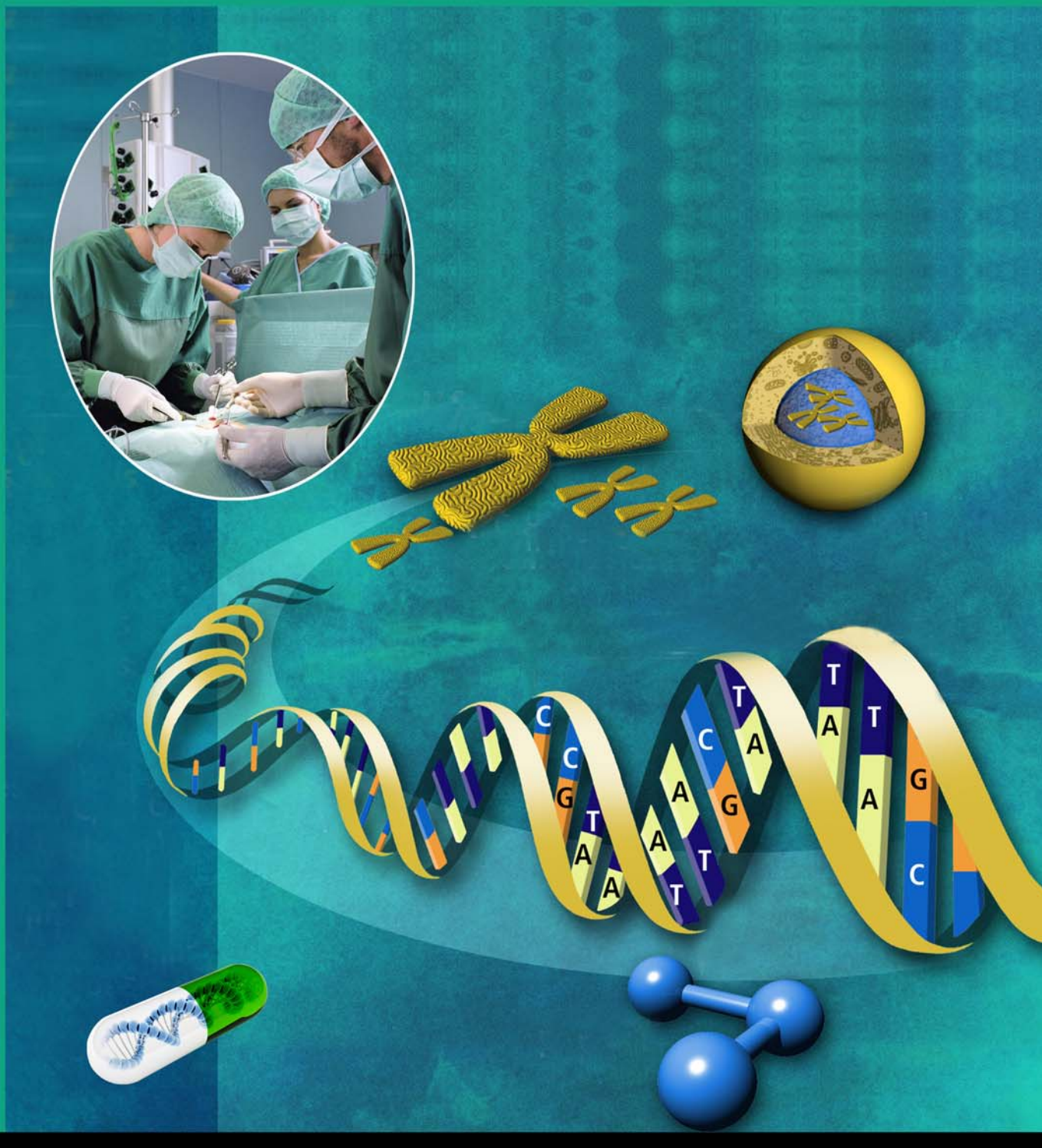
ISSN 2278 - 5221
Vol. 3, No. 1, January 2014

International Journal of Pharma Medicine and Biological Sciences

IJPMBS



WWW.IJPMBS.COM

editorijpmbs@gmail.com or editor@ijpmbs.com

International Journal of Pharma Medicine and Biological Sciences

ISSN 2278 – 5221 www.ijpmbs.com
Vol. 3, No. 1, January 2014

Research Paper

RISK FACTORS FOR TYPE 2 DIABETES MELLITUS IN RURAL POPULATION OF NORTH KARNATAKA: A COMMUNITY-BASED CROSS-SECTIONAL STUDY

Sanjay D Bhalerao[1]*, Manjunath Somannavar[2], Sunil S Vernekar[1], Rajashree Ravishankar[1] and Shivprasad S Goudar[1]

Corresponding Author: **Sanjay D Bhalerao ✉ sanjaybiophysics@gmail.com*

Background: Diabetes Mellitus is emerging as a major health problem owing to its serious complications. It is important to assess the various factors contributing to the occurrence of the diseases so that by limiting these factors the progression of the disease in patients can be controlled. Hence, the present study was undertaken to determine the risk factors for T2DM amongst adults aged above 30 years in rural population of North Karnataka. Methods: Community based cross sectional study was carried out at three Primary Health Centers of Handignur, Vantamoori and Kinnaye under administrative control of Jawaharlal Nehru Medical College, Belgaum, Karnataka, India. Statistical analysis: Logistic regression analysis was used to study the association of different risk factors with prevalence of type 2 DM. P values <0.05 was considered as statistically significant. Results: Age, occupation, Body Mass Index, diet, smoking, alcohol, truncal obesity and family history of DM were significantly associated with prevalence of T2DM whereas gender and literacy were not. Interpretation and conclusion: The prevalence of T2DM was influenced by predictors such as age, occupation, BMI, diet, Smoking, alcohol consumption, truncal obesity and family history of diabetes.

Keywords: Sociodemogrpahic correlates, Type 2 diabetes mellitus, Risk factors

INTRODUCTION

Diabetes mellitus (DM) is becoming a pandemic disease worldwide. As per World Health Organization (WHO), DM is a heterogeneous metabolic disorder characterized by common features of chronic hyperglycemia with disturbance of carbohydrate, fat and protein metabolism. Multicentric study in 2004 showed prevalence of DM as 5.4% and 3.4% in urban and rural parts of India respectively (Ramchanran, 2000; Wild, 2004). The difference in the prevalence of diabetes mellitus among urban –

[1] Department of Physiology, KLE University's Jawaharlal Nehru Medical College, Belgaum, Karnataka, India.
[2] Department of Biochemistry, KLE University's Jawaharlal Nehru Medical College, Belgaum, Karnataka, India.

rural population within the same ethnic group (Indians) can be attributed primarily to the 'modern' lifestyle of urban Indians compared to the 'traditional' lifestyle of rural Indians. The differences in lifestyle factors in urban-rural India include dietary pattern, physical activity and mental stress. The prevalence of diabetes mellitus differs not only across the rural-urban divide but also across the different States o India. This is because different Indian states are at different stages of demographic transition (Mohan *et al*., 2008 and Ramchandran *et al*., 2004). In 2008, The World Health Organization has stressed on the importance of studies related to diabetes epidemiology which in turn, would be helpful in carrying out appropriate interventions (World Health Organization, 2008).

DM requires continuing medical care and patient education to prevent acute complications and to reduce the risk of long-term complications (American Diabetes Association, 2001 ;UKPDS, 1998). There is widespread agreement that specific tests are necessary to monitor for early signs of diabetic complication (Gavin *et al.,* 2004). DM is expected to continue as a major health problem owing to serious complications. Before the commencement of any kind of management measures it is important to assess the various factors contributing to the occurrence of the disease so that by limiting these factors the progression of the disease in diabetic patients can be controlled. As well as the chance of occurrence of type 2 diabetes mellitus in susceptible individuals can be prevented by reducing the exposure to the specific pre disposing factor that has been ruled out. The baseline data regarding the prevalence and its risk factors is essential before implementation of National Program for control of Diabetes, Cardio-vascular diseases and Stroke (Chythra Rao, 2010 and Majagi, 2012). The present study will be helpful in increasing the awareness about diabetes and its complications in the rural population of these regions of north Karnataka. So this study is intended to access the various predisposing factors for type 2 diabetes mellitus in rural population of North Karnataka (Bhalerao, 2013).

OBJECTIVES OF THE STUDY

- The primary objective was to study the various risk factors for type 2 diabetes mellitus in rural population of north Karnataka.
- The secondary objective was to correlate the prevalence of T2DM with various risk factors for T2DM such as: Age groups, Gender wise distribution of the diabetic subjects (male and female), Literacy status, Occupation, Diet (Vegetarian and Non-vegetarian), Smoking and Alcohol consumption, Family history of Diabetes, Central and Truncal obesity.

MATERIALS AND METHODS

Study Design

A community based cross-sectional study

Study Site and Duration

The study was carried out in three Primary Health Center (PHC) areas at Handignur, Vantamoori and Kinnaye, associated with J N Medical College, Belgaum (North Karnataka), India during August 2009 to 2012. These areas were chosen due to their proximity to Belgaum facilitating collection of fasting blood samples in the early mornings. The study was approved by the JNMC Institutional Ethics Committee.

Inclusion Criteria

Individuals with typical symptoms of T2DM, physician diagnosed patients as T2DM (FBG>126 mg/dl), individuals who were 30 years and above aged, overweight (BMI>25 kg/m^2), and Hypertension (>140/90 mm Hg)

Exclusion Criteria

Individuals who declined for informed consent, not available at home after repeated visit, pregnant women/who had delivered a baby weighing >4.5 kg, by women who had gestational diabetes, individuals with psychological and endocrinal disorders.

Sample Size and Sampling Method

The sample size was calculated based on data from prevalence study conducted in rural areas of Mysore District (lowest being 3.8%) which are geographically and socio-culturally similar to the study area. Considering error of 1% with 95% confidence level, the sample size was estimated to be 3000. The detailed sample size calculation and sampling method is published elsewhere (Bhalerao, 2013).

Blood Glucose Measurements

WHO recommends standard glucometer to measure blood glucose for epidemiological purpose (WHO, 1999). On a pre-informed date, fasting blood glucose (FBS) was estimated (after overnight fast) in morning by using a standard digital Glucometer (Omnitest Plus B-Brown Germany). Glucometer was standardized by (as per ISO criteria) cross-checking laboratory results (Biochemistry Laboratory of KLES Hospital & Medical Research Centre, Belgaum). Difference in the glucometer and the laboratory readings was not above 1% and correlation coefficient was found to be 0.8 (WHO, 2003 and Sadikot, 2004)

Anthropometrical Measurements

Anthropometric measurements include height, weight, waist circumference and hip circumference (WHO, 2000). Weight was recorded by using a standard Krups weighing scale kept on firm horizontal surface. Weight was recorded to the nearest 500 g. Height was recorded by using a measuring tape to the nearest 1 cm. Subjects were requested to stand upright without shoes with their back against the wall, heels together and looking forward Body Mass Index (BMI) was calculated by formula: weight in kilogram divided by height in meter squared [weight (kg)/height (m^2)] (WHO, 1995 and Suchalatha, 2003). Waist circumference was measured to the nearest 0.1 cm at the mid-point between the costal margin and iliac crest using a non- stretchable measuring tape at the end of normal expiration with the subject standing erect in relaxed position feet 25-30 cm apart. Hip circumference was measured at the level of greater trochanters (widest position of hip to the nearest 0.01 cm with a measuring tape, while the subject was standing with the arms by side and feet together. Waist-Hip ratio was calculated as the ratio of waist circumference and Hip circumference (WHO, 2000). Study subjects were considered to be overweight when BMI>23 kg/m^2 and obese if body mass index (BMI>25 kg.m^2). Central/abdominal obesity was considered to be present when waist circumference >90 cm in males and >80 cm in females. Waist-Hip ratio of >1.0 for males and >0.85 for females was defined as truncal obesity (Khan, 2006, Ashwinkamath, 2011).

Blood Pressure Measurement

Blood pressure was measured on the left arm in sitting posture, with the subject in a relaxed state. Standardized mercury sphygmomanometer

(Diamond deluxe BP apparatus, Pune India) with adult size cuff was used. The first appearance of (phase I of Korotkoff sounds) sound was used to define Systolic Blood Pressure (SBP). The disappearance of sound (phase 5) was used to define Diastolic Blood Pressure (DBP). Study subjects were considered to be hypertensive if he/she was an already diagnosed case of hypertension and /or on treatment or with a current SBP of >140 mmHg or DBP>90 mm Hg (JNC VII criteria) (Chobanian *et al*., 2003).

Socioeconomic Status

The participants were interviewed with a pre-tested questionnaire regarding identification, demographic details, behavioral components, social and biological variables. Education was classified based on International Standard Classification of Education (UNSCO, 1997). The occupation of study subjects was classified as workers and non-workers as per census of India 2001. Further workers were subdivided based on their occupation such as Skilled-I to Skilled –IV (Govt. of India Report, 2004). Non-workers included house-wives and elderly persons who have stopped working(Chaturvedi, 1996).

Family History of Diabetes

Detailed family history of T2DM was taken. This was verified either by blood glucose measurement of the parents or in the person's absence, by other circumstantial evidences such as physician report, diet modifications, consumption of drugs. Known cases of T2DM were included in the study. Duration of diabetes and medication details were noted. In the present study, if the response was "diabetes status of parents not known", it was assumed to be "No family history of DM" (Prabhakaran, 2005, Meigs, 2000 and Vishwanathan *et al*., 1996).

Smoking and Alcohol

Smoking and alcohol were considered as risk factors. Smoking was measured in terms of frequency those who were smoking daily for 6 months and quantum tobacco chewing/beedies/ cigarettes/cheroots per day (Toshimi *et al*., 2004 and Nakanishi *et al*., 2000). Based on tobacco content of Indian beedis, cigarettes and cheroots, Indian cigarette equivalents of beedi and cheroot were calculated (The alcohol consumption pattern (amount, type and frequency) of current drinkers and past drinkers (who have stopped before 12 months) was noted (Saleai *et al*., 2006, Wei *et al*., 2000 and Howard, 2004).

STATISTICAL ANALYSIS

Descriptive statistics was used to assess the frequency distribution. Student unpaired 't' test was used to compare the mean values in diabetic and non-diabetic participants. The trends in the prevalence of diabetes among different correlates Chi-square test was used. To study the impact of selected socio-demographic factors, anthropometric measurements (BMI) and other risk factors on prevalence of T2DM, multiple logistic regression analysis was done considering diabetes as a dichotomous outcome and age, sex, occupation, literacy, family history, substance abuse, BMI, Waist-Hip ratio as independent variables. Statistical analysis was performed using statistical analysis package for Social Science (SPSS) version 16.0. P-value >0.05 was considered significant.

RESULTS

The study included 3000 subjects with response rate of 89.28%. The baseline characteristics of the study subjects are shown in Table 1. There was inadequate representation of males in the study

sample (36.8% males Vs 63.2% females) as most of them were involved in agricultural work and were not available during survey. A total 474 T2DM (299 known and 175 newly detected) were identified, the total prevalence being 17.7% (Table 1).

Table 1 revels the baseline descriptive statistical features associated with the socio-demographic profile of the study population. Table 1 showed that the prevalence of diabetes increased significantly with age. The increased prevalence was observed in the middle age group 40-49 years (30.4%) and in the old age group above 60 years age group (37.8%)

The prevalence of T2DM among gender was observed elevated in females (64.6%) compared to males (35.4%). The prevalence of T2DM in association with literacy observed in this study was - Illiterate group (47.3%), Primary education group (19.2%), Secondary school group (28.7%) and graduation and above group (4.9%). The prevalence stratified by occupation ranged from 11.7% (skilled I) to 23.4% (Non workers) (Table 1).

The increase in the prevalence of T2DM across the BMI classes was significant. The prevalence of T2DM was 21.7% and 44.1% among subjects with BMI less than 24.9 kg/m^2 and more than 25 kg/m^2 respectively. The prevalence of T2DM in mixed diet was 75.5% and in veg diet was 24.3%.. The prevalence of type 2 DM increased with the family history of diabetes. The prevalence of T2DM was 86.1% amongst subjects having family history of diabetes. Prevalence of T2DM was more in those who had maternal history of diabetes (53.43%) than paternal history (17.15%) (Table 1 and Figure 1).

The prevalence of T2DM in relation to substance abuse like smoking was 30.2% and alcohol consumption was 26.4%. The prevalence of T2DM in association with truncate obesity was 51.5% and central obesity was 46.6 % (Table 1).

Table 2 reveals the difference of Mean±SD values in diabetic and non-diabetic individuals by using independent 't' test analysis. Among the study participants, in diabetic individuals Mean age was 53.43±8.5 and in non-diabetic individual it was 52.01±8.89. Mean height was 154.7±8.0 for diabetic individuals and 156.4±8.0 for non-diabetic individuals. The Mean±SD of weight among diabetic individuals and non-diabetic individuals was 67.27±8.5 and 59.6±7.9, respectively. In the BMI category, Mean±SD of BMI amongst diabetic and non-diabetic individuals was 58.25±4.3 and 24.43±3.3, respectively. The Mean±SD value for Waist-Hip ratio among diabetic and non-diabetic individuals was found to be 0.88±0.07 and 0.88±0.06, respectively. The Mean±SD of fasting blood sugar in diabetic and non-diabetic individuals was 128.2±35.1 and 100.2±11.4, respectively. The Mean±SD values of SBP in diabetic and non-diabetic individuals were 129±13.2 and 125.4±10.5, respectively. The Mean±SD values of DBP in diabetic and non-diabetic individuals were 85.5±8.4 and 87.7±5.6, respectively. The mean value of duration of diabetes which was observed only in known diabetic individuals was 6.96±6.1 years.

Table 1 shows the association of risk factors with prevalence of T2DM by chi-square test analysis. Risk factors such as age, occupation, BMI, diet, smoking, alcohol drinking, truncal obesity and family history of T2DM were significantly associated with prevalence of T2DM, whereas variables as gender, literacy, were not significantly associated with prevalence of T2DM

The results of logistic regression analysis are

Table 1: Sociodemogrpahic Details and Correlation of Various Risk Factors with Prevalence of T2DM

Demographic Characteristics			Correlation of Different Risk Factors and Prevalence of T2DM	Association of T2DM and Risk Factors by Chi-square Test
Variable	Category of Variable	Frequency Distribution (%)	T2DM Prevalence (%)	
Age	30-39	6.82	4.9	0.006*
	40-49	32	30.4	
	50-59	29.7	27.0	
	≥60	31.4	37.8	
Gender	Male	36.8	35.4	0.508
	Female	63.2	64.6	
Literacy	Illiterate	45.1	47.3	0.510
	Primary	18.6	19.2	
	Secondary	31.6	28.7	
	Graduation and above	4.69	4.9	
Occupation	Skilled I	42.4	11.7	<0.001*
	Skilled II	10.5	19.8	
	Skilled III	3.46	21.5	
	Skilled IV	10.7	20.2	
	Non workers	32.9	23.4	
BMI	≤18.9	3.13	0.2	<0.001*
	19-24.9	51.3	21.7	
	25-29.9	35	44.1	
	≥30	10.5	33.1	
Diet	Veg	28.3	24.3	0.031*
	Non-veg	71.7	75.7	
Smoking	Yes	20.4	30.2	<0.001*
	No	79.6	69.8	
Alcohol	Yes	17.3	26.4	<0.001*
	No	82.7	73.6	
Central obesity	Yes	47.2	46.6	0.794
	No	52.8	53.4	
Truncal obesity	Yes	47.2	51.5	0.042*
	No	52.8	48.5	
Family History of DM	Yes	23.4	86.1	<0.001*
	No	76.6	13.9	
Total no of participants enrolled(2684)		100		p≤0.05*=significant

Figure 1: Association of Parental History and Prevalence of T2DM(%)

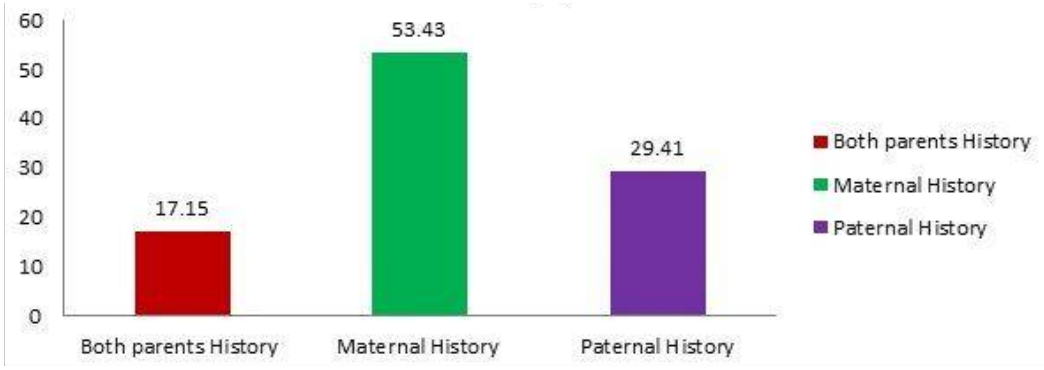


Table 2: Comparisons of Mean ± SD Values of Diabetic and Non-diabetic Individuals of Study Group

Variable	Type 2 DM	Mean ± SD	P value
Age	absent	52.01±8.8	<0.002*
	present	53.43±8.5	<0.001*
Height	absent	156.4±8.0	<0.001*
	present	154.7±8.0	<0.001*
Weight	absent	59.6±7.9	<0.001*
	present	67.27±8.5	<0.001*
BMI	absent	24.43±3.3	<0.001*
	present	28.25±4.3	<0.001*
Waist-Hip Ratio	absent	.88±0.06	0.075
	present	.88±0.07	0.106
FBS	absent	100.2±11.4	<0.001*
	present	128.2±35.1	<0.001*
SBP	absent	125.4±10.5	<0.001*
	present	129.0±13.2	<0.001*
DBP	absent	87.7±5.6	0.390
	present	85.5±8.4	0.077
DDM	absent	–	–
	present	6.96±6.1	0.260

Note: P ≤ 0.05* = significant.

Table 3: Univariate and Multivariate Logistic Regression Analysis of Risk Factor for T2DM

Risk Factors	Category	Univariate Analysis			Multivariate analysis		
		Unadjusted OR	95%CI	P value	Adjusted OR	95%CI	P value
Age	30-39	1			1		
	40-49	1.41	1.09-1.81	0.007*	0.86	0.60-1.25	0.439
	50-59	1.34	1.05-1.70	0.020*	0.97	0.87-1.39	0.867
	e"60	1.87	1.17-2.98	0.008*	6.62	3.42-12.82	<0.001*
Occupation	Skilled -I	1			1		
	Skilled- II	0.89	0.53-1.51	0.678	1.44	0.68-3.03	0.338
	Skilled-III	2.06	1.22-3.49	0.007*	3.58	1.69-7.57	<0.001*
	Skilled-IV	1.08	0.61-1.91	0.788	2.44	1.07-5.58	0.034*
	Non-Workers	1.11	0.62-1.97	0.721	1.72	0.75-3.93	0.200
Diet	Veg	1			1		
	Nonveg	1.29	1.02-1.62	0.031*	1.29	0.92-1.79	0.134
Smoking	No	1			1		
	Yes	1.94	1.55-2.42	<0.001*	1.39	0.76-2.31	0.331
Alcohol	No	1			1		
	Yes	1.97	1.56-2.50	<0.001*	2.23	1.24-4.01	0.007*
BMI	d"18.9	1			1		
	19-24.9	4.36	3.29-5.78	<0.001*	4.48	2.96-6.80	<0.001*
	25-29.9	15.38	11.36-20.83	<0.001*	14.70	9.52-22.72	<0.001*
	e"30	19.61	7.752-50	<0.001*	9.90	3.24-30.30	<0.001*
Truncal	No	1			1		
Obesity	Yes	1.23	1.01-1.50	0.042*	1.41	1.05-1.89	0.022*
Family	No	1					
History	Yes	35.96	27.60-46.85	<0.001*	35.67	26.42-48.42	<0.001*

Note: P ≤ 0.05* = significant.

shown in Table 3. According the Univariate and Multivariate analysis, eight out of eleven variables appeared as approximately significant predictors of T2DM. In accordance with their importance of participant's age, occupation, BMI, diet, family history of diabetes, smoking, alcohol consumption and truncal obesity have shown statistically significant effect on T2DM whereas participant's gender, literacy status and central obesity did not show any significant effect on T2DM.

In univariate and multivariate analysis referral category of age was considered as 30-39. Participants belonging to 40-49, 50-59, >60 of age group showed higher risk of T2DM respectively compared to referral category of age in univariate analysis. The corresponding Odds Ratio (OR) for age category of 40-49, 50-59 and >60 are 1.41, 1.34 and 1.87 respectively. Multivariate analysis showed participants with age >60 having higher risk of T2DM and the corresponding odds ratio to be 6.62. In univariate and multivariate analysis referral category of occupation was considered as skilled – I category. Participants belonging to skilled –III category showed higher risk of T2DM compared to referral skilled – I category. The corresponding odds ratio was 2.06. Multivariate analysis showed participants belonging skilled – III category and skilled – IV category having higher risk of T2DM. The corresponding odds ratios were 3.58 and 2.44, respectively. In diet category, vegetarian diet was considered as referral category for univariate and multivariate analysis. Participants having non-veg diet showed higher risk of T2DM and the corresponding odds ratio was 1.29 in univariate analysis while in multivariate analysis diet did not show any effect. In substance abuse category for smoking, non-smokers were considered as referral category for both univariate and multivariate analysis. Participants who were smoking have revealed higher risk to the T2DM. The corresponding odds ratio was 1.94 in univariate analysis. In multivariate analysis there were no significant changes associated with smoking. In substance abuse category for alcohol, non-alcoholic was considered as referral category in univariate and multivariate analysis. Participants belonging to alcoholic group have shown higher risk to T2DM. The corresponding odds ratios were 1.97 and 2.23 in univariate and multivariate analysis respectively. In BMI category, BMI>18.5 was considered as referral category for univariate and multivariate analysis. Participants belonging to BMI of 19-24.9, 25-29.9 and >30 showed higher risk to T2DM in both univariate and multivariate analysis. The corresponding odds ratios for BMI category of was 4.36, 15.38 and 19.61 in univariate analysis and the corresponding odds ratios were 4.48, 14.70 and 9.90 in multivariate analysis. Participants having no truncal obesity were considered as referral category for univariate and multivariate analysis. Individual having truncal obesity showed higher risk to T2DM. The corresponding odds ratios were 1.23 and 1.41 for univariate and multivariate analysis. The Participants having no family history of diabetes were taken as referral category in univariate and multivariate analysis. Participants having family history of T2DM revealed higher risk for T2DM. The corresponding odds ratios were 35.96 and 35.67 in univariate and multivariate analysis.

DISCUSSION

Epidemiological data from different parts of India showed a rise in prevalence of diabetes. In the present study different finding was observed compared to other studies, despite adopting WHO standards which could be due to difference in methodologies for measuring blood glucose, definition of diabetes, age group and geographical situations. The present study showed high prevalence of T2DM (17.7%) in rural population of north Karnataka, while similar study reported lower prevalence (5.2%) in rural population in costal Karnataka (Mohan *et al.*, 2008, Bhalerao, 2013, Chow, 2006 and Kokiwar, 2007).

In present study it is also observed that the increasing in age was significantly associated with higher risk of T2DM. Bhalerao (2013) and Howard (2004) had reported the similar results. This may be due to prolonged exposure to stress, obesity, genetic factor, advancement of age. The high prevalence among young adults 30-39 years (4.9%), the most productive age group of the community is unacceptable and hence focus on prevention of diabetes among young is essential. (Khatib, 2008 and Di Nardo, 2009).

The present study showed that BMI is a significant predictor of development of diabetes. Several studies reported BMI as an independent risk factor for development of diabetes (Snehalata, 2003 and Khan, 2006). The present study also supported the evidence among Indian, even at lower BMI, there was high odds of diabetes (adjusted OR 2.1). Hence early identification of high BMI would be helpful for primary prevention and early diagnosis of diabetes. Khan *et al.* reported that in obese individuals, adipose tissue releases increased amounts of non-esterified fatty acids, glycerol, hormones, pro-inflammatory cytokines and other factors that are involved in the development of insulin resistance (khan *et al.,* 2000).

The present study showed that there was a significant association of occupation with increasing prevalence of T2DM. Similar findings were reported by some other studies in India (Agardh, 2011). This association of diabetes with occupation could be due to combined effect of physical inactivity in employees, house wife and work related stress among those who work in agriculture field (Agardh, 2011).

There was no significant association with literacy. Similar results were reported from a cohort study amongst industrial workers. (Chaturvedi, 1996). However some western studies had reported a decrease in prevalence with increase in educational status. Low educations may influence the lesser awareness, lesser opportunity for prevention and control. Higher educational status may influence the lifestyle factors (Chaturvedi, 1996 and Howard, 2004).

Dietary habits also demonstrated a significant association with incidence of T2DM in this study. Non vegetarian dietary habits were associated with 1.29 times odds for incident T2DM compared with those with good dietary habits (Chow, 2006).

The present study showed association between truncal obesity and prevalence of T2DM. Whereas there was no significant association of central obesity with the increase in prevalence of T2DM. Several studies reported truncal obesity can be a risk factor for diabetes(WHO, 2000, Khan, 2006, Khan, 2000 and Agardh, 2011). There were no significant gender differences in prevalence of diabetes. Similar findings were reported by multicentric studies in India (WHO, 2000 and Khatib, 2008). However few studies have showed a higher prevalence in females and some other studies showed higher prevalence in males (Prabhakaran, 2005). This is possibly due to coexisting risk factors in specific gender. Alternatively gender may not be a risk factor in T2DM (Prabhakaran, 2005, Meigs, 2000 and Wei *et al.*, 2000).

The present study showed that the odds of diabetes among those with family history of T2DM (in terms of parental history) were 35.97 times as compared to those without a family history of T2DM. The present study also reported the maternal history of T2DM to be stronger

compared to paternal history of T2DM. Studies reported relatively higher risk with maternal history of diabetes compared to paternal(Meigs, 2000 and Vishwanathan *et al.,* 1996). When both parents were diabetic, the risk increases synergistically. However in the present study no such effect was observed, probably because there were only a few subjects with both parents diabetic. Family history of T2DM could act through environmental factors (diet, stress, physical activity, socioeconomic status) as well as a genetic mechanism through gene expression. Family history of diabetes could be an important public health tool in predicting development of diabetes (Khatib, 2008).

The present study showed that smoking is associated with diabetes. Smoking habits were associated with 1.94 times odds for incident T2DM. This finding agrees with several other cohort studies(Nakanishi *et al.*, 2000 , Sakai *et al*., 2006 and Chow, 2006). The present study showed a significant association between alcohol consumption and risk of diabetes. This is probably due to the development of insulin resistance, which is a key factor in the pathogenesis of T2DM among heavy alcohol drinkers and this has been shown by some studies to be mediated by increased obesity, especially abdominal obesity. Literature showed varied association of alcohol consumption and increased risk of diabetes (Wei *et al.*, 2000 and Howard, 2004). The present study was cross-sectional community based study in rural population of North Karnataka and there were no other studies which reported the prevalence and associated risk factor for T2DM in this region.

CONCLUSION

A high prevalence of type 2 diabetes was noted in the rural population of North Karnataka. In the present study it was observed that advanced age, occupational changes, BMI, substance abuse like alcohol and smoking, truncal obesity and family history of diabetes were highly associated risk factors for T2DM whereas literacy, gender and central obesity showed no association with risk of T2DM. This study created awareness of diabetes and its complication in rural population of this region. The baseline data of the present study regarding the prevalence of T2DM and its associated risk factors could be useful for implementation of the National Program for control of Diabetes, cardiovascular diseases and Stroke (NPDCS). Therefore, future research in this direction is a need of the time.

ACKNOWLEDGMENT

The authors thank all participants, Medical officers, ASHA workers of all three Primary Health Centres (PHCs), Statistician Mr. M D Mallapur for their participation and cooperation throughout the study. The authors are grateful to the department of community medicine and department of biochemistry for their support and help during the study. Author expresses cordial thanks to all the teaching, postgraduates' students and non-teaching faculty of the department of physiology for encouragement, support and guidance during the study.

REFERENCES

1. Agardh E, Allebeck P, Hallqvist J, Moradi T and Sidorchuk A (2011), "Type 2 diabetes incidence and socio-economic position: a systematic review and meta-analysis", *Int J Epidemiol.,* June, Vol. 40, No. 3, pp. 804-18. doi: 10.1093/ije/dyr029. Epub 2011 Feb 19.
2. American Diabetes Association ADA (2001), "Standard of medical care for patients with

diabetes mellitus", *Diabetes Care,* Vol. 24 (suppl 1), pp. S33-S43.

3. AshwinKamath, Shivprakash G and PrabhaAdhikari (2011), "Body mass Index and Waist circumference in type 2 diabetes mellitus patient attending diabetic clinic", *Int J Biol Med Res.*, Vol. 2, No. 3, pp. 636-638.
4. Bhalerao S D, Manjunath Somannavar and Shivprasad S Goudar (2013), "Prevalence of type 2 Diabetes in rural population of North Karnataka-A community based cross sectional study", *Biomedicine,* Vol. 33, No. 2.
5. Chaturvedi N, Stephenson J and Fuller J (1996), "The relationship between socioeconomic status and diabetes control and complications in the EURODIAB IDDM Complications Study", *Diabetes Care,* Vol. 19, pp. 423-430.
6. Chobanian A V, Bakris G L, Black H R, Cusman W C, Green LA, IzzoJ LJr, *et al.* (2003), "The seventh report of the Joint national committee on prevention, detection, evaluation and treatment of high blood pressure: The JNC report", *JAMA*, Vol. 289, pp. 2560-72.
7. Chow C, Raju P and Raju R (2006), "The pre Prevalence and management of diabetes in rural India", *Diabetes Care*, Vol. 29, pp. 1717-18.
8. Chythra R Rao, Veena G Kamath, Avinash Shetty and AshaKamath (2010), "A study on the prevalence of type 2 diabetes in costal Karnataka", *Int J DiabDevCtries.*, Vol. 30, No. 2.
9. Di Nardo F, Burattini R, Cogo C E, Faelli E and Ruggeri P (2009), "Age-related analysis of insulin resistance, body weight and arterial pressure in the Zucker fatty rat", *ExpPhysiol,* Vol. 94, pp. 162-168.
10. Gavin J Putzar, Arnold M Ranirez, Kelvin Sneed, H J Brownlee *et al.* (2004), "Prevalence of patient with type 2 diabetes mellitus reaching American diabetes association target guidelines in a university primary care setting", *Southern medical journal,* Vol. 97, No. 2.
11. Govt. of India (2004), "Directorate General of Employment & Training. National Classification of Occupations - 2004", Ministry of Labour, Government of India 2004, *dget.nic.in/nco/preface.pdf,* Cited on 8 January 2013.
12. Howard A, Arnsten J and Gourevitch M (2004), "Effect of alcohol consumption on diabetes mellitus", *Annals of Internal Medicine*; Vol. 140, pp. 211-219.
13. Jazet I M, Piji H and Meinders A E (2003), "Adipose tissue, an endocrine organ: imparts on insulin resistance", *Neth J MED, Vol.* 61, pp. 194-212.
14. Kahn B B and Flier J S (2000), "Obesity and insulin resistance", *J Clin Invest*, Vol. 104, pp. 473-481.
15. Khan S, Hull R and Utzschneider K(2006), "Review Article Mechanisms linking obesity to insulin resistance and type 2 diabetes", *Nature*; Vol. 444, pp. 840-846.
16. Khatib N M, Quazi Z S, Gaidhane A M, Wagjare T S and Goyal R C (2008), "Risk factors of type 2 diabetes mellitus in rural wardha: A community based study", *Int J Diabetes DevCtries,* Vol. 28, pp. 79-82.
17. Kokiwar P, Gupta S and Durge P (2007),

"Prevalence of diabetes in a rural area of central India", *Int J Diabetes DevCtries*, Vol. 27, No. 1, pp. 8-10.

18. Majagi S M, Soudarssanne B M, Roy G and Das A K (2012), "Risk factors of diabetes mellitus in rural Pondicherry", *Online J Health Scs*, Vol. 11, No. 1, p. 4.

19. Meigs J, Cupples L and Wilson P (2000), "Parental transmission of type 2 diabetes: the Framingham Offspring Study", *DiabetesCare,* Vol. 49, No. 12, pp. 2201-2207.

20. Mohan V, Mathur P, Deepa R *et al.* (2008), "Urban rural differences in prevalence of self-reported diabetes in India the WHO-ICMR Indian NCD risk factor surveillance", *DiabetesResearch Clinical Practice*, Vol. 80, pp. 159-168.

21. Nakanishi N, Nakamura K, Matsuo Y *et al.* (2000), "Cigarette Smoking and Risk for Impaired Fasting Glucose and Type 2 Diabetes in Middle-Aged Japanese Men", *Annals of Internal Medicine,* Vol. 133, pp. 183-191.

22. Non-communicable Diseases and Mental Health (2003), "STEPS Field Manual Appendices. Geneva: World Health Organization" 2003; 1-31, *Http://www.idf.org/webdata/docs/GGT2D%2001%20Screening%20and%20diagnosis.pdf*, Cited on January 8, 2013.

23. Prabhakaran D, Chaturvedi V and Ramakrishnan L (2005), "Risk factors related to the development of diabetes in men working in a north Indian industry", *National Medical Journal of India*, Vol. 20, No. 1, pp. 4-10.

24. Ramchandran A, Das A K, Joshi S R, Rajnik C S, Shah S, Prassanna Kumar *K M et al.* (2010), "Current status of diabetes in India and Need for Novel Therapeutic Agents", *JAPI*, Vol. 58.

25. Ramchandran A, Snehalata C, Baskar A D, Mary S, Kumar C K, Selvam S *et al.* (2004), "Temporal changes in prevalence of diabetes and impaired glucose tolerance associated with life style transition occurring in the rural population in india", *Diabetologia,* Vol. 47, pp. 860-5

26. Report of world health organization consultation (1995), "Physical status: The use and interpretation of anthropometry", Geneva, Switzerland: World health organization; WHO Tech Rep Ser No.845, *Http://whqlibdoc.who.int/trs/WHO_TRS_854.pdf,* cited on 22 July 2009.

27. Report of World Health Organization Consultation (2000). Obesity: Preventing and managing the global epidemic. Geneva, Switzerland: World Health Organization; WHO Tech RespSer No.894, *Http://whqlibdoc.who.int/trs/who_trs_916.pdf*, cited 9 January 2013.

28. Sadikot S, Nigam A and Das S (2004), "The burden of diabetes and impaired fasting glucose in India using the ADA1997 criteria: prevalence of diabetes in India study (PODIS)", *Diabetes Research and Clinical Practice*, Vol. 66, pp. 293-300.

29. Sakai Y, Yamaji T, Tabata S *et al.* (2006), "Relation of alcohol use and smoking to glucose tolerance status in Japanese men", *Diabetes Research Clinical Practice,* Vol. 73, pp. 83-88.

30. Snehalatha C, Viswanathan V and Ramachandran A(2003), "Cutoff values for normal anthropometric variables in Asian Indian Adults", *Diabetes Care* Vol.26:1380-1384.

31. Toshimi S, Hiroyasu I, Akio N, Takako H, Fujiko I, Yoko S, Atsushi M, Hisayuki F. *et al.* (2004), "Cigarette smoking and risk of type 2 diabetes mellitus among middle-aged and elderly Japanese men and women", *Am J Epidemiol*., Vol. 160, pp. 158-162.

32. Training for middle level manager. Expanded program on immunization world health organization.(1991), *Http//whqlibdoc.who.int/hq/1991/WHO_EPI_MLM_91.1.Pdf.* Cited on 8 January 2013.

33. UK prospective Diabetes study group (1998), "Tight blood pressure control and risk of microvascular and microvascular complication in type 2 diabetes (UKPDS 33)", *Lancet*, Vol. 352, pp. 837-853.

34. UNESCO (1997), International Standard Classification of Education ISCED (1997), *Http://tuikapp.tuik.gov.tr/DIESS/FileUpload/yayinlar/ISCDE_2011_draft.pdf,* Cited on 9 January 2013.

35. Viswanathan M, McCarthy M, Snehalatha C *et al.* (1996), "Familial aggregation of Type 2 (non-insulin-dependent) diabetes mellitus in south India: absence of excess maternal transmission", *Diabetic Medicine,* Vol. 13, pp. 232-237.

36. Wei M, Gibbons L, Mitchell T *et al.* (2000), "Alcohol intake and incidence of type 2 Diabetes in men", *DiabetesCare* Vol. 23 (1), pp. 18-22.

37. Wild S, Roglic G, Green A, Sicree R and King H (2004), "Global prevalence of diabetes: estimates for the year 2000 and projections for 2030", *Diabetes Care*, Vol. 27, pp. 1047-53.

38. World Health Organization (1999), Definition, Diagnosis and Classification of Diabetes Mellitus and its Complications. Geneva: Department of Non-communicable Disease Surveillance, *Http://whqlibdoc.who.int/hq/1999/ who_ncd_ncs_ 99.2.pdf,* Cited on 9 January 2013.

39. World Health Organization (2000), "The Asia Pacific Perspective. Redefining Obesity and its treatment. International Association for the study of obesity and international obesity. Task Force", International Diabetes Institute: Melbourne: Health communication, *Http://biotech.law.lsu.edu/obesity/who/obesity_final.pdf,* cited on 8 January 2013.

40. World Health Organization (2008), *Http://www.who.int/nmh/Actionplan-PC-NCD-2008.pdf*, cited 12 April 2011.

International Journal of Pharma Medicine and Biological Sciences
Hyderabad, INDIA. Ph: +91-09441351700, 09059645577
E-mail: editorijpmbs@gmail.com or editor@ijpmbs.com
Website: www.ijpmbs.com

ISSN 2278-5221
9 772278 522003 01