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Original Article

High Prevalence of Type 2 Diabetes Melitus and Its Risk Factors Among the Rural Population of Pondicherry, South India

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ABSTRACT

Background: We aimed to assess the prevalence of type-2 diabetes in rural Pondicherry and to study the determinants of Diabetes Mellitus (DM) in the rural population of Pondicherry, south India.

Methods: It was a cross-sectional community-based study conducted from November 2010 to January 2012 in two of the field practice villages affiliated to a Medical College in Pondicherry. Sample size was calculated using open source software, Open Epi Version 2.3.10. The sampling frame comprised individuals aged above 25 years and single stage cluster random sampling was carried out. After obtaining the verbal informed consent each of the study participants were interviewed face-to-face using a pre-tested structured questionnaire. Data were analyzed using the SPSS version 16.

Results: The age of the study participants ranged from 25 to 98 years with mean of 42.6 (±13.7) and majority of the study participants 339 (32.5%) from the age-group of 30-39 years. The prevalence of diabetes was 19.8% (60-69 years), 17.1% (40-49 years), 16.8% (50-59 years), and 13.6% (>69 years) among study subjects. In univariate analysis, higher age, being educated, unemployed and poor was associated with higher risk of diabetes mellitus (DM). Furthermore, a high triglyceride level was significantly associated with increase in the risk of DM (adjusted odds ratio: 3.01; 95% CI: 1.86, 4.86).

Conclusions: Type-2 diabetes mellitus (T2DM) is an important public health problem in the adults of rural Pondicherry. Among non-modifiable factors, higher age, better socio-educational background and positive family history of diabetes was significantly associated with T2DM.

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Introduction

Diabetes mellitus (DM) is a chronic metabolic disease characterized by hyperglycemia either due to absolute (Type 1 DM) or relative (Type 2 DM) insufficiency of the insulin hormone[1]. In contrast to the earlier assumption that DM is a predominant disease diagnosed in developed countries, recent findings have shown a considerable rise in number of new cases of type 2 DM with an earlier onset and associated complications, even in developing countries[2-4]. Furthermore, almost 347 million people worldwide have diabetes and it is likely to be doubled by 2030 in absence of any intervention[5,6].

In addition, more than 80% of diabetes deaths occur in low and middle-income countries and it will be ranked as the seventh leading cause of death in 2030[6,7]. India has been designated as "diabetes capital" of the world, and diabetes now affects a staggering 10-16% of urban population and 5-8% of rural population in India alone[8,9]. The causation of DM is multi-factorial, and includes both non-modifiable (viz. age, genetic defects, family history) and modifiable (viz. obesity, sedentary lifestyle, diet, stress, alcohol, viral infections, socioeconomic status)[2,10,11]. Diabetes not only affects the quality of life of patients but also virtually hampers the routine functioning of every system of the body, especially if blood sugar remains deranged for a considerable period of time[1,12].

Realizing the magnitude of the disease and dearth of community-based studies especially in rural areas, the present study has been conducted to assess the prevalence of type-2 diabetes in rural Pondicherry and to study the determinants of DM in the rural population of Pondicherry.

Methods

Study setting

It was a cross-sectional descriptive study conducted from November 2010 to January 2012 in two of the catchment villages, namely Ramanathapuram and Pillaiyarkuppam under the JIPMER Rural Health Centre. Sample size was calculated using a freely available open source software, Open Epi Version 2.3.10, with a 95% confidence interval (CI) and 80% power, to detect a DM prevalence of 5.8% (±2.2), minimum of 434 subjects were needed[11]. Taking into account a design effect of 2 for the cluster sampling and a non-response rate of 25%, sample size was calculated to be 1043. The sampling frame comprised individuals aged above 25 years (n=2608).

Single stage cluster random sampling was carried out. Using streets as the primary sampling unit, four streets in Ramanathapuram and six streets in Pillaiyarkuppam were chosen by lot method.

Inclusion and exclusion criteria

From the houses of the selected streets, all participants aged more than 25 years were invited to take part in the study. Subjects not willing to participate (n=31) in the study were excluded. Data for pregnant women (2) and missing forms (7) were excluded from analysis.

Study tool

After obtaining the verbal informed consent each of the study participants were interviewed face-to-face using a structured questionnaire. The questionnaire was pre-tested on a group of 30 individuals before its utilization in the current study.

Study variables

Socio-demographic parameters (viz. age, sex, education, occupation, per capita income), family history, level of physical activity, and addiction to tobacco / alcohol. In addition, each of the study subjects was subjected to anthropometric measurements (viz. height, weight & waist circumference); assessment of pulse rate & blood pressure and laboratory investigations (viz. lipid profile, estimation of fasting and postprandial blood glucose, and HbA1C levels, if diabetic).

Operational definitions

Education was classified using International Standard Classification of Education as no formal schooling and attended school[13]. Census guidelines and B G Prasad modified classification were utilized for classifying the work status and socioeconomic status respectively[14,15]. Physical activity was measured using the International Physical Activity Questionnaire15 (short version)[16]. Total metabolic equivalents/week (MET/wk) were calculated and individuals grouped as physically inactive (<600 MET/wk) and physically active (≥600 MET/wk)[16]. Smoking was defined as the current use of any tobacco product on a regular basis for ≥ six months[17]. Alcohol use was defined as the consumption of any type of alcohol in the last one year[17]. Indian Council of Medical Research guidelines were used for diagnosis and classification of diabetes and participants with fasting (>125 mg/dL) and/ or postprandial (>200 mg/dL) blood glucose were diagnosed as diabetic[18]. Standard guidelines were followed to measure height and weight. However, to negate observer's bias, measurement was done twice one by the investigator and other by a trained person and the average of two was taken. Body mass index (BMI) was calculated and classified as per the WHO classification (<23 kg/m^2 as normal and ≥23 kg/m^2 as overweight and obese)[19]. Blood pressure was checked with digital sphygmomanometer with study subjects sitting comfortably.

Ethical considerations

The survey was conducted after taking approval from the institutional Ethics Committee. Verbal informed consent was obtained from all study participants before interviewing them and utmost care was taken to maintain privacy and confidentiality.

Statistical analysis

Data were analyzed using the SPSS statistical package version 16.0 for Windows (SPSS Inc., Chicago, United States of America). The statistical significance was set at $P<0.05$. The associations were assessed using Chi-square test and unpaired *t*- test the categorical (%) and continuous (mean ±SD) variables respectively. Adjusted risk of diabetes was assessed with backward logistic regression model. Variables with $P<0.2$ in univariate analysis were forced in the regression model.

Results

Table 1 describes the socio-demographic characteristics of study participants and their distribution with reference to the gender. The age of the study participants ranged from 25 to 98 years with mean of 42.6 (±13.7). Majority of the study participants 339 (32.5%) belonged to the age-group of 30-39 years. The higher proportion of women (44.6%) did not attend the school as compared to men (15.3%). In females, nonworking status was more prevalent than males (47.2% vs 13.2%, $P=0.004$). Among the other socio-demographic and lifestyle risk factors, men and women did not differ with respect to per capita income, physical activity and obesity. However, central obesity as measured by waist circumference was more in women than men (39.1% vs 29.5%, respectively).

Males consumed more amounts of calories and proteins than females. Similarly, statistically significant difference was observed between men and women pertaining to some of the estimates of lipid profile (viz. total cholesterol, LDL and HDL levels). In univariate analysis, higher age, being educated, unemployed and poor was associated with higher risk of DM. Among the modifiable risk factors, physically inactive, being obese, high blood pressure, and deranged lipid profile were the significant risk factors of diabetes. Oil intake among diabetics was higher than non-diabetics. People with diabetes had higher resting pulse rate and pulse pressure than those without diabetes (Table 2).

Table 3 reveals the diet pattern and its association by gender and diabetes in study subjects. Among all the dietary practices studied, consumption of fried food intake was significantly less among women than men (17.3% vs 12.4%, $P=0.029$). A considerable proportion of women (15%) were consuming tobacco in chewable form as compared to men (4.1%). Among the modifiable risk factors, addiction to cigarette smoking and alcohol usage were the significant predictor as they augmented the risk of DM by 2.37 and 1.62 times respectively.

Table 4 presents the association between risk factors and obesity using multivariate analysis. After adjusting for the risk factors, increasing age, being educated, higher income and positive family history were the non-modifiable significant risk factors of diabetes. Although, subjects with high blood pressure have 1.63 times risk of diabetes but the association was not statistically significant ($P=0.069$). Among the modifiable risk factors, physical activity was the strongest predictor with being inactive raising the risk of DM by 5.34 times. In addition, having a waist circumference higher than the normal recommended levels (viz. males - ≥90 cm, females - ≥80cm) increased the risk of DM by 1.86 times. Furthermore, high triglyceride levels raises the risk of DM (ad-

justed odds ratio: 3.01; 95% CI: 1.86, 4.86). High pulse rate was significantly associated with DM, as rise in pulse rate by 10 led to 40% increased risk of diabetes.

Table 1: The odds ratio (OR) estimates of diabetes by variables

Variables	Without diabetes n=1043	With diabetes n=127	OR (95% CI)	*P* value
Age (yr)				
25-29	85	3	1.00	
30-39	339	18	1.53 (0.44, 5.33)	0.502
40-49	252	43	5.62 (1.70, 18.63)	0.005
50-59	190	32	5.54 (1.65, 18.62)	0.006
60-69	111	22	6.76 (1.95, 23.42)	0.003
>69	66	9	4.32 (1.12, 16.64)	0.034
Educational status				
Illiterate	316	27	1.00	
Attended school	727	100	1.70 (1.09, 2.67)	0.018
Occupational status				
Worker	724	74	1.00	
Non-workers	319	53	1.75 (1.20, 2.56)	0.004
Per capita income in Rs/month				
≥3100	954	107	1.00	
<3100	89	20	2.30 (1.34, 3.92)	0.002
Physical activity level (MET/wk)				
Active (≥600)	968	100	1.00	
Inactive (<600)	75	27	4.88 (2.92, 8.20)	0.001
Family history of T2 DM				
Absent	776	74	1.00	
Present	267	53	2.35 (1.60, 3.45)	0.001
Body mass index (kg/m^2)				
<25	758	73	1.00	
≥25	285	54	2.19 (1.50, 3.21)	0.001
Waist circumference (cm)				
Normal (<88)	684	52	1.00	
High risk (≥88)	359	75	3.21 (2.20, 4.70)	0.001
Blood pressure (mmHg)				
Normal (<120/80)	806	68	1.00	
Above normal (≥120/80)	237	59	3.60 (2.45, 5.29)	0.001
Total cholesterol (mg/dl)				
Normal (<200)	724	69	1.00	
Above normal (≥200)	232	48	2.48 (1.66, 3.71)	0.001
Triglyceride (mg/dl)				
Normal (<150)	758	66	1.00	
Above normal (≥150)	198	51	3.64 (2.42, 5.46)	0.001
Low density lipoprotein (mg/dl)				
Normal (<70)	753	80	1.00	
Above normal (≥70)	203	37	1.88 (1.23, 2.87)	0.003
High density lipoprotein (mg/dl)				
Normal (≥40l)	401	66	1.00	
Above normal (<40)	117	51	0.51 (0.35, 0.76)	0.001

Table 2: Risk factors and its association by gender and diabetes in study subjects using independent t-test

Variables	Women	Men	*P* value	Normal	Diabetics	*P* value
Calories (kcal/day), mean (SD)	1674 (550)	2326 (856)	0.001	1987 (781)	2007 (815)	0.802
Proteins (gm/day), mean (SD)	42 (16)	57 (23)	0.001	49 (21)	49 (21)	0.872
Oil (ml/month), mean (SD)	760 (327)	745 (344)	0.457	743 (336)	814 (334)	0.026
Pulse rate, mean (SD)	79 (10)	78 (12)	0.064	77 (11)	84 (15)	0.001
Pulse pressure, mean (SD)	43 (12)	43 (11)	0.722	43 (11)	48 (15)	0.001

Discussion

The prevalence of diabetes among the study participants was 12.2%, which is much higher than a similar study done in a rural community of Pondicherry where prevalence was 5.8% among study participants[9]. Another study conducted among the rural areas of Tamil Nadu revealed that prevalence of diabetes in studied population was 5.99%[20]. Findings of a systematic review and meta-analysis revealed that rural prevalence of diabetes in low-middle income countries has increased from 1.8% (1985-89) to 7.5% (2005-11)[21]. However, a significantly higher prevalence was observed among migrants (14%) in a cross-sectional study[22]. Most of the prevalence results have revealed that a definite hike in diabetes prevalence has been observed, especially in rural settings of developing countries[23]. However, the heterogeneity in results could also be probably because of socio-demographic variability and employment of differing guidelines (cut-off values) in reaching a diagnosis of diabetes.

Table 3: Diet pattern and its association by gender and diabetes in study subjects

Variables[a]	Without diabetes n=1041	With diabetes n=125	OR (95% CI)	*P* value
Diet preference				
Vegetarian	61	11	1.00	
Non-vegetarian	980	116	0.61 (0.31, 1.21)	0.151
Vegetable intake (g/day)				
Low (<100)	669	84	1.00	
High (≥100)	351	41	0.95 (0.64, 1.41)	0.798
Fruit intake				
Absent	80	13	1.00	
Present	961	114	0.69 (0.37, 1.30)	0.249
Salt intake (g/day)				
Normal (<5)	403	52	1.00	
High (≥5)	623	74	0.91 (0.62, 1.33)	0.625
Cooking oil				
Mixed	28	6	1.00	
Single type	991	117	0.49 (0.19, 1.24)	0.123
Fried food intake				
Absent	155	13	1.00	
Present	885	114	1.62 (0.89, 2.95)	0.115
Aerated drinks intake				
Absent	498	65	1.00	
Present	543	62	1.16 (0.80, 1.69)	0.421
Tobacco chewing				
Absent	942	113	1.00	
Present	101	14	1.18 (0.65, 2.15)	0.586
Cigarette smoking				
Absent	988	114	1.00	
Present	42	13	2.37 (1.24, 4.56)	0.008
Alcohol use				
Absent	787	85	1.00	
Present	256	42	1.62 (1.09, 2.42)	0.017

[a] Dietary data missing for 2 subjects

Table 4: Multivariate analysis for association of risk factors and obesity

Variables	Without diabetes n=1043	With diabetes n=127	OR (95% CI)	*P* value
Age (yr)				
25-29	85	3	1.00	0.001
30-39	339	18	1.66 (0.43, 6.46)	0.464
40-49	252	43	6.98 (1.85, 26.42)	0.004
50-59	190	32	6.01 (1.56, 23.21)	0.009
60-69	111	22	8.48 (2.08, 34.48)	0.003
>69	66	9	3.82 (0.76, 19.16)	0.104
Educational status				
Illiterate	316	27	1.00	
Attended school	727	100	2.28 (1.24, 4.20)	0.008
Per capita income in Rs/month				
≤3100	89	20	1.00	
>3100	954	107	2.16 (1.07, 4.35)	0.031
Family history of Diabetes Mellitus				
Absent	776	74	1.00	
Present	267	53	1.96 (1.20, 3.23)	0.008
Physical activity level (MET/wk)				
Inactive (<600)	75	27	1.00	
Active (≥600)	968	100	5.34 (2.62, 10.88)	0.001
Waist circumference				
Normal	684	52	1.00	
High risk	359	75	1.86 (1.16, 2.98)	0.010
Blood pressure (mmHg)				
Normal (<120/80)	806	68	1.00	
Above normal (≥120/80)	237	59	1.63 (0.96, 2.75)	0.069
Triglyceride (mg/dl)				
Normal (<150)	758	66	1.00	
Above normal (≥150)	198	51	3.01 (1.86, 4.86)	0.001
Low density lipoprotein (mg/dl)				
Normal (<70)	753	80	1.00	
Above normal (≥70)	203	37	1.57 (0.93, 2.64)	0.089
Pulse pressure (mmHg)				
Normal (<60)	966	43	1.00	
Abnormal (≥60)	77	84	1.02 (1.00, 1.04)	0.055
Pulse rate (beats/minute)				
Normal (60-100)	1000	79	1.00	
Abnormal (<60 or >100)	43	48	1.04 (1.02, 1.06)	0.001

In the current study, a directly proportional relationship was observed in the prevalence of diabetes and increasing age among the study subjects. Similar sorts of results were obtained in studies done in other parts of the country[24,25]. The probable reason for rise in prevalence of diabetes with increasing age is because of the amplification of the physical

inactivity, obesity, adoption of harmful lifestyles over the years. This clearly reflects the incompetency of the public health system and the health care professionals in preventing people from adopting harmful lifestyles.

The study subjects who were unemployed or were poor had a higher prevalence of diabetes in the present study. However, contrasting results were obtained in some of the other studies done in different settings[26,27]. This relationship of diabetes and occupation is usually determined by the level of physical activity and stress associated with job. In addition, our study reflected and even supported the findings of other studies that diabetes is no more a disease which is prevalent more in people from higher socio-economic class[2,24].

The present study showed that subjects who were obese (those with BMI >25kg/m^2) or were physically inactive had a much higher prevalence of diabetes than non-obese individuals. This is not a new finding and many studies have eventually showed quite identical results[25,26]. Thus, regular measurement of BMI levels over a period of time can assist in early detection of the potential risk factor and implementation of the desired preventive strategies in high-risk groups.

In this cross-sectional study, subjects, who were known to have higher levels of blood pressure, also had higher prevalence of diabetes among them. This was even observed in another study conducted to estimate the risk factors of diabetes, and is probably because of the same patho-physiologic mechanism involved in both the onset and the progression of the disease[28].

Furthermore, it was found that subjects who were addicted to tobacco (smokeless or smoking form) and/or alcohol had a definite higher prevalence than their counterparts who were non-addicted. Consumption of tobacco or alcohol was a significant determinant in another epidemiological study[29]. However, contrasting results have also been obtained in some other studies[11,30]. On performing the multivariate analysis, positive family history of diabetes aggravated the risk of diabetes significantly (OR - 1.96, CI - 1.20-3.23). Positive family history has been identified as one of the important determinants predicting the onset of the diabetes in different setting as well[11]. This again reiterates the importance of obtaining the family history correctly, as it will help the health professionals to advice people to adopt to lifestyle modification at an early age.

The strength of the present study is that it considered most socio-demographic, lifestyle and anthropometric variables which provided adjusted association of risk factors with T2DM. In limitation, single contact data was collected for dietary assessment by 24 hours recall method and family level aggregate information was obtained on vegetable, oil and salt intake. It may have added recall bias to the study results.

Conclusions

The study has revealed that T2 DM is an important public health problem in the adults of rural Pondicherry. Among non-modifiable factors, higher age, better socio-educational background and positive family history of diabetes was related to T2DM. Physically inactivity, central obesity, high triglycerides levels, and raised pulse rate increased the risk of DM significantly. We recommend screening of those with age above 30 years, positive family history of diabetes and obesity for ruling out hyperglycemic risk. Those with raised pulse rate and adverse lipid profile should be monitored for development of diabetes.

Conflict of interest statement

There was no conflict of interest to be stated.

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