

# Prevalence and Risk Factors of Type 2 Diabetes in Malappuram, Kerala

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## ABSTRACT

**Background:** Diabetes is a major public health problem all over the world. In India, the prevalence of Type 2 diabetes is higher in Kerala. Since there is lack of population based studies in the Malappuram district of Kerala, the study aimed to find out the prevalence of type 2 diabetes and its risk factors in Malappuram.

**Methods:** A cross sectional study was conducted among 798 adults in the age group of 25 to 75 years. Information on their socio demographic, physical, bio chemical and behavioural characteristics, family history of diabetes was collected using the pre tested interview schedule. All known cases of type 2 diabetes and those with Fasting Blood Sugar level >125mg/dl were considered as diabetic. The prevalence of type 2 diabetes and pre diabetes were estimated and their risk factors were statistically analysed.

**Results:** The prevalence of type 2 diabetes among the study participants was 22.4 percent. The significant risk factors of diabetes found among the adults studied were age, family history of diabetes, both generalized and central obesity, tobacco chewing and hypertension ( $p < 0.05$ ). Among them, advancing age, family history of diabetes, central obesity and hypertension were the major predictors of type 2 diabetes in the study population ( $p < 0.001$ ).

**Conclusion:** High prevalence of diabetes was observed in the study area. Central obesity and hypertension were the major risk factors to be modified in the study population through sustainable and effective lifestyle changes.

**Key words:** Type 2 diabetes, prevalence, risk factor, Kerala.

## INTRODUCTION

Diabetes is a global health issue threatening the life of people and economy of the nations. Type 2 diabetes (T2DM) is the major form of diabetes commonly seen in adults. <sup>[1]</sup> Around 424.9 million adults were living with diabetes in 2017. <sup>[2]</sup> It is the major cause for mortality and morbidity among the people, affecting mainly those in the developing countries. <sup>[3]</sup> India stands

second in sharing the global burden of diabetes with a prevalence of 72.9 million adults with diabetes. <sup>[2]</sup> In India, different states have divergent trends in the prevalence of diabetes. <sup>[4]</sup> Among the states, Kerala is reported as the 'Diabetes capital' of India with the highest prevalence of 19.4% of diabetes. <sup>[5]</sup>

In Kerala, Pathanamthitta, Malappuram and Kozhikode districts were

identified as the districts having diabetes as the major chronic disease. [6] Few population based studies on T2DM were done in central and southern Kerala. [7- 11] Although diabetes was reported as the major chronic disease in Malappuram, there is lack of published population based study on the assessment of the risk factors of the disease. Hence, the study was conducted to find out the prevalence of T2DM and its risk factors among the adults in the age group of 25 to 75 years residing in Malappuram.

## **MATERIALS & METHODS**

The Kondotty municipality in Malappuram district was randomly selected for the study through multistage random sampling method. A cross sectional study was carried out in the selected two wards of the municipality during the period between May 2017 and December 2017. The sample size for the study was calculated based on the prevalence of T2DM obtained from the records of District Medical Office, Malappuram. Thus, around 798 adults in the age group of 25 to 75 years belonging to 309 families were selected for the study. The families were selected from the two wards through systematic sampling method. Those who had been residing in the area at least for the past 3 months and willing to participate in the study through informed written consent were included. Pregnant women and those who are seriously ill and/or bed ridden were excluded from the study. The municipal chairperson and the concerned ward counsellors were informed about the conduct of the study in their area.

### **Assessment of socio demographic and behavioural characteristics:**

A house to house survey was conducted to collect information on the sociodemographic characteristics, family history of diabetes, personal history of hypertension and diabetes, dietary habits and personal behaviours such as tobacco chewing, smoking and alcoholism of the study subjects using a pre tested interview schedule. Socio economic status of the subjects were derived based on the

Kuppuswamy's SES classification. [12] Current user of smokeless tobacco was defined as the one who had the habit of chewing tobacco in any form for the past 6 months. Smoker was the subject who ever smoked in the past 6 months and ex-smoker was the one who stopped smoking. The term 'ever used' included both the current users and those who stopped using it. Current alcohol user was the one who used to drink alcohol at least once in a year. [13]

### **Assessment of physical characteristics:**

Anthropometric measurements such as height, weight, waist and hip measurements of each subject were taken as per WHO guidelines. [14] Height, waist and hip measurements were taken using a standard measuring tape and weight was assessed with the help of an electronic weighing machine (Healthgenie - model: HD 221). Blood pressure of each subject was recorded using the automatic blood pressure monitor (Omron - Model: HEM-8712, Omron Healthcare Corporation, Kyoto, Japan). Body Mass Index (BMI) and Waist Hip Ratio (WHR) were also calculated and categorised based on WHO criteria. Subjects with BMI  $\geq 25 \text{kg/m}^2$  were considered as obese and those males with waist circumference  $\geq 90$  cm and females with waist circumference  $\geq 80$  cm were identified as having central obesity. Also, WHR  $> 0.9$  in males and  $> 0.85$  in females were taken as the characteristics of abdominal obesity. [15-17]

### **Assessment of blood sugar:**

All the subjects who had not tested their Fasting Blood Sugar (FBS) in the last two months were screened for diabetes by testing their capillary FBS using One touch-Simple Glucometer. Any subject who reported that he /she was a diabetic and on treatment (or not) was considered as self reported diabetic. Their FBS value in the current or previous month of study was recorded. All the non diabetics who had a glucometer reading greater than 100mg/dl were assessed again for venous FBS and OGTT on another day in an authorised laboratory.

WHO (2016) criteria was followed to find out the prevalence of T2DM among the study population. Subjects with FBS>125mg/dl were considered as diabetic after the confirmation by a physician for type 2 diabetes. Subjects with FBS values between 110 mg/dl and <126 mg/dl and 2h-PG values <140mg/dl were considered as cases of Impaired Fasting Glucose (IFG) and those having FBS <126mg/dl and 2h-PG values between 140mg/dl and <200mg/dl were taken as cases of Impaired Glucose Tolerance (IGT).<sup>[17]</sup> Subjects with IFG or IGT were grouped under Pre diabetics. Thus the study population was classified into diabetics, pre diabetics and non diabetics.

#### **Ethical consideration:**

The study protocol was approved by the Institutional Ethical Committee of Gandhigram Rural Institute (Deemed to be University), Tamil Nadu.

#### **Statistical analysis:**

The data was analysed in SPSS 23.0 version. The association of risk factors with the prevalence of diabetes was statistically analysed using Chi square test. One way ANOVA was used to find out the significance of continuous risk variables on the glycaemic status of subjects. The strength of association between the risk factors in the population and prevalence of diabetes was assessed using Odds ratio. Adjusted odds ratio was determined in binary logistic regression for analysing the impact of risk factors on the prevalence of diabetes. All the tests were carried out at 95% confidence level and  $p < 0.05$  was considered as statistically significant.

## **RESULTS**

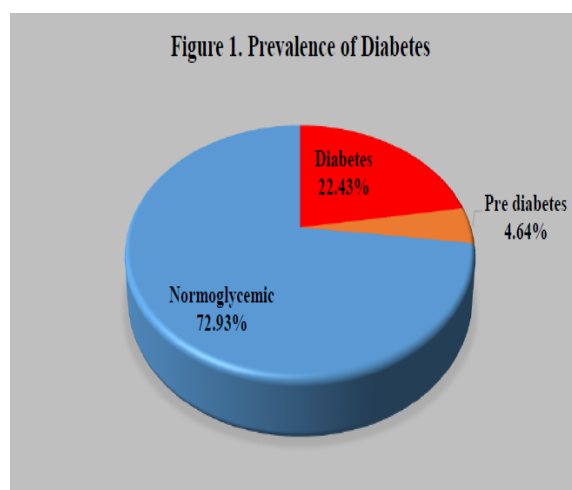
### **Baseline characteristics of the study population:**

The study population (N = 798) consisted of 44.5% males and 55.5% females. The mean age of male and female subjects was  $45.78 \pm 12.92$  years and  $44.05 \pm 13.34$  years respectively. Around

55.4% of the subjects were above 40 years of age. 81.1 percent of the subjects were Muslims whereas the rest of them were Hindus. 87.1 percent of the subjects were married. 38.7 percent belonged to nuclear family, followed by 31.7% and 29.6% of subjects in extended and joint families respectively. 54.6 percent of the subjects had a family size of 4 to 8 members. Around 37.6% of the subjects had high school education while 33% had higher secondary education and above. 56 percent of the study population were unemployed in which 7.3% were males and 48.7% were females. 35.5 percent of the subjects belonged to the lower middle category of socio economic status as derived on the basis of Kuppuswamy's SES classification.

### **Prevalence of Type 2 diabetes and pre diabetes:**

The prevalence of diabetes and pre diabetes in the study population was 22.4% and 4.6% respectively (Figure 1). Around 91% of the diabetics were already known cases of diabetes.



Nearly 9% of the diabetics and 70.3% of the pre diabetics were newly diagnosed. Among the pre diabetics, all the females (100%) and 81.8% of males had Impaired Glucose Tolerance.

**Risk factors of diabetes in the study population:**

**Table 1. Non modifiable risk factors and prevalence of diabetes**

Risk factors	Diabetic N=179 (%)	Pre diabetic N=37 (%)	Non diabetic N=582 (%)	Total N=798	p value
<b>Gender</b>					
Male	83 (23.4)	11 (3.1)	261 (73.5)	355	
Female	96 (21.7)	26 (5.9)	321 (72.5)	443	
<b>Age (years)</b>					<0.001
25-30	0 (0.0)	1 (0.8)	127 (99.2)	128	
31-45	40 (12.4)	12 (3.7)	270 (83.9)	322	
46-60	89 (37.9)	15 (6.4)	131 (55.7)	235	
61-75	50 (44.2)	9 (8.0)	54 (47.8)	113	
<b>Family history of diabetes</b>					<0.001
Absent	59 (15.4)	14 (3.7)	310 (80.9)	383	
Present	120 (28.9)	23 (5.5)	272 (65.5)	415	

The association of non-modifiable risk factors with diabetes is shown in Table 1. Majority of the diabetics was in the age group of 46 to 60 years. The prevalence of diabetes was higher in the age of 61-75 years while the prevalence of pre diabetes was higher in the age of 45-60 years. Males had higher prevalence of diabetes than that of females. But, the prevalence of pre diabetes was higher in females. More than half of the study population had positive family history of diabetes, in which the prevalence of diabetes and pre diabetes was found higher. Among the non-modifiable risk factors, increasing age and family history of diabetes were positively associated with the prevalence of diabetes (p<0.001).

**Table 2. Modifiable risk factors and prevalence of diabetes**

Risk factors	Diabetic N=179 (%)	Pre diabetic N=37 (%)	Non diabetic N=582 (%)	Total N=798	p value
<b>BMI</b>					0.012
Not obese	74 (18.3)	17 (4.2)	313 (77.5)	404	
Obese	105 (26.6)	20 (5.1)	269 (68.3)	394	
<b>Waist circumference</b>					<0.001
Normal	27 (13.2)	7 (3.4)	171 (83.4)	205	
Central obesity	152 (25.6)	30 (5.1)	411 (69.3)	593	
<b>Waist Hip ratio</b>					0.002
Normal	63 (17.7)	11 (3.1)	281 (79.2)	355	
High risk	116 (26.2)	26 (5.9)	301 (67.9)	443	
<b>History of Hypertension</b>					<0.001
Absent	138 (20.0)	30 (4.3)	523 (75.7)	691	
Present	41 (38.3)	7 (6.5)	59 (55.1)	107	
<b>Diet</b>					0.121
Non vegetarian	177 (22.3)	37 (4.7)	581 (73.1)	795	
Lacto vegetarian	2 (100.0)	0 (0.0)	0 (0.0)	2	
Lacto-ovo- vegetarian	0 (0.0)	0 (0.0)	1 (100.0)	1	
<b>Activity</b>					0.363
Sedentary worker	163 (23.3)	34 (4.9)	502 (71.8)	699	
Moderate worker	13 (16.9)	3 (3.9)	61 (79.2)	77	
Heavy worker	3 (13.6)	0 (0.0)	19 (86.4)	22	
<b>Alcoholism</b>					0.543
Alcoholic	2 (25.0)	1 (12.5)	5 (62.5)	8	
Non alcoholic	177 (22.4)	36 (4.6)	577 (73.0)	790	
<b>Smoking</b>					0.952
Smoker	10 (23.3)	1 (2.3)	32 (74.4)	43	
Ex smoker	4 (19)	1 (4.8)	16 (76.2)	21	
Non smoker	165 (22.5)	35 (4.8)	534 (72.8)	734	
<b>Smokeless tobacco</b>					0.007
Current user	1 (33.3)	0 (0.0)	2 (66.7)	3	
Used earlier	4 (80.0)	1 (20.0)	0 (0.0)	5	
Never used	174 (22.0)	36 (4.6)	580 (73.4)	790	

Prevalence of diabetes and pre diabetes were higher among the subjects with obesity, central obesity and hypertension (Table 2). Around 99.6% of the subjects were non vegetarians. Among the modifiable risk factors, central obesity and history of hypertension were strongly associated with the prevalence of diabetes and pre diabetes (p<0.001). Other

significant risk factors of diabetes and pre diabetes were BMI ( $p < 0.05$ ), waist hip ratio and use of smokeless tobacco ( $p < 0.01$ ). Tobacco chewing was reported only among very few older adults. Physical activity, alcohol consumption and smoking were not significantly associated with the prevalence of diabetes in the study population ( $p > 0.05$ ).

**Table 3. Physical and biochemical parameters of subjects with their glycaemic status**

Risk factors	Diabetic (N=179)	Pre diabetic (N=37)	Non diabetic (N=582)	Total (N=798)	F value p value
Age (years)	54.81±10.4	50.59±12.4	41.38±12.3	44.82±13.2	91.989 <0.001
BMI (kg/m <sup>2</sup> )	25.95±4.1	25.95±3.9	24.97±3.7	25.23±3.9	5.210 <0.01
Waist circumference (cm)	94.17±9.1	92.62±8.5	89.25±8.8	90.51±9.1	22.241 <0.001
Waist hip ratio	0.95±0.1	0.92±0.1	0.91±0.1	0.92±0.1	25.329 <0.001
Systolic blood pressure (mm/Hg)	135.36±15.5	130.81±12.0	126.25±9.9	128.51±12.1	43.648 <0.001
Diastolic blood pressure (mm/Hg)	87.49±8.4	85±7.5	81.1±7.5	82.72±8.2	48.569 <0.001
Fasting blood sugar (mg/dl)	155.25±37.5	115.65±6.2	84.08±8.0	101.51±35.3	962.52 <0.001

In the study population, the diabetic subjects had significantly higher values of BMI, waist circumference, waist hip ratio and blood pressure than other subjects (Table 3). Comparison of the mean values of age, BMI, waist circumference, waist hip ratio, blood pressure and fasting blood sugar of the subjects with their glycaemic status showed strong association of all the parameters with the prevalence of diabetes ( $p < 0.001$  and BMI –  $p < 0.01$ ).

**Table 4. Prevalence of diabetes and its associated risk factors**

Risk factors	Prevalence of diabetes N=798 (%)	Odds Ratio (95% CI)	p value*
<b>Age (Years)</b>			<0.001
25 -45	40 (8.9)	1	
>45	139 (39.9)	6.817 (4.620 – 10.060)	
<b>Sex</b>			0.565
Female	96 (21.7)	1	
Male	83 (23.4)	1.103 (0.790 – 1.540)	
<b>Family history of diabetes</b>			<0.001
Absent	59 (15.4)	1	
Present	120 (28.9)	2.234 (1.575 – 3.168)	
<b>Obesity</b>			0.005
Absent	74 (18.3)	1	
Present	105 (26.6)	1.620 (1.157 – 2.269)	
<b>Central obesity</b>			<0.001
Absent	27 (13.2)	1	
Present	152 (25.6)	2.272 (1.456 – 3.545)	
<b>WHR</b>			0.005
Normal	63 (17.7)	1	
High risk	116 (26.2)	1.644 (1.165 – 2.321)	
<b>Activity</b>			0.110
Not sedentary	16 (16.2)	1	
Sedentary	163 (23.3)	1.578 (0.898 – 2.770)	
<b>Alcoholism</b>			0.861
Non alcoholic	177 (22.4)	1	
Alcoholic	2 (25.0)	1.154 (0.231 – 5.770)	
<b>Smoking</b>			0.911
Non smoker	165 (22.5)	1	
Ever smoked	14 (21.9)	0.966 (0.521 – 1.790)	
<b>Smokeless tobacco</b>			0.006
Never used	174 (22.0)	1	
Ever used	5 (62.5)	5.900 (1.396 – 24.934)	
<b>History of Hypertension</b>			<0.001
Absent	138 (20.0)	1	
Present	41 (38.3)	2.489 (1.616 – 3.835)	

\*p value is calculated using chi-square test



Among all the risk factors, age, family history of diabetes, central obesity and history of hypertension were strongly associated with the prevalence of diabetes ( $p < 0.001$ ). BMI, high waist hip ratio and tobacco chewing were also significantly associated with diabetes ( $p < 0.01$ ). However, the risk factors such as gender, activity, alcohol intake and smoking were not found to be significantly associated with diabetes ( $p > 0.05$ ). The prevalence of diabetes among the subjects aged above 45 years was 6.8 times higher than those below 45 years. Among the subjects with obesity, the prevalence of diabetes was 1.6 times higher than those who were not having obesity (Table 4).

**Table 5. Multivariate analysis of risk factors for prevalence of diabetes\***

Risk factors	Adjusted Odds Ratio	95% CI
<b>Age</b>		
25 – 45 years	1	
>45 years	8.565	5.615 – 13.066
<b>Family history of diabetes</b>		
Absent	1	
Present	3.502	2.342 – 5.238
<b>Central obesity</b>		
Absent	1	
Present	2.395	1.472 – 3.898
<b>History of hypertension</b>		
Absent	1	
Present	1.693	1.039 – 2.760

\*Variables adjusted in the model are BMI, Waist hip ratio and smokeless tobacco

Multiple variate analysis of risk factors in binary logistic regression showed age above 45 years, family history of diabetes, central obesity and hypertension as the major predictors of diabetes. In the study population, the risk of developing diabetes after 45 years of age was 8.5 times higher than that below 45 years. The family history of diabetes increases the risk of getting the disease by 3.5 fold. Presence of central obesity and history of hypertension increases the chance of diabetes by 2.4 times and 1.7 times respectively (Table 5).

## DISCUSSION

The present study constituted higher percentage of females. Earlier studies done in Kerala also reported the higher participation of women and it may be

mainly due to the high female ratio in the population. [8,9,11] The age standardised prevalence of diabetes was high (22.4%) among the study population. High prevalence of diabetes was identified by many studies including both cross sectional and cohort studies done in Kerala. [9-11,18,19] A study done by ICMR- INDIAB in 15 states of India documented high prevalence of diabetes in various states of India. [20]

The prevalence of pre diabetes in the study population was 4.6%. Earlier studies conducted in rural central Kerala and Chennai reported lower prevalence of pre diabetes. [9,21] Low prevalence of pre diabetes and higher prevalence of diabetes may denote a rapid progression from normoglycemic to diabetes causing a drastic increase in the diabetes epidemic. [22] Contradictory to this, high prevalence of pre diabetes was recorded by few other studies. [10,11]

Even though there were gender differences in the prevalence of diabetes and pre diabetes, gender was not significantly associated with the prevalence of diabetes as described in the previous studies reported in other parts of Kerala. [11,23] Similar findings were also stated in few other studies. [24,25] But the studies conducted in Pondicherry and Northern Spain documented gender as a significant risk factor. [26,27]

Increasing age was found to be the most significant risk factor in the study population. Age as a significant risk factor of diabetes was reported in the earlier studies done in and around Kerala. [11,18,23,24,28] Several studies revealed age above 50 years as a potential risk factor of diabetes. [29-32] Family history of diabetes was the second significant risk factor that was highly associated with the prevalence of diabetes and pre diabetes among the adults studied. Similarly, the previous studies in Kerala described the strong association of family history diabetes with the prevalence of diabetes among the population. [9,11,18] Various other studies also showed the same findings. [27-31,33] Hence, increasing age and family history of diabetes were found to be

the significant non modifiable risk factors of diabetes among the adults under study.

There was significant association between high BMI and diabetes indicating obesity as a strong risk factor of diabetes in the study population. A recently done 10-year prospective cohort study in Kerala also reported obesity as a risk factor for T2DM.<sup>[11]</sup> The significant relationship between obesity and diabetes was revealed in several other previous studies.<sup>[26,29-36]</sup>

Even though generalized obesity and central obesity were found to be significantly associated with diabetes, central obesity was found to be more significantly associated with the prevalence of diabetes and pre diabetes in the study population. This finding coincides with that of the earlier studies conducted in other parts of Kerala.<sup>[9,11,18]</sup> Several other studies also stated central obesity as a significant risk factor of diabetes.<sup>[24,26,29-37]</sup>

Among the behavioural risk factors, the habit of chewing tobacco was significantly associated with the prevalence of diabetes. Even though the prevalence of T2DM was higher among sedentary workers, physical activity was not significantly associated with the prevalence of diabetes. Similar finding was reported in an earlier study.<sup>[11]</sup> But, physical inactivity or sedentary activity was recorded as a significant risk factor of diabetes in several other studies.<sup>[24,28,37,38]</sup> Smoking and alcohol intake were not significantly related with the prevalence of diabetes and pre diabetes. But smoking was found as a potential risk factor in a study conducted in Palakkad.<sup>[18]</sup>

History of hypertension was strongly associated with the prevalence of diabetes and pre diabetes. The odds of occurring T2DM among the people with the history of hypertension was 2.48 fold higher than those without hypertension. Earlier studies also observed hypertension as a significant risk factor of diabetes.<sup>[9,11,23]</sup> Hence, both generalized obesity and central obesity, hypertension and use of smokeless tobacco were the significant modifiable risk factors in the study population.

Increasing age, family history of diabetes, central obesity and hypertension were the major risk factors of T2DM in the study population. Similar results were obtained in the recently done study at Kerala.<sup>[11]</sup> Among them, central obesity and hypertension can be modified with effective interventions on lifestyle. Sedentary lifestyle with high consumption of carbohydrate and fat rich foods but low intake of fruits and vegetables are the causes of obesity. Hence, interventions on life style changes are essential to prevent the incidence of T2DM.

## CONCLUSION

The present study indicates high prevalence of 22.4% of T2DM in the study population. The major strength of our study is that it was the first population based cross sectional study conducted in the study area to the best of our knowledge, to explore the prevalence and risk factors of diabetes. The risk factors such as age, family history of diabetes, obesity, central obesity and hypertension are found to be the potential causes of T2DM in the study population. Among these risk factors, central obesity and hypertension can be reduced by bringing modifications in the lifestyle of the study population. Hence, formulation and implementation of effective and sustainable positive lifestyle changes is essential to restrict the growing epidemic of T2DM.

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**Conflict of interest:** None

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