A RETROSPECTIVE STUDY ON EMERGING OCCURRENCE OF TYPE 2 DIABETES MELLITUS IN NORTH KERALA

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ABSTRACT

The prevalence of Type 2 Diabetes mellitus (T2DM) is rapidly rising worldwide. As the International Diabetes Federation (IDF) suggests that the number of adults living with diabetes worldwide was increasing from time to time. Kerala, a state in the southern part of India with a prevalence of T2DM of 20% leads the country in an epidemiologic transition and is the most advanced Indian state with highest T2DM prevalence. The study was conducted to assess the emergence occurrence of T2DM in North Kerala during the last decade, and also developed a mathematical model to predict the gender wise growth of T2DM.The study was undertaken as a retrospective study in three multi-speciality hospitals in North Kerala. Details regarding the age and yearly census of both male and female in patients (IP) and out patients (OP) of T2DM were retrieved from the hospital records of past 10 years. These secondary data were subjected to statistical analysis to predict the growth in the occurrence of both diabetes IP and OP till the year 2025. The findings of the study concluded that there would be a substantial escalation in the growth of T2DM in North Kerala in upcoming years. Gender based growth examination point out that male has greater chance of being affected by diabetes than females in North Kerala. After 40 years the chances of hospital admission related to diabetes was high, but as the age progresses the need for medical emergencies increased gradually.

Keywords: Type 2 diabetes, epidemiological transition, inpatients, outpatients, prediction, mathematical model.

INTRODUCTION

The prevalence of T2DM is rapidly rising worldwide. IDF estimated that the global prevalence of diabetes is 429 million by the year of 2017 and this number is expected to rise 628.6 million by 2045. It was also reported that approximately 4.0 (3.2-5.0) million people aged between 20 and 79 years are estimated to die from diabetes in 2017, which is equivalent to one death every eight seconds. Diabetes accounted for 10.7 percent of global all-cause mortality among people in this age group[1].

The burden of ill health due to diabetes has also been increasing, primarily in developing world; in 2014 diabetes caused 1.5 million deaths worldwide and more than 80% of these deaths occurred in low- and middle-income countries.[2] India, a country experiencing rapid socioeconomic progress and urbanization, carries a considerable share of the global diabetes burden. Studies in different parts of India have demonstrated an escalating prevalence of diabetes not only in urban populations, but also in rural populations as a result of the urbanization of lifestyle parameters.[3]

Kerala, a state in the southern part of India with a prevalence of T2DM of 20% leads the country in epidemiologic transition and is a harbinger of what will happen in the rest of India, and is reported as the most advanced Indian state in epidemiological transition and has the highest T2DM prevalence.[4] In a large multi-center study, the prevalence of diabetes in Thiruvananthapuram was 17 % compared to 15% in Hyderabad and New Delhi.[5] However, data on incidence of diabetes in Kerala are limited. Only very few published studies are available on the prevalence of Diabetes in the Kerala state, most of which indicate high prevalence. The emerging occurrence of T2DM creates this a disease of considerable concern at the individual patient level and also at the public health level.

OBJECTIVES

- To assess the gender wise occurrence of incidence of T2DM in North Kerala during last decade
- To develop a mathematical model to predict the growth of T2DM among male and female patients
- To assess the age wise occurrence of diabetes among T2DM patients.

MATERIALS AND METHODS

This is a retrospective study chiefly conducted in three leading multi-speciality hospitals in Calicut, Malappuram and Wayanad districts of North Kerala. Secondary data available from the medical records of 2007 January to 2016 December were used as a tool for collecting data. The raw data regarding the OP and IP visited the hospital for past 10 years retrieved from hospital records and registers were subjected to statistical computations using the SPSS (Statistical Package for Social Sciences) version 21.0.

The statistical methods adopted were Least Square Method (LSM) in regression analysis to predict growth of diabetes, One-way ANOVA to compare means of selected variables and Post Hoc analysis to confirm where the differences occurred between groups.

RESULTS AND DISCUSSIONS

Results and discussion pertaining to the study is presented under the following heads. Figure1 represents the daily census of patients visited the hospital for the years from 2007 to 2016.

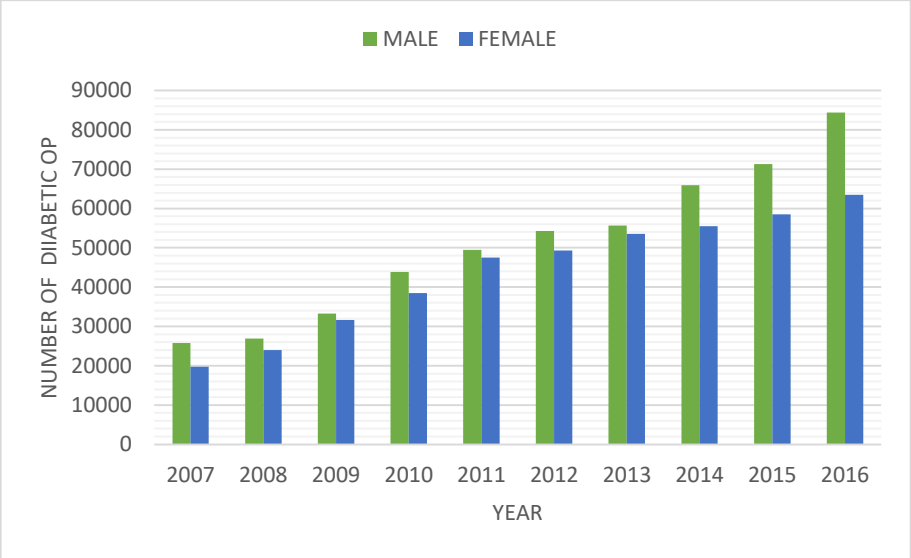

Fig 1 - Yearly censuses of OP visited the Hospital for the last decade

Figure 1 indicates that as the year progressed the number of diabetic OP both males and females also increased gradually. In the present study male patients had high prevalence of diabetes than their female counter parts. Similar tendency was noted in another study which describes men are in general more insulin resistant than women, which can be explained by their higher proportion of visceral and hepatic fat compartments associated with insulin resistance.[6] Unhealthy lifestyle habits like tobacco chewing, smoking and alcoholism was prominently noted among male patients than females in Kerala, so this may also be a reason for increased prevalence of diabetes among males than females. The secondary data from hospital records on diabetes patients as shown in figure 1 was subjected to regression analysis to predict the growth in the occurrence of diabetes OP and the details are presented in the Table 1.

Table 1- Growth and incidence of Male diabetic OP

r2 0.977		n	10	
r 0.988		k	1	
Std error 3133.49		Dep.Var	Male OP census	
ANOVA				
Source	SS	MS	F	P-value
Regression	3.284	3.284	334.501	<0.001
Residual	7.855	9818791.05		
Total	3.363	9		
Regression Output				
Variables	Coefficients Std error	t(df=2)	p-value	
Intercept	-1.264 693940.9	-18.216	<0.001	
t	6309.582 334.9	18.286		

Table 1 illustrated the gender based growth and prevalence of diabetes OP. Secondary OP census revealed an increased prevalence of diabetes among male patients. The growth and prediction of male diabetes patients were done using LSM. The model had high

reliability, which interpreted that there exists 97.7% reliability between the year and number of patients. When statistically tested ANOVA test was positively significant (p = < 0.001). It points out that the model developed was highly suitable. Mathematically the prediction of OP diabetic males can be expressed in terms of formula

$$y = -1.26 \times 10^7 + (6309.582 \times Year).$$

Table 2 - Prediction of growth and incidence of male diabetic OP

Year(t)	Male DM OP	Predicted	Residual	Growth % yearwise	Growth % from 2007
2007	25776	22681	3095		100
2008	26895	28990	-2095	127.82	127.82
2009	33258	35300	-2042	121.76	155.64
2010	43892	41610	2282	117.87	183.46
2011	49501	47919	1582	115.16	211.27
2012	54260	54229	31	113.17	239.09
2013	55632	60538	-4906	111.64	266.91
2014	65893	66848	-955	110.42	294.73
2015	71256	73157	-1901	109.44	322.55
2016	84376	79467	4909	108.62	350.37
2017		85777		107.94	378.19
2018		92086		107.36	406.01
2019		98396		106.85	433.82
2020		104705		106.41	461.64
2021		111015		106.03	489.46
2022		117325		105.68	517.28
2023		123634		105.38	545.10
2024		129944		105.10	572.92
2025		136253		104.86	600.74

In 2007 the total number of male OP was 25776, but within 5year the two times increase was noted among male population. In 2016 after one decade the number of male patients increased up to 84376. Trend analysis showed that if this trend continued there would be four times increase in the number of male patients by the year of 2020. Moreover, the estimated annual number of total male diabetic OP indicated that there would be 600.74% estimated growth from 2007 to 2025.

The secondary data on gender wise census of diabetic patients from hospital records was again subjected to regression analysis to predict the growth in the occurrence of diabetes female OP, and the details are presented in Table 3.

Table 3 - Growth and incidence of female diabetes outpatients

r2	0 .961		n	10	
r	980		k	1	
Std error	3138.30054		Dep.Var	**Female OP census**	
ANOVA					
Source	SS	df	MS	F	P-value
Regression	1.949	1	1.949	197.852	<0.001
Residual	7.879	8	9848930.2		
Total	2.027	9			
Regression Output					
Variables	Coefficients	Std error	t(df=2)	p-value	
Intercept	-9.732	695005.1	-14.002	<0.001	
t	4860.018	345.5	14.006		

An attempt to project the growth and incidence of female diabetic OP was done using the LSM model with 96.1% reliability. ANOVA results indicated a positive significance with the year and increase in the diabetic female OP. The regression model for predicting the growth and incidence of female diabetes OP was calculated by a formula

$$Y = -9.732 \times 10^6 + (4860.018 * year)$$

Table 4 - Prediction of growth and incidence of male diabetic OP

Year (t)	Female DM OP	Predicted	Residual	Growth % yearwise	Growth % from 2007
2007	19776	22310	-2534		100
2008	23961	27170	-3209	121.78	121.78
2009	31638	32030	-392	117.89	143.57
2010	38476	36890	1586	115.17	165.35
2011	47531	41750	5781	113.17	187.13
2012	49324	46610	2714	111.64	208.92
2013	53568	51470	2098	110.43	230.70
2014	55475	56330	-855	109.44	252.49
2015	58536	61190	-2654	108.63	274.27
2016	63512	66050	-2538	107.94	296.05
2017		70910		107.36	317.84
2018		75770		106.85	339.62
2019		80630		106.41	361.41
2020		85490		106.03	383.19
2021		90350		105.68	404.97
2022		95210		105.38	426.76
2023		100070		105.10	448.54
2024		104930		104.86	470.33
2025		109790		104.63	492.11

The trend analysis showed that there would be a constant increase in the growth and incidence of diabetes in the female OP if the present scenario persists. The percentage growth of female OP was calculated by fixing the year 2007 as a base year and the data revealed that there would be 492.11% growth in the diabetes from 2007 to 2025. The estimated annual number of female diabetes OP is expected to increase from 85490 in 2020 to 1000070 in 2023 and to 109790 in 2025 (104.63% increase from 2024 to 2025).

A study conducted in United States reported that progress in reducing mortality rates among persons with diabetes has been limited to men. The study also consolidated that diabetes continues to be greatly increased the risk for death, particularly among women than man.[7] The secondary data obtained from female and male IP census was subjected to Regression analysis and plotted in figure 2.

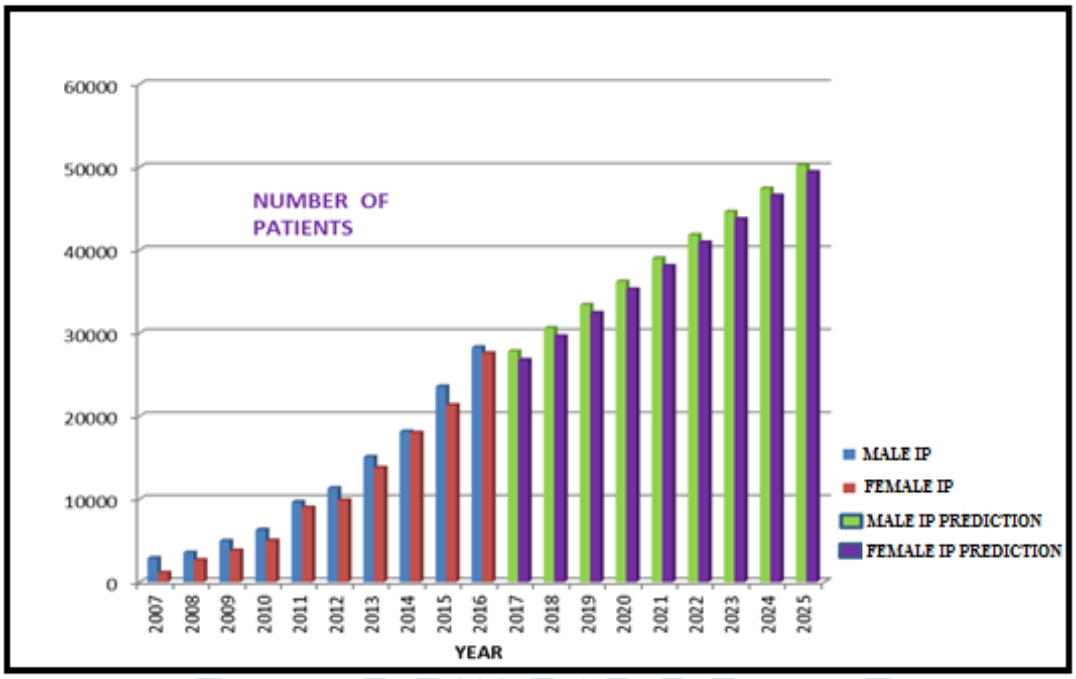

Fig 2 - Growth and incidence of gender based prediction of diabetic IP

Like OP data IP census also revealed that male had high prevalence of diabetes than female. Figure 2 represent the growth of IP which included both males and females. LSM model was also used to predict the growth of diabetes patient from 2007 to 2025 during the retrospective phase of the study It was observed that the particular model was very much fit in prediction as there is 94.7% and 94.4% reliability respectively. There were 2896 males and 1119 females IP visited the hospital in the year 2007 and it became 28284 males and 27561 females by the year of 2016. The formula used for predicting the male and female IP were

$$\textit{Number of female IP} = -5.676 \times 10^{6} + (2828.921 * \textit{year})$$

$$\textit{Number of male IP} = -5.626 \times 10^{6} + (2803.139 * \textit{year})$$

By substituting this formula, we can predict the growth of IP ahead. There would be 50219 males (growth percentage 105.9) and 49393 females (growth percentage 106.08) by the year of 2025.

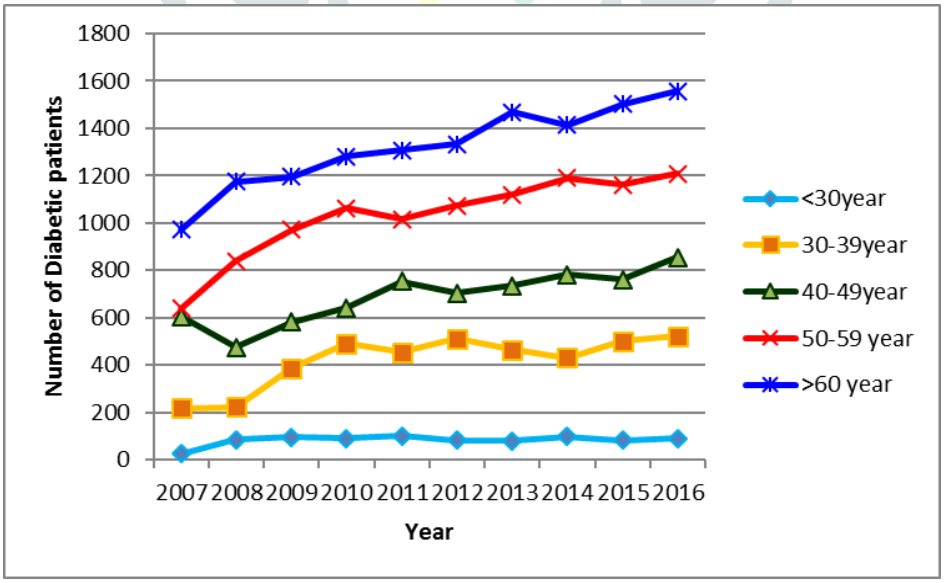

Fig 3 - Age wise comparison of diabetes inpatient in the Hospital

It was observed from the figure 3 that a steady increase in the number of diabetes IP occurred as the age increased. In 2007 very few patients (24) below 30 years were admitted in the hospitals for treatment but within five years (2011) four times hike were noticed among these age group (101). This is somewhat a serious issue that may affect the productivity of nation itself. Different studies conducted by TODAY study group reported that Individuals diagnosed as having T2DM at a younger age seem to have

an increased risk of developing diabetes-related complications compared with those diagnosed later in life, suggesting a more aggressive phenotype.[8] Similarly, 8.8% of patients with 30-39 years of age were admitted for the treatment of diabetes in the year of 2007. But within one decade the number enhanced to 12.3%. This data also indicated that by younger people there is an enhancement in hospital admission for proper blood sugar management. A study conducted in Chennai, had noted that the prevalence of diabetes in persons below 44 years of age had increased from 25% of the total prevalence in 2000 to 34.7% in 2006.[9]Gradual increase in the IP admission was noticed among diabetes patients with age of 50-59 years. 29.7% patients were admitted in 2007 and it became 30.1% in 2016. This revealed the increased trend of various diseases and complications associated with diabetics. However maximum number of admission was appeared among diabetes patients with more than 60 years of age.

Table 5 - Age wise distribution of diabetes inpatients based on ANOVA

Age	Mean	Std dev	N	F	sig
30 years	80.8	21.78	10	9.749	<0.000
30-39 years	420.3	112.729	10		
40-49 years	689	112.842	10		
50-59 years	1028.8	176.243	10		
>60 years	1320.4	176.339	10		

Table 5 reveals that maximum number of patients admitted in the hospital during the past 10 years. Mean value indicated that age and hospital admission was directly associated. As the year progressed the number of hospital admission also increased. The ANOVA results also indicated a positive significance (p = 0.000). The relationship of each age group was also assessed using Post Hoc test to identify the most affected age group among these IP. The results were described in Table 6.

A positive statistical significance was observed between the diabetes patients with age group of 40 – 49 years, 50-59 years and above 60 years respectively. This indicate that after 40 years the chances of hospital admission related to diabetes was high, but as the age progressed the need for medical emergencies also increased gradually. WHO (2016) reported that after the age of 50, middle-income countries have the highest proportion of deaths attributed to high blood glucose, for both men and women. Except in high-income countries, the proportion of deaths attributable to high blood glucose for both men and women were highest in the age group 60–69 years.[10]

Table - 6 Age wise distribution of diabetic IP based on Post- Hocks test

(I) AGE GROUP	(J) AGE GROUP	Mean Difference (I-J)	p value
<30 years	30-39 years	-3432.5	0.871
	40-49 years	-1.47	0.001
	50-59 years	-3.07	0.000
	>60 years	-4.08	0.000
30-39 years	<30 years	3432.5	0.871
	40-49 years	-1.13	0.023
	50-59 years	-2.73	0.000
	>60 years	-3.73	0.000
40-49 years	<30 years	14692.40*	0.001
	30-39 years	11259.90*	0.023
	50-59 years	-1.60	0.000
	>60 years	-2.61	0.000
50-59 years	<30 years	30721.90*	0.000
	30-39 years	27289.40*	0.000
	40-49 years	16029.50*	0.000
	>60 years	-10050.9	0.053
>60 years	<30 years	40772.80*	0.000
	30-39 years	37340.3	0.000
	40-49 years	26080.40*	0.000
	50-59 years	10050.9	0.053

CONCLUSION

The findings of the study concluded that there would be a substantial escalation in the growth of T2DM in North Kerala in upcoming years. Gender based growth examination point out that male has greater chance of being affected by diabetes than females in North Kerala. After 40 years the chances of hospital admission related to diabetes related problem was high, but as the age progresses the need for medical emergencies increased gradually. Maximum number of admission was appeared among diabetes patients with more than 60 years of age.

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