Original Article

High Prevalence of Type 2 Diabetes Mellitus and Other Metabolic Disorders in Rural Central Kerala

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Abstract

Background: Within India, inter-regional disparities in burden of type 2 diabetes mellitus (DM) are expected because of varying lifestyles and demographic patterns. Hence, to estimate the prevalence of DM and impaired fasting glycaemia (IFG), and to explore the predictors of DM, a study was conducted in rural Kerala.

Methods: In 2007, a cross-sectional survey was conducted among 1990 adults (women: 1149; men: 841) of two Panchayat Wards in Venmony Panchayat, Chengannur Taluk, Kerala, India. Those who were already on drugs for DM and/or having fasting plasma glucose (FBS) ≥ 126 mg/dL were considered as DMs; those with FBS 100 –125 mg/dL were considered as IFGs. Pearson's Chi-Square test and multiple logistic regression were used for statistical analysis.

Results: The response rate was 82.7 percent. The crude- and age-adjusted prevalence of DM was 14.6 percent and 12.5 percent respectively, and that of IFG was 5.1 percent and 4.6 percent respectively. The crude prevalence of hypertension (BP≥ 140/90), hypercholesterolemia (fasting total serum cholesterol ≥ 200 mg/dL) and central obesity (WHR ≥ 0.80 [women] and ≥ 0.90 [men]) was 36.1 percent, 37.0 percent and 85.6 percent respectively. Adjusted for age and sex, DM was significantly associated with positive family history of DM [Odds ratio: 2.81; 95% CI (2.04-3.86)], high socioeconomic status [1.43; (1.04-1.95)], central obesity [3.91; (1.77-8.64)], hypercholesterolemia [1.93; (1.42-2.62)], and hypertension [1.71; (1.24-2.37)].

Conclusion: High prevalence of DM even in rural community validates the pandemic trend of DM. The co-existence of other non-communicable diseases amplifies the burden of DM. The impact of socioeconomic transition on the occurrence of DM needs to be explored further.©

Introduction

Estimates suggest that, in the year 2000, 171 million people of all ages worldwide had their blood glucose levels in the diabetes range.[1] Over the next 30 years the global prevalence of diabetes mellitus is projected to increase by over 100 percent. This will raise the global burden of diabetes mellitus to 366 million by the year 2030.[2]

India shelters the most number of people with diabetes mellitus worldwide. From 31 million in the year 2000, the number of persons with diabetes mellitus in India would register a 2.5 fold increase over the next 30 years so as to reach an alarming level of estimated 80 million by the year 2030.[2] The only published nationally representative study on burden of diabetes mellitus in India is Prevalence of Diabetes in India Study – PODIS (2002), a multi-centric study (49 urban and 59 rural centres) on 41,000 Indian people. PODIS has estimated the age and gender standardised prevalence of diabetes mellitus in India to be 3.3 percent.[3] The prevalence estimates ranged from 5.6 to 12.4 percent in urban area and 2.4 to 2.7 percent in rural area.[4] This urban – rural difference in the prevalence of diabetes mellitus within the same ethnic group (Indians) is attributed primarily to the 'modern' lifestyle that urban Indians follow when compared to the 'traditional' lifestyle of rural Indians. The urban-rural differences in lifestyle factors in India include dietary pattern, physical activity and mental stress.

The prevalence of diabetes mellitus differs not only across the rural-urban divide in India but also across the Indian States. This is because different Indian states are at different stages of demographic transition. Hence, a higher prevalence of diabetes could be expected in Kerala since Kerala has the highest proportion of elderly in India.[5] With a very low crude death rate, the state is also well on its way in the advancing epidemiological transition. Kutty et al reported 16.3 percent crude prevalence of diabetes mellitus among 322 adults aged 20 years or above in an urban settlement in Kerala.[6] In another study from southern Kerala, the crude prevalence of diabetes mellitus among urban residents was 12.7 percent compared to 2.7 percent prevalence among coastal residents.[7] Amritha Diabetes and Endocrine Population Survey (ADEPS) (2005) identified 9 percent reported- prevalence and 10.5 percent prevalence of newly detected diabetics among semi-urban and urban adult residents aged 18 years and above in Central Kerala.[8]

Many villages in Kerala have undergone a drastic change in living standards and lifestyles in the span of 20-25 years, on account of the influx of money in recent years from people working abroad in the Gulf States and other affluent countries. The change in disease profiles brought about by this sudden affluence, and its differential impact on different social classes, largely remain unstudied. This was the point of departure for our exploration into the prevalence of diabetes and related states in a small community in the central part of the southern region of the State.

This study carried out to estimate the prevalence of

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diabetes mellitus and impaired fasting plasma glucose in the adult population of two wards of the Venmony panchayat in Chengannur taluk, Alappuzha district of Kerala.

Also, we tried to explore the prevalence of other chronic non-communicable diseases like hypertension, obesity and hypercholesterolemia in the same population.

Materials And Method

Study Participants

The participants belonged to two Panchayat wards in Venmony Panchayat, Chengannur Taluk, Alappuzha District of central rural Kerala, India. A panchayat is the smallest politically administered unit in Kerala (as in the rest of India) and a ward is the smallest division in a panchayat in Kerala; around 8-12 wards of 1000-2000 people each make up a panchayat. The selection of the study area was primarily dictated by nearness to the Medical Trust Hospital, which initiated the study; it was also prompted by the observation that over the past few years, there has been a visible change in the lifestyle of the residents. Substantial numbers of individuals from this region have migrated abroad for employment, mainly to the Middle East states of United Arab Emirates, Kuwait, Bahrain etc, as well as to Europe and the United States. This has brought in drastic changes in the lifestyle of other members of their family at home over a short span of time. Meanwhile there is a sizeable proportion, which still follows traditional work and life patterns. Thus, we anticipated that the study population would yield an adequate blend of individuals who follow various lifestyles so that the impact of these on the origin of type 2 diabetes could be evaluated.

Study Design

We conducted a cross-sectional survey among the participants. We obtained the list of households from the Panchayat. Through a house-to-house survey we created an eligible participant list of all the usual adult residents (i.e., aged 18 years or above and, resident in the locality for at least 6 months in the previous year, or has started residing in the locality within 6 months and continuing to reside). There were 726 households in both the Wards, with 995 usual adult residents from 371 households in Ward A, and 995 usual adult residents from 355 households in Ward B. Thus 1990 usual adult residents comprising of 1149 women (57.7 percent) and 841 men (42.3 percent) were eligible participants. We attempted to contact every listed participant and evaluate his/her glycaemic status.

We used a pre-tested questionnaire that explored demographic details, past history and family history of disorders, diet pattern, physical activity and socio-economic status. An informed written consent was obtained prior to data collection. We asked additional questions to the key informant of each household to assess the socio-economic status of the households. Anthropometric measurements and blood pressure of each participant was recorded. Trained nurses collected fasting blood samples from all participants for estimation of fasting plasma glucose and cholesterol values.

The two wards were not selected as a random sample from the list of wards; therefore we do not claim that the prevalence estimates are representative of the village in a strict sense. The estimates represent only the two wards studied, a total population of around 3000, in which the attempt was to study every adult. However, since our major goal was to trace the differences within the study subjects and relate it to lifestyle attributes, this does not take away from the merit of the study. Moreover, we plan to continue studying this population over a longer period, and in this sense this initial survey can be considered similar to a baseline survey of an inception cohort.

Institutional Review Board (Ethics Committee) of the Medical Trust Hospital approved the study. The data collection extended from 1st March 2007 to 31st May 2007.

Defining Variables

Fasting Plasma Glucose

a. Type 2 diabetes mellitus (DM): Those who reported as having diabetes, and/or those with fasting plasma glucose ≥ 126 mg%.
b. Impaired fasting glycaemia (IFG): Those who had fasting plasma glucose in the range 100–125 mg%.
c. Normoglycaemia: Those who had fasting plasma glucose < 100 mg%.

Blood Pressure (BP)

For estimation of blood pressure we used digital Omron apparatus. The cuff of the BP apparatus was tied round the right upper arm with the patient in sitting posture. On switching on the apparatus, the cuff automatically inflated and then deflated to give the systolic and the diastolic BPs. The measurement was repeated twice more with an interval of 2-3 minutes in between. Thus there will be three BP recordings for each participant. The first recording was discarded. The averages of latter two recordings were then used for calculating average systolic and average diastolic blood pressure.

a. Systemic hypertension: Those who were on blood pressure medication, plus those having systolic blood pressure ≥140 mm of Hg, and/or diastolic blood pressure ≥90 mm of Hg.
b. Pre-hypertension: Those who were not on blood pressure medication and having systolic blood pressure in the range 120 -139 mm of Hg and/or diastolic blood pressure in the range 80 - 89 mm of Hg.
c. Normotension: Those who were not on blood pressure medication and having systolic blood pressure < 120 mm of Hg and diastolic blood pressure < 80 mm of Hg.

Lipid (Total Cholesterol)

a. Hypercholesterolemia: Those who are on medication for elevated cholesterol, and/or having fasting serum total cholesterol ≥200 mg%.
b. Normal serum cholesterol: Those who are not on oral hypolipidemic drugs and having fasting serum total cholesterol < 200 mg%.

Waist-to-Hip Ratio (WHR)

a. Central obesity: WHR ≥ 0.80 in women, WHR ≥ 0.90 in men
b. Normal WHR: WHR < 0.80 in women, WHR < 0.90 in men

Body Mass Index (BMI)

a. Obesity: BMI ≥ 25.00
b. Overweight: BMI 23.00–24.99
c. Normal BMI: 18.50–22.99
d. Underweight: <18.50

Socioeconomic Status

Socioeconomic status of each household was assessed based on the possession of 14 household items: computer, washing

Table 1 : Prevalence of type 2 diabetes by major demographic and socio-cultural categories in the study population

Category	Total Number	Type 2 diabetics (percentage)
Age		
18-29 years	297	2 (0.7)
30-44 years	441	34 (7.7)
45-59 years	408	88 (21.6)
60 years and above	415	117 (28.2)
Sex		
Female	971	138 (14.2)
Male	590	103 (17.5)
Religion		
Hindu	883	97 (11.0)
Muslim	272	55 (20.2)
Christian	406	89 (21.9)
Caste		
Dalit (schedule caste)	254	15 (5.9)
Socially disadvantaged castes	466	80 (17.2)
High caste	841	146 (17.4)

machine, private car/other four wheeler vehicle, refrigerator, inverter, television, cable connection, cooking gas connection, telephone, motorcycle/scooter, mixer grinder, subscription of newspaper, subscription of magazines and electricity connection. These were arranged in an ordinal way, with more common items at the bottom end of the scale. Houses were graded into four categories based on which of the possessions they had; if any household possessed an item from a higher category, it was automatically placed in the higher category. Of the 14 items electricity connection is a baseline in the socio-political environment of Kerala. Hence, a household with only electricity connection or not even electricity connection was considered very poor. Basic items of consumer spending like subscription of newspaper, subscription of magazines, and radio, in addition to the electricity connection, put the household in poor category. Possession of more household durable goods like television, cable connection, refrigerator, cooking gas connection, telephone makes the household middle class. Mixer grinder, computer, inverter, or four-wheeler for private use will put the household in the affluent category. Though this classification is not a comprehensive one, it is simple and less time-consuming, and only objective variables have been included to reduce inter-observer variability. This scale was constructed on the basis of experience of other all Kerala surveys like the KSSP Keralapadhanom survey.[9]

Physical Activity

Physical activity questionnaire included questions on leisure-time period, work-related activity, and walking, and the activity was categorised into Low, Moderate and High.

Diet

Food frequency questions and 24 hour diet recall were used to identify the diet pattern.

Analysis

Entire data was entered in spreadsheet by masking personal identity of each respondent, cleaned and analysed. We used Pearson Chi-square test to establish the association between diabetes mellitus and various independent predictors under exploration. We tabulated people with type 2 diabetes and with normal values of fasting glucose across predictor variables such as sex, age group, socio-economic status, religion and caste, and major behavioural traits. Multiple logistic regression was used to identify age- and - sex-adjusted strength of association between diabetes mellitus and other variables. P value ≤ 0.05 was considered statistically significant throughout.

Table 2 : Distribution of physical activity, diet preference, blood pressure, serum cholesterol and body mass index

Category	In the whole population	Among men	Among women
Physical activity (PA)			
Low PA	207 (14.5)	135 (25.3)	72 (8.1)
Moderate PA	737 (51.7)	179 (33.5)	558 (62.6)
High PA	482 (33.8)	220 (41.2)	262 (29.4)
Diet			
Vegetarian	60 (3.7)	21(3.4)	39 (3.8)
Non vegetarian	1582 (96.3)	601(96.6)	981 (96.2)
Blood pressure			
Normotension	475 (28.9)	125 (20.0)	350 (34.3)
Pre-hypertension	574 (34.9)	256 (41.0)	318 (31.1)
Hypertension	596 (36.1)	243 (39.0)	353 (34.5)
Serum cholesterol			
Normal	1037 (63.0)	434 (69.6)	603 (59.1)
Hypercholesterolemia	608 (37.0)	190 (30.4)	418 (40.9)
Body Mass Index (BMI)			
<18.5	196 (11.9)	88 (14.1)	108 (10.6)
18.5-22.99	558 (33.9)	241 (38.7)	317 (31.0)
23.00-24.99	314 (19.1)	112 (18.0)	202 (19.8)
>=25.00	576 (35.0)	182 (29.2)	394 (38.6)

For bivariate and multivariate analysis persons with impaired fasting glycaemia were excluded and the analyses were done exclusively for the diabetics contrasted with those with normal blood glucose.

Results

Of the 1990 eligible participants 1645 provided entire data viz. interview schedule, anthropometric measurements, blood pressure measurement and blood samples. Thus, the overall response rate was 82.7 percent: 88.9 percent among women (1021/1149) and 74.2 percent (624/841) among men. Among 1645 respondents, the gender representation was overwhelmingly in favour of the females- 1021 (62.1 percent) were women and 624 (37.9 percent) were men.

The mean age of the study population was 47.2 ± 17.4 years [95% CI: 46.3 – 48.0], men: 48.2 ± 18.2 years [95% CI: 46.8 – 49.6], women: 46.2 ± 16.9 years [95% CI: 45.5 – 47.6]. For detailed analysis, age was grouped into categories <30 years, 30-44 years, 45-59 years and ≥60 years. Details of baseline demographic characteristics of the study population are given in Table 1. Of the men, 45.5 percent (284/624) had smoked at least once in their life time, which included 30.6 percent (191/624) of current daily smokers. Thirty four percent of the men (212/624) reported alcohol consumption in the preceding 1 year. Among men, 20.4 percent of the men (127/624) reported using non-smoke tobacco products at some point of time, and 12 percent (75/624) were currently using non-smoke tobacco products daily. Among women, this was 5.2 percent (53/1021) and 7.3 percent (75/1021) respectively.

The frequency distributions of specific correlates of diabetes mellitus that we looked into are given in Table 2.

Table 3 : Prevalence of type 2 diabetes with other morbid conditions

Category	Number	Type 2 diabetics (percentage)
Family history of diabetes*		
Absent	1092	128 (11.7)
Present	466	113 (24.2)
Waist to hip ratio*		
Normal	230	7 (3.0)
Centrally obese	1325	234 (17.7)
Body mass index*		
Normal/Underweight	719	69 (9.6)
Overweight	299	56 (18.7)
Obese	542	116 (21.4)
Blood pressure*		
Normal	455	26 (5.7)
Pre-hypertension	546	70 (12.8)
Hypertension	560	145 (25.9)
Serum cholesterol level*		
Normal	996	109 (10.9)
Hypercholesterolemia	565	132 (23.4)

*p value < 0.05

The overall crude prevalence of type 2 diabetes was 14.6 percent (241/1645). The crude prevalence of type 2 diabetes among men was 16.5 percent (103/624) and among women, 13.5 percent (138/1021). Among the 241 diabetics, 198 (12.0% of the population) were already known diabetics; the rest 43 (2.6% of the population) were newly detected by the survey. The proportions of known and newly detected diabetics among men were 13.8 percent (86/624) and 2.7 percent (17/624) respectively, and among women 11.0 percent (112/1021) and 2.5 percent (26/1021) respectively. The prevalence of impaired fasting glucose, (defined as fasting plasma glucose value between 101-125 mg/dl) - was 5.1 percent (84/1645) overall, 5.4 percent (34/624) among men and 4.9 percent (50/1021) among women. Hence, one out of every five respondents (19.8 percent) was hyperglycaemic- i.e., either diabetic or with impaired fasting glucose (men: 22.0 percent, women: 18.4 percent). Standardised to a WHO reference population, the age-standardised prevalence of pre-diabetes and diabetes mellitus (in the age group 20-80 years) were 4.6 percent and 12.5 percent respectively. Other results are given in Tables 1-4.

Discussion

The response rate in our study is high, considering the nature of community surveys. The response rate among men was relatively less compared to that among women because of lower participation rate of young and middle aged men, who represent the major workforce in the community. This lower participation of men compounds the gender ratio of participants further in favour of females, from an already female-favourable ratio in the population. The higher proportion of elderly men among respondents may be an artifact due to relatively less participation of young and middle aged men. The religion and caste break up of the study population more or less resembles the population in Alappuzha District, Kerala. In the study population there was somewhat greater representation of Muslims and Schedule caste compared to the District statistics.[10] Our finding that the socio-economic status of families in this village was predominantly middle-class (combined proportion of two

Table 4 : Age and sex adjusted odds ratios (OR) for type 2 diabetes mellitus among subjects with known risk factors for diabetes

Risk category	Reference category	Odds ratio (95% CI)
Positive family history	No family history	2.81 (2.04-3.86)
Affluent	Rest	1.43 (1.04-1.95)
Hypercholesterolemia	Normal serum cholesterol	1.93 (1.42-2.62)
Elevated blood pressure	Normal blood pressure	1.71 (1.24-2.37)
Waist-to-hip ratio high	Rest	3.91 (1.77-8.64)

categories, the middle class and the poor, excluding the affluent and the very poor = 80%) is consistent with other recent socio-economic surveys in Kerala. This provides an indirect validation of the representative character of our study area with regard to the whole of Kerala.

Our prevalence estimate of 14.6 percent for type 2 diabetes is one of the highest reported from any Indian State. Age standardisation brought down the prevalence estimate a little because of the young character of the population. Prevalence of diabetes mellitus in rural India is within a broad range of 0.8 percent to 9.3 percent according to available reports.[11-16] An earlier study from Kerala puts the prevalence of diabetes mellitus at 2.7 percent in coastal Kerala.[7] Other prevalence estimates from Kerala are from urban populations, and even those prevalence estimates are less when compared to ours.[6,8] A high proportion of diabetics was already identified previously and they were on treatment, a feature which has been reported by other studies from Kerala.[7] This is perhaps a reflection of health awareness brought about by the high literacy in the state.

The reasons for this high prevalence are not completely evident. We presume that the changes in lifestyle, cutting across socio-economic barriers, have contributed much to this. These changes include those of diet as well as physical activity. The study population, as in the rest of Kerala, has only a very low proportion of vegetarian households. Physical activity among men is clustered in two categories: most of them are either sedentary or have strenuous physical activity, whereas among women, most belong to the category of moderate physical activity. Less than 30 percent of the study population overall had blood pressure in the accepted normal range: the proportion of high blood pressure was slightly higher among males. About 37 percent of population fell into the category having hypercholesterolemia in which the proportion of women outnumbered that of men. The mean cholesterol of the study population was comparable to that reported among urban South Indian population.[17] More than one-third of this population had a BMI over 25.

In the study area, rising age is associated with higher prevalence of diabetes, as is the male sex. We have looked for prevalence of diabetes across some other demographic, socio-cultural and biological variables, and found statistically significant association between some of them, such as positive family history, high levels of serum cholesterol, high blood pressure, and obesity. The last three, along with high levels of blood sugar, constitute elements of what is known as the metabolic syndrome, and this is well known to be a precursor of coronary heart disease. Family history provides one of the strongest associations with type 2 diabetes; high socio-economic status has only a weak association. This

may be explained by the homogeneity of life-styles across the socio-economic spectrum, a characteristic feature of life in Kerala. However, affluence is a risk factor for diabetes in this society. Evidence from West suggests an inverse relation with SES[18] while evidence from India suggests a positive relation.[19] In the Western population, the more affluent adapt to a healthier lifestyle with increasing voluntary leisure-time physical activity and greater consumption of healthy foods; in developing societies, less physical activity and consumption of more calories accompanies one's ascent in the socio-economic spectrum. Our findings indicate that what is happening in Kerala may be typically what many developing country populations are going through in their experience. In our study population, low socioeconomic class was predominantly represented by the dalits, who have a lifestyle characterised by more physical activity. Though an inverse relationship was observed between physical activity and prevalence of diabetes mellitus, the association was not statistically significant. The reasons for varying prevalence of type 2 diabetes across religion remain unclear and have to be explored further.

Limitations

One major limitation was that we did not estimate the prevalence of impaired glucose tolerance. There is evidence that the proportion of people with impaired fasting glucose is different from that of those with impaired glucose tolerance. Had we done post-prandial glucose estimation too our prevalence estimate could have further been high. However, doing a glucose challenge test would have entailed considerably greater resources in time and money. We followed convenience sampling.

Hence the prevalence estimates do not represent that of the village in the strict sense. Women outnumbered men in the baseline population: this is true of Kerala as a whole. There was greater response from women, which probably introduced a selection bias in the sample. However, we have separate estimates for men and women, and have adjusted for gender in the multivariate analysis.

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