ORIGINAL RESEARCH ARTICLE

Prevalence of Diabetes and Its Associated Factors Among the Adult Tribal Population in Tamilnadu, India

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ABSTRACT

Background: Diabetes is increasing at alarming rate among Indians especially South Indians with prevalence of diabetes mellitus varying in populations of different regions. There are very limited data available among the tribals. A cross-sectional study was conducted to estimate the prevalence of diabetes mellitus and its associated factors in an adult tribal population.

Methodology: A total of 425 peoples were selected using multi-stage random sampling techniques. A modified STEP-wise questionnaire was used and detailed interview was conducted with the participants aged above 30 years. Random blood sugar and Body mass index (BMI) were estimated for all the participants. Chi-square and Adjusted Odds-ratio was used to study the strength of association.

Results: Prevalence of diabetes was 7.8% (33) among the study participants and 92.2% (392) of them were non diabetic. Among diabetic 21.2% (7) were newly diagnosed, 33.3% (11) of them had diabetes between 1-5years, 21.2% (7) have diabetes between 5-10 years and 24.3% (8) of them had diabetes more than 10years. Increasing Age, Education, Physical-inactivity and Obesity showed a strong association with diabetes.

Conclusions: The prevalence of diabetes and the burden of lifestyle risk factors for diabetes have been observed to be 7.8% among tribal populations in this study setting. Effective strategies to prevent this have to be devised.

Keywords: Diabetes, Risk factors, Adult, Tribal Population, Kalvarayan hills, Tamilnadu

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INTRODUCTION

The tribal population of India makes up 8.6% of the overall population of the country, making it the second largest in the world.[1] The majority of indigenous people reside in remote hamlets or villages. Some of them maintain their traditional values, beliefs, customs, and mythology despite living far from society. Therefore, early risk assessment and appropriate lifestyle habit awareness will impact an individual's morbidity, functional reliance, and premature mortality. The incidence of chronic diseases is on the rise in many nations, and this trend is probably going to continue for a variety of reasons. Chronic diseases are becoming more common as a result of people's fast changing lifestyles and behavioural habits.

A class of metabolic diseases known as diabetes mellitus are characterized by elevated blood glucose levels. Compared to the general population, those with diabetes have a greater risk of morbidity and death. Because of its increasing illness burden, diabetes was named by the UN as one of four priority non-communicable diseases that needed immediate attention.[2] Men were found to have a greater prevalence of high blood glucose levels (>140 mg/dl) in the NFHS-5 than women (15.6 versus 13.5%).[3] Over the last several decades, adult diabetes prevalence has increased globally. An estimated 30 million individuals had diabetes in 1964.[4] The WHO predicted that 171 million individuals had diabetes less than 40 years later.[5] In 2000, the International Diabetes Federation (IDF) estimated that 151 million people worldwide were affected by the disease,[6] 194 million in 2003,[7] 246 million in 2006,[8] 285 million in 2009,[9] 366 million in 2011,[10] and 382 million in 2013.[11] It was estimated that by 2040, there would be 642 million (uncertainty interval: 521–829 million) diabetics in the world who are between the ages of 20 and 79.[12]

The planning and monitoring of prevention and treatment strategies, as well as the evaluation of progress made toward achieving the targets established by the Sustainable Development Goals and the Global Action Plan for Non-Communicable Diseases, depend on precise estimates and projections of diabetes prevalence at the national, regional, and global levels.[13]

This study was done among the adult tribal population of the Kalvarayan Hills in the Kallakurichi district of Tamil Nadu, India. The objective of this study was to estimate the prevalence of Diabetes and its associated factors among the adult tribal population of Kalvarayan Hills.

METHODOLOGY

A Cross-sectional study was conducted from June 2023 - October 2023 in Kalvarayan hills. Adults aged 30 years and above from both genders who were permanent residents of the study area, as confirmed by verifying the family card and who gave consent were included in the study. Whereas those who are not willing to participate in the study or give consent and who are not available at the time of visits [after 3 consecutive visits] were excluded from the study.

Using the study by Manjareeka et al,[14] which reported an overall 13.9 % of participants are diabetic, a sample size of 184 is obtained using formula $n = Z^2pq/d^2$ with 5% allowable error. With a non-response rate of 10%, Sample size was 203. Multi stage random sampling methods was used. on first stage we selected 1 PHC by simple random sampling because of feasibility reasons from the total 5 PHC in the study area. Single participant who satisfied the study criteria were included in the study. Next stage, from the selected PHC one sub-center were randomly selected out of 6 Subcenters. All the nine villages under the sub-center have been covered through probability proportionate to size. If more than one eligible respondent is available in the selected house then one respondent is selected using Lottery method, so as to give equal importance to all eligible age groups. If the particular house didn't satisfy the criteria, or participants refused to give the consent or if the house was locked for 3 consecutive visits, then the successive house was taken for the study. Following institutional ethical committee clearance, the data collection was started. Each individual was interviewed face to face. The interview was conducted by single interviewer to avoid inter-observer bias. A detailed interview of participant was conducted using a pretested validated modified STEP wise questionnaire [15] which included personal information, Socio-demographic details, smoking, alcohol consumption, diet, family history of any disease. Participant's including known diabetic and also those within normal limit due to treatment were included as the questionnaire contains information regarding past history of diabetes and also to analyse further variables like duration of the disease and risk factors assessment. All the study participants were screened for diabetes by the primary investigator including known diabetic by random blood glucose levels (Capillary Blood Glucose) using standard ACCU-CHEK GUIDE glucose monitor. Based on random blood sugar (RBS), the cut-off values were fixed as sugar level ≥200 mg/dl are considered as diabetic, and sugar levels between 140 and 199 mg/dl are considered to be prediabetic, and sugar level <140 mg/dl is normal.[16]

Body mass index (BMI) was calculated for all participants based on their anthropometry and classified according to the Asian classification. BMI of <18.5kg/m^2 – underweight, 18.5 – 22.99 kg/m^2 – normal, ≥23 kg/m^2 – overweight, and ≥25 kg/m^2 – obesity.[17]

Total consumption of 400gms of fruits and vegetable is considered as healthy diet. Measurements were made using standard servings. One standard serving is said to be 100 grams. For fruits, 1 medium size fruit is considered as 1 serving and chopped ½ cup of

fruit is considered as 1 serving. Similarly for vegetables, ½ cup of chopped raw or cooked vegetable is considered as 1 serving.[18]

Physical activity is defined as any bodily movement produced by skeleton muscles that requires energy expenditure including activities undertaken while working, doing household chores, travelling and engaging in recreation. Eg: walking, gardening, and sports activity. 150 minutes of moderate intensity aerobic activity or 75 - 150 minutes of vigorous intensity aerobic activity in a week is said to be Physically active.[18]

Tobacco uses once who consumed in the past 30 days were considered as current tobacco user. Alcohol use once who consumed alcohol in the last one year was considered as current alcohol user. Alcohol use was assessed as Standard drinks (one standard drink = 100ml wine or 285ml bear or 30ml Spirit). [15]

Data collected were entered into Microsoft excel 360 and analysed using SPSS version 26. The analysis included calculating proportions and performing Chi-square tests to assess associations between categorical variables. Mean, standard deviation for quantitative Variables were calculated, p- value <0.05 was considered statistically significant. Odds's ratio and Adjusted odd's ratio with 95% confidence interval was used to measure the strength of association between the categorical Variables. Variables showing a statistically significant association with diabetes ($p < 0.05$) in the univariate analysis were further examined using binary logistic regression to identify significant predictors while controlling for potential confounders.

RESULTS

The total sample size covered was 425. 56.9% (242) were females as compared to 43.1% (183) males. Majority of the subjects 44.7 % belonged to the age group of 30-44 years and 56.5% of them were illiterate. In the study population 65.2% were unskilled workers and 79.1% of them belong to lower socioeconomic class (Table 1). The average height of the participants was 154.5 cm [± 8.32] and weight was 51.8 kg [± 9.44]. The mean CBG was 130 mg/dl [±48.11]. The study participants' mean BMI was 21.6 kg/m2 [± 3.02] (Table 2).

Prevalence of diabetes was 7.8% (33) among the study participants and 92.2% (392) of them were non diabetic. Among diabetic patient 21.2% (7) were newly diagnosed, 33.3% (11) of them had diabetes between 1-5years, 21.2% (7) have diabetes between 5 to 10 years and 24.3% (8) of them had diabetes more than 10 years (Table 3). Prevalence of lifestyle risk factors like unhealthy diet was 95.1% (404), physical inactivity seen among 30.4% (129), tobacco usage was reported among 12.7% (54) of the participants and use of alcohol was seen among 43.5 % (185) of the study participants (Table 1).

Table 1: Socio demographic profiles and known risk factors among the study participants

Variables	Participants (%)
Gender	
Male	183 (43.1)
Female	242 (56.9)
Age (years)	
30-44	190 (44.7)
45-59	115 (27.1)
≥60	120 (28.2)
Marital status	
Married	370 (87.1)
Separated	3 (0.7)
Widowed	45 (10.6)
Unmarried	7 (1.6)
Type of family	
Nuclear	215 (50.6)
Joint	35 (8.2)
3 generation	175 (41.2)
Education	
Graduation	13 (3)
Higher secondary	21 (4.9)
Secondary	49 (11.5)
Middle	29 (6.8)
Primary	74 (17.4)
Illiterate	240 (56.4)
Occupation*	
Professional	6 (1.4)
Skilled	7 (1.7)
Semi-skilled	32 (7.5)
Unskilled	277 (65.2)
Unemployed/Homemaker	103 (24.2)
Socio economic status**	
I (Upper)	0 (0)
II (Upper-middle)	7 (1.6)
III (Middle)	18 (4.2)
IV (Lower-middle)	64 (15.1)
V (Lower)	336 (79.1)
Body mass index	
Underweight	69 (16.2)
Normal	234 (55.1)
Overweight	69 (16.2)
Obese	53 (12.5)
Unhealthy diet	404 (95.1)
Physically inactive	129 (30.4)
Smokers	54 (12.7)
Alcohol users	196 (46.1)

*Government of India, minister of human resource development department of school education and literacy [19]

**Modified BG Prasad Scale 2023 is used to calculate Socio Economic Status of the study participants

Table 2: Mean and Standard deviations of health parameters in the study population

Health Parameters	Mean ± Standard Deviation
Height [cm]	154.5 ± 8.32
Weight [kg]	51.8 ± 9.44
CBG [mg/dl]	130 ± 48.11
BMI [kg/m^2]	21.6 ± 3.02

The Table 4 includes binary logistic regression analysis of dependent and independent variables. Age was a significant factor, with those over 45 years having a much higher prevalence of DM (13%) compared to those under 45 years (1%), with an adjust-

ed odds ratio (OR) of 16.80 (95% CI: 4.71-67.39, p < 0.0003). Gender and type of family did not show significant associations with DM prevalence, as the adjusted ORs were 1.12 (95% CI: 0.38-3.29, p = 0.65) for females compared to males, and 1.63 (95% CI: 0.73-3.64, p = 0.65) for nuclear families compared to others. However, education level showed a strong association, with illiterates having a higher DM prevalence (12%) compared to literates (3%), and an adjusted OR of 1.71 (95% CI: 1.54-5.39, p < 0.001). Socioeconomic status, while not significant, showed a trend towards higher prevalence in Class V (lower) with an adjusted OR of 1.70 (95% CI: 0.41-6.94, p = 0.09). Healthy diet did not significantly impact DM prevalence, though those without a healthy diet had an adjusted OR of 5.27 (95% CI: 1.21-73.17, p = 0.34). Physical activity was borderline significant, with non-active individuals showing higher DM prevalence (12%) and an adjusted OR of 3.75 (95% CI: 0.91-5.17, p = 0.05). Smoking and alcohol consumption did not significantly affect DM prevalence, with adjusted ORs of 3.62 (95% CI: 0.97-13.53, p = 0.32) and 0.55 (95% CI: 0.21-1.45, p = 0.65), respectively. Finally, BMI showed a strong association, with those having a BMI >23 kg/m^2 exhibiting higher DM prevalence (15%) and an adjusted OR of 4.62 (95% CI: 2.89-9.18, p < 0.0003). In summary, age, education level, physical activity, and BMI were significant predictors of diabetes prevalence in this population.

Table 3: Distribution of Diabetes mellitus in the study population

Study Population	Participants (%)
Without diabetes	392 (92.2)
With diabetes	33 (7.8)
Newly diagnosed diabetes	7 (21.2)
1 - 5 years of diabetes	11 (33.3)
5 -10 years of diabetes	7 (21.2)
More than 10years of diabetes	8 (24.3)

Table 4: Binary logistic regression analysis of dependent and independent variables

Variable	Diabetes mellitus		Total (%)	OR (95% CI)	aOR (95% CI)	p-value
	Yes (%)	No (%)				
Age						
<45 years	2 (1)	188 (99)	190 (100)	14.28 (3.37-60.50)	16.8 (4.71-67.39)	**<0.0003***
>45 years	31 (13)	204 (87)	235 (100)	1	1	
Gender						
Male	13 (7)	170 (93)	183 (100)	1	1	0.65
Female	20 (8)	222 (92)	242 (100)	0.84 (0.41-1.75)	1.12 (0.38-3.29)	
Type of family						
Nuclear	17 (8)	186 (92)	203 (100)	0.84 (0.41-1.73)	1.63 (0.73-3.64)	0.65
Others	16 (7)	206 (93)	222 (100)	1	1	
Education						
Illiterate	28 (12)	212 (88)	240 (100)	1	1	**<0.001***
Literate	5 (3)	180 (97)	185 (100)	4.75 (1.79 -12.56)	1.71 (1.54-5.39)	
Socio Economic Status						
Class V (Lower)	30 (9)	306 (91)	336 (100)	1	1	0.09
Others	3 (3)	86 (97)	89 (100)	2.81 (0.83-9.43)	1.7 (0.41-6.94)	
Healthy diet						
Yes	0 (0)	21 (100)	21 (100)	3.87 (0.22-65.45)	5.27 (1.21-73.17)	0.34
No	33 (8)	371 (92)	404 (100)	1	1	
Physical activity						
Yes	18 (6)	278 (94)	296 (100)	2.03 (0.99-4.18)	3.75 (0.91-5.17)	**0.05***
No	15 (12)	114 (88)	129 (100)	1	1	
Smoking						
Yes	6 (11)	48 (89)	54 (100)	1	1	0.32
No	27 (7)	344 (93)	371 (100)	1.59 (0.62-4.05)	3.62 (0.97-13.53)	
Alcohol						
Yes	14 (7)	182 (93)	196 (100)	1	1	0.65
No	19 (8)	210 (92)	229 (100)	0.85 (0.41-1.74)	0.55 (0.21-1.45)	
Body Mass Index						
<23 kg/m^2	14 (4)	289 (95)	303 (100)	3.81 (1.84-7.87)	4.62 (2.89-9.18)	**<0.0003***
>23 kg/m^2	19 (15)	103 (85)	122 (100)	1	1	

OR: Odds ratio; aOR: Adjusted Odds; *p-value <0.05 shows statistically significant

DISCUSSION

This is a cross-sectional study performed in Kalvarayan hills situated in Kallakurichi district of Tamil Nadu among 425 adult tribal participants aging 30 years or above.

Majority of the participant (44.7%) in the present study belonged to age group 30-44 years followed by the age group of 60 years and above (28.2%) and 45-59 years (27.1%). The mean age of the study participants was 48.7 years, with a standard deviation of 14.4. The age of the study participants varied from 30 to 85 years. The observation in present study is similar to the studies reported by Akila doddamani et al[20] with mean age of 42.5 years with a standard deviation of 12.5 and Sarma P S et al [21] with mean

age of 42.5 years with a standard deviation of 14.8. About 56.9% were females and 43.1 % were males. The observation in present study is similar to the study reported by Sathyanarayanan et al[22] with 59.8 % were females and 40.2% were males.

In the present study, majority of the study population were illiterate 56.5% (240) and 17.4% (74) perceived their primary school education. Whereas study conducted by Sathyanarayanan et al[22] among the tribal population in Jawadhu hills revealed that 82.2 % were illiterate which seems to be higher than our study. In study conducted by Logaraj Muthunarayanan et al[23] on cardiovascular risk prediction in rural population revealed that 38.1% illiterates and 18% perceived primary education.

Majority of the study population were in Lower (79.1%) followed by Lower middle (15.1%), Middle class (4.2 %) and (1.6%) of them where in Upper middle socio-economic class. These observations are also reported by earlier studies in the literature by Akila doddamani et al[20].

With respect to occupation 65.2% of the study population were unskilled, followed by 12.9% were unemployed, 11.3% were homemaker, 7.5% of them were semi-skilled, 1.6% were skilled, 0.9% were professional and 0.5% were semi-professional. In study conducted by Logaraj Muthunarayanan et al[23] revealed that 64.1 % were home-makers,19.5 % were unskilled, 6.4 % were professional and 4.7 % were unemployed in rural block of Tamilnadu.

In the present study, Prevalence of diabetes was 7.8% (33) among the study population and 92.2% (392) of them were non diabetic. Among diabetic patient 21.2% (7) were newly diagnosed, 33.3% (11) of them had diabetes between 1-5years, 21.2% (7) have diabetes between 5 to 10 years and 24.3% (8) of them had diabetes more than 10 years. Madhu.B et al[24] conducted a study in south India among 415 tribal population 2.9% were diabetic; This difference in results could be attributed to the tribes' distinct social and cultural practices as well as the subjects' reluctance to be screened using simple tests like capillary blood glucose. Therefore, there is a greater need to focus on diabetes prevention strategies and raise awareness of diabetes screening. Pangi Vijaya Nirmala et al[25] conducted a Comparative Study of the prevalence of Type-2 Diabetes Mellitus in Various Demographic Regions of Andhra Pradesh in which 7.8% tribal population had diabetes which is similar with the present study.

Leila Ismail et al[26] conducted a systematic review of various risk factors for type 2 diabetes and observed that smoking, dyslipidemia, hypertension, ethnicity, family history of diabetes, obesity, and physical inactivity are all strongly associated with the development of type 2 diabetes. The current study found that Increasing Age, Education, Physical inactivity and BMI (overweight and obesity) have a strong association in the development of diabetes among participants.

The limitation of this study is that it was only a cross-sectional study which might not show temporal relationships and thus the observed associations may not necessarily be causal. The lack of biochemical testing for diabetes is a significant disadvantage. The inclusion of adults above the age of 35 years could also affect the overall prevalence. Though dietary practices among tribal population plays a commendable role in diabetes among them, this study could not explore this aspect.

Conclusion

The prevalence of diabetes among tribal populations was found to be 7.8%, and the burden of lifestyle risk factors for diabetes, such as an unhealthy diet of 95.1%, physical inactivity of 30.4%, tobacco use of 12.7% of participants, and alcohol use of 43.5%, were found to be proportionally high among them. So effective strategies to prevent this have to be devised among the indigenous population. Increasing Age, Education, Physical inactivity and BMI (overweight and obesity) showed a strong association with diabetes.

References

1. Scheduled tribes in India:census of India 2011.Available at https://tribal.nic.in/downloads/statistics/3-STinindiaascensus2011.pdf Accessed on February 15th 2024.
2. Sahadevan P, Kamal VK, Sasidharan A, Bagepally BS, Kumari D, Pal A. Prevalence and risk factors associated with undiagnosed diabetes in India: Insights from NFHS-5 national survey. J Glob Health . 2023;13:04135.
3. Non communicable disease – WHO. Available at https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases. Accessed on February 22nd 2024.
4. Entmacher PS, Marks HH. Diabetes in 1964; A world survey. Diabetes 1965;14(4):212–23.
5. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. Diabetes Care 2004;27(5):1047–53.
6. Atlas D. International diabetes federation. IDF Diabetes Atlas, 1st edn. Brussels, Belgium: International Diabetes Federation. 2000.
7. Atlas D. International diabetes federation. IDF Diabetes Atlas, 2nd edn. Brussels, Belgium: International Diabetes Federation. 2003.
8. Atlas D. International diabetes federation. IDF Diabetes Atlas, 3rd edn. Brussels, Belgium: International Diabetes Federation. 2006.
9. Atlas D. International diabetes federation. IDF Diabetes Atlas, 4th edn. Brussels, Belgium: International Diabetes Federation. 2009.
10. Atlas D. International diabetes federation. IDF Diabetes Atlas, 5th edn. Brussels, Belgium: International Diabetes Federation. 2011.
11. Atlas D. International diabetes federation. IDF Diabetes Atlas, 6th edn. Brussels, Belgium: International Diabetes Federation. 2013.
12. Ogurtsova K, da Rocha Fernandes JD, Huang Y, Linnenkamp U, Guariguata L, Cho NH, et al. IDF Diabetes Atlas: Global esti-

mates for the prevalence of diabetes for 2015 and 2040. Diabetes Research and Clinical Practice . 2017;128:40–50.

13. World Health Organization. Health in 2015, from MDGs, millennium development goals to SDGs, sustainable development goals; 2015.
14. Manjareeka M, Palo SK, Swain S, Pati S, Pati S. Diabetes mellitus among newly diagnosed tuberculosis patients in tribal Odisha: An exploratory study. Journal of clinical and diagnostic research: JCDR. 2016 Oct;10(10):LC06
15. STEP wise approach to NCD risk factor surveillance (STEPS). Who.int. Available at https://cdn.who.int/media/docs/default-source/ncds/ncd-surveillance/steps/steps-manual.pdf?sfvrsn=c281673d_8. Accessed on January 15th 2024
16. Somannavar S, Ganesan A, Deepa M, Datta M, Mohan V. Random capillary blood glucose cut points for diabetes and prediabetes derived from community-based opportunistic screening in India. Diabetes Care. 2009;32(4):641–3.
17. Lim JU, Lee JH, Kim JS, Hwang YI, Kim TH, Lim SY, Yoo KH, Jung KS, Kim YK, Rhee CK. Comparison of World Health Organization and Asia-Pacific body mass index classifications in COPD patients. International journal of chronic obstructive pulmonary disease. 2017 Aug 21:2465-75
18. Jameson, J. L., & Loscalzo, J. Harrison's principles of internal medicine. (19th edition.). New York,McGraw Hill Education,(2015).
19. Government of India, minister of human resource development department of school education and literacy https://dsel.education.gov.in/. Accessed on February 20th 2024.
20. Doddamani A, Ballala ABK, Madhyastha SP, Kamath A, Kulkarni MM. A cross-sectional study to identify the determinants of non-communicable diseases among fishermen in Southern India. BMC Public Health. 2021;21(1):414.
21. Sarma PS, Sadanandan R, Thulaseedharan JV, Soman B, Srinivasan K, Varma RP, et al. Prevalence of risk factors of non-communicable diseases in Kerala, India: results of a cross-sectional study. BMJ open. 2019;9(11).
22. Sathiyanarayanan S, Muthunarayanan L, Devaparthasarathy TA. Changing perspectives in tribal health: Rising prevalence of lifestyle diseases among tribal population in India. Indian Journal of Community Medicine. 2019;44(4):342–6.
23. Muthunarayanan L, Russel J, Hegde S, Ramraj B. Ten years risk prediction of a major cardiovascular event in a rural block in Tamil Nadu. Heart India. 2015;3(2):43.
24. Madhu B, Prathyusha K, Prakruthi P, Srinath KM. Comparison of prevalence of life style risk factors and 10-year risk of CVD event among rural and tribal population of Kollegal Taluk, Chamrajanagar district, South India. Diabetes & Metabolic Syndrome: Clinical Research & Reviews. 2019 Sep 1; 13(5): 2961-6.
25. Nirmala PV, Gudivada M, Lashmi C. Comparative study of the prevalence of type-2 diabetes mellitus in various demographic regions of Andhra Pradesh, India: A population-based study. International Journal of MCH and AIDS. 2016;5(2):103–11.
26. Ismail L, Materwala H, Al Kaabi J. Association of risk factors with type 2 diabetes: A systematic review. Computational and structural biotechnology journal. 2021 Jan 1;19:1759-85.