RESEARCH ARTICLE

A study on the association of demographical factors with the prevalence of diabetes in North Eastern states of India

Sandipan Paul*, Dulumoni Das, Pranami Basak

ABSTRACT

Background: Diabetes mellitus, commonly known as diabetes, is a growing epidemic in India. Diabetes has now become a major threat to most of the Indian household. The awareness for prevention of such metabolic disease is negligible among adults with sedentary lifestyles, and obesity is the prime culprit for it. *Objective:* The aim of the paper is to find an association of demographic factors with the prevalence of diabetes in India and its North Eastern states. *Methodology:* The data was collected from a cross-sectional study conducted by a longitudinal aging study in the year 2017 of 72,055 individuals aged 45 and above across India. The chi-square test and ANN model are used to study the impact of different demographic variables on the prevalence of diabetes in India and its North Eastern states. *Results:* Occupation, community, religion, sex, working status, caste, and marital status, and education are the demographic factors that are significantly associated with the prevalence of Diabetes in India. The best ANN model from those significant variables over the prevalence of diabetes is from Arunachal Pradesh, followed by Assam and Nagaland. *Conclusion:* Diabetes is a burden for a nation like India, but its prevention, treatment, and control are low among the adults of the Indian population, mostly who are married and employed in the government or private sectors.

Keywords: Chi-square test, Diabetes, India, North-east region, Prevalence.

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INTRODUCTION

Diabetes is one of the most common deaths causing disease along with cancer, respiratory disorders, and cardiovascular disease.[1] According to the World Health Organization (WHO),non-communicable diseases accounted for 74% of deaths worldwide in 2019. It was ranked as the tenth most common cause of death in 2019, with 1.6 million deaths worldwide.[2] By 2025, it is estimated that 592 million will pass away from diabetes, 90% of which are from type 2 diabetes. Type 2 diabetes, mostly observed in Western nations, has now become a leading cause of death even in younger generations. In many developing countries like China and India, diabetes has become an epidemic. According to the World Health Organization, countries with moderate or low economies have the fastest increase in the prevalence of diabetes. The main cause of the worldwide rise in the diabetes epidemic is unhealthy eating patterns and sedentary lifestyles due to the fast changes observed in socioeconomic conditions brought by urbanization and industrialization.[3] Diabetes raises healthcare expenditure for a family, community, and also healthcare system of a nation. Diabetes acts as a progressive illness that brings major complications. Uncontrolled diabetes leads to various vascular diseases, mostly from type 2 diabetes, which includes diabetic retinopathy, nephropathy, neuropathy, cardiovascular, cerebral vascular, and peripheral artery disease.

Diabetes's Global Burden

There has been a global increase in diabetic individuals, especially those with type 2 diabetes, in the past two decades. However, the prevalence of Type 2 diabetes is mostly seen in pacific islanders, Asian Indians, and Native Americans.

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Based on the report produced by the International Diabetes Foundation (IDF), the prevalence of diabetes in the adult population is 8.8%, whereas for men, it is 9.6%, which is slightly higher than compared to males at %. The latest global figures indicate that there are 463 million individuals with diabetes and 374 million with impaired glucose tolerance (IGT), which is a disease that leads to diabetes. By the year 2045, the number of individuals with diabetes would rise to 700 million, while for impaired glucose, 548 million are estimated to be affected. It also indicates a 51% increase in the prevalence of diabetes from the figures recorded in 2019.[1] According to IDF, the Western Pacific region has the largest number of patients suffering from diabetes, with a total of 163 million. After the Western Pacific region, the region with the second highest number of individuals suffering from Diabetes is Southeast Asia, with a total of 88 million. The Middle East and North Africa account for 55 million, followed by North America and the Caribbean, with a total of 47.6 million diabetes cases. Presently, the regions with the smallest

figures are South and Central America, with 36.1 million, and Africa, with 19.4 million suffering from such metabolic disease. Hence it is evident that the diabetes epidemic is not limited to prospectus regions of North America and Europe.

Diabetes an Upcoming Burden in India

The prevalence of diabetes has been consistently increasing in India over the last three decades.[2] which has made India a significant contributor to the overall burden of such a disease, which can be declared an epidemic in the upcoming few years. An epidemiological transition has been observed in disease patterns in the Indian subcontinent, resulting in a significant decrease in immortality due to communicable, maternal, neonatal, and nutritional diseases (CMNNDs). At the same time, an increase in the contribution of non-communicable diseases and injuries has brought the mortality rate into focus. In 1990, in India, the combined disability-adjusted life years (DALYs) attributed to CMNNDs accounted for 61% of the total, while non-communicable diseases accounted for 30 and injuries for 9% of the total. In the year 2016, a significant epidemiological shift has been observed over time where the burden of DALYs caused due to CMNNDs has declined to33%. In contrast, the burden of DALYs caused by NCDs has risen to 55% and injuries to 12%. In 2016, the disease burden in India was four times higher for diabetes as compared to previous years. While examining the main reason for DALYs in India, NCDs have increased in rank since 1990. Diabetes showed a significant spike, from the 35th position in 1990 to the 13th position in 2016.[4]

Matur *et al*. have observed that, in India, the prevalence rate of diabetes was 9.3%, from which 15.7% had it under control, 36.1% were receiving medication, and 45.8% were aware of it. More than 74.8% of people sought treatment from allopathic practitioners, while 84% of adults sought it through consultations. Elderly people have higher chances of developing diabetes and are 16 times more aware of it. Adults in India have a high prevalence of diabetes, but the knowledge, treatment, and control are still low, and there are significant age group differences in this regard. Various strategies such as increased knowledge, better prevention, and counseling are required to stop diabetes in India. Additionally, incorporating traditional medical practices like Ayurveda, Yoga, Unani, Siddha, and Homeopathy (AYUSH) adds controlling and prevention strategies for diabetes may help to manage this epidemic.[5]

Ranasinghe *et al*. (2021) performed a systematic meta-analysis to produce the latest overview of the prevalence and trends of pre-diabetes and diabetes patients in both urban and rural areas of India. The data reveals a significant prevalence of diabetes and pre-diabetes in both urban and rural parts of India but with a small difference between them. Therefore, an urgent need for immediate primary and secondary preventive methods is required in both areas in order to reduce the escalation in the number of individuals suffering from diabetes.

Accordingly, the current study was planned to find the association of demographic variables over the prevalence of diabetes in India with its northeastern states and to identify the best model that prominently defines the impact of different demographic variables on the prevalence of diabetes in India and its northeastern states.

METHODOLOGY

The study uses data from the Longitudinal Ageing Study in India (LASI) Wave-1 conducted between 2017 and 2018, Managed by the International Institute for Population Sciences (IIPS) and funded by the Ministry of Health and Family Welfare, Government of India. Focusing on individuals aged 45 and above across India (excluding Sikkim), the dataset includes responses from 72,055 participants with an 85% response rate. The analysis includes demographic variables such as occupation, community, religion, sex, working status, caste, current marital status, education, and type of tobacco consumption. Statistical methods like Frequency Count with percentage, P-value of Chi-square test, and Normalized Score of Artificial Neural Networking Model for different demographic variables are employed using SPSS-23 and MS-Excel to calculate normalized scores among North-eastern states and Indian people.

RESULTS

Tables 1A and 1B represent the prevalence of diabetes patients in India and the seven northeastern states under certain socio-demographic conditions. It has been observed that 74% of the diabetic patients of Northeastern India are government employees, whereas 17% are from the private sector. But in India, approximately 40% of employees in govt. or private sector employees are suffering from diabetes. Diabetes cases are mostly observed in currently non-working (52%) state individuals in India, whereas for NE regions, a different scenario has been observed in 55% of currently working states.

The majority of Bengalis in NE states have diabetes, whereas Hindi-speaking people have the highest number of diabetes patients, covering 23% of the population in India. The prevalence rate of the Christian communities in the North Eastern states is higher, contributing 50% of the total, whereas, as for India as a nation is mostly observed in the Hindu population with a 70% prevalence rate. Mostly, females (55%(NE), 54%(INDIA)) are more prone to diabetes than males in both NE states and India. Approximately 75% of married people in both NE regions and India are more prone to suffer from diabetes. Smokeless tobacco consumers have a higher chance of developing diabetes compared to others who consume smoking-tobacco in both India and its northeastern states. Table 1 findings also reflect that occupation, community, religion, sex, current working status, caste, marital status, and education are the demographic factors that are significantly associated with the prevalence of diabetes in India.

Table 1: A. Distribution of diabetes patients (%) with different demographic variables (Occupation, Community, Religion, and Sex) present among NE states and India.

		Tripura	*Assam*	*Meghalaya*	*Manipur*	*Mizoram*	*Arunachal Pradesh*	*Nagaland*	*Average % of NE*	*India*	*P values**
Occupation (%)	Govt. Sect.	57	55	67	38	100	100	100	74	40	0.001
	Pvt. Sect.	30	27	33	27	0	0	0	17	41	
	Cooperatives	0	-	0	0	0	0	0	0	1	
	Self-employment	9	18	0	27	0	0	0	8	13	
	NGO	-	-	0	0	0	0	0	0	2	
	Others	4	-	0	8	0	0	0	2	2	
Community (%)	Assamese	-	45	0	0	0	0	0	8	1	0.002
	Nepali	-	2	0	1	1	2	2	1	0	
	Punjabi	-	0	0	0	0	0	0	0	5	
	Rajasthan	-	0	0	0	0	0	0	0	1	
	Bengali	83	39	9	0	0	11	2	20	7	
	Gujrati	0	0	0	0	0	0	0	0	5	
	Hindi speaking	0	3	3	0	0	7	0	2	23	
	Manipuri	3	1	0	62	1	0	0	10	1	
	Oriya	1	1	0	0	0	0	0	0	2	
	Telugu	0	0	0	0	0	0	0	0	10	
	Others	14	10	88	37	98	81	97	61	44	
Religion (%)	None	0	0	0	2	0	2	0	0	0	0.001
	Hindu	91	70	9	52	1	21	8	36	70	
	Muslim	1	27	3	3	0	0	2	5	15	
	Christian	3	1	79	32	99	49	90	50	9	
	Sikh	5	0	0	0	0	0	0	1	4	
	Buddhist	0	1	0	2	0	9	0	2	1	
	Others	0	0	9	10	0	19	0	5	1	
Sex (%)	Male	50	51	18	55	47	60	34	45	46	0.004
	Female	50	49	82	45	53	40	66	55	54	

**p*-values obtained from the Chi-square test.

Table 2 depicts the importance of each significant variable over the prevalence of diabetes with the power of classification of the study population over the significant variables of India and its North Eastern states. The AUC scores specify that the best ANN model formed from the significant variables regarding the prevalence of diabetes is from Arunachal Pradesh (0.981), Assam (0.906), and Nagaland (0.818), with excellence regarding the power of classification. The model formed from the variables for Mizoram (0.737), Tripura (0.671), Manipur (0. 665), and Meghalaya (0.657) has acceptable power of classification. The ANN model of India, with an AUC score of 0.619, has a random power of classification with community (100%) as the highest score of importance, followed by working status, marital status, and education. Nevertheless, sex (53.3%), religion (57.4%), and caste (53.8%) are observed to have the least importance in the ANN model for India.

DISCUSSION

In this study, an attempt has been made to show the influence of demographic factors on the prevalence of diabetes in India and its seven Northeastern states. Our study reveals that the high prevalence of diabetics is mostly observed in currently married individuals both in India and its

Table 1: b. Distribution of diabetes patients(%) with different demographic variables (Working status, Caste, Marital status, Education, and Type of Tobacco consumed) present among NE states and India.

		Tripura	Assam	Meghalaya	Manipur	Mizoram	Arunachal Pradesh	Nagaland	Average of NE	India	P values*
Currently Working (%)	Yes	62	55	32	56	59	80	39	55	48	0.001
	No	38	45	68	44	41	20	61	45	52	
Caste (%)	Caste Specify	88	72	3	64	0	14	0	35	45	0.001
	Tribe Specify	8	6	91	32	99	75	92	57	33	
	No Caste	4	22	3	4	1	11	8	8	17	
	Don't Know	0	0	3	0	0	0	0	0	5	
Marital Status (%)	Currently Married	62	81	55	84	71	79	78	73	76	0.001
	Widowed	13	18	36	12	26	19	22	21	21	
	Divorced	0	0	0	0	3	0	0	0	0	
	Separated	1	0	3	2	0	2	0	1	1	
	Deserted	1	0	3	0	0	0	0	1	0	
	Live-in-relationship	-	0	0	0	0	0	0	0	1	
	Never Married	-	1	3	2	0	0	0	1	1	
Education (%)	Less than primary	18	22	26	7	28	3	19	18	17	0.002
	Primary Completed	21	8	22	8	17	23	26	18	23	
	Middle Completed	31	27	17	20	22	30	24	24	16	
	Matric Completed	11	18	13	25	9	23	19	17	21	
	Senior Secondary Completed	12	9	9	14	3	10	7	9	10	
	Diploma Graduate Degree & Higher	7	16	13	26	21	10	5	14	14	
Type of Tobacco (%)	Absent	26	10	3	17	24	39	20	20	25	0.733
	Smoking tobacco	28	22	18	28	39	43	23	29	40	
	Smokeless tobacco	28	69	82	51	48	43	46	52	51	
	Both	28	10	0	21	13	14	31	17	8	

*p-values obtained from the Chi-square test.

Northeastern region. However, significantly higher chances of diabetes prevalence are also seen in the Northeastern region's government employees than in other sectors in the Northeastern region and India. One study conducted by Shockey *et al*.[8] demonstrated that three broad occupation groups with the highest adjusted prevalence of diabetes were protective services (8.9%), farming, fishing, and forestry (8.8%), and community and social services (8.4%). Our study also reveals that occupation, community, religion, sex, current working status, caste, marital status, and education are the demographic factors that are significantly associated with the prevalence of diabetes in India. A similar study conducted by Maiti et al. showed that education, age, sex, religion, marital status, and household size have a significant impact on the prevalence of diabetes in India.[9] The study also shows that the prevalence of diabetes among females is more as compared to males in India and some of the northeastern states. However, different results are observed in Assam, Manipur,

Table 2: Effect of different demographic variables on the prevalence of diabetes using Artificial neural networking model (ANN) among Northeastern states and Indian People:-

	Tripura	*Assam*	*Meghalaya*	*Manipur*	*Mizoram*	*Arunachal Pradesh*	*Nagaland*	*India*
Occupation (%)	81.8	45.1	35.9	67.1	67.1	14.0	37.6	61.1
Community (%)	81.6	93.7	28.7	46.1	48.2	92.2	26.6	100.0
Religion (%)	63.2	77.7	29.2	100.0	100.0	51.9	67.6	57.4
Sex (%)	23.2	61.5	69.1	51.4	37.0	27.2	5.3	53.3
Current Working Status (%)	15.8	36.9	47.6	31.2	56.1	-	100.0	80.2
Caste (%)	32.7	67.4	13.3	50.5	26.6	53.4	28.6	53.8
Marital Status (%)	21.6	74.2	100.0	76.8	79.3	73.5	35.4	79.8
Education (%)	100.0	100.0	58.7	84.5	72.6	100.0	64.0	74.1
AUC Value	0.671	0.906	0.657	0.665	0.737	0.981	0.818	0.619
Remark for classification	Acceptable	Excellent	Acceptable	Acceptable	Acceptable	Excellent	Excellent	Random

and Arunachal Pradesh, where the diabetes prevalence rate is higher in males than females. Whereas equality in the prevalence of diabetes patients in both genders is observed in Tripura. Suwannaphant *et al.* suggested that females aged 55 and above with low educational attainment in Thailand were found to be vulnerable to Diabetes Mellitus.[10] Another study conducted by Sujata and Thakur[11] regarding the risk factors associated with diabetes in different genders in India reveals that the prevalence rates of diabetes in the age group 15-49 are higher in males than females. However, the females in urban areas, Christian communities, and those with no schooling are obese and with daily consumption of meat and eggs are affected more than their counterparts. Whereas the males in rural areas with obesity, non-vegetarian, and sedentary lifestyles have higher chances of occurrence of diabetes. Education has a greater impact on the prevalence of diabetes in the Northeastern parts of India. The model with high AUC scores for Arunachal Pradesh and Assam are observed to have higher importance for education as a variable for discrimination. The model obtained by the Indian prevalence rate has education as a satisfactory variable for discrimination. It has also been observed that most prevalence of diabetes is observed in people who have completed their middle school or matriculation. However, a downward trend regarding education is observed in Manipur, where the lowest prevalence rate is among individuals with no schooling or primary education and the highest with graduation, diploma, or a certified course.

Declarations Ethical Approval

The secondary dataset serves as the basis for the research, and no personal information about survey respondents is included. The Ministry of Health and Family Welfare carried out the LASI (WAVE-1) Survey, which was organized by the International Institute for Population Sciences in Mumbai. The Institutional Ethical Review Board authorized all of the survey protocols used in the LASI (WAVE-1) Survey.

Data Availability

The data is available on the Institutional Website & can be easily downloaded for the research purpose by the students, faculty & other researchers in India.

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PEER-REVIEWED CERTIFICATION

During the review of this manuscript, a double-blind peer-review policy has been followed. The author(s) of this manuscript received review comments from a minimum of two peer-reviewers. Author(s) submitted revised manuscript as per the comments of the assigned reviewers. On the basis of revision(s) done by the author(s) and compliance to the Reviewers' comments on the manuscript, Editor(s) has approved the revised manuscript for final publication.