Understanding Progression and Management of Diabetes in Indian Settings From Electronic Medical Records of an Urban Community: The Case of Chips Cohort Study

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There has been a growing demand for comprehensive studies on the management of type II diabetes in Indian settings. This paper presents a case study demonstrating how electronic medical records (EMR) from a community covered under the Contributory Health Services Scheme (CHSS) can help address important research gaps in diabetes care and management. The Hospital Information Management System (HIMS), which covers 89,204 CHSS beneficiaries, records every interaction between beneficiaries and healthcare providers. Using this database, a cohort of 835 patients newly diagnosed with diabetes during 2011–2012 was identified, and their 10-year medical history following diagnosis was reconstructed. For comparison, a cohort of 1,670 age- and sex-matched non-diabetic beneficiaries with similar longitudinal medical histories was also created. This cost-effective cohort dataset enabled researchers to examine several issues related to diabetes incidence and management, including the risk of diabetes in the community, transitions between non-diabetic, pre-diabetic, and diabetic stages, excess morbidity among diabetic patients, and seasonal variations in glycaemic levels. The findings underline the significant potential of EMR-based cohort reconstruction for understanding diabetes risk, progression, and management in community settings.

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For supplementary materials such as appendices, datasets, and author disclosure statements, see the article page at https://healthempirics.org/

Global trends and projections on the prevalence of diabetes indicate that it is one of the most hostile chronic health conditions threatening the quality of healthy life globally. The situation is similar in India, where one out of every five persons aged 45 years and above, amounting to over 50 million people, are self-reporting a previous diabetes diagnosis or having HbA1c of 6·5% or higher (Sekher et al., 2025). According to the International Diabetes Federation, of the global estimate of 589 million people with diabetes in the 20-79 age group, 17 percent reside in India (IDF, 2025). The number of persons with diabetes in India is estimated to be 101 million by 2030. Such an elevation in the number of diabetes patients would lead to an exponential increase in financial resources required to prevent, diagnose, and treat this non-reversible condition. Estimates show that diabetes accounts for 3 percent of deaths in India and that years of life lost (YLL) due to diabetes-induced premature mortality is more than years of life lived with disability (YLD) due to diabetes (Tandon et al., 2018). With the ongoing epidemiological transition, these YLD will be more than YLL in future years, which underlines the need for more research and interventions for countering the comorbidities in the life cycle of patients diagnosed with diabetes.

As noted in most of the less developed countries, the prevalence of self-reported diabetes in India is relatively higher in the urban population than in the rural population and in higher socio-economic strata than in lower socio-economic strata (IIPS et al., 2020, 2020; IIPS & ICF, 2017). Though there are several studies on the self-reported prevalence of diabetes in India, only a few studies provide estimates of the incidence of diabetes in Indian settings (Mohan et al., 2014; Narayan et al., 2021; Vijayakumar et al., 2019). These studies, based on longitudinal surveys of population cohorts from various sites, have illustrated the effect of various behavioural risk factors on the incidence of diabetes. Additionally, Indians are characterized by a stronger genetic predisposition to diabetes and a greater degree of insulin resistance (IIPS & ICF, 2017; Narayan et al., 2021; Tripathy et al., 2017).

Diabetes is often accompanied by connected chronic comorbidities. Conditions like hypertension, hypertriglyceridemia, retinopathy, thyroid disorder, hypercholesterolemia, dyslipidaemia, cardiovascular disease, stroke, and chronic kidney disease are prevalent in Indian diabetes patients (Kumar et al., 2013; Murthy et al., 2012; Pradeepa et al., 2008; Premalatha et al., 2000; Rema et al., 2005; Tripathy et al., 2017; Unnikrishnan et al., 2007). Though comorbidities are part of diabetes, little is known about their onset in diabetic patients, which is essential for a better understanding of risk stratification for the incidence of these morbidities. Another significant issue is the lack of preparedness of the health systems to manage diabetes effectively. All these strengthen the call to fill the research gaps in understanding the incidence, disease burden, spectrum of complications, and management of diabetes in the country (Kaveeshwar & Cornwall, 2014; Unnikrishnan et al., 2016).

This is a brief description of the scientific investigation process initiated to study the onset and multiple aspects of the management of diabetes in the life cycle of patients in an urban community in Greater Mumbai. All the members of the community are beneficiaries of the contributory health services scheme (CHSS) provided by their government employer. The CHSS functions under the medical division, Bhabha Atomic Research Centre (BARC), which collaborated with the International Institute for Population Sciences (IIPS) for this research study. The CHSS-IIPS project titled CHIPS study aims to augment evidence base towards the strengthening of diabetes management in India. Innovative element here is the effective use of electronic medical records for preparing the CHIPS cohort data. The objective of this paper is to disseminate the experience in setting CHIPS cohort and to highlight usefulness of this data in public health research.

- **Contributory health service scheme**

The CHSS had 89,204 beneficiaries in the year 2021, which includes current employees, retired employees, and their dependent family members. Out of these, 49,030 beneficiaries reside in the well-planned gated township, and 40,174 beneficiaries living outside the township are spread over various localities in Greater Mumbai. CHSS offers medical care to the employee, spouse, and their children aged up to 25 years. Employees and their spouses are entitled to CHSS benefits even after retirement from the service till death or unless they opt out for some reason like migration, employee's resignation, etc. Employee's dependent parents are also enrolled as beneficiaries of this CHSS. The CHSS covers all preventive and curative care needs of all beneficiaries.

Each CHSS beneficiary, based on their residential pin code, is attached to a CHSS zonal dispensary. Beneficiaries can walk into that facility where the family physicians attended to their health care needs. The beneficiaries can also avail services under specialist doctors' advice whenever needed at a dedicated multispecialty hospital, which is situated inside the township. The hospital and all the dispensaries are connected with a computerised hospital information management system (HIMS). There are 16 such dispensaries and one multispecialty hospital with 390 beds. The hospital and dispensaries are manned by about 65 specialist doctors, 200 family physicians, and an adequate number of nursing and technical staff.

Methods

- **Cohort Design:**

A 10-year retrospective cohort data set is constructed using the medical records maintained for these CHSS beneficiaries. The uniqueness of the CHIPS cohort is the universal access to health care in this urban community. Results from most of the cohort-level studies available are likely to have a bias arising out of extreme inequities in access to health care services in the country (Balarajan et al., 2011; Baru et al., 2010; Hazarika, 2013). Factors like limited access to medical facilities, perception of disease, and treatment continuity could have added to the delay in diagnosis of diabetes, leading to aggravation of diabetes-related complications (Deepa et al., 2014; Mohan et al., 2014; Wangnoo et al., 2013). Universal access reduces the risk of undiagnosed diabetes in the study community and complications arising due to delay or discontinuity in treatment. A retrospective type of design is preferred due to the irreversible nature of diabetes and to make use of existing medical records data already available for the study population. This cost-effective design has the potential to answer a plethora of patient and medical care provider-level questions relating to the management of diabetes.

The cohort was designed after taking stock of the secondary data from existing medical records maintained for the newly diagnosed diabetes patients availing the medical services. The specific objectives of the CHIPS cohort study, initiated in 2022, were to:

- Estimate the incidence of diabetes and disease burden in the study population using hospital medical records.
- To understand the probability of and the time duration for transitioning from a pre-diabetic to a diabetic.
- To study the clinical progression and major clinical events in the course of the disease.
- To understand the seasonal pattern in glycaemic levels in diabetic patients.
- To study the interrelationship between frequency of interaction with the health care provider and glycaemic control.
- To determine COVID-19-induced temporal variation in glycaemic control among diabetes patients.

- **Health Information Management Systems Data**

Near-uniform protocols were used for completing the medical records of every beneficiary who visits the medical facilities under this CHSS. All relevant investigations were offered to the patients, and laboratory reports were available in the HIMS. Details of medicines issued to the patients from an in-house pharmacy, and the prescription was available in HIMS. We extracted details about their visits to casualty, dispensaries, outpatient departments, Inpatient discharge notes, medical case progress notes, laboratory investigations, medical prescriptions, and death summaries. Details of patients referred to outside health facilities for specialized treatment or other reasons are also captured in the HIMS. The other vital parameters of patients, such as body weight, blood pressure, etc., expected to be recorded by the physician in the case-sheet during an outpatient care visit, were noted to be incomplete in HIMS. The digitization of medical records in HIMS was started in 1996; however, connectivity to peripheral zonal dispensaries was extended in phases till 2009. Hence, complete data on all interactions between each beneficiary and health facilities are available from 2010.

Each beneficiary is issued an individual Medical Record Department (MRD) identity number at the time of inception into the CHSS. To follow the ethical code of conduct in this research, every patient's MRD number was masked using an encrypted version, as per a pre-defined algorithm. Anonymous patient records with encrypted identity numbers were provided to the CHIPS study team. All study objectives in the CHIPS study were within the limits of information available from the medical records of beneficiaries. No primary data collection or interaction with patients occurred in this phase of the study.

- **Identifying diabetes patients from medical records:**

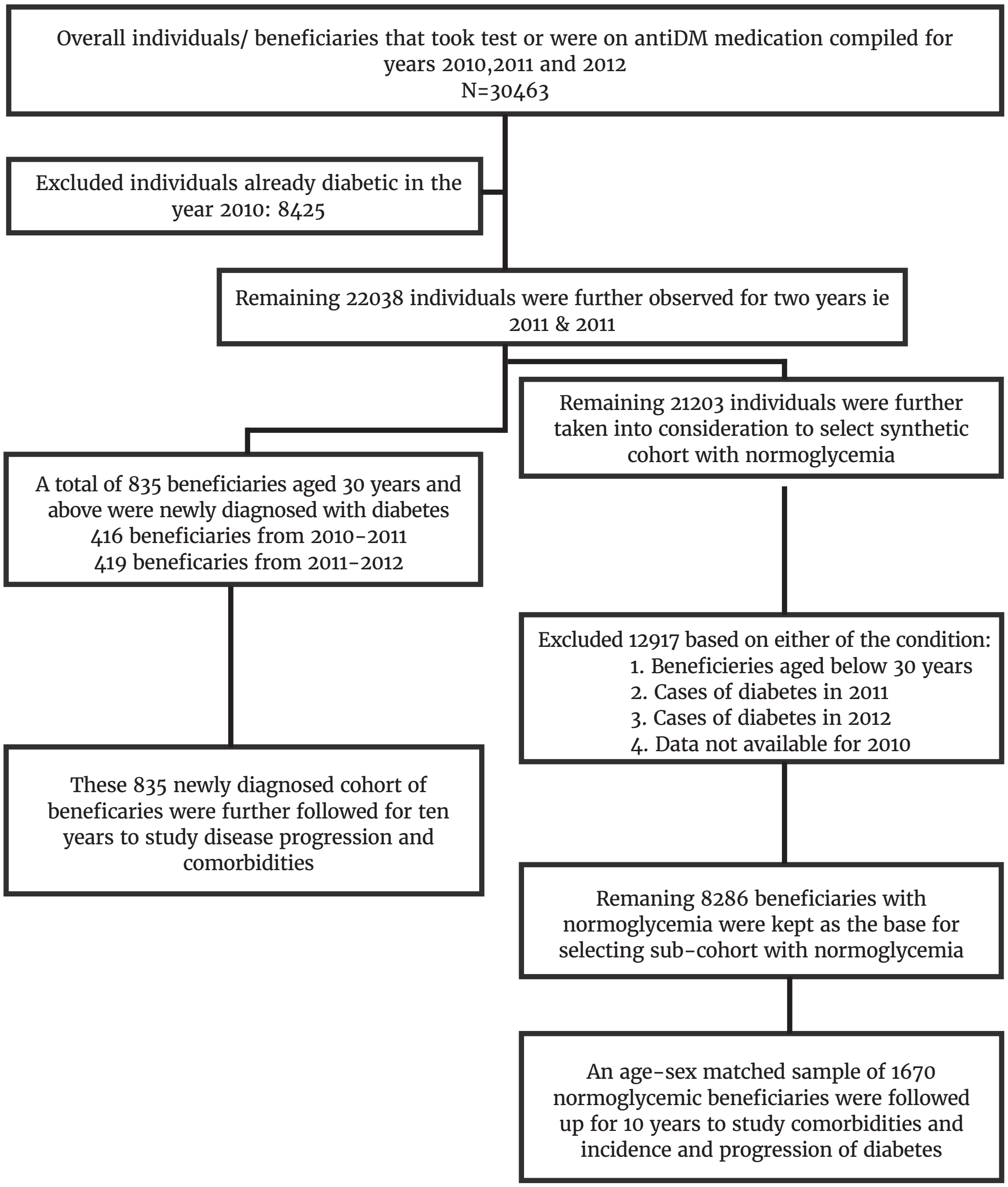
We used an operational definition to identify diabetes patients from the medical records of all beneficiaries who utilized CHSS between 2010 and 2012. Medical records also contained information on all beneficiaries who were tested for diabetes, as well as those receiving medication for diabetes. The CHSS beneficiaries with either glucose levels above cut-off (FPG>=126 mg/ dL or PPG>=200 mg/dL or HbA1c >=6.5%) or who had taken diabetes medication in that calendar year or patients with classic symptoms of hyperglycaemia or hyperglycaemic crisis, were identified and categorized as diabetic.

- **Identification of newly diagnosed diabetes cohorts for follow-up:**

The next important step is the identification of newly diagnosed diabetes patient cohorts and eliciting their medical history from HIMS records through a retrospective follow-up. Considering the availability of digitized data from HIMS, we fixed the retrospective follow-up period for the newly identified patients to 10 years. Despite this data constraint, we consider a 10-year follow-up period to be sufficient to study the type II diabetes-related comorbidity and excess mortality among the patient cohorts. The CHSS beneficiaries diagnosed as diabetic in 2011-2012 were eligible to be in this cohort. Those who were found to be diabetic in a particular year but were tested as non-diabetic and were not taking any medicine for diabetes in the previous year were defined as newly diagnosed diabetic patients.

To identify the cohorts for follow-up the first task was to identify all CHSS beneficiaries who underwent diabetes-related diagnostic tests between 2010 and 2012 or received anti-diabetic medication. For this, a scrutiny of the entries in 144,511 lab records and 247,473 drug records available in HIMS for the period 2010 to 2012, was performed. The study followed the American Diabetes Association

Figure 1: Flowchart showing the selection of 835 newly diagnosed diabetes cases and 1,670 normoglycemia cases from medical records (2010–2012) for cohort wise follow-up.



(ADA) diagnostic criteria for diabetes, Fasting Plasma Glucose (FPG) level of ≥126 mg/dL, Postprandial Glucose (PPG) level of ≥200 mg/dL during a 75 g Oral Glucose Tolerance Test, and Haemoglobin A1c (HbA1c) of ≥6.5%. The total count of such CHSS beneficiaries who either underwent these diagnostic tests or were prescribed antidiabetic medications was 30,463, with annual figures standing at 16,485 in 2010, 17,183 in 2011, and 18,606 in 2012.

Those previously diagnosed with diabetes or were taking anti-diabetic medicine in 2010 or before were dropped. Beneficiaries who exhibited diagnostic markers such as FPG, PPG, and HbA1c levels indicative of diabetes or those who were started anti-diabetic medication in 2011 and 2012, were specifically retained. This strategy ensured that the cohort consisted only of individuals newly diagnosed with diabetes in 2011 or 2012, thereby establishing a clear baseline for subsequent analysis. To ensure focus on Type 2 Diabetes, those aged less than 30 years were excluded. Ultimately, 835 participants were identified as individuals with newly diagnosed diabetes (See figure I). These individuals were meticulously followed over the next decade, forming a critical diabetic cohort for our longitudinal examination.

- **Identification of non-diabetic beneficiary cohorts for follow-up**

A separate cohort comprising beneficiaries without diabetes at the time of initiation of the original cohorts (i.e. 2012) is required for comparison purposes for arriving at excess co-morbidity and for understanding the transition from the pre-diabetic stage in 2012 to diabetes in the 10-year follow-up period. For this, an age-sex matched control group with double the size of the newly diagnosed diabetes cohort was created from the same HIMS database. This group of 1670 non-diabetic CHSS beneficiaries were selected from a list of persons who were tested as non-diabetic in 2012 and were not taking any medicine for diabetes. More details of selection this normoglycemic cohorts who were followed up for next ten years is in figure 1.

Cohort characteristics

In summary, the CHIPS cohort comprised 835 newly diagnosed diabetic patients in 2011-2012, of which 55 percent were females (Table 1). Male-female distribution indirectly hints at relatively higher risk on diabetes in women between 30-49 ages. The majority of males (83 percent) in CHSS were employees, while the majority of females (85 percent) were dependents of employees. This composition is a reflection of the overall work participation among women in India. Age distribution of newly diabetic patients shows the onset of diabetes to be earlier in females than in males. As can be expected, the characteristics of the age-sex matched control group of 1670 non-diabetic patients were similar to those of newly diagnosed diabetic cohorts.

- **Attrition in the cohort size**

The 10-year retrospective medical record data on the above-mentioned diabetes-related parameters were compiled for the 835 newly diagnosed patients. There were 586 patients who were available at the end of the follow-up period in 2021. The year-wise attrition in sample size or loss to follow-up cases in the cohort is presented in Figure 2. Of the 249 patients lost during follow-up, we discovered that

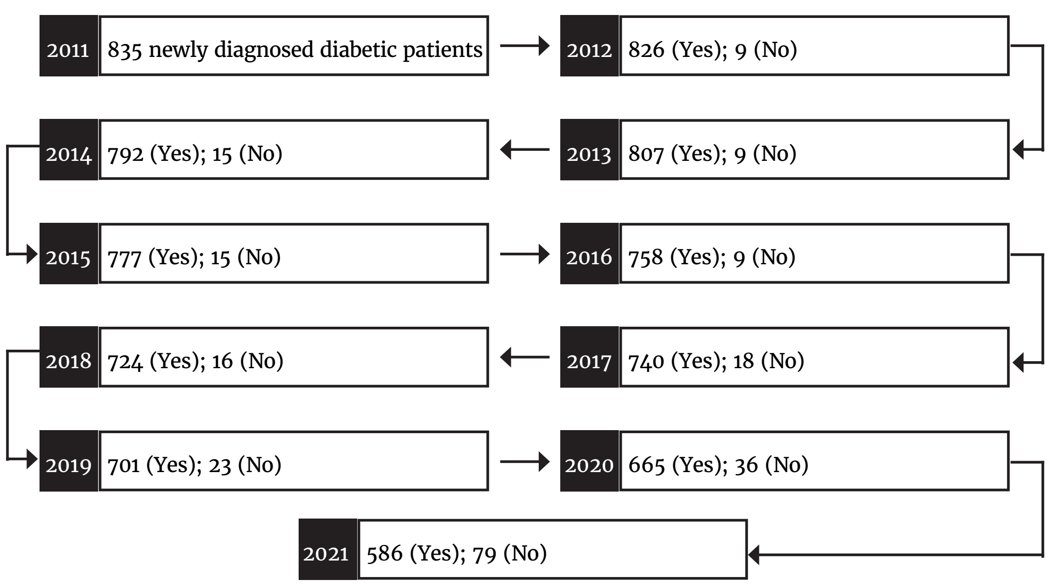
Table 1: Baseline characteristics of CHIPS study subjects, 2011–12

	Newly diabetic patients (Cases) % (N)			Non-diabetic beneficiaries (Controls) % (N)		
	Females	**Males**	**Total**	**Females**	**Males**	**Total**
Age in years						
30–39	13.2 (61)	5.3 (20)	9.7 (81)	13.2 (122)	5.3 (40)	9.7 (162)
40–49	30.2 (139)	18.2 (68)	24.8 (207)	30.2 (278)	18.2 (136)	24.8 (414)
50–59	27.1 (125)	30.5 (114)	28.6 (239)	27.1 (250)	30.5 (228)	28.6 (478)
60–69	18.7 (86)	25.7 (96)	21.8 (182)	18.7 (172)	25.7 (192)	21.8 (364)
70–80	10.4 (48)	17.9 (67)	13.8 (115)	10.4 (96)	17.9 (134)	13.8 (230)
>80	0.4 (2)	2.4 (9)	1.3 (11)	0.4 (4)	2.4 (18)	1.3 (22)
Type of beneficiaries						
Employees	14.9 (69)	83.2 (311)	45.5 (380)	16.9 (156)	84.6 (633)	47.2 (789)
Dependents	85.1 (392)	16.8 (63)	54.5 (455)	83.1 (766)	15.4 (115)	52.8 (881)
Total	100 (461)	100 (374)	100 (835)	100 (922)	100 (748)	100 (1670)

Source: CHIPS cohort database

78 patients had expired. The details of the causes of death, including whether it was a diabetes-related death or otherwise, were not available from the HIMS. Another 36 beneficiaries have left the CHSS and cannot be followed up. About 159 of the remaining patients were not seeking CHSS health services, and the reason for this is being traced as part of the research project. Mortality, gestational diabetes cases, migration of beneficiaries and discontinuation of health services were the potential reasons for this attrition.

Figure 2: Attrition in the cohort of 835 newly diagnosed diabetes patients followed up from 2011 to 2021



Discussion

Results from a sizeable number of research articles using the CHIPS data set is already available. To start with, the age-adjusted incidence of Type II diabetes in the 30+ population within the urban community during this 10-year follow-up period was found to be 40 cases per 1000 person-years, with risk being elevated in males than females (Sharma, Dilip, Kulkarni, & Bhandarkar, 2024). Further, the lifetime risk of type II diabetes in the 40+ population was 40% and a decline in risk with advancing age was illustrated. Then, the expected years of life that a person can live without diabetes was estimated across broad five-year age groups (Sharma et al., 2023). To illustrate, a person aged 40-44 years in this community, on average, can live another 7.5 years without diabetes (Sharma, Dilip, Kulkarni, Mishra, et al., 2024). The other major contribution coming out of this cohort analysis is that it generated estimates of transition between normoglycemia, pre-diabetic and diabetic stages. Here, the reversion from prediabetes to normoglycemia peaked at around 60% within the first 2–3 years and later declined, indicating the critical importance of early detection and timely intervention during the pre-diabetic phase to prevent progression to diabetes and associated complications (Sharma et al., 2025).

Research on overtime changes in glycaemic control, comorbidity, and health services in the 10-year follow-up period among the newly diagnosed diabetic patient cohort is in progress. A time series-wise decomposition of seasonal variations in glycemic control revealed that blood sugar levels decline during the monsoon (June–September) and pronounced peaks during the pre- and post-monsoon months of April–May and October–November (Goswami, Thandassery, et al., 2025). An examination of the vitamin D levels in the diabetic cohort showed that poor glycaemic control was strongly associated with increased odds of deficiency (Goswami, Dilip, et al., 2025). Further analysis about risk of diabetes-related comorbidities (hypertension, hypothyroidism and dyslipidemia), overtime changes in glycaemic control, and health service use among this cohort is in progress.

More importantly, the results from this research study in a population with universal coverage provide unbiased estimates of disease progression in the life cycle of the patients, including diabetes-related comorbidity, to the larger medical research community. This is important as disease progression and management in a community is often dependent on the economic and physical access to treatment in health care systems characterized by shortage of adequate resources. The results from this type of cohort studies in population with universal access to health care are relatively free from biases arising from several cultural and gendered roles of patients within their families, which determine their capacity to seek treatment and pursue medical advice.

Limitations

The characteristics of a government employer-based CHSS cohort will not match exactly with a population-based cohort. Firstly, the age composition in any similar CHSS cohort will be older than the general population cohort. For this, the age-adjusted rates were prepared for comparison of results from this study with other national or sub-national scenarios. Secondly, there will not be any representation for the very poor in this cohort as CHSS only comprises salaried/ retired government employees and their dependents. Due to this factor, the prevalence of diabetes is relatively higher in this relatively more affluent CHSS population than in the general population.

Conclusion

The near-uniform protocols for patient evaluation and follow-up in the CHSS are the major strength of the CHIPS study. Additionally, this research initiative illustrated the potential for reconstructing medical history from electronic medical records in a limited timeframe and their prospective research applications. There is a need to promote similar cost-effective cohort studies among existing private/ private sector entities in formal sector that provide comprehensive medical care for their employees and their dependents. Results when pooled can serve as a resource for generating much needed evidence base while preparing or updating national/ regional level treatment guidelines and policies.

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