Review Article

A revisit to prevailing care and challenges of managing diabetes in India: Focus on regional disparities

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ABSTRACT

An unprecedented rise in diabetes mellitus (DM) prevalence in India is the outcome of lifestyle changes in the background of genetic predisposition. Moreover, there are substantial regional variations in diabetes prevalence and management. The highest prevalence of DM was observed in southern region (Ernakulum, Kerala) and lowest prevalence was observed in North Eastern region (Manipur). Similarly large variations have been evident in overall awareness and diabetes care across the geographies within India. The regional challenges are largely affected by poor disease awareness, socioeconomic disparity and underutilization of the public health-care services. Though government has taken initiatives to address this issue, overall situation demands a collaborative effort from patients, health care professionals and the state. An exhaustive literature search was performed for articles and studies published on electronic databases. Present article assesses the regional disparity of diabetes epidemiology, current management practices and government policies for T2DM in India, identifies policy and research gaps, and suggests corrective measures to address the lacunae in diabetes care.

Key words: Diabetes care, diabetes epidemiology, regional prevalence, shortfalls in diabetes care, federal policies and programmes

Introduction

Non-communicable diseases (NCD) contribute a huge burden on the healthcare system in India as compared to past when the burden was due to infectious diseases.[1,2] More than half of the deaths in India are attributed to NCD of which diabetes is on the forefront and has emerged as an epidemic in India.[3] The severity of the present situation in the Indian context can be judged from the alarming figures that during 2004, diabetes has been directly responsible for 109,000 deaths, 1157 years of life lost and 2263 disability adjusted life years.[4]

India is the second most populated country in the world with wide regional variations of caste, religion, socioeconomic status, lifestyle and food habits. These variations reflect not only in the epidemiology of diabetes but also in its care. A better understanding of the regional variation in diabetes is necessary for better planning of healthcare policies to ensure an effective care. This review delves into the regional disparities of diabetes epidemiology, current management practice and government policies for type 2 diabetes mellitus (T2DM) care in India. It also attempts to identify policy and research gaps, and to suggest corrective measures.

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Regional Disparities in Diabetes Prevalence

According to recent data, 62.4 million Indians have been

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reported to have diabetes and the figures are expected to reach 87 million by the year 2030.[5] The occurrence rates of diabetes for urban, semi urban and rural population vary from 5-15%, 4-6% and 3-5%, respectively, showing wide regional disparities with respect to different local settings.[6] Rural population has exhibited a 3 times(2.4% to 6.4%) shift in the prevalence during last 14 years. Such rapidly increasing prevalence has remarkably narrowed the gap between rural and urban areas. Improved socioeconomic status, excessive use of motorized transport, switching over to occupational attributes with increased mechanization, and constricting urban/rural disparity account for this shift.[7] This is evident from rural prevalence rates in Kerala, which have even overtaken urban prevalence rates, so much so that the whole of Kerala can now be considered to be urbanized [Figure 1].[8] Mostly single center studies have been conducted across four regions of India viz. North, South, East and West to find out the prevalence of DM. Only few multi-centric studies such as the Indian Council of Medical Research (ICMR) studies 1979[9] and 1991,[10] DiabCare 2001[11], National Urban Diabetes Survey (NUDS) 2001[12]. The Prevalence of Diabetes in India Study (PODIS) 2004,[13] WHO-ICMR NCD Risk factor Surveillance study 2008[14] and recently published The Indian Council of Medical Research-India Diabetes(ICMR–INDIAB) study 2011[15] has given us new insight.

North

A cross-sectional survey among employees aged 20-59 years of a large industry near Delhi (n = 2935) reported crude prevalence of 14-17% and 37% for diabetes and prediabetes, respectively.[1] A study by Misra *et al.* in a slum area of Delhi showed diabetes prevalence of 10.3%.[16] NUDS also reported the prevalence of diabetes and Impaired Glucose Tolerance (IGT) as 11.6% and 8.6%, respectively in Delhi.[12]

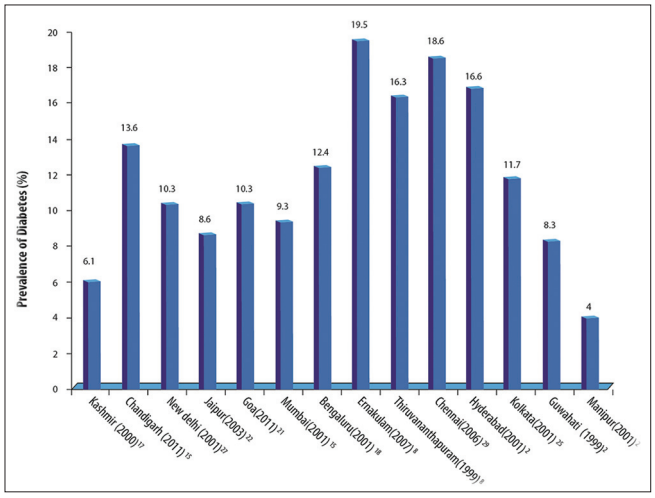

Figure 1: Regional differences in diabetes prevalence in India. Diabetes is most prevalent in Ernakulum (19.5%) while Manipur is least affected (4%). Years when studies were conducted are shown in parentheses against each state or region.[2,8,15,17,18,21,22,25,27,29]

ICMR–INDIAB study demonstrated Chandigarh to have 0.12 million people with diabetes and 0.13 million with prediabetes with overall weighted prevalence of 13.6% and 14.6%, respectively. Though the diabetes prevalence was high in urban (14.2%) than in rural (8.3%); prediabetes prevalence was found to be equal (urban 14.5%; rural 14.7%).[15] The lowest prevalence rates for diabetes (6.1%) and IGT (8.1%) in north was found in Kashmir.[17]

South

Amrita Diabetes and Endocrine Population survey conducted in urban areas of Ernakulam (Kerala) district showed prevalence of diabetes as 19.5%.[18] Results from another study carried out in rural Kerala showed crude and age-adjusted prevalence to be 14.6% and 12.5%, respectively, whereas Impaired Fasting Glucose (IFG) was found to be 5.1% and 4.6%, respectively.[8]

A rise in diabetes prevalence was observed in Chennai from 13.5% (2000) to 18.6% (2006) whereas the prevalence of IGT decreased from 16.8% (2000) to 7.4% (2006). Kancheepuram reported 16.7% diabetes and 4.3% IGT prevalence in 2006. The rise in diabetes prevalence rates from 2000 to 2006 suggests the high conversion rates of prediabetes to diabetes.[1]

Recent ICMR–INDIAB study has shown urban, rural and overall diabetes prevalence in Tamil Nadu to be 13.7%, 7.8% and 10.4%, respectively, although prediabetes prevalence was low i.e. 9.8%, 7.1% and 8.3% in urban, rural and overall population.[14]

In a study conducted among urban Puducherry population, known diabetes was found to be 5.6% (5.31% in males and 6.1% in females).[19] Coastal Karnataka showed an overall diabetes prevalence of 16%. Rao *et al.* (2010) found that 40-49, 50-59 and 60 years age groups had two-fold, four-fold and six-fold higher risk of diabetes, respectively, when compared to the 30-39 year age group.[20]

West

ICMR–INDIAB study has shown an overall diabetes prevalence of 8.4% in Maharashtra. Urban areas had significantly higher diabetes population than rural part of state (10.9% vs. 6.5%, $P < 0.05$). Overall prevalence of IFG was higher (8.0%) than IGT (3.1%).[15] The prevalence in rural Maharashtra was shown to be higher (9.3%) in another study.[18] Rural area of Mandur, Goa also showed prevalence of 10.3% (n = 1266).[21]

Jaipur reported an age-standardized prevalence of 8.6%, in a study using American Diabetes Association (ADA) criteria.[22] The prevalence of prediabetes as well as diabetes

was low amongst the subjects of camel-milk consuming rural Raica community from north-west Rajasthan. The age-adjusted prevalence of diabetes, IFG, and IGT in these subjects was significantly lower (0%, 3.2% and 8.6%) than the other-milk consuming Raica subjects (4.6%, 7.8%, and 20.6%) and non-Raica subjects (7.5%, 13.4% and 15.1%), respectively ($P < 0.01$).[23]

East

The overall prevalence of diabetes in Jharkhand was found to be 5.3% with approximately 0.96 and 1.5 million people with diabetes and prediabetes, respectively. The prevalence of diabetes was quite higher in urban (13.5%), than in rural (3%) areas.[15]

Das *et al*. (2005) reported a prevalence of 1.66 ± 0.58% (male 0.99 ± 0.88; female 1.3 ± 0.75), 3.00 ± 0.74% (male 3.17 ± 1.04; female 2.80 ± 1.04) and 4.8 ± 0.98% (male 5.31 ± 1.43; female 4.27 ± 1.32) in the rural, industrial and urban areas of West Bengal, respectively.[24] However, out of 2160 subjects with a mean age of 36.4 years in the Kolkata policeman study (2008), diabetes was found in 11.5% (10.4% known and 1.1% newly diagnosed) whereas 6.2% had IFG.[25]

The prevalence of diabetes in peri-urban population of Manipur was 4.0%.[2] A community-based survey of the 141 residents of Khowai district, Tripura found 9% of the subjects having pre-existing diabetes. A further 9% had 'borderline' (in the IGT range) or elevated levels, with no previous history of diabetes. 24% had normal blood glucose, but an existing risk factor for diabetes (family history or overweight) and 58% had normal blood glucose with no identifiable risk factor.[26]

Poor Outcome and T2DM Complications as an Indicator of Insufficient Care and Monitoring

Various studies in India indicate that more than 50% of people with diabetes have poor glycemic control (HbA1c >8%), uncontrolled hypertension and dyslipidemia, and a large percentage have diabetic vascular complications.[11,27–29] Results from Maharashtra region in a recent nationwide study showed that among known ($n = 679$) DM patients, in spite of 93.2% being on pharmacological agents [64.8% on sulfonylureas and 18% on insulin (66.4% on premix and 34.4% on basal)], HbA1c was found to be >7% in 72.7% patients among the people who were tested.

Similarly, in diabetic subjects of Madhya Pradesh ($n = 540$) 72% had HbA1c ≥7%. Among those, 484 (95%) were on oral anti-diabetic agents (OAD), 15 (3%) patients took insulin and 12 (2%) patients took both OAD and insulin.[30]

Recently published Delhi Diabetes Community (DEDICOM) survey including 819 adults from middle and upper socioeconomic background showed that only 13% had their HbA1c estimated in the preceding one year. Dilated eye examination and cholesterol examination were performed in only 16.2% and 32%, respectively. The mean frequency of self-monitoring of blood glucose (SMBG) was reported to be 3.1/month with 42% having HbA1c more than 8%.[27]

Ramachandran *et al*. in 2008 analyzed and compared the clinical profile and glycemic outcome in known diabetic cases in South Indian urban and peri-urban populations and found that the clinical outcome in known diabetic cases was far from satisfactory even in the cities where specialized diabetes care was available [mean age at diagnosis was 45.3 years, prevalence of hypertension was 57.4% (32% known); 48% were obese and a larger percentage (63.3%) had abdominal obesity; 50% had dyslipidemia].[28]

Suboptimal diabetes management leads to various microvascular and macrovascular complications, which largely influence the mortality and morbidity rates among the diabetic patients. In T2DM, Coronary Artery Disease (CAD) may start even before the onset of diabetes.[31] In an Indian study the prevalence of CAD was 21.4% among diabetic subjects compared to 9.1% in subjects with normal glucose tolerance.[32]

In the Chennai Urban Rural Epidemiology Study (CURES) 17.6% patients were found to have diabetic retinopathy (DR), 26.9% had microalbuminuria and 26.1% had peripheral neuropathy. The study also demonstrated that 1 in every 5 diabetic individual, may develop DR.[33] As per the Chennai Urban Population Study (CUPS), 21.4% had CAD and 6.3% had peripheral vascular disease (PVD).[34] Another study from South India found retinopathy (23.7%) and neuropathy (27.5%) amongst the most common complications of T2DM. Other complications in this study were cardiovascular disease (CVD) 11.4%; PVD 4.0%; stroke 0.9% and hypertension (in 38% of patients).[35] Foot infection and amputation rates were found to be higher among rural than in urban patients; (34 vs. 26%, $P = 0.0001$) and (8 vs. 3%, $P < 0.05$), respectively.[34] A recent hospital-based observational study from Gujarat showed renal dysfunction in 10% ($n = 62$) and vision impairment in 9% ($n = 57$) of the 622 T2DM subjects.[36]

Programmes, Policies and Initiatives for T2DM Management in India

Our discussions so far have underscored the magnitude of the multifaceted problems stemming out of the epidemic

of T2DM. All the stakeholders i.e. patients and their relatives, government bodies and communities should be sensitized towards the growing menace of T2DM. Quite understandably, it will require all round efforts at various levels to implement different plans and strategies in truly meaningful way. Government of India (GoI) along with state governments have launched several programs related to diabetes, aimed to provide awareness about T2DM and its complications, screening and assessment of prevalence of diabetes in Indian masses. Some of the major programs initiated by GoI and state governments are outlined below. An expanded list of such programmes and policies is provided in Table 1.[15,37-49]

Government of India programs

National diabetes control program

This program was initiated in 1987 with objectives of identifying high risk subjects at early stage, prompt management of complications associated with diabetes and imparting health education to general population. It was started in some districts of Tamil Nadu, Jammu and Kashmir and Karnataka but was suspended due to lack of funds.[37]

National programme for prevention and control of diabetes, cardiovascular diseases and stroke

This programme was launched in January 2008 in 7 states (Kerala, Tamil Nadu, Assam, Punjab, Karnataka, Rajasthan and Andhra Pradesh). The objectives were early diagnosis and management of NCDs, training healthcare professionals, and establishing palliative and rehabilitative care.[38]

Diabetes prevalence and management survey

It was launched in June 2010 by Ministry of Health and Family Welfare in 8 states of North East.[39]

ICMR-MRC diabetes prevention project

Launched in 2012 with joint funding from the ICMR and the Medical Research Council (MRC), UK, to address the current diabetes burden in the respective countries.[40]

State government programs

Chennai rural epidemiology study

Initiated in August 2001 with objectives to study insulin resistance syndrome (IRS) in rural and urban population and incidence of complications associated with T2DM. In subsequent years, population characteristics and prevalence of diabetic retinopathy, diabetic nephropathy etc., were studied, and the results were published.[41]

Prevention awareness counseling evaluation

PACE Diabetes Project was initiated in September 2004, to create awareness regarding diabetes and its complications in Chennai city. Total of 774 education sessions were conducted and 76,645 individuals underwent blood glucose screening. The project was completed by the year 2007. It was estimated that project reached out to approximately 2 million people in Chennai city [42].

Prevention and control of diabetes

Started in January 2012 by Catholic Health Association of India (CHAI), to create awareness for the prevention and control of diabetes with special focus on pregnant women. Regions covered are Lalitpur, Maharajganj, Varanasi, Sitapur and Shahjahanpur districts of Uttar Pradesh.[43]

Project MARG

Initiated in 2007 with aim to create awareness about diabetes, obesity, lipid disorders and heart disease in children and adolescents. 40,196 children (aged 8-18 years), 25,000 parents and 1500 teachers were educated about healthy nutrition, physical activity, non-communicable diseases and healthy recipes in three cities of North India (New Delhi, Agra and Jaipur).[44]

Policy and Level of Care Gaps in Diabetes Care in India

As evident, there are number of programs supported by GoI as well as respective state governments but to be effective, the most important aspect is coordination and communication so that best practices of each program is shared and emulated by others. National Diabetes Control Program with its important objective of identifying high-risk individuals and management of complications of T2DM was shelved in between due to lack of funds. Such instances can be detrimental in the bigger canvas of fight against DM. On the other hand, state run initiatives such as CURES is successfully achieving its mission by publishing the important findings on DM associated complications.

A single body should be constituted that can monitor the progress of all these programs at national level and incentives should be given to the programs that are successful in achieving their stated objectives. This body should also be made responsible for co-ordination and exchange of information between different bodies running these programs. The shortcomings in overall diabetes care can stem out of the following factors.

Lack of awareness

Lack of awareness, which is the first major obstacle in diabetes care is rather common amongst not only the general population, but the patients also!. CURES study reported that approximately 25% of the population was unaware of diabetes and only 41% of diabetic patients

knew that diabetes could be prevented.[50] Similarly, a population based study by Murugesan N *et al*. (2007) revealed that only 41% of adults (>20 years age) in India were aware of risk associated. Over 92% of the patients approached general physician for treatment instead of a qualified diabetologist. The awareness of the disease was extremely low in the rural areas and the ratio of unknown-to-known diabetes is 3:1 as compared to 1:1 in the urban areas.[52] Data from community-based survey conducted among the residents of Khowai district, Tripura revealed that even though 91% had heard about diabetes and 44% were concerned about developing it in the future, only 39% were aware of its association with overweight status and 37% knew it required long-term treatment.[26] Similar finding from southern India reveals that 75% of the patients with diabetes in rural Tamaka, Kolar district of Karnataka were unfamiliar with the long term effects of diabetes and diabetic care.[51] These trends and figures clearly show the lack of knowledge about the disease in general and the availability of treatment options.

Screening and diagnosis

Early diagnosis and regular screening which is the key for effective management and prevention of complications is not being undertaken as per standard protocols. HbA1c testing is nearly absent at government centers and insignificant in private centers as well. Only 31% specialized diabetes centers advocate HbA1c testing. Practice of SMBG was not stressed upon in government centers and was inadequate even in specialty centers. These results are comparable to DiabCare Asia study which also suggests poor frequency of SMBG.[53]

Treatment modalities

Biguanides and sulfonylureas were the only oral hypoglycemics prescribed at the government health centers, regardless of blood glucose values and duration of diabetes. Despite the fact that insulin was available free of cost, it was not initiated in patients who attended government centers due to poor availability of insulin, lack of trained manpower for educating the methods of injection practices and inadequate facilities for storage and maintenance. Similar findings were reported by WHO and results from a rural study.[53]

Inadequate spending

Healthcare in general and diabetes in particular are very heavily dependent on adequate infrastructure and funding. India spends only 5% of its GDP on healthcare and DM requires a significant proportion of that amount for effective control and management. A study estimated the total annual cost of diabetes care in the year 2010 varied from 1230 billion to 1837.3 billion Indian Rupees. Although, India has worked continuously to improve its health care system in recent decades and efforts have been made to expand the public health system and reduce the burden of disease, unfortunately treatment outcome is far from optimal in India.[11,20,27,28]

Suggestive corrective/remedial measures

Self-management and awareness

As highlighted earlier, the patient is the key entity in the overall picture of DM. So, it is of utmost importance that patient is armed with the basic tenets of diabetic disease process and care. Lack of awareness can have serious implications; for example, patients who never receive diabetes education may have substantially increased risk of a major complications. Various media sources such as print/audio-visual and information technology (IT) aides should be effectively used to spread the awareness about the disease both in general population and diabetics. Family members of patients should be separately counseled about the disease process and importance of regular monitoring and checkups. School going children should be made aware about the importance of maintaining healthy lifestyle and physical activities. Healthcare workers, at all levels should be adequately trained to disseminate information to patients regarding diabetes. Being a chronic disease, it is needless to say that patient compliance is the most important factor in fight against T2DM. Self-awareness can effectively increase the patient compliance issues related to adopting healthy diet and lifestyle, regular checkups of glycemic status, and periodic screening.

Improving dietary habits

Healthy eating habits and good nutrition can go a long way in preventing and managing diabetes. Healthy food items such as whole grains are rich in components like dietary fiber, starch, fat, antioxidant nutrients, minerals, vitamin, lignans, and phenolic compounds that have been linked to the reduced risk of obesity, insulin resistance, dyslipidemia, T2DM and heart diseases.[53]

Physician approach to care

Next to the patient, physician is the key component in the management of diabetes. It has been shown that various factors like inadequate knowledge of guidelines, primary focus on acute management rather than the preventive care, competing care demands, somewhat delayed clinical response to poor control, time constraint, inadequate resources and attitudinal issues are some of the physician related issues in diabetes control in India.[4] To overcome these shortcomings in the diabetic care specialized CME programs should be constituted to help the physicians to be updated. Also, it has been shown that guidelines arising out of evidence-based medicine (EBM) can effectively reduce the practice variations thereby improving the level

of care, so it makes lots of clinical sense to instill the concepts of EBM among general physicians. To popularize the guidelines formulated from EBM, physicians should be adequately trained, motivated and incentivized to use standard guidelines. These can be also be made legally binding so physicians will have to follow to comply from medico-legal perspective. Physicians also argue that western guidelines are often not applicable to Indian patients. To overcome this, an effort should be made to formulate local guidelines that can accommodate subtle disease variations and patient characteristics in Indian context.[53-55] It has also been observed that physicians are often reluctant to prescribe insulin due to dosage and mode of administration constraints. A conscious effort has to be made to resolve this vital issue with caregivers.

Psychosocial aspect of diabetes care

Ethnocentric approach

In an evolving model of holistic approach of managing diabetes, psychosocial treatment forms the key to achieve appropriate biomedical outcomes. Lack of awareness amongst healthcare providers in this aspect and absence of proper guidelines forms the basis of diversity among the standards of clinical practice. Recently published evidence-based recommendations for the whole nation are a positive step in this aspect.[56] In a vast country like India geographical, socio-cultural and economic diversity contribute to the complexity of psychosocial care itself. Two recent publications have tried to identify and suggest practical solutions for vulnerable populations from North East India and Uttarakhandand.[57]

Assigning a role for the family

The second Diabetes Attitudes, Wishes and Needs (DAWN2) study was performed by interviewing approximately 16,000 respondents, including 9,000 people with diabetes and nearly 5,000 family members of people with diabetes. Participants were belonging from 17 countries across four continents including a mix of developed and developing economies, with varying sociocultural climates and health-care system. This study, examined the psychosocial outcomes, experiences and concerns of family members, cross-national comparisons of perceptions on healthcare provision. DAWN2 has demonstrated the need to increase accessibility to and availability of diabetes self-management education tools. The study also underscored the negative impact on all psychosocial aspects investigated, ranging from 20.5% on relationship with family/friends to 62.2% on physical health.[58-60]

While India fared poorly in hard parameters of diabetes care delivery, family members of diabetic patients from India had the least likelihood of feeling depressed, and perceiving significant burden in helping the diabetic person they live with.[59] A recent editorial has underscored the need to utilize the services of family members efficiently through suitable strategies in the fight against diabetes.[61]

Government support

While GoI and state governments are contributing in preventing and managing T2DM there remains a great scope for the governments to aid effectively in dealing with this ever-growing epidemic. Special budgetary allocation should be provided to T2DM as it can be a harbinger to many other serious ailments and maladies. A central-monitoring cell should be created to monitor and co-ordinate the workings of all the programs related to diabetes. Special media campaigns should be run by state authorities to promote the awareness of the disease. Direct/indirect incentives should be given to agencies involved in R and D in any aspect of T2DM.

Greater co-ordination and collaboration of stakeholders

There are three key entities namely patients, physicians and government bodies all of which need to work in tandem to fight the epidemic of T2DM. A physician's job is to treat and make the patient aware regarding the evils of T2DM. Patient's job is to comply with the treatment regimen and government's job is to provide robust infrastructure (hospitals, health clinics, awareness campaigns, projects and programs) to effectively deal with T2DM [Figure 2].

Patient Issues and corrective measures

As stated earlier, diabetic patients are not well aware about the treatment options and dreaded complications. This is complicated with the sedentary lifestyle and improper diet. These problems can be overcome with proper education imparted by caregivers.

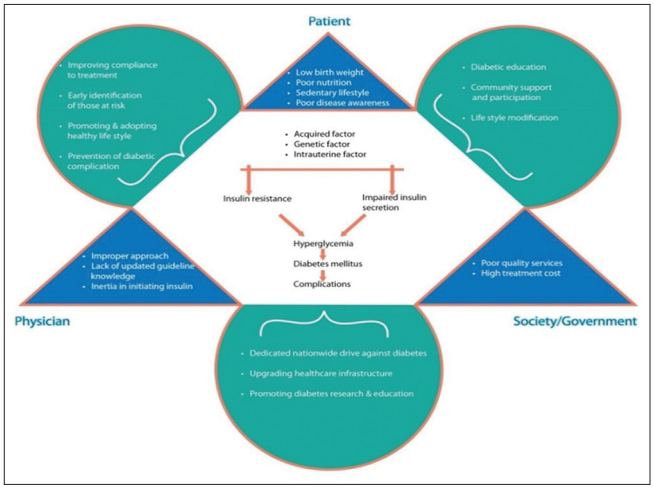

Figure 2: Role of patients, physicians and government bodies/society in management of T2DM, gaps in the care and suggestive measures to overcome those gaps

Table 1: Enlisted programmes are the major initiatives by the national and various state governments aimed to provide insight to the prevalence of diabetes and create awareness about the disease and its complications amongst Indian masses. For detailed descriptions please see the main text

	Programme	Date of project implementation and objectives	Progress	Current status
Initiative by central government	National diabetes control programme (Pilot basis)[37]	Initiated in 1987 with objectives of identifying high risk subjects at early stage, prompt management of complications associated with diabetes and imparting health education to general population	Initiated on a pilot basis in some districts of Tamil Nadu, Jammu & Kashmir and Karnataka but later suspended due to lack of funds	Not applicable
	IDSP[45]	Launched in November 2004 with aim of regular survey for NCD risk factors such as anthropometry, blood pressure, physical activity, nutrition, tobacco use etc.,	Survey is being carried out regularly. From April 2010 to March 2012, World Bank released funds for Central surveillance unit at NCDC & 9 states	Outlay of Rs. 63 Crore has been approved for 2012-2013
	NRHM[46]	Launched in April 2005. The intention was to address weakness in primary health care and to improve rural health infrastructure	In 2009, Andhra Pradesh reported 75% patient satisfaction; however in other states (Uttar Pradesh, Rajasthan and Bihar) it was lower	Not applicable
	NPDCS[38]	Launched in January 2008 in 7 states (Kerala, Tamil Nadu, Assam, Punjab, Karnataka, Rajasthan and Andhra Pradesh). The objectives were early diagnosis and management of NCDs, training healthcare professionals, and establishing palliative and rehabilitative care		Presently the NPCDCS programme is implemented in 100 districts across 21 states and is expected to reach 640 districts by 2017
	Diabetes prevalence and management survey[39]	Launched in June 2010 by Ministry of Health and Family Welfare in 8 states of North East		
	ICMR-MRC Diabetes Prevention Project[40]	Launched in 2012 with joint funding from by the Indian council of medical research and Medical research council, UK, to address the current diabetes burden in the respective countries	Mobile technologies are being used to encourage sustained lifestyle changes for prevention of Type 2 diabetes in India and the UK	Ongoing
	DiaBSmart Foot Research Project[47]	Launched in 2012 with aim to design customized footwear products to help reduce lower limb issues in diabetes patients		Ongoing
State initiatives	CURES[41]	Initiated in August 2001 with objectives to study insulin resistance syndrome in rural and urban population and incidence of complications associated with T2DM	In subsequent years, population characteristics and prevalence of diabetic retinopathy, diabetic nephropathy etc., studied, and results were published.	Not Available
	PACE[42]	PACE Diabetes Project was initiated in September 2004, to create awareness regarding diabetes and its complications in Chennai city	774 education sessions were conducted and 76,645 individuals underwent blood glucose screening. The project was completed by the year 2007. It was estimated that project reached out to approximately 2 million people in n Chennai city	Completed
	D-CLIP[48]	Started in 2009 with objective to evaluate the effects of lifestyle intervention (healthy eating/exercise/behavior change) on prevention of type 2 diabetes mellitus in India	Not available	Not available

Contd...

Table 1: Contd...

Programme	Date of project implementation and objectives	Progress	Current status
Prevention and control of diabetes[43]	Started in January 2012 by Catholic health association of India, to create awareness for the prevention and control of diabetes with special focus on pregnant women	Lalitpur, Maharajganj, Varanasi, Sitapur and Shahjahanpur districts of Uttar Pradesh are being covered under this project	The project is undergoing and is expected to complete by April 2014
MARG[44]	Initiated in 2007 with aim to create awareness about diabetes, obesity, lipid disorders and heart disease in children and adolescents.	40,196 children (aged 8-18 years), 25,000 parents and 1500 teachers were educated about healthy nutrition, physical activity, non-communicable diseases and healthy recipes in three cities of North India (New Delhi, Agra and Jaipur).	Completed
Advance study[49]	It was an international study to assess the effect of blood pressure lowering and intensive glucose control for the prevention of vascular disease among high risk patients with Type 2 diabetes	In India, over 400 patients participated from 4 major centres	Completed in 2008
ICMR–INDIAB[15]	This study was started to assess prevalence of diabetes in India covering all 28 states, the National Capital Territory of Delhi, and two of the union territories	124,000 subjects will be studied. Of 3 phases of the study, phase 1 has been completed covering Tamil Nadu, Maharashtra, Jharkhand and Chandigarh, with a sample size of 16,000 persons	Ongoing

CHAI: Catholic health association of India, D-CLIP: Diabetes community lifestyle improvement program, CURES: Chennai rural epidemiology study, PACE: Prevention awareness counseling evaluation, ICMR: Indian council of medical research; MRC: Medical research council, IRS: Insulin resistance syndrome, NPDCS: National programme for prevention and control of diabetes, cardiovascular diseases and stroke, NRHM: National rural health mission, IDSP: Integrated disease surveillance project, CSU: Central surveillance unit , NCD: Non-communicable diseases

Government issues and corrective measures

The GoI and other bodies have started number of programs but not all of them have been able to achieve their stated objectives. These programs should aim towards greater participation of patients and physicians alike.

Conclusion

Although sporadic studies on prevalence of diabetes have been available for several decades, reliable epidemiological data became available in India since the 1970s. Published studies vary in methodologies adopted and sampling frames and hence comparison of prevalence rates is not meaningful.

Focus on diabetes education, proactive physician participation, assigning a strategic role to family members, and well-planned healthcare system oriented towards diabetic care, form main areas of desired intervention. There is need for promoting research for better understanding of diabetes care in India and development of novel, effective and safe therapeutic agents. Another welcome initiative on the part of the government will be to subsidise the treatment and care of patients with diabetes. Thus a combined effort from patients, family members, healthcare professionals, government and NGO's can only help to tide over the situation.

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