

Problems associated with diabetes care in India



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Practice Points

- Developing countries such as India face a huge burden of diabetes and its complications.
- Several issues in delivering diabetes care prevail in these countries, including socioeconomic factors and problems with medical infrastructure.
- Appropriate monitoring and follow-up of diabetic patients is routinely not carried out by general physicians in India.
- Proper access to healthcare needs is lacking in several parts of India, in addition to a lack of requisite medical facilities.
- The financial burden of diabetes both on the patient and the nation's economy is extremely high, which might hinder efficient care.
- Presence of economic disparities owing to major differences in diabetes care delivery in the government and private sectors is an additional burden.
- Nonadherence to recommended guidelines by some of the government institutions results in inappropriate diabetes care.
- Effective strategies and policies to tackle these problems involved in diabetes care are needed to reduce the prevailing burden of diabetes.

SUMMARY More than 61 million people with diabetes live in India, a country that is already facing challenges such as malnutrition, poverty and socioeconomic burden caused by communicable diseases. The main reasons for the ever-increasing diabetes epidemic are population growth, urbanization, unhealthy food habits, obesity and lack of physical activity. Diabetes also causes other complications, including cardiovascular disorders, diabetic retinopathy, diabetic nephropathy and peripheral neuropathy, which are responsible for severe morbidity and mortality. Treatment of diabetes and its complications is a major challenge in India owing to several issues, including sociocultural factors, lack of appropriate facilities for diabetes care, an inadequate health system, poor monitoring and follow-up of patients, and problems in implementing effective management and

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educational strategies. Healthcare professionals and policymakers have to come together to address these problems in diabetes care and design appropriate preventative and management strategies.

Diabetes was previously considered to only affect more affluent communities and societies. Developing countries, which are already crippled with infectious diseases such as tuberculosis, AIDS and malaria, were considered to be almost immune from diabetes. Nevertheless, the situation has been changing in recent years, and chronic noncommunicable diseases (NCDs) such as diabetes, hypertension and cardiovascular disorders have become the most serious health concerns in both developed and developing countries [101]. It has been estimated that the largest increase in the number of people with diabetes will occur in the regions comprising the developing countries [1].

The main risk factors for the high prevalence of diabetes include high familial aggregation, obesity, insulin resistance and metabolic syndrome, lifestyle changes such as increased consumption of saturated fats, sugars and sedentary behavior as a result of urbanization, and gestational diabetes [2]. Moreover, Indians are more prone to developing diabetes and coronary artery disease, owing to the prevalence of the so-called 'Asian-Indian phenotype', which consists of increased insulin resistance, higher waist circumference despite lower BMI, lower adiponectin and higher high sensitive C-reactive protein levels [3].

Unlike in the West, where older populations are mostly affected, the burden of diabetes in Asian countries is disproportionately high in young- to middle-aged adults [4,5]. Furthermore, diabetes-related complications such as nephropathy are also a huge burden in developing countries. The WHO Multinational Study of Vascular Disease in Diabetes showed that proteinuria was associated with an increased risk of death from chronic kidney disease or cardiovascular disease, as well as death of any cause [6]. Foot-related complications such as chronic nonhealing ulcers and amputations cause severe morbidity and mortality [7].

This ever-increasing epidemic of diabetes and its complications could have long-lasting adverse effects on a nation's health and economy, especially in a developing country such as India, which has several socioeconomic and political barriers in the management of diabetes. Problems such as lack of proper awareness about

diabetes, lack of better healthcare facilities dedicated towards diabetes care, a poor economy, nonadherence to treatment and diet advice, and sociocultural factors are some of the challenges in diabetes care in India. Tackling these problems requires a concerted and multidisciplinary approach from various stakeholders and professionals involved in diabetes care. Effective preventive and educational programs/campaigns have to be implemented by governmental and/or private organizations to increase the awareness about the risk factors of diabetes and its complications.

Global burden of diabetes

The global prevalence of diabetes was reported to the world when the 5th edition of the International Diabetes Federation (IDF) Atlas was released during World Diabetes Day, 14 November 2011 [1]. The number of people with diabetes was approximately 366 million in 2011, and by the year 2030 this number has been predicted to increase to 552 million. It is also estimated that approximately 80% of people with diabetes live in the low- and middle-income countries, which are designated as the developing economies in the world. China and India will bear the major burden of diabetes, with an estimated 129.7 and 101.2 million cases, respectively, by 2030. The largest age group currently affected by diabetes is the 40–59 years age group, and by 2030 this is expected to move to the 60–79 years age group [1]. In addition, there will be a doubling of prevalence of diabetes in the Middle East, north Africa, south Asia and sub-Saharan Africa. More than 1 million people die due to diabetes each year, two-thirds of these are in developing countries [8]. Undiagnosed diabetes accounts for 85% of those with diabetes in studies from South Africa, 80% in Cameroon, 70% in Ghana and more than 80% in Tanzania [102].

Burden in India

In India, as in other low- and middle-income countries, diabetes and other NCDs are relatively overshadowed by the persistent burden of communicable and nutrition-related diseases. While these diseases are still present – although slowly decreasing – the rise of NCDs has been

rather fast. According to the World Health Report 2005 [9], NCDs already contribute to 52% of the total mortality in India and this is expected to increase to 69% by the year 2030 [10]. Therefore, countries such as India are currently facing an epidemiologic transition with a 'double burden' of disease. As per the latest IDF atlas, there were approximately 61.3 million people with diabetes in India, which will increase to more than 100 million by 2030 [1].

There is a bit of controversy regarding the prevalence of diabetes in India, since most of the available data are derived from a few scattered studies conducted in different parts of the country. Few multicentric studies are available, those published include: the Indian Council of Medical Research (ICMR) study conducted during the 1970s, which reported a prevalence of 12–19% in urban areas and 4–10% in the rural areas of India [11,12]; the National Urban Diabetes Survey (NUDS), which reported a prevalence of more than 12% among urban Indians [13]; the Prevalence of Diabetes in India Study (PUDIS) that reported a prevalence of 5.9 and 2.7% among urban and rural subjects, respectively [14]; and the WHO-ICMR NCD Risk Factor Surveillance study, which reported greater than 11% prevalence of diabetes among urban Indians [15]. Hence, there has been no national study that has looked at the prevalence of diabetes in India as a whole, covering all the states of the country or even in any single state with comprehensive urban and rural representation. Nevertheless, the available data certainly provide at least some relevant information on the prevalence of diabetes in India. For example, a recent multicentric study reported the overall prevalence of diabetes to be 10.4% in Tamil Nadu, 8.4% in Maharashtra, 5.3% in Jharkhand and 13.6% in Chandigarh, with a significantly high prevalence rate in the urban settings compared with the rural areas in these states [16]. Another study in the Ernakulam district of Kerala reported 20% prevalence [17]. Regarding the prevalence of diabetic complications, there are several clinic-based and a few population-based studies. Chennai Urban Rural Epidemiology Study (CURES) and Chennai Urban Population Study (CUPS) provide population-based data from India on virtually all complications of diabetes. CURES reported an overall prevalence of 17.6% diabetic retinopathy [18], 2.2% overt nephropathy and 26.9% microalbuminuria [19]. The prevalence of peripheral

neuropathy was reported to be 26.1% [20]. Results from CUPS show that coronary artery disease was observed in 21.4% of diabetic subjects and peripheral vascular disease in 6.3% of diabetic subjects [21,22].

Problems involved in diabetes care in India

Management of diabetes and its complications in India is a huge challenge owing to several problems, including a lack of general awareness about diabetes and its complications among the population, and scarcity of healthcare personnel, monitoring equipment and even drugs, especially in remote areas. All of these issues significantly contribute to delayed presentation and missed diagnosis, which further increases the existing burden of diabetes.

■ Awareness of diabetes in India

Patients' lack of knowledge about diabetes can hinder their ability to manage their disease. Several studies have looked at the awareness levels of diabetes among both patients and healthcare providers. CURES reported that nearly 25% of the population was unaware of diabetes and only 22.2% of the population and 41% of known diabetic subjects felt that diabetes could be prevented [23]. The study also reported that awareness levels increased with education, although only 42.6%, comprising mainly post-graduates, medical professionals and lawyers, knew that diabetes could be preventable. The knowledge of risk factors of diabetes was even lower, with only 11.9% of study subjects reporting obesity and physical inactivity as the risk factors; 23% knew that diabetes could lead to foot problems; and only 5.8% knew it could cause heart attack [23]. Another population-based study reported that only 41% of adult Indians aged over 20 years were aware of the risk of diabetes and almost all diabetic patients (92.3%) sought the help of a general practitioner for treatment instead of a diabetic specialist [24]. Hence, there is a pressing need to improve the awareness of diabetes among the general population as well as diabetic patients in India. This is important as better patient self-management ability is strongly related to improved diabetes control.

■ Diagnosis & access to treatment for diabetes

One of the foremost aspects of diabetes care and management is timely diagnosis and adequate

treatment, in the absence of which complications and morbidity due to diabetes can increase drastically. In India, Type 2 diabetes remains undetected for many years and the diagnosis is often made from associated complications or incidentally through an abnormal blood or urine glucose test. This results in more than half of the diabetes population being undetected [25]. Diab-Care Asia, a multicountry study in Asia, reported that diagnosis of diabetes among Indian subjects was determined at a delayed stage, with the mean age being 43.6 years, and that 50% had poor diabetes control, as measured by HbA1c, and 54% had late severe complications [26]. In another study, it was observed that approximately 70% of diabetic patients were diagnosed by general practitioners and diagnostic tests for complications were prescribed for only a few patients – 17.6% for ophthalmic examination, 5.6% for kidney function tests and 4.2% for lipid tests [27].

Another important aspect is the availability of and access to diabetes drugs. An estimate based on sales of antidiabetic pharmaceutical agents showed that, on average, only 10–12% of people with diabetes received modern pharmacological treatment in India [28]. The availability of glibenclamide in public health facilities varied from 100 to 3.8% in the states of Karnataka and West Bengal, respectively [29]. Although insulin therapy is accepted as one of the most effective and dependable treatment option, barriers to its use were identified in the IMPROVE Control India study [30]. In most patients, insulin was delayed until it was absolutely necessary or when the HbA1c levels had deteriorated further to approximately 9%. Moreover, this study also observed several other problems in the management of diabetes, such as lack of standardization in laboratory techniques and irregular monitoring of diabetes status [30]. Therefore, problems such as the uncertainty of availability of diabetic medicines and lack of pricing control over the private sector result in poor compliance with medication.

■ Financial constraints

Diabetes care, including treatment of its associated complications, often requires expensive healthcare resources such as hospitalization charges, laboratory tests and drugs (Figure 1). A study from India showed that the total annual cost of diabetes care varied from 1230 billion Indian Rupees (INR; \$25.5 billion) to

INR1837.3 billion (\$38.0 billion) in the year 2010 [31]. Presence of complications further increases the cost of treatment; for example, a recent study reported that the cost of diabetes care for a patient with foot ulcers was more than four times higher (INR19,020; US\$409) than that for a patient without foot ulcers (INR 4493; US\$97) [32].

The patient bears the excessive cost and the economic loss due to lost workdays or lost economic opportunity. In general, the absence of a significant or credible social security system in India requires the patient to depend on family support. This means that if the breadwinner of the family suffers a chronic illness, it would have a significant effect on the whole family. It may force other nonworking members to start work, often prematurely at lower wages, cut short children's education with long-term financial consequence for them and the family [33]. In the study by Tharkar *et al.*, it was observed that more than 60% of the low-income group had to borrow or mortgage property for their diabetes treatment costs and approximately 70–80% of the high income group spent most of their personal savings on treatment [31]. Hence, it can be said that the financial burden borne by people with diabetes and their families depends on their economic status and the social insurance policies of the country.

In the poorest countries, people with diabetes and their families bear almost the whole cost of medical care. In India, a situation prevails in which individuals with limited financial resources continue to spend a major proportion of their income on diabetes management [34]. This situation is a major financial burden to people in India, owing to poor economic conditions, unlike in developed nations. Moreover, the presence of associated complications further increases their financial burden. A study from south India reported the increasing expenditure by patients with diabetic complications in both rural and urban settings (Figure 2) [34]. The total annual cost to treat diabetic patients in India (including direct and indirect expenses) was estimated to be \$420 per capita. If that per capita expenditure were to remain constant, the total estimated cost of treating the disease would reach \$30 billion by 2025 [103].

The concept of medical reimbursement in the form of insurance policies is still not put into its full use by the majority of developing nations. In an analysis using data from 35 low- and

middle-income countries, such as Kenya, Vietnam, Bangladesh, Mali, Ethiopia, Pakistan and India, included in the World Health Survey [104], Smith-Spangler *et al.* reported that health insurance had a meager role in reducing the medical expenses of diabetic individuals [35]. Studies in India reported that only 6.4% of the urban low-income group received medical reimbursement, whereas this was 21.3% in the high-income group [34]. This implies that even in urban settings, the concepts of health insurance and mediclaim policies seem better understood and are only utilized by the high-income group.

Health resources in India and other developing countries are very limited with only 5% of gross domestic product (GDP), being spent on healthcare [105]. The majority of healthcare expenditure was private (4% of GDP) with only 0.9% of GDP spent on public healthcare. Therefore, careful planning based on health economic assessments is necessary in order to maximize the use of funds for the treatment and prevention of diabetes [33].

■ Social barriers

Apart from financial constraints, there are some sociocultural barriers that can be a stumbling block for the proper management of diabetes. In some developing countries, youngsters who have been newly diagnosed with diabetes sometimes do not reveal their condition and most probably do not take insulin or medications due to the social stigma attached to the condition when finding spouses, in addition to the excessive cost spent and the chance of being excluded from certain jobs or turned down for insurance or mortgage products [101]. Diabetes care in such cases becomes difficult and physicians may face a challenge in advising these patients appropriately. Moreover, although the majority of diabetic cases in India are diagnosed and managed by general practitioners, including cardiologists, neurologists and nephrologists, there is a lack of regular monitoring and patient education for these patients. This situation implies that general physicians need to understand and update their knowledge on diabetes education and prevention aspects, and monitoring of patients to prevent complications.

■ Economic disparities in the healthcare system

NCDs such as diabetes have not received enough medical attention as communicable

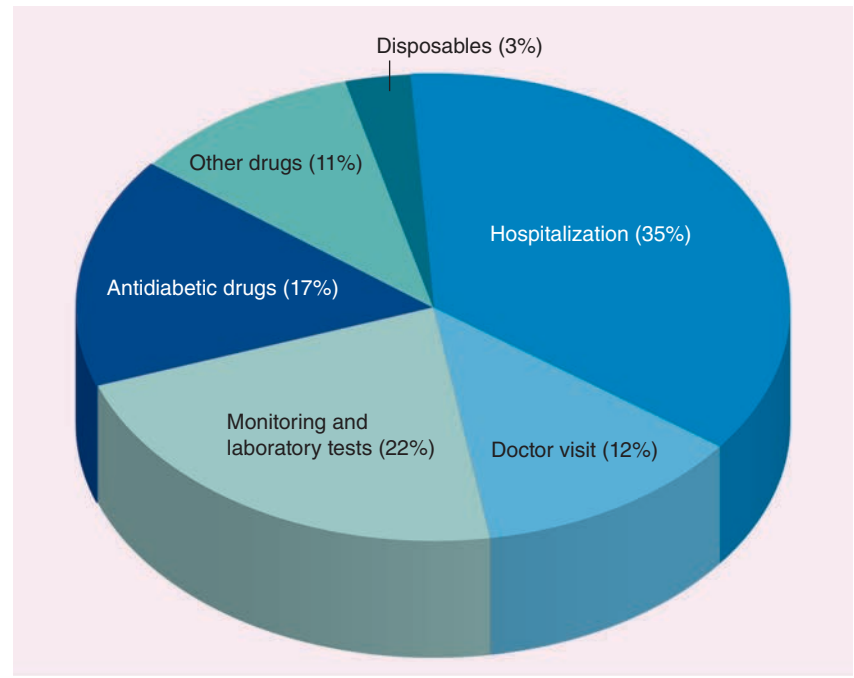


Figure 1. Distribution of direct costs in diabetes care.

Data taken from [33].

diseases such as tuberculosis and AIDS in India. Therefore, the allocation of financial resources towards diabetes or cardiovascular diseases is much less when compared with those allocated to infectious diseases [101].

In India, there is a wide disparity in the healthcare facilities available in rural and urban areas due to the nonuniformity of the healthcare system. Healthcare delivery is shared by the institutions run by the state (where medical care is free or offered at subsidized rates), private institutions (where patients have to pay for services) and a large number of medical practitioners. People do not have any restrictions in utilizing any of the available medical facilities and they can access any level of care depending on their economic feasibility, proximity and knowledge about the facility. Individuals who can afford it are able to attend the private centers for their diabetes care [36]. Nevertheless, there is a considerable variation in the quality and cost of care from place to place, depending on the available resources, the physician's skill and interest in diabetes, and the patients' capability to spend. The hospital services are provided by government hospitals, including district hospitals and medical college hospitals. Treatment in government hospitals is provided free or at a nominal charge depending on the person's

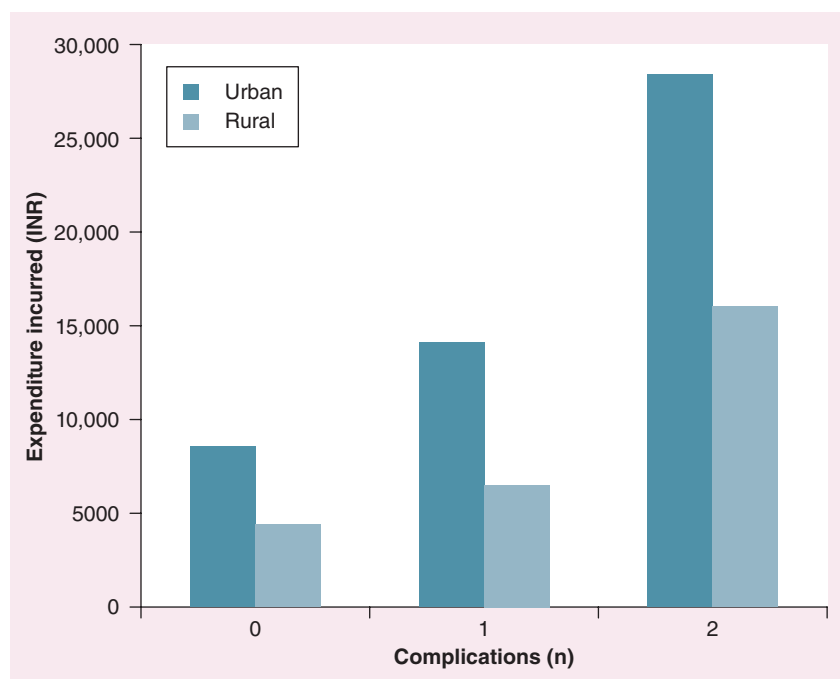


Figure 2. Expenditure incurred by urban and rural subjects in relation to the number of complications.

INR: Indian Rupees.

Reproduced with permission from [34].

income; however, due to scant and limited resources and poor infrastructure, government care focuses mainly on acute pressing illnesses, rather than diabetes. Therefore, on the whole, the quality of diabetes care is low.

The scenario in the private sector is quite different, where treatment is based mainly on monetary resources. Those seeking private medical care have to pay for everything themselves as there is limited or no reimbursements, and here too, the infrastructure for chronic care is limited. In the past few decades, several high-tech corporate medical facilities have arisen in India, which aim to provide sophisticated healthcare, although only affluent people can have access to it. This increases the expectations of the poorer sections of society, who anticipate the same services from government institutions [36]. Although private healthcare facilities are sought after, it is likely that many patients may cross over to public healthcare facilities due to financial burdens.

In the rural areas, health facilities that are based on primary health centers and subcenters need more attention, because these are not well appreciated due to inadequacy of facilities (lack of staff, equipment, laboratory facilities

and essential drugs). Some nongovernmental organizations offer free healthcare facilities for the low economic classes, but again these are less utilized due to lack of awareness, poor education and occupational problems.

Hence, long-term prognosis of diabetes is affected due to lack of adequate facilities (in the government sector) and capacity to pay (in the private sector). When uniformly good quality care is accessible to all, the disease outcome is at least not predetermined by individuals' socioeconomic standing. The prevailing poverty, ignorance, illiteracy and poor health consciousness further adds to the problem [33].

■ Adherence to recommended guidelines

Suboptimal knowledge of or improper adherence to the recommended guidelines is an issue present in India, which leads to delay in diagnosis and improper management of blood glucose levels, resulting in an increase in other complications. In the IMPROVE Control India study, it was observed that although most physicians agreed that HbA1c testing is crucial, it was only prescribed in 79% of the patients, whereas fasting and postprandial glucose tests were administered for 97 and 96% of patients, respectively. Many physicians felt that standardization of glycated hemoglobin (HbA1c) in laboratories is not reliable and, therefore, preferred the fasting and postprandial glucose measurements [30]. Another recent study by Tharkar *et al.* observed that most of the recommended clinical guidelines for diabetes care, such as performing HbA1c tests, advising about self-monitoring of glucose and diabetes education were not being adhered to in most of the government healthcare centers in India [37]. Even among the private institutions, only 31.7% of specialty clinics prescribed HbA1c tests. Professional advice and counseling regarding healthy lifestyle, diet modification and physical activity methods was given only at specialized diabetes centers, while such advice was almost absent in the government hospitals [37]. Nonadherence to recommended guidelines may lead to poor glycemic control, which can directly raise the risk of complications and increase the cost burden.

■ Need to strengthen the existing healthcare infrastructure

Despite the steep growth in the Indian economy, there has been a lag in the growth of India's healthcare infrastructure, which is quite

inadequate to meet today's healthcare demands. While India has several centers of excellence in healthcare delivery, these facilities are limited in their ability to drive healthcare standards because of the poor condition of the infrastructure in the vast majority of the country. Of the 15,393 hospitals in India in 2002, roughly two-thirds were public. After years of under-funding, most public health facilities provide only basic care. With a few exceptions, public health facilities are inefficient, inadequately managed and staffed, and have poorly maintained medical equipment. The number of public health facilities is also inadequate. For example, India needs 74,150 community health centers per million people, but has less than half that number. In addition, at least 11 Indian states do not have laboratories for testing drugs, and more than half of existing laboratories are not properly equipped or staffed. The principal responsibility for public health funding lies with the state governments, which provide approximately 80% of public funding. The central government contributes another 15%, mostly through national health programs [103]. Hence, there is an urgent need to improve the existing medical infrastructure in order to strengthen the healthcare needs of the people.

Prevention of diabetes

One of the fundamental aspects in the prevention of diabetes and its complications is imparting appropriate education to the community and at-risk population. An effective educational program insisting on physical activity, consuming a healthy diet, avoiding alcohol and smoking, and leading a stress-free life could be very effective in reducing the burden of diabetes. Every diabetic clinic and hospital must ensure that a patient receives the proper diabetes education at every visit. Implementation of all these strategies may not be practical in a country such as India, which is slowly emerging out of poverty and still struggling with problems such as unemployment. In this situation, healthcare organizations have a significant role in promoting diabetes education and management through community-based campaigns at the community level.

■ Diabetes education programs

The Prevention, Awareness, Counselling and Evaluation (PACE) diabetes project was a successful venture undertaken to increase awareness about diabetes, its risk factors and complications

among the general population in Chennai city of Tamil Nadu, India [38]. Diabetes education was imparted to the population through public education, media campaigns, general practitioner training and community-based 'real life' prevention programs. One of the major outcomes of the PACE project was that there was approximately a 6% increase in the number of people reporting that they knew about diabetes. There were also significant increases in the awareness levels of risk factors, such as family history of diabetes, obesity, stress and hypertension, among the population of Chennai. Increases in the knowledge levels of diabetic complications such as nephropathy, retinopathy and foot problems were also observed in this study. In addition, nearly 46% of the people realized that diabetes could be prevented after attending the PACE program [38].

Another recent study was carried out to assess whether a short messaging service through mobile phones could motivate patients to adhere to treatment prescriptions, which included enhanced physical activity, diet modifications and the use of drugs [39]. It was observed that the majority of patients with access to a mobile phone and knowledge of the English language preferred to receive messages on all aspects of diabetes care. The messages consisted of instructions on diet, physical activity, reminders for following drug prescriptions and healthy living habits. Patients who received the messages showed significant reductions in their glycaemic levels compared with the control group of patients who received the same diabetes care with the exception of the message service [39].

Studies on awareness and education for diabetic foot complications have shown promising results in preventing and reducing the burden of foot ulceration and amputations. A research study from India had shown the beneficial effects of foot care education, which involved simple foot care management advice to patients, such as daily examination of feet, how to perform a pedicure and usage of proper/therapeutic footwear. Foot care education was effective in healing foot ulcers in more than 80% of the patients. A higher number of patients (26%) who did not adhere to foot care advice developed newer foot problems and required surgical procedures, compared with those who followed the advice (14%) [40]. Moreover, those who regularly wore the prescribed therapeutic footwear showed significant reductions in reoccurrence of foot ulcers [41]. Approximately 60% of patients'

ulcers healed and they remained ulcer-free over a 34-month period of observation. Recurrence of healed ulcers occurred in only a sixth of patients and amputation was required in 1% of subjects [41]. These studies demonstrate that it is possible to reduce the burden of foot problems by educating patients on foot care and using appropriate footwear.

Nevertheless, large-scale programs have to be effectively implemented to cover the whole nation, for which both the public and private sectors need to work together. The National Rural Health Mission has launched a new pilot National Programme for Prevention and Control of Diabetes, Cardiovascular Disease and Stroke, which could offer opportunities for improving care for diabetes and other NCDs through service provision at the primary and secondary levels of care [42]. Guidelines for the management of diabetes in the Indian context have also been developed through a joint consultation by the ICMR and WHO [43].

Diabetes education, awareness and improving motivation for self-care improves care, reduces complications and may reduce the overall economic costs of diabetes. Lifestyle modifications such as weight control, increased physical exercise and smoking cessation are potentially beneficial in preventing diabetes mellitus [44]. Prevention of diabetes must essentially aim at targeting two main groups of population: the high-risk group that includes individuals with a family history of diabetes who carry a genetic susceptibility, individuals with impaired glucose tolerance, aging individuals, sedentary individuals and the obese; and the general population, for whom strategies to lower the mean risk level of diabetes can be implemented by advising them to engage in regular aerobic physical activity, improve their diet and reduce obesity. Several studies of community-based NCD prevention projects have attempted to prevent the onset of diabetes through lifestyle modifications, a reduction in obesity or through pharmacological means. Such projects have also clearly demonstrated a significant reduction of risk factors by following a healthy lifestyle [106] and maintaining normal body weight (BMI: 18.5–24.9 kg/m²) [2], which could in turn bring a huge benefit to the community.

Conclusion & future perspective

The overwhelmingly increasing number of people with diabetes in a country such as India

poses several challenges that have to be critically met with for the proper management and care of diabetes. Problems such as lack of appropriate infrastructure and health personnel, poor updating of knowledge about diabetes among general practitioners, poor access to diabetes drugs and healthcare facilities, economic disparities in the healthcare system, and the socio-economic burden on the patient are the main obstacles in diabetes care.

Effective management of people with diabetes offers only part of the solution for the problem of diabetes, which means that other aspects of care important from the perspective of diabetes control may be difficult to provide within the health system itself. Aspects related to diet and the amount of physical activity undertaken will be influenced by an interplay of various sectoral policies and forces. In India, several rural areas are still facing the problem of undernutrition and are unable to access better food products. Dietary restriction advice for diabetic patients in such areas becomes difficult, which means that national or state policies for food procurement, pricing and marketing have to be implemented for a sustained availability of inexpensive and accessible dietary substitutes in the market. Population-based strategies for health promotion and risk reduction, along with surveillance of trends in disease and risk factors, are equally important components in any public health approach for diabetes control.

The health system in India, as in other countries, is traditionally designed to focus on acute illnesses and maternal and child health problems. This means that there is still a lack of appropriate infrastructure and healthcare personnel to meet the raising demands of NCDs, which require the availability of trained clinicians, investigational facilities and drugs. Recently, owing to several community-based research studies, the importance of primary prevention through promotion of healthy lifestyles and risk reduction has been recognized as the most cost-effective intervention in resource-poor settings. Therefore, the health system in India has to strengthen the standard of diabetes care at all levels, along with nationally accepted management protocols and regulatory framework, which can help in tackling this challenge.

In conclusion, strong and effective preventive measures addressing all these problems have to be framed by the government, other stakeholders and policy makers, and ensure that

they are implemented and followed up successfully, in order to tackle the problems involved in diabetes care in India. In addition, health-care professionals have a big role to play in this regard, as they must always maintain up-to-date knowledge required for the diagnosis and treatment of diabetes, and they should stress the need for effective education on all aspects of diabetes care for the patients as well as the general population.

References

Papers of special note have been highlighted as:

■ of interest

■ of considerable interest

- 1 International Diabetes Federation. *International Diabetes Federation Atlas (5th Edition)*. International Diabetes Federation, Brussels, Belgium (2011).
- 2 Yadav R, Tiwari P, Dhanaraj E. Risk factors and complications of Type 2 diabetes in Asians. *CRIPS* 9, 8–12 (2008).
- 3 Mohan V, Sandeep S, Deepa R. Epidemiology of Type 2 diabetes: Indian scenario. *Indian J. Med. Res.* 125, 217–230 (2007).
- 4 Chan JC, Malik V, Jia W *et al.* Diabetes in Asia: epidemiology, risk factors, and pathophysiology. *JAMA* 301, 2129–2140 (2009).
- 5 Ramachandran A, Wan Ma RC, Snehalatha C. Diabetes in Asia. *Lancet* 375, 408–418 (2010).
- 6 Hossain P, Kawar B, El Nahas M. Obesity and diabetes in the developing world: a growing challenge. *N. Engl. J. Med.* 356, 213–215 (2007).
- 7 Vijay V, Satyavani K. Pattern and causes of amputation in diabetic patients – a multicentric study from India. *J. Assoc. Physicians India* 59, 148–151 (2011).
- 8 Narayan KMV, Zhang P, Williams D *et al.* How should developing countries manage diabetes? *CMAJ* 175(7), 733 (2006).
- 9 *World Health Report 2005*. WHO, Geneva, Switzerland (2005).
- 10 Roglic G, Unwin N, Bennett PH *et al.* The burden of mortality attributable to diabetes: realistic estimates for the year 2000. *Diabetes Care* 28, 2130–2135 (2005).
- 11 Ahuja MMS, Sivaji L, Garg VK, Mitroo P. Prevalence of diabetes in northern India (Delhi area). *Horm. Metab. Res.* 4(5), 321–324 (1974).
- 12 Gupta OP, Joshi MH, Dave SK. Prevalence of diabetes in India. *Adv. Metabolic Disord.* 9, 147–165 (1978).
- 13 Ramachandran A, Snehalatha C, Kapur A *et al.* High prevalence of diabetes and impaired glucose tolerance in India: National Urban Diabetes Survey. *Diabetologia* 44(9), 1094–1101 (2001).
- 14 Sadikot SM, Nigam A, Das S *et al.* The burden of diabetes and impaired glucose tolerance in India using the WHO 1999 criteria: Prevalence of Diabetes in India Study (PODIS). *Diabetes Res. Clin. Pract.* 66, 301–307 (2004).
- 15 Mohan V, Mathur P, Deepa R *et al.* Urban rural differences in prevalence of self-reported diabetes in India – the WHO-ICMR Indian NCD risk factor surveillance. *Diabetes Res. Clin. Pract.* 80, 159–168 (2008).
- 16 Anjana RM, Pradeepa R, Deepa M *et al.* Prevalence of diabetes and prediabetes (impaired fasting glucose and/or impaired glucose tolerance) in urban and rural India: Phase I results of the Indian Council of Medical Research–India Diabetes (ICMR–INDIAB) study. *Diabetologia* 54(12), 3022–3027 (2011).
- **Reports the results of the first phase of a national study to determine the prevalence of diabetes and prediabetes in three states and one union territory in India, using a stratified multistage sampling design. The prevalence rates were assessed by measurement of fasting and 2-h post-glucose load capillary blood glucose.**
- 17 Diamond J. Diabetes in India. *Nature* 469, 478–479 (2011).
- 18 Rema M, Premkumar S, Anitha B, Deepa R, Pradeepa R, Mohan V. Prevalence of diabetic retinopathy in urban India: the Chennai Urban Rural Epidemiology Study (CURES) Eye Study-1. *Invest. Ophthalmol. Vis. Sci.* 46, 2328–2333 (2005).
- 19 Ranjit UI, Rema M, Pradeepa R *et al.* Prevalence and risk factors of diabetic nephropathy in an Urban South Indian population: the Chennai Urban Rural Epidemiology Study (CURES-45). *Diabetes Care* 30, 2019–2024 (2007).
- **Study carried out to determine the prevalence of diabetic nephropathy among urban Asian-Indian Type 2 diabetic subjects. Study subjects were selected from Chennai Urban Rural Epidemiology Study (CURES).**
- 20 Pradeepa R, Rema M, Vignesh J, Deepa M, Deepa R, Mohan V. Prevalence and risk factors for diabetic neuropathy in an urban south Indian population: the Chennai Urban Rural Epidemiology Study (CURES-55). *Diabet. Med.* 25, 407–412 (2008).
- **Conducted to determine the prevalence of, and risk factors for, diabetic neuropathy in south Indian Type 2 diabetic subjects. Subjects were recruited from CURES.**
- 21 Mohan V, Deepa R, Shanthirani CS, Premalatha G. Prevalence of coronary artery disease and its relationship to lipids in a selected population in South India. *J. Am. Coll. Cardiol.* 38, 682–687 (2001).
- 22 Premalatha G, Shanthirani CS, Deepa R, Markovitz J, Mohan V. Prevalence and risk factors of peripheral vascular disease in a selected south Indian population – the Chennai Urban Population Study (CUPS). *Diabetes Care* 23, 1295–1300 (2000).
- **Chennai Urban Population Study (CUPS) is an epidemiological study involving two residential areas in Chennai in south India. The purpose of this study was to determine the prevalence and risk factors of peripheral vascular disease among south Indians.**
- 23 Deepa M, Deepa R, Shanthirani CS *et al.* Awareness and knowledge of diabetes in Chennai – the Chennai Urban Rural Epidemiology Study [CURES-9]. *J. Assoc. Physicians India* 53, 283–287 (2005).
- 24 Murugesan N, Snehalatha C, Shobhana R, Roglic G, Ramachandran A. Awareness, about diabetes and its complications in the general and diabetic population in a city in southern India. *Diabetes Res. Clin. Pract.* 77, 433–437 (2007).

- 25 International Diabetes Federation. *International Diabetes Federation Atlas (4th Edition)*. International Diabetes Federation, Brussels, Belgium (2010).
- 26 Raheja BS, Kapur A, Bhoraskar A *et al*. Diabcare Asia – India Study: diabetes care in India – current status. *J. Assoc. Physicians India* 49, 717–722 (2001).
- 27 Bjork S, Kapur A, King H, Nair J, Ramachandran A. Global policy: aspects of diabetes in India. *Health Policy* 66, 61–72 (2003).
- 28 Kapur A, Shishoo S, Ahuja MMS, Sen V, Mankame D. Diabetes Care in India: Patient's Perceptions Attitudes and Practices (DIPPAP-1 Study). *Int. J. Diab. Dev. Countries* 17, 2–12 (1997).
- 29 Kotwani A, Ewen M, Dey D *et al*. Prices and availability of common medicines at six sites in India using a standard methodology. *Indian J. Med. Res.* 125, 645–654 (2007).
- 30 Joshi SR, Das AK, Vijay VJ, Mohan V. Challenges in diabetes care in India: sheer numbers, lack of awareness and inadequate control. *J. Assoc. Physicians India* 56, 443–450 (2008).
- 31 Tharkar S, Devarajan A, Kumpatla S, Viswanathan V. The socioeconomics of diabetes from a developing country: a population based cost of illness study. *Diabetes Res. Clin. Pract.* 89(3), 334–340 (2010).
- Population-based study conducted to assess the annual healthcare expenditure for a patient with diabetes. Retrospective data for the last 12 months on direct costs through records, indirect cost through human capital approach and intangible cost by contingent valuation method were collected and analyzed.
- 32 Satyavani K, Hemalatha K, Shabana T, Vijay V. The costs of treating long term diabetic complications in a developing country: a study from India. *J. Assoc. Physicians India* (2012) (In Press).
- Highlights the direct cost estimates and economic burden of treating severe long-term diabetic complications in Indian patients.
- 33 Kapur A. Economic analysis of diabetes care. *Indian J. Med. Res.* 125, 473–482 (2007).
- Highlights several important issues such as cost of diabetes care in India, factors influencing costs of care, sources of funding, and complications and quality of care.
- 34 Ramachandran A, Shobhana R, Snehalatha C *et al*. Increasing expenditure on health care incurred by diabetic subjects in a developing country. *Diabetes Care* 30, 252–256 (2007).
- 35 Smith-Spangler CM, Bhattacharya J, Goldhaber-Fiebert JD. Diabetes, its treatment, and catastrophic medical spending in 35 developing countries. *Diabetes Care* 35, 319–326 (2012).
- 36 Ramachandran A. Socio-economic burden of diabetes in India. *J. Assoc. Physicians India* 55, 9–12 (2007).
- 37 Tharkar S, Devarajan A, Barman H, Mahesh U, Viswanathan V. How far has translation of research been implemented into clinical practice in India? Are the recommended guidelines adhered to? *Int. J. Diabetes Mellitus* doi.org/10.1016/j.ijdm.2011.01.002 (2011) (Epub ahead of print).
- 38 Somannavar S, Lanthorn H, Deepa M, Pradeepa R, Rema M, Mohan V. Increased awareness about diabetes and its complications in a whole city: effectiveness of the “Prevention, awareness, counseling and evaluation” [PACE] Diabetes Project [PACE-6]. *J. Assoc. Physicians India* 56, 497–502 (2008).
- 39 Shetty AS, Chamukuttan S, Nanditha A, Raj RK, Ramachandran A. Reinforcement of adherence to prescription recommendations in Asian Indian diabetic patients using Short Message Service (SMS) – a pilot study. *J. Assoc. Physicians India* 59, 711–714 (2011).
- 40 Vijay V, Sivagami M, Seena R, Snehalatha C, Ramachandran A. Amputation Prevention Initiative in South India. Positive impact of foot care education. *Diabetes Care* 28, 1019–1021 (2005).
- Reported the beneficial effects of intensive treatment and education strategies in preventing diabetic foot problems in diabetic patients with high-risk diabetic foot disease.
- 41 Vijay V, Sivagami M, Saraswathy G *et al*. Effectiveness of different types of footwear insoles for the diabetic neuropathic foot. A follow-up study. *Diabetes Care* 27, 474–477 (2004).
- 42 National Rural Health Mission. *Framework for Implementation*. Ministry of Health and Family Welfare. Government of India, New Delhi, India (2005).
- 43 *Guidelines for Management of Type 2 Diabetes*. Indian Council of Medical Research, New Delhi, India (2005).
- 44 Leung GM, Lam KS. Diabetic complications and their implications on health care in Asia. *Hong Kong Med. J.* 6, 61–68 (2000).
- Websites
- 101 The Economist Intelligence Unit Report. The silent epidemic: an economic study of diabetes in developed and developing countries (2007). http://viewswire.eiu.com/report_dl.asp?mode=fi&fi=1882281973.PDF&rf=0
- 102 World Diabetes Foundation. Diabetes facts. www.worlddiabetesfoundation.org/composite-35.htm (Accessed 30 March 2012)
- 103 PriceWaterhouseCoopers. Healthcare in India. Emerging market report (2007). www.pwc.com/en_GX/gx/healthcare/pdf/emerging-market-report-hc-in-india.pdf (Accessed 9 April 2012)
- 104 WHO. World Health Survey: current status of the World Health Survey (2011). www.who.int/healthinfo/survey/en/index.html. (Accessed 2 April 2012)
- 105 Peters DH, Yazbeck SA, Sharma RR, Ramana GNV, Pritchett LH, Wagstaff A. A better health systems for India's poor: findings analysis and options (2002). www.worldbank.org/publications/pdfs/15029overview.pdf (Accessed 2 April 2012)
- 106 WHO SEARO. Integrated community-based prevention of major NCD in SEAR. Report of an informal consultation (2003). www.searo.who.int/LinkFiles/Non_Communicable_Diseases_NCD-59.pdf (Accessed 11 April 2012)