DIABETES IN INDIA- BURDEN AND PREVENTION

V.MOHAN
R.PRADEEPA
K.S.CHELLA

MADRAS DIABETES RESEARCH FOUNDATION
&
Dr. MOHAN'S DIABETES SPECIALITIES CENTRE
GOPALAPURAM, CHENNAI, INDIA

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ADDRESS FOR CORRESPONDENCE:
Dr. V. MOHAN, M.D., FRCP (Lond, Edin, Glasg & Ire), Ph.D., D.Sc., FNASC, FNA.,
DIRECTOR & CHIEF OF DIABETES RESEARCH,
MADRAS DIABETES RESEARCH FOUNDATION &
Dr. Mohan's DIABETES SPECIALITIES CENTRE,
WHO COLLABORATING CENTRE FOR NONCOMMUNICABLE DISEASES,
PREVENTION & CONTROL & IDF CENTRE FOR EDUCATION
4, CONRAN SMITH ROAD, GOPALAPURAM,
CHENNAI - 600 086, INDIA.
TEL NO: (9144) 4396 8888, FAX NO: (9144) 2835 0935,
Email: drmohans@diabetes.ind.in ; Website:www.drmohansdiabetes.com

ABSTRACT

Diabetes mellitus is a serious chronic disorder that affects millions of persons worldwide. The recent Diabetes Atlas, of the International Diabetes Federation (IDF), reports that in 2011, there are 366 million people with diabetes globally and it is projected that this would grow to 552 million by 2030. The countries with the largest number of diabetic subjects are China, India, and U.S. and in the former two countries diabetes occurs mostly in the working age group (45-64 yrs). There is an exponential increase in number of diabetic people in India, which has increased from 19 million in 1995 to 62.4 million in 2011. Epidemiological studies conducted in India, over the past 3 decades, have shown that not only the prevalence is high in urban India but it is also increasing rapidly in the rural population. Generally, more than 50% percent of those with diabetes do not know that they have the disorder. Even though the prevalence of microvascular complications of diabetes like retinopathy and nephropathy are comparatively lower in Indians, the prevalence of premature coronary artery disease is much higher compared to other ethnic groups. The explosion of the diabetes epidemic in developing regions of the world, combined with the significant morbidity and mortality due to the enormous burden associated with its complications underscores the urgent need for prevention and control programmes. The natural history of type 2 diabetes provides chances for prevention at three transition points: primary prevention-prevention of diabetes itself, secondary prevention-early detection to prevent the complications and tertiary prevention-prevention of progression of complications. Prevention of diabetes can be achieved by strengthening the health system but requires a multi-sectoral approach beyond health sector, to curb the diabetes epidemic.
INTRODUCTION:

Diabetes mellitus is characterized by elevated blood sugar levels that occur when the pancreas does not produce enough insulin, or when the body cannot effectively use the insulin it produces. There are 2 types of diabetes. Type 1 diabetes occurs when there is an absolute deficiency of insulin due to damage to insulin producing beta cells of the pancreas and usually accounts for only a minority (5-10%) of the total burden of diabetes. However, type 1 diabetes is also increasing in incidence in both the developing and developed countries. Type 2 diabetes, usually seen in adults, accounts for about 90-95% of people globally and is characterized by a combination of insulin resistance and insulin secretion defects. Diabetes is widely recognized as one of the leading causes of death and disability worldwide. This devastating disease can affect nearly every organ system in the body. It can cause visual impairment, lead to end stage renal disease, lower-extremity amputations and increase the risk for stroke, ischemic heart disease, peripheral vascular disease, and neuropathy. Diabetes creates an economic burden not only as a costly disease requiring expensive treatment, but also in terms of man hours lost due to the debilitating effect disease has on an individual and his or her family. This article will discuss the burden of type 2 diabetes and its complications in India and examines the role of preventive strategies for diabetes.

BURDEN OF DIABETES:

Global Scenario

Diabetes imposes a large and growing burden on public health worldwide. The prevalence of diabetes is rapidly rising all over the globe at an alarming rate. It is important to note that the rise in prevalence is seen in all six inhabited continents of the globe. The Diabetes Atlas, 5th edition of the International Diabetes Federation (IDF), figures show that in 2011, there are 366 million people with diabetes in the world and it is projected that this would grow to 552 million by 2030. The IDF has also declared that diabetes had reached epidemic proportions and predicts that most of the increase will be contributed by developing countries. The major proportion of this increase will occur in developing countries of the world where the disorder also predominantly affects younger adults in the economically productive age range and hence it poses an even greater threat to the economies of these nations. In contrast to developing countries, diabetes predominantly affects older people in developed nations. According to the IDF Diabetes Atlas, China today leads the world with the largest number of diabetic subjects in any given country followed by India and USA (Figure 1) and a similar trend is also predicted in 2030 also.

![Figure 1: Top three countries of people with diabetes in the world (2011 and 2030)](image)


Indian Scenario

In India, diabetes mellitus has been described as early as 1500 BC in the ancient medical texts such as the 'Charaka Samhita' and the 'Sushruta Samhita'. Since then, the disease seems to have slowly evolved and recently grown rapidly in terms of the number of people suffering from the disorder. This is attributed due to the economic transition, industrialization and globalization that have occurred in India during the past two decades. As more and more individuals succumb to diabetes and its complications, it not only produces a strain on heath resources but also a serious threat to the future of the nation in terms of productivity, growth and development.

Thus it is clear that in recent years, India has witnessed a rapidly exploding epidemic of diabetes. The number of people with diabetes in India has increased from 19 million in 1995 to 32 million in 2000, to 41 million in 2007, to 50.8 million in 2010 and to 62.4 million in 2011 (Figure 2).
Epidemiological studies conducted in India have shown that the prevalence is higher in urban India and is also increasing faster as compared to the rural population. The national prevalence of diabetes in India according to the Diabetes Atlas - 5th edition of the International Diabetes Federation is estimated at 8.3%, although there are significant differences across geographic areas and socio-economic classes. The national prevalence was first estimated to be 2.1% by a survey of six cities and adjacent rural areas by ICMR in 1972-1975. There have been five other multi-centric studies. The 2001 National Urban Diabetes Survey, showed age-standardized prevalence of 12.1% in India's six largest metropolitan cities. The Prevalence of Diabetes in India Study, published in 2004, reported urban prevalence of diabetes to be 5.9% and 2.7% in small towns and rural areas. The WHO-ICMR NCD Risk Factor Surveillance Study conducted between 2003-2005 in urban and rural areas of six different states, reported an overall prevalence of self-reported diabetes of 4.5%.

Recently the first representative study of 4 states in the country has been completed. This study called the Indian Council of Medical Research-INDIA DIABetes (ICMR-INDIAB) study studied three states and the Union territory of Chandigarh and found that the prevalence of diabetes (both known and newly diagnosed) was 10.4% in Tamilnadu, 8.4% in Maharashtra, 5.3% in Jharkhand, and 13.6% in Chandigarh. Extrapolated to the whole country, these estimates would translate to 62.4 million individuals with diabetes. In Tamilnadu, the prevalence of diabetes in urban area (13.7%) is almost double the rates found in rural area (7.8%). In Jharkhand, the prevalence of diabetes in urban area is four fold higher than rural area (urban: 13.5% vs. rural: 3%, p<0.001). In Chandigarh, the prevalence of diabetes in urban is higher than the rates in rural area (urban: 14.2% vs. rural: 8.3%, p<0.001). In Maharashtra also, the prevalence of diabetes in urban is higher than the rates in rural area (urban: 10.9% vs. rural: 6.5%, p<0.001). The overall number of people with diabetes in India in 2011 was estimated to be 62.4 million and this was confirmed by the Diabetes Atlas 5th edition which gave a number of 61.3 million in India in the age group of 20-79 years. Figure 3 and 4 presents the prevalence of diabetes in urban and rural India respectively based on various studies done in India during the last 3 decades.
Burdon of Undiagnosed Diabetes:

One of the unfortunate aspects about diabetes is that more than 50% of the people with diabetes are unaware of their disorder. In Chennai Urban Rural Epidemiology Study (CURES), conducted in 2001 the prevalence of known diabetes was 6.1% and that of undiagnosed diabetes was 9.1%. Similarly, in the Amrita Diabetes and Endocrine Population Survey (ADEPS), the prevalence of known and undiagnosed diabetes was 9.0% and 10.5% respectively. In the ICMR-INDIAB study, the prevalence of undiagnosed diabetes among urban residents of Tamilnadu, Maharashtra, Jharkhand and Chandigarh were 5.2%, 7.2%, 5.1% and 7.6% and that among rural residents, 3.8%, 4.9%, 7.3% and 5.5% respectively. Undiagnosed diabetes may impose substantial public health implications because these patients who are unaware of their disease status are left untreated and are thus more prone to microvascular as well as macrovascular complications. Hence, it is necessary to detect the large pool of undiagnosed diabetic subjects in India and offer earlier therapy to these individuals to curb the epidemic of diabetes.

Burdon of Diabetic Complications:

The epidemic of diabetes will unfortunately, be paralleled by a corresponding increase in the prevalence of its complications. The most specific complications of diabetes are microvascular (small vessel) complications including affection of the inner part of the eye (diabetic retinopathy), kidney (diabetic nephropathy) and the peripheral nerves (diabetic neuropathy). Macrovascular (large vessel) complications affect the heart (cardiovascular disease), brain (cerebrovascular disease) and the peripheral arteries (peripheral vascular disease). Unfortunately, even today many people do not discover that they have diabetes until they have developed one or more of these serious complications, which substantially increase the morbidity and mortality associated with the disease and also reduce the quality of life. Till recently, there was no population-based data on diabetes-related complications, however several clinic-based were available. Such population-based data is of great significance since it represents the true burden of this disease as clinic based data are subject to referred bias. The Chennai Urban Rural Epidemiology study (CURES) and the Chennai Urban Population Study (CUPS) have reported on the prevalence of various diabetes-related complications and they have shown interesting differences in the patterns of complications seen in Asian Indians compared to Europeans.

Diabetic Retinopathy (DR) is the most specific of all diabetic complications. A study in Andhra Pradesh of known diabetic subjects by opthalmoscopy reported a 22.4% prevalence of DR, while a similar study of self-reported diabetics in Kerala revealed a prevalence of 26.8%. The CURES Eye Study a part of the CURES study conducted on a representative population of Chennai using retinal photography revealed that 17.6% of the diabetic subjects had DR, which included 20.8% in known diabetic subjects and 5.1% in newly detected diabetic subjects. It appears that the prevalence of DR is lower than that reported among Europeans, where prevalence rates of 35-50% have been reported in several studies.

Diabetic Neuropathy (DN) is one of the commonest complications of diabetes and certainly one of the most distressing leading to a loss of sensation in several parts of the body. Diabetic neuropathy may cause a number of complications including damage to the nerves in the feet, which along with poor circulation, can predispose to ulcers and to gangrene leading to amputation of feet. There are very few population-based studies on neuropathy from developing countries. The CURES determined the prevalence of, and risk factors for, diabetic neuropathy measured by biothesiometry (cut point ≥ 20 V) and reported the prevalence to be 26.1% (27.8% and 19.5% in those with known and newly detected diabetes respectively).

Diabetic Nephropathy is the leading cause of end stage renal disease worldwide. Early studies of immigrant and native Asian Indians suggested a high prevalence of microalbuminuria, an indicator of renal disease, while more recent studies of migrant Indians contradict this finding, suggesting a decreased prevalence of renal diseases in diabetic Asian Indians compared to Europeans. In a clinic based study in Type 2 diabetic patients, 9.4% of subjects had overt proteinuria, while 36.3% had evidence of microalbuminuria. In a study done in north India, the prevalence of microalbuminuria was 26.6%, 18.7% had diabetic nephropathy, from another diabetes centre at Chennai, while 8.9% had diabetes nephropathy in a study conducted in Vellore. The CURES study, which is one of the few population based studies from India
reported the prevalence of microalbuminuria to be 26.9% and that of overt nephropathy to be 2.2%, which are comparatively lower than that reported in the Western population.

**Coronary Artery Disease (CAD):** Indians have the highest prevalence of premature coronary heart disease in the world. In CUPS study, the prevalence was higher among diabetic subjects (21.4%), i.e. 25.3% among known diabetics and 13.1% among those newly diagnosed compared to 14.9% among those with pre-diabetes (impaired glucose tolerance) and 9.1% among those with normal glucose tolerance.

**Peripheral Vascular Disease (PVD):** It is a major cause of morbidity and mortality affecting the diabetic population for whom the prevalence is several times higher compared to age and sex matched non-diabetic subjects. Earlier clinic reports suggested that PVD is less common among Asian Indian diabetic subjects in the UK and South Africa. In the population based CUPS study, PVD prevalence was 6.3% among diabetic subjects compared to 2.7% among non-diabetic, subjects. Thus, in contrast to CAD, the prevalence of PVD is low in Indians. Table 1 presents studies on the prevalence of diabetes-related complications in India based on clinic and population studies. As there are 62 million people with diabetes in India this translates to millions of people with complications of diabetes in India.

**TABLE 1: PREVALENCE OF DIABETIC COMPLICATIONS IN INDIA AMONG TYPE 2 DIABETIC SUBJECTS**

<table>
<thead>
<tr>
<th>Author, Place &amp; Year</th>
<th>Complications</th>
<th>Type 2 diabetic subjects (n)</th>
<th>Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CLINIC BASED STUDIES</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rema et al, Chennai (1996)</td>
<td>Retinopathy</td>
<td>2319</td>
<td>34.1%</td>
</tr>
<tr>
<td>Gupta et al, New Delhi (1991)</td>
<td></td>
<td>102</td>
<td>26.6%*</td>
</tr>
<tr>
<td>Yajnik et al, Pune (1992)</td>
<td></td>
<td>146</td>
<td>23.0%*</td>
</tr>
<tr>
<td>Vijay et al, Chennai (1994)</td>
<td></td>
<td>600</td>
<td>18.7% #</td>
</tr>
<tr>
<td>Mohan et al, Chennai (2000)</td>
<td></td>
<td>1848</td>
<td>6.9% Y</td>
</tr>
<tr>
<td>Varghese et al, Chennai (2001)</td>
<td></td>
<td>1425</td>
<td>36.3%*</td>
</tr>
<tr>
<td>Ashok et al, Chennai (2002)</td>
<td></td>
<td>1000</td>
<td>19.1%</td>
</tr>
<tr>
<td>Chanda et al, Bangalore (2006)</td>
<td>Neuropathy</td>
<td>67</td>
<td>64.1%</td>
</tr>
<tr>
<td>Mohan et al, Chennai (1995)</td>
<td></td>
<td>6597</td>
<td>17.8%</td>
</tr>
</tbody>
</table>

| **POPULATION BASED STUDIES** |                        |                               |            |
| Dandona et al, Hyderabad (1999) | Retinopathy        | 2522                          | 22.6%      |
| Narendran et al, Palakkad (2002) |                       | 5212                          | 26.8       |
| Rema et al, Chennai (2005)    |                       | 1382                          | 17.6%      |
| Unnikrishnan et al, Chennai (2006) | Nephropathy      | 1716                          | 26.9%*, 2.2%α |
| Mohan et al, Chennai (2001)   |                       | 1399                          | 21.4%      |
| Premalatha et al, Chennai (2000) |Peripheral Vascular disease | 1262                          | 6.3%       |

* Microalbuminuria; ** Overt nephropathy'; # Proteinuria; Y Macroproteinuria with retinopathy; α Overt nephropathy with diabetic retinopathy
The relatively high prevalence of diabetic complications in developing nations like India may perhaps be attributed to delayed diagnosis, serious intercurrent illness, inadequate health care systems that are preoccupied with infectious diseases, and the high cost of medications, particularly insulin leading to poor control of diabetes.

MORTALITY AMONG PEOPLE WITH DIABETES:

People with diabetes have an excess risk of mortality and morbidity compared with those without diabetes. According to a WHO report, there are about five times as many deaths indirectly attributable to diabetes. Asian Indians with diabetes also have higher mortality than people with diabetes from other ethnic groups. South Asia currently has the highest number of diabetes-related deaths; accurate prevalence estimates of complications in large segments of the population are glaringly absent. Information on mortality and cause of death due to diabetes in India is mainly from retrospective hospital-based clinical or autopsy studies. In 1999, Zargar et al reported that the common causes contributing to death in diabetic patients in a tertiary hospital at Srinagar were infections (33.8%), chronic renal failure (30.8%), coronary artery disease (16.3%), cerebrovascular disease (13.7%), hypoglycaemia (7.8%), diabetic ketoacidosis (6.6%) and hyperosmolar coma (2.2%). Bhansali et al in 2003 also reported that infections were the leading cause of mortality in diabetic subjects in a tertiary hospital in Chandigarh in North India, similar to the findings observed by Zargar et al. A recent study conducted by Zargar et al in 2009 reported that death was attributed to a single cause in 52.9%, two causes in 36.3% and three or more causes in 7.0% of the diabetic subjects. The study also reported that about one sixth of all deaths occurred in people with diabetes aged less than 50 years and over half of all deceased people with diabetes were 60 years or older and one fourth of people with diabetes died at age of 70 years or above.

There are very few population-based studies on mortality in India. The CUPS study conducted in Chennai in South India provided evidence on the effect of type 2 diabetes on mortality in a population. The overall death rates were nearly threefold higher in people with diabetes than in those without (18.9 vs 5.3 per 1000 person-years). The hazards ratio for all-cause mortality for diabetes was found to be 3.6 compared with non-diabetic people. The study also showed that the leading cause of mortality in diabetes was cardiovascular (52.9%) and renal (23.5%) diseases. It is thus clear that diabetes appears to be a significant public health problem in India.

SOCIOECONOMIC & PSYCHOLOGICAL BURDEN OF DIABETES:

Type 2 diabetes is in many respects, a disease of poverty. As diabetes occurs at a younger age (45–64 years) in developing countries, long-term complications of diabetes will occur in a large proportion of diabetic subjects during the most productive years of their lives, causing severe economic and social burden. In addition, the indirect and social and personal costs are incalculable. An individual with diabetes spends around twice as much on medical care compared to his/her contemporary without diabetes. In India, the mean annual direct costs of diabetes (Consultation, investigation, medication, management, hospitalization, treating complications, transportation and time utilized for care) was INR 7158/-. And indirect cost (man days lost, low productivity, disability payment, social security, depression) was INR 17756/-. While the mean direct annual cost for outpatient care for all patients with diabetes was INR 4724/-, those without complications had an 18% lower cost while those with three or more complications had a 48% higher cost.

Being diagnosed with diabetes is quite traumatizing and imposes a long term psychological burden on the individual and the family. To some individuals with diabetes, the demands of self-care (including medication) can be overwhelming, frustrating and quite a burden to live with. Many report feeling angry, guilty, or frightened about the disorder, and often are unmotivated to complete diabetes self-care tasks. Thus, unless effective prevention strategies are put into place, the epidemic of diabetes will continue to rise adding to the already strained health budgets of nations, particularly in developing countries like India.

PREVENTION AND CONTROL OF DIABETES

Early detection is the key to prevention and effective control of diabetes. As diabetes is largely asymptomatic, regular screening for diabetes is of utmost importance. It is well known that diabetes is a hereditary disease. Hence
it is logical that screening of diabetic families would be the first priority. If the family history is very strong, eg. more than two generations of diabetes in the family, the first screening test could be done even by 20-25 years of age and thereafter on a yearly, or two yearly, basis.

Though diabetes is an inherited disorder, lifestyle modifications can help in the prevention of diabetes. There are three points in the natural history of the disease where prevention is possible (Figure 5). Primary prevention of diabetes refers to the prevention of diabetes before it develops. Primary prevention of diabetes should begin in childhood or early adulthood and risk reduction education should be directed at the entire family. All patients should be regularly screened for risk factors and encouraged at each health care visit to pursue a healthy lifestyle, including a healthy diet, adequate exercise and weight control. Secondary prevention of diabetes refers to therapy to prevent the progression of disease to stages of complications. Subjects with diabetes should be managed more aggressively to prevent the occurrence of complications. Tertiary prevention of diabetes should be aimed at limiting physical disability and rehabilitation measures in those who have already developed diabetic complications and to prevent them to go into end stage complications of diabetes.

Studies in the west and in India have shown that diabetes is preventable by lifestyle modification mainly through increased physical activity. However, several questions remain unanswered: Are such approaches possible at the community level and in a real life setting? Can these simple approaches benefit the community? How will the community respond to such approaches? Finally, are such community-based lifestyle changes possible in India? We present below some of our experiences in India which are very encouraging. Specifically we show that community based intervention programmes are not only feasible, but are also welcomed by the community in India.

In 1996, two residential areas were selected and involved in the population-based study called the Chennai Urban Population Study (CUPS), Asiad Colony in Tirumangalam, and the Bharathi Nagar Colony in T.Nagar, representing the middle and lower income groups in Chennai. The age standardized prevalence rates of diabetes were significantly higher in the middle income group (Asiad Colony-12.4%) compared to a low-income group colony studied (6.5%). These results where shared with the middle income group colony residents in order to empower them regarding diabetes and the need for prevention. The results of the study clearly demonstrated that with affluence, which was invariably associated with decreased physical activity, there was a marked increase in the prevalence rate of diabetes. Having realized the importance of diabetes prevention, the colony residents felt the need for increasing physical activity and constructed a park just adjacent to their colony by mobilizing funds from various resources which included their own resources and donations from philanthropists.

A follow-up survey after ten years demonstrated that the construction of the park led to a 300% increase in number of people who exercised in this community. Compared to the rest of Chennai, where the prevalence rates have now increased to over 18%, in the Asiad colony where the intervention was introduced through community empowerment, the prevalence rate had only marginally increased to 15.4% (24% increase). Meanwhile, in the low income colony which had much lower prevalence rates in 1998, it had increased to 15.3% (135% increase). This demonstrates that by making a modest investment of money (building of a park) and time (physical activity in the form of walking for about 30 minutes a day) diabetes can be prevented in a substantial proportion of people. Further studies have shown that this is already having an impact on prevention of diabetes and obesity in the colony. If this model can be replicated nationally, it could lead to prevention of not just diabetes, but of non communicable diseases (NCD’s) in general in India.
Ultimately prevention of diabetes can only be achieved by strengthening the health system through i) provision of counselling services for lifestyle modification; ii) developing norms and standards for diabetes care; iii) training physicians and paramedical staff; iv) ensuring availability of medications –Oral hypoglycemic drugs, Insulin and drugs for complications; v) linking primary health care with tertiary care to combat diabetic complications and vi) focusing on health promotion activities and to increase public awareness about diabetes and its complications. The time for action is NOW!

RECOMMENDATIONS FOR READING:


