CHAPTER

17

Changing Trends in Epidemiology of Diabetes

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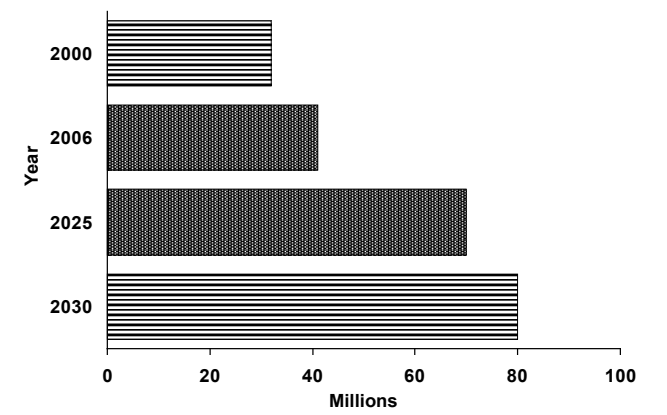
Introduction

A diabetes epidemic is sweeping across India. According to latest estimates by the International Diabetes Federation (IDF), India leads the world in the number of diabetic subjects in India is around 41 million in 2006 and this is set to rise to 70 million by the year 2025.[1] Estimates by the World Health Organisation also suggest that the number of diabetic subjects would increase to 80 million by the year 2030 (Figure 1).[2] Several studies have looked at the prevalence of type 2 diabetes in India since the turn of this century. Although these studies differ in terms of diagnostic criteria, methods and study populations, they give us a fair idea about the rising trend in the prevalence of type 2 diabetes in India. This article will try to give a brief overview of some of the published studies from India.

Figure 1 : Estimated Number of Diabetic Subjects In India



Diabetes in Ancient India

Diabetes (Madhumeha/ Prameha) is probably one of the well described disorders in ancient India. The oldest reference to diabetes in Indian literature dates back to 4500 years.[3] The Charaka Samhita explains in detail about the etiopathogenesis, symptomatology, complications and treatment of prameha. Although there is no recorded data on the prevalence of diabetes in ancient India, it is quite evident that the disorder was not uncommon. The treatment options of this "maharoga" were diet, exercise and medicine.[3,4]

The initial surveys on the prevalence of diabetes in India

To do a comparative analysis on the prevalence of diabetes in the first half of 20th century is difficult as there were no standard criteria for diagnosing diabetes. Most of the earlier studies were based on hospital records and used glycosuria as the diagnostic criteria. Ramaiya et al[5] has made an excellent compilation of all earlier studies in their article published in 1991. One of the earliest studies on the prevalence of type 2 diabetes in India was done at Kolkatta (Calcutta then), in 1938.[6] This study,

based on urine sugar showed that the prevalence of type 2 diabetes was 1%. Another hospital based study from Mumbai reported a prevalence of 0.7% in 1959.[7] In 1966, a population based survey reported a prevalence of 2.3% from Chandigarh.[8] In the same year, a survey done in Pondicherry (now Puducherry) using blood sugar for diagnosis reported a prevalence of 0.7%.[9] A prevalence of 1.2% was reported from Cuttack in 1971.[10] In 1972 the prevalence of diabetes in urban Hyderabad was 2.5%[11] and Delhi had a prevalence of 2.3 %.[12] A study from Bangalore showed a prevalence of 2.3% in 1973.[13] The first multicentric study in India was done by the Indian Council of Medical Research (ICMR) between 1972 and 1975 in six different areas of India. The study reported a prevalence of 2.3% in urban areas and 1.5% in rural areas.[14] From these reports, it is evident that till the 1970s, the prevalence of diabetes was less than 3% even in urban areas. Subsequent studies from different parts of India revealed a rapid rise in the prevalence of diabetes in India.

Rise in the prevalence of diabetes in India in the last quarter of 20th century

The earliest indication of the impending epidemic was observed in the Tenali study of 1984, which reported a high prevalence of 4.7% in a town in Andhra Pradesh.[15] A relatively higher prevalence of 3.8% was also reported in 1986 from Bhadlan, a rural area in Haryana.[16] A study done in Kudremukh, a small township in Karnataka revealed a prevalence of 5.0%.[17] The Eluru survey, done in rural Andhra Pradesh showed a prevalence of 1.5%.[18] However, the prevalence of known diabetes was 6.1% in individuals aged above 40 yrs which was unexpectedly high for a rural area.[18] A subsequent study done in 1988 in Chennai reported a prevalence of 8.2% in the urban and 2.4% in rural areas.[19] A study done in the same urban area after five years showed that the prevalence had risen to 11.6%.[20] A study done in Kerala showed a very high prevalence of 16.3% in 1999.[21] At the same time, a study from Guwahati reported a prevalence of 8.2%.[22] The Kashmir Valley study done in 2000 recorded that the prevalence of 6.3%.[23] The prevalence of 'known' diabetes was 1.9% whereas the prevalence of 'undiagnosed' diabetes was 4.3%, which was more than double that of diagnosed cases.[23]

The National Urban Diabetes Survey (NUDS)

The National Urban Diabetes Survey (NUDS) was a population based study conducted in six large cities from different regions of India. This study was done on 11,216 subjects aged over 20 years from all socio-economic strata.[24] The WHO criteria[25] was used for diagnosis of diabetes after an Oral Glucose Tolerance Test using capillary blood. The study showed that the age standardized prevalence of type 2 diabetes was 12.1%. The prevalence was the highest in Hyderabad (16.6%), followed by Chennai (13.5%), Bengaluru (12.4%), Kolkatta (11.7%), New Delhi (11.6%) and Mumbai (9.3%).

Recent studies on the prevalence of diabetes in India

A study from Jaipur reported an age-standardized prevalence of 8.6% in 2003.[26] A recent study from rural Maharashtra showed a high prevalence of 9.3%.[27] The Amrita Diabetes and Endocrine Population Survey (ADEPS), a community based cross-sectional survey done in urban areas of Ernakulam district in Kerala has revealed a very high prevalence of 19.5%.[28] The ADEPS has revealed the highest prevalence of diabetes in a population in India. Figure 2 summarises some of the population-based studies in India suggesting the rising prevalence of type 2 diabetes in urban and rural areas.

Secular trends in the prevalence of diabetes- Evidence from Chennai

The Chennai Urban Rural Epidemiology Study (CURES)

The Chennai Urban Rural Epidemiology Study (CURES) provides the latest reports on the rising prevalence of diabetes in Indians. This study was conducted on a representative population of

Chennai.[29] The sampling for CURES was based on the model of systematic random sampling, wherein of the 155 wards of the corporation of Chennai, 46 were selected to represent all the 10 zones. A total of 26,001 individuals were selected from these 46 wards for Phase 1 of CURES and a fasting capillary glucose measurement was obtained in all. Phase 2 focused on the study of complications of diabetes in the self-reported diabetic subjects identified in Phase 1, while Phase 3 aimed to recruit every tenth subject (n = 2600) screened in Phase 1 for an oral glucose tolerance test. Phase 3 had a response rate of 90.4 per cent (i.e., 2350/2600 subjects participated). The CURES investigators had a unique opportunity to compare prevalence rates of diabetes in Chennai city which is the only region in India that has had repeated well-conducted epidemiology studies on prevalence of diabetes over the past two decades. They were thus able to compare the data obtained from CURES with three earlier epidemiological studies carried out in the same city using similar methods.[19,20,24] The overall crude prevalence of diabetes using WHO criteria in CURES was 15.5 per cent (age standardized: 14.3%), while that of IGT was 10.6 per cent (age-standardized: 10.2%.[30] From 1989 to 1995, the prevalence of diabetes in Chennai increased by 39.8 per cent (8.3 to 11.6%); between 1995 and 2000 by 16.3% (11.6 to 13.5%) and between 2000 and 2004, by 6.0% (13.5 to 14.3%). Thus within a span of 14 years, the prevalence of diabetes increased significantly by 72%.

Urban- Rural differences in the prevalence of diabetes

Urban rural differences in the prevalence of diabetes has been consistently reported from India. While the ICMR study reported that the prevalence was 2.1% in urban and 1.5% in rural areas,[14] a later study showed that the prevalence was three times higher among the urban (8.2%) compared to the rural population (2.4%).[19] A study done in southern Kerala looked at the variations in the prevalence of type 2 diabetes among different geographic divisions within a region. The prevalence of diabetes was the highest in the urban (12.4%) areas, followed by the midland (8.1%), highland (5.8%) and coastal division (2.5%).[31] A recent study done on young adults (aged 26-32 years) in Vellore, Tamil Nadu has reported that the prevalence of type 2 diabetes was 3.7% in urban areas and 2.1% in rural areas.[32] The prevalence of impaired glucose tolerance (IGT) was 18.9% in the urban and 14.3% in rural subjects[32] revealing a large pool of pre diabetic subjects in the young age group on the verge of getting converted to diabetes.

The Prevalence of Diabetes in India Study (PODIS)

The PODIS study was carried out in 108 centers (49 urban and 59 rural) in different parts of India to look at the urban-rural differences in type 2 diabetes and glucose intolerance.[33,34] Diabetes was defined according to WHO and ADA criteria. According to ADA criteria, the prevalence of diabetes was 4.7% in the urban and 2.0% in the rural areas. The prevalence of diabetes according to WHO criteria was 5.6% and 2.7% among urban and rural areas respectively.

The WHO-ICMR national NCD risk factor surveillance

The WHO-ICMR national NCD risk factor surveillance was done in five states of India to obtain continuous surveillance of NCD risk factors in India.[35, 36] The five states represented different geographical locations (north, south, east and West/ central India). About 40,000 individuals aged 15 to 64 yrs with equal distribution from Urban, peri-urban and rural areas were recruited for the study. The overall prevalence of the self reported diabetes was 4.5%. Urban area had the highest prevalence of 7.3%, per-urban/ slum areas a prevalence of 3.2% and rural areas had the least prevalence of 3.1%.[37] It is interesting to note that the prevalence in the urban area was more than double that of rural area. This is the latest data showing the urban- rural differences in the prevalence of diabetes in India.

Shift in the age of onset of diabetes in India

One of the most disturbing facts in the changing trend in the epidemiology of diabetes all over the world is the shift of onset to a younger age group. The CURES provided valuable evidence from India in this regard. It was shown that there was a temporal shift in the age at diagnosis to a younger group when compared to the NUDS study published just five years earlier[24,30] (Figure 3). A study from Delhi also reported a high prevalence of insulin resistance in children which was associated with excess body fat and adiposity.[38] The shift in the age of onset of diabetes and the rising prevalence of type 2 diabetes in children can have long lasting effects on the health of the nation and its economy.

Impact of Socio-economic status and migration on the prevalence of type 2 diabetes.

The Chennai Urban Population Study (CUPS)

The CUPS was done to assess the effect of socio-economic status on the prevalence of type 2 diabetes and related abnormalities.[39] The study involved two residential areas in Chennai representing the lower and middle income group. The overall prevalence of diabetes was 12% in the population aged above 20 yrs.[40] The age standardised prevalence was 12.4% in the middle income group compared to 6.4% in the lower income group. The prevalence of related metabolic abnormalities like obesity and cardiovascular risk factors were also markedly higher in the middle income group.[40]

Diabetes related complications in India

The CURES and the CUPS have provided valuable data on the complications of type 2 diabetes in Indians. The prevalence of coronary artery disease was 21.4% among diabetic subjects compared to 9.1% in subjects with normal glucose tolerance.[41] Atherosclerosis as assessed by carotid IMT was also found to be higher in subjects with type 2 diabetes compared to those with normal glucose tolerance.[42] The prevalence of peripheral vascular disease (PVD) was higher in type 2 diabetic subjects compared to (6.3% vs 2.7% $p < 0.001$).[43] The CURES eye study is the largest population based data on the prevalence of diabetic retinopathy in India. This study reported a prevalence of 17.6%, which is lower compared to the reports from the west.[44] The prevalence of Nephropathy was 2.2% and that of microalbuminuria was 26.9%.[45] It is thus interesting to note that while Asian Indians have greater predilection for cardiovascular complications the prevalence of microvascular complications appears to be lower than in Europeans. The CUPS also provided some evidence on the effect of type 2 diabetes on mortality rates in a population. The overall mortality rates were nearly three-fold higher in diabetic subjects compared to non-diabetic individuals (18.9 vs 5.3 per 1000 person-years).[46] The hazards ratio (HR) for all cause mortality for diabetes was found to be 3.6 compared to non-diabetic subjects.[46]

Causes of the escalation in diabetes prevalence

Epidemiological transition- Fast food and Sedentarinism

The rapid rise in the prevalence of type 2 diabetes and related disorders like obesity and hypertension could be attributed to the changes in lifestyle that has occurred in the post-independence India, especially in the past two decades. Intrusion of fast food culture into our society has a major negative impact on its health. The easy availability of calorie rich 'fast- foods' has been an important factor in the rise of obesity and diabetes in Indian cities. As most of the immigrant population depend on the numerous fast food joints, the prevalence of diabetes among urban slum dwellers is also on the rise. A recent study from New Delhi showed that even the slum dwellers had high prevalence of obesity, glucose intolerance and dyslipidemia.[47] Diabetes can longer be called a disease of the affluent or a rich man's disease. It is becoming a problem even

among the poorer sections of the society. Studies have shown that the poor diabetic subjects are more prone to complications as they have little access to quality health care.[48] This presents an alarming picture as vast majority of Indian population is still below poverty line.

The shift of jobs from physically demanding manual labour to the physically less demanding office jobs has also triggered the diabetes epidemic in the current generation. Decreased physical activity, referred to as 'sedentarinism' is affecting the children also. Few children are seen playing outdoors as most of them get addicted to television channels and video games. Evidence from the CUPS study confirms the effect of physical activity on the prevalence of type 2 diabetes and cardiovascular disorders. It was observed that the prevalence of type 2 diabetes was nearly 3 times higher in individuals with light physical activity compared to those having heavy physical activity.[49] It was also noted that individuals with light-grade physical activity had 2.4 times higher chances of developing coronary artery disease compared to those with high grade physical activity.

Genetic predisposition-'Asian Indian phenotype' and 'The Thin Fat Indian Baby'

Although the roles of changes in dietary patterns and physical activity in the changing trend in the epidemiology of type 2 diabetes in India have been well established, studies on migrant Indians have also pointed out to an increased genetic predisposition of Asian Indians to type 2 diabetes and related metabolic abnormalities compared to other ethnic groups.[50, 51] The so called "Asian Indian Phenotype" refers to certain unique clinical and biochemical abnormalities in Asian Indians and this constellation of abnormalities is considered to be one of the major factors contributing to increased prevalence of type 2 diabetes in Asian Indians.[52-54] Despite having lower prevalence of as defined by body mass index (BMI), Asian Indians tend to have greater waist circumference and waist to hip ratios thus having a greater degree of central obesity.[55] Further, Asian Indians have more visceral fat for any given BMI[56] and for any given body fat they have greater insulin resistance.[57] Moreover, they have lower levels of the protective adipokine, adiponectin and also have increased levels of adipose tissue metabolites.[58] Studies on neonates reported that Indian babies are born smaller but relatively fatter compared to European babies and are referred to as "thin fat Indian baby".[59, 60] A recent study has confirmed this hypothesis and suggested that the 'thin fat phenotype' persisted in childhood and could be a forerunner of the diabetogenic adult phenotype.[61] All these evidences suggest that apart from the lifestyle factors, certain genetic factors also predispose Asian Indians to type 2 diabetes and related abnormalities. However, the molecular mechanisms by which the genetic factors predispose Asian Indians to type 2 diabetes in still not elucidated. Recent studies from India have shown that while some genes appear to confer increased susceptibility to diabetes in Asian Indians, some protective genes in Europeans do not appear to protect Indians.[62-64]

Early Identification and Prevention

Diabetes being a multifactorial disorder with a strong environmental components, which are 'modifiable', early identification of these modifiable risk factors and interventions such as dietary changes and increasing physical activity would help in the prevention or at least delay the onset of diabetes. Hence, early identification of at- risk individuals is of extreme importance if we are to prevent diabetes in India.

Indian Diabetes Risk Score (IDRS)

The recently developed Indian Diabetes Risk Score (IDRS) is a simple, inexpensive tool for identifying at risk individuals for type 2 diabetes[65] (Table 1). This Asian Indian specific risk score was developed based on the CURES, a large scale epidemiological study. It uses four simple variables namely, age, family history, regular exercise and waist circumference (Table). The individuals were classified as having high risk

Table 1 : Indian Diabetes Risk Score (IDRS) [65, 66]

(Developed by Dr. V. Mohan and colleagues at Madras Diabetes Research Foundation)

Particulars	Score
Age:	
<35 years	0
35 – 49 years	20
≥ 50 years	30
Waist circumference:	
Waist < 80 cm [female], <90 cm [male]	0
Waist ≥ 80 - 89 cm [female], ≥ 90 – 99 cm [male]	10
Waist ≥ 90 cm [female], ≥ 100 cm [male]	20
Physical activity:	
Vigorous exercise [regular] or strenuous [manual] work at home / work	0
Moderate exercise [regular] or moderate physical activity at home / work	10
Mild exercise [regular] or mild physical activity at home / work	20
No exercise and sedentary activities at home / work	30
Family history of diabetes:	
No diabetes in parents	0
One parent is diabetic	10
Both parents are diabetic	20

Interpretation: Score < 30 – low risk, score 30-50 medium risk and score ≥60 high risk for type 2 diabetes and cardiovascular diseases.

(score ≥ 60), moderate risk (score 30 - 50) and low risk (score < 30) out of a total score of 100. IDRS has a sensitivity and specificity of over 60% for a cut-off > 60 and can be used to do a selective screening or a two step screening, where the blood glucose estimation is done only in a high risk group thus reducing the cost of screening. This is significant especially in rural areas where a physician can advise blood sugar estimation if a person is found to have high risk score. Further reports have also shown that the IDRS is not only an indicator of future diabetes risk, but also an indicator of cardiovascular disorders and coronary artery disease even in individuals with normal glucose tolerance.[66] Risk assessment with IDRS will also help in promoting the awareness about the modifiable risk factors of type 2 diabetes like abdominal obesity and physical activity. Data from CURES also revealed that the awareness about diabetes even in urban areas is extremely low.[67] Nearly 25% of the public were not aware of a condition called diabetes. Moreover, even among the diabetic subjects, the knowledge and awareness about complications was poor and less than 50% knew that diabetes is preventable. Mass awareness programmes like camps, public lectures, video clippings and distribution of educational pamphlets have a great impact on increase in improving awareness levels in the community. A recent study from Chennai has shown that such mass education programmes increased the proportion of those who exercised by 277% in a span of 7 years.[68] Mass awareness programmes not only help in the prevention of diabetes, but also help in increasing the awareness about other related non-communicable diseases.

In conclusion, India is today facing an epidemic of diabetes which could affect not only the individuals and his family but also the health and economy of the nation. Prevention of diabetes should therefore be a priority for the health program of the nation. A joint effort by government, non-governmental organisations (NGOs) and the public is needed to stem the tide of the diabetes epidemic currently sweeping across India.

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