Indian J Med Res 125, March 2007, pp 217-230

Epidemiology of type 2 diabetes: Indian scenario

V. Mohan, S. Sandeep, R. Deepa, B. Shah* & C. Varghese**

*Madras Diabetes Research Foundation & Dr Mohan's Diabetes Specialities Centre, Chennai, *Indian Council of Medical Research, New Delhi & **Office of the World Health Organization Representative to India, New Delhi, India*

Received January 10, 2007

India leads the world with largest number of diabetic subjects earning the dubious distinction of being termed the "diabetes capital of the world". According to the Diabetes Atlas 2006 published by the International Diabetes Federation, the number of people with diabetes in India currently around 40.9 million is expected to rise to 69.9 million by 2025 unless urgent preventive steps are taken. The so called "Asian Indian Phenotype" refers to certain unique clinical and biochemical abnormalities in Indians which include increased insulin resistance, greater abdominal adiposity *i.e.*, higher waist circumference despite lower body mass index, lower adiponectin and higher high sensitive C-reactive protein levels. This phenotype makes Asian Indians more prone to diabetes and premature coronary artery disease. At least a part of this is due to genetic factors. However, the primary driver of the epidemic of diabetes is the rapid epidemiological transition associated with changes in dietary patterns and decreased physical activity as evident from the higher prevalence of diabetes in the urban population. 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 in Indians compared to other ethnic groups. The most disturbing trend is the shift in age of onset of diabetes to a younger age in the recent years. This could have long lasting adverse effects on nation's health and economy. Early identification of at-risk individuals using simple screening tools like the Indian Diabetes Risk Score (IDRS) and appropriate lifestyle intervention would greatly help in preventing or postponing the onset of diabetes and thus reducing the burden on the community and the nation as a whole.

Key words Asian Indians - diabetes epidemic - epidemiological transition - epidemiology - Indian Diabetes Risk Score - prediabetes - south Asians - type 2 diabetes

The prevalence of diabetes is rapidly rising all over the globe at an alarming rate[1]. Over the past 30 yr, the status of diabetes has changed from being considered as a mild disorder of the elderly to one of the major causes of morbidity and mortality affecting the youth and middle aged people. It is important to note that the rise in prevalence is seen in all six inhabited continents of the globe[2]. Although there is an increase in the prevalence of type 1 diabetes also, the major driver of the epidemic is the

more common form of diabetes, namely type 2 diabetes, which accounts for more than 90 per cent of all diabetes cases.

Nowhere is the diabetes epidemic more pronounced than in India as the World Health Organization (WHO) reports show that 32 million people had diabetes in the year 2000[2]. The International Diabetes Federation (IDF) estimates the total number of diabetic subjects to be around 40.9 million in India and this is further set to rise to 69.9 million by the year 2025[3] (Fig. 1).

Evolution of the diabetes epidemic in India

The first national study on the prevalence of type 2 diabetes in India was done between 1972 and 1975 by the Indian Council Medical Research (ICMR, New Delhi)[4]. Screening was done in about 35,000 individuals above 14 yr of age, using 50 g glucose load. Capillary blood glucose level >170 mg/dl was used to diagnose diabetes. The prevalence was 2.1 per cent in urban population and 1.5 per cent in the rural population while in those above 40 yr of age, the prevalence was 5 per cent in urban and 2.8 per cent in rural areas.

Subsequent studies showed a rising trend in the prevalence of diabetes across different parts of India. In 1988, a study done in a small township in south India reported a prevalence of 5 per cent[5]. The prevalence of impaired glucose tolerance in the same study was 2 per cent. A national rural diabetes survey was done between 1989 and 1991 in different parts of the country in selected rural populations[6]. This study which used the 1985 WHO criteria to diagnose diabetes, reported a crude prevalence of 2.8 per cent[6]. The Eluru survey which looked at the prevalence of known diabetes in four villages in Andhra Pradesh showed a prevalence of 1.5 per cent. The prevalence of known diabetes was 6.1 per cent in individuals aged above 40 yr which was unexpectedly high at that time for a rural area with low socio-economic status and decreased health awareness[7]. A study done in 1988 in Chennai reported a prevalence of 8.2 per cent in the urban and 2.4 per cent in the rural areas[8]. A subsequent

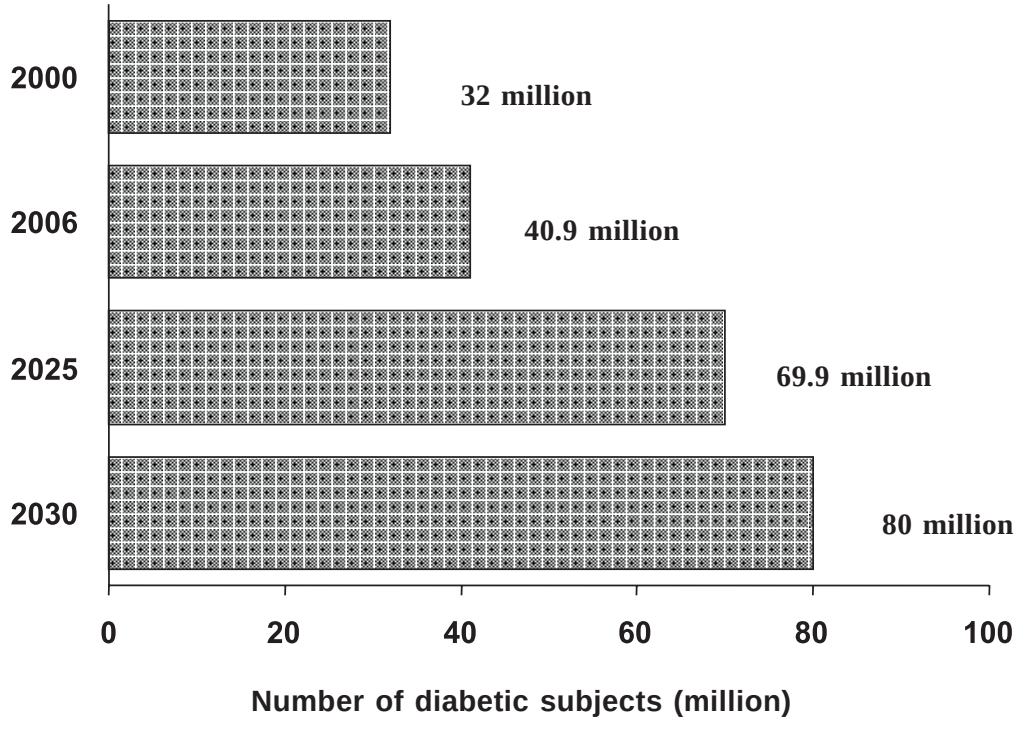

Fig. 1. Estimated number of diabetic subjects in India.
Source: Ref. 2, 3.

study in the same urban area done after five years showed an age standardized prevalence of 11.6 per cent indicating a rising trend in prevalence of diabetes[9]. A very high prevalence of 16.3 per cent was reported in Thiruvanathapuram in Kerala State in the year 1999[10]. In the same year, a prevalence of 8.2 per cent was reported from Guwahati[11]. A cross-sectional population survey was done in the Kashmir valley in 2000 and the prevalence of 'known diabetes' among adults aged >40 yr was found to be 1.9 per cent[12].

The National Urban Diabetes Survey (NUDS), a population based study was conducted in six metropolitan cities across India and recruited 11,216 subjects aged 20 yr and above representative of all socio-economic strata[13]. An oral glucose tolerance test was done using capillary glucose and diabetes was defined using the WHO criteria[14]. The study reported that the age standardized prevalence of type 2 diabetes was 12.1 per cent. This study also revealed that the prevalence in the southern part of India to be higher-13.5 per cent in Chennai, 12.4 per cent, in Bangalore, and 16.6 per cent Hyderabad; compared to eastern India (Kolkatta), 11.7 per cent; northern India (New Delhi), 11.6 per cent; and western India (Mumbai), 9.3 per cent. The study also suggested that there was a large pool of subjects with impaired glucose tolerance (IGT), 14 per cent with a high risk of conversion to diabetes.

A study done in western India showed age-standardized prevalence of 8.6 per cent in urban population[15]. A more recent study reported a high prevalence (9.3%) in rural Maharashtra[16]. The Amrita

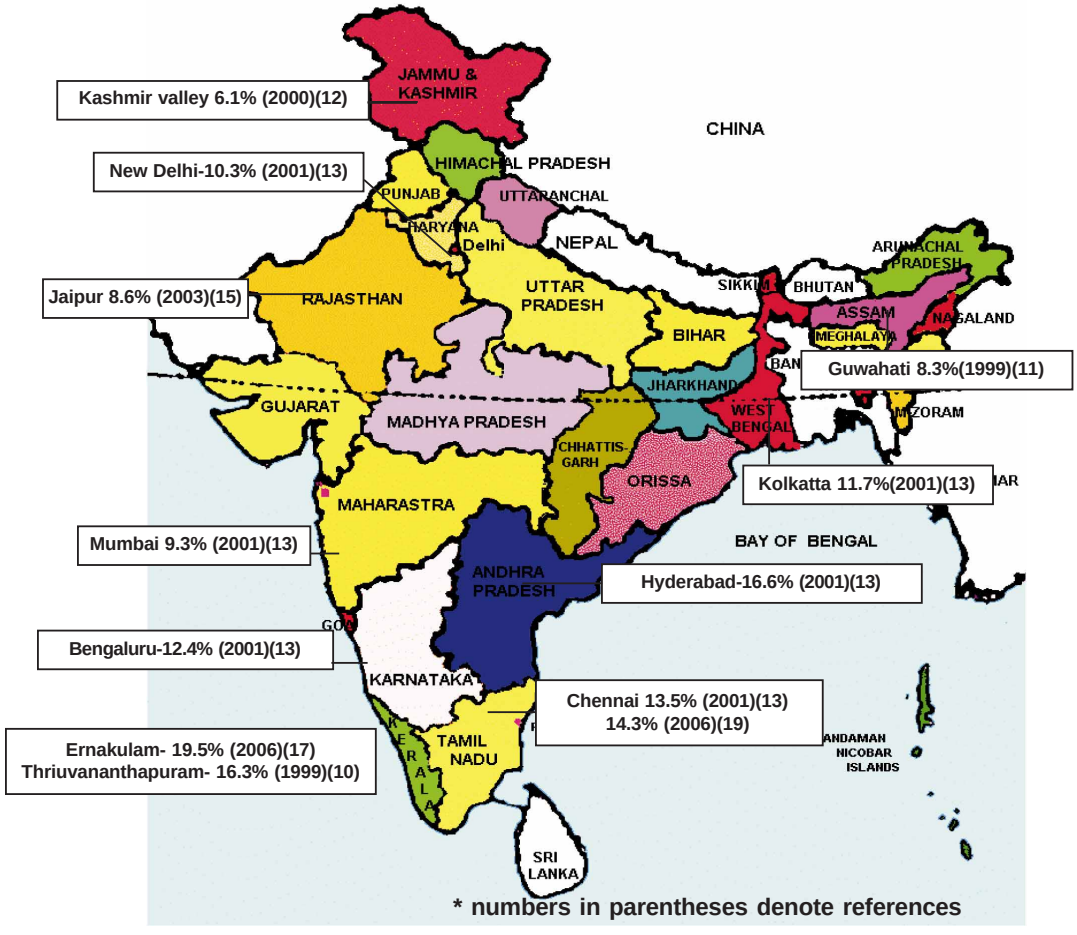

Fig. 2. Recent population based studies showings the prevalence of type 2 diabetes in different parts of India.
Source: Ref. 10, 11, 12, 13, 15, 17, 19.

Diabetes and Endocrine Population Survey (ADEPS)[17], a community based cross-sectional survey done in urban areas of Ernakulam district in Kerala has revealed a very high prevalence of 19.5 per cent. Fig. 2 is a map of India showing the States where population-based studies have been done and it also shows the prevalence of type 2 diabetes reported in different regions of India.

Chennai Urban Rural Epidemiology Study (CURES)

Further support for the rising prevalence of diabetes comes from the results obtained from the Chennai Urban Rural Epidemiology Study (CURES)[18]. This study was conducted on a representative population of Chennai. 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 the 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 recruited 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).

This study gave us 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. We were thus able to compare the data obtained from CURES with three earlier epidemiological studies[8,9,13] carried out in the same city using similar methods.

The overall crude prevalence of diabetes using WHO criteria[14] in CURES was 15.5 per cent (age-standardized: 14.3%), while that of IGT was 10.6 per cent (age-standardized: 10.2%). From 1989 to 1995, the prevalence of diabetes in Chennai increased by 39.8 per cent (8.3 to 11.6%); between 1995 to 2000 by 16.3 per cent (11.6 to 13.5%) and between 2000 to 2004, by 6.0 per cent (13.5 to 14.3%). Thus within a span of 14 yr, the prevalence of diabetes increased significantly by 72.3 per cent (P<0.001). Fig. 3 shows the prevalence of diabetes in different age groups as reported by the CURES. The prevalence of diabetes seems to be more or less the same in both genders[13].

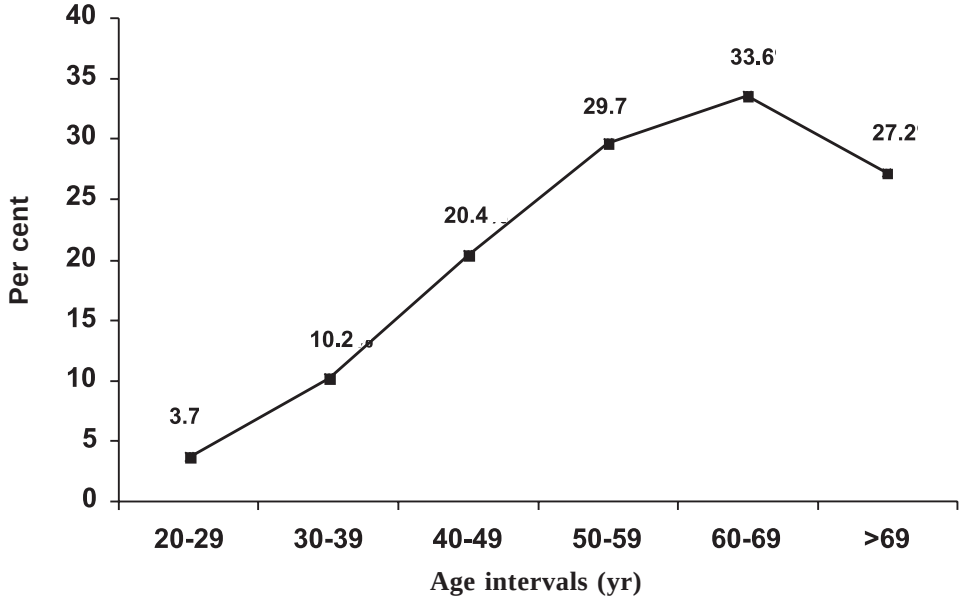

Fig. 3. Prevalence of diabetes in different age groups in Chennai-The Chennai urban rural epidemiology study (CURES)[18]. *Source* : Ref. 19.

Shift in age of onset of diabetes: The CURES[19] also reported a temporal shift in the age at diagnosis to a younger group when compared to the NUDS study published just five years earlier[13] (Fig. 4). This is a disturbing finding as the earlier age of onset combined with increasing prevalence of diabetes could have adverse effects on nation's health and economy. A study from Delhi also reports a high prevalence of insulin resistance in post pubertal children which was associated with excess body fat and abdominal adiposity[20]. This is of great concern because if the epidemic shifts to children it could have serious consequences on the health of the nation.

Undiagnosed diabetes - the hidden danger

It is important to note that the studies that have shown an increase in prevalence of diabetes have also reported a very high prevalence of undiagnosed diabetes in the community. While in CURES, the prevalence of known diabetes was 6.1 per cent, that of undiagnosed diabetes was 9.1 per cent[19]. Similarly, in the ADEPS, the prevalence of known and undiagnosed diabetes were 9.0 and 10.5 per cent respectively[17]. The Kashmir valley study showed that the prevalence of undiagnosed diabetes was 4.25 per cent, which was more than double to that of the known diabetes (1.9%)[12]. The individuals 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 early therapy to these individuals.

Urban-rural differences in diabetes prevalence

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 per cent in urban and 1.5 per cent in rural areas[4], a later study showed that the prevalence was three times higher among the urban (8.2%) compared to the rural population (2.4%)[8]. A study done in southern Kerala looked at the variations in the prevalence of type 2 diabetes among different geographic divisions within a region[21]. 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%).

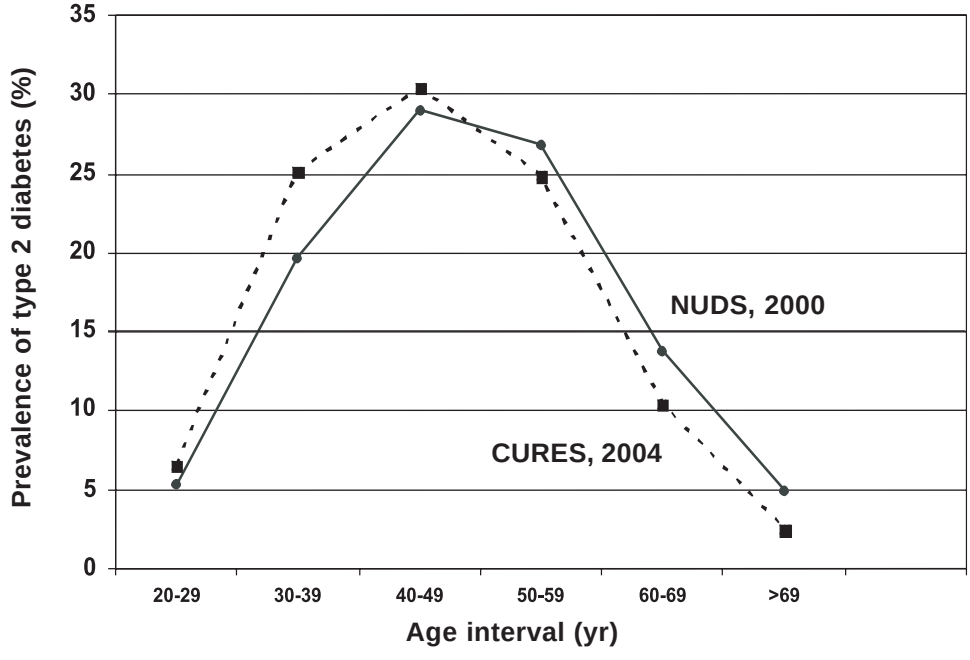

Fig. 4. Temporal shift in age at diagnosis of diabetes in 2004 (CURES-dotted line) compared to 2000 (NUDS-thick line). *Source*: Ref. 13, 19.

The prevalence of diabetes in India study (PODIS): This study was carried out in 108 centres (49 urban and 59 rural) to look at the urban-rural differences in the prevalence of type 2 diabetes and glucose intolerance[22]. Capillary blood was used to estimate glucose levels and glucose intolerance was defined according to the WHO 1999 as well as the American Diabetes Association (ADA) 1997 criteria[22,23]. According to the ADA criteria, the prevalence of diabetes was 4.7 per cent in the urban compared to the 2.0 per cent in the rural population while the prevalence of diabetes according to the WHO criteria was 5.6 and 2.7 per cent among urban and rural areas respectively.

The WHO-ICMR national NCD risk factor surveillance

In order to obtain continuous surveillance of NCD risk factors in India, the WHO and the ICMR took up NCD Risk Factor Surveillance in five States of India, representing different geographical locations (north, south, east and west/central India)[24,25]. About 40,000 individuals aged 15 to 64 yr with equal representation from urban, peri-urban (slum) and rural areas were recruited for the study[24]. The overall frequency of self reported diabetes study was 4.5 per cent. Urban area had the highest prevalence (7.3%), followed by peri-urban/slum (3.2%) and rural areas (3.1%).

Prediabetes- the harbinger of future diabetes

Impaired glucose tolerance (IGT) and impaired fasting glucose (IFG) collectively called as pre-diabetic states, have a high risk of conversion to diabetes. Several studies have shown that these pre-diabetic states are also high risk stages for cardiovascular disease[26,27]. Hence data on IGT and IFG are also urgently needed as they are indicators of future diabetes prevalence and burden on the nation. The NUDS results indicate that the prevalence of IGT was higher than that of type 2 diabetes in four out of six cities studied[13]. The prevalence of IGT was 16.8 per cent in Chennai, 14.9 per cent in Bengaluru (formerly Bangalore), 29.8 per cent in Hyderabad, 10 per cent in Kolkatta, 10.8 per cent in Mumbai and 8.6 per cent in New Delhi. The ADEPS done in Kerala showed that 11.2 per cent of the subjects had either IFG or IGT[17]. The PODIS reported that the prevalence of IGT was significantly high in both rural and urban populations[22]. A recent study

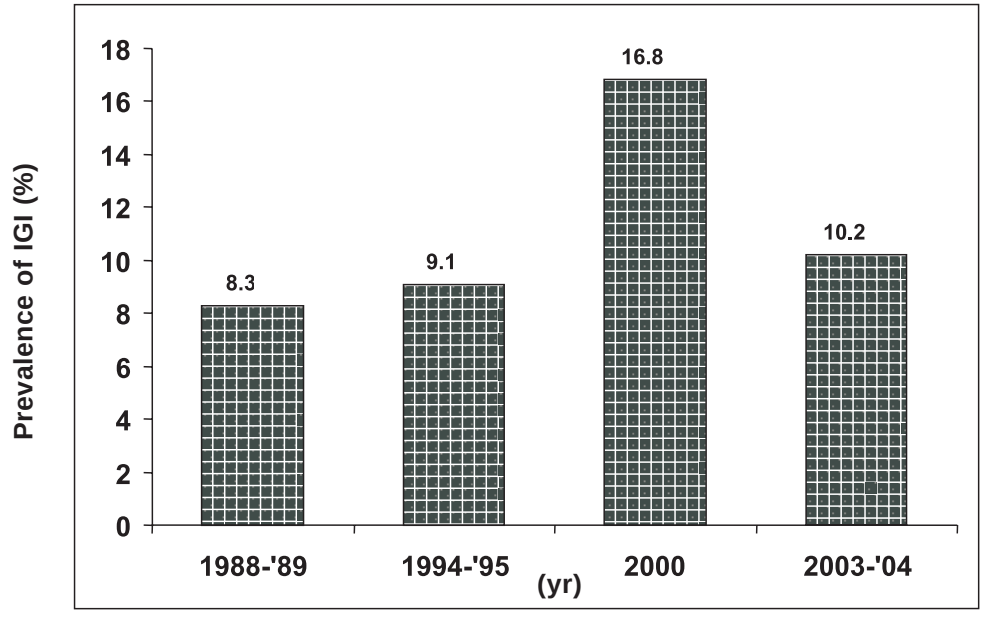

Fig. 5. Prevalence of impaired glucose tolerance at Chennai. *Source*: Ref. 8, 9, 13, 19.

has reported a decreased prevalence of IGT in an urban population compared to earlier studies done in the same city[19] (16.8% in 2000 to 10.2% in 2004) (Fig. 5). This could suggest that the diabetes epidemic in urban India may be slowing down or it may also suggest that there could be a rapid progression from the normal state through IGT to diabetes, which could imply a rapid increase in the diabetes epidemic or a worsening diabetogenic environment.

Burden of diabetes related complications in India

Both macrovascular and microvascular complications cause significant morbidity and mortality among diabetic subjects[28]. The Chennai Urban Population Study (CUPS) and CURES provided valuable data from India on the complications related to diabetes. The prevalence of coronary artery disease was 21.4 per cent among diabetic subjects compared to 9.1 per cent in subjects with normal glucose tolerance[29]. The prevalence of CAD in IGT subjects were 14.9 per cent in the same study. It was also seen that the diabetic subjects had increased subclinical atherosclerosis as measured by intimal medial thickness (IMT) at every age point compared to subjects with normal glucose tolerance[30]. A recent study showed that carotid intima medial thickness increased with worsening grades of glucose tolerance as well as with increase in the number of components of metabolic syndrome[31]. The prevalence of peripheral vascular disease (PVD) was 6.3 per cent among diabetic subjects compared to 2.7 per cent in non-diabetic subjects[32], and these figures are lower than the prevalence reported in western populations[33]. This is probably due to lower age at onset for diagnosis of type 2 diabetes in India. It is well known that PVD is more common in older individuals. The CURES Eye study is the largest population based data on the prevalence of diabetic retinopathy done in India. This study showed that the overall prevalence was 17.6 per cent, which was lower when compared to the reports from the West[34]. A recent population based study reported that the prevalence of overt nephropathy was 2.2 per cent in Indians while microalbuminuria was present in 26.9 per cent. Glycated haemoglobin, duration of diabetes and systolic blood pressure were independently associated with diabetic nephropathy[35]. Overall, Asian Indians appear to have a greater predilection for cardiovascular complications whereas the

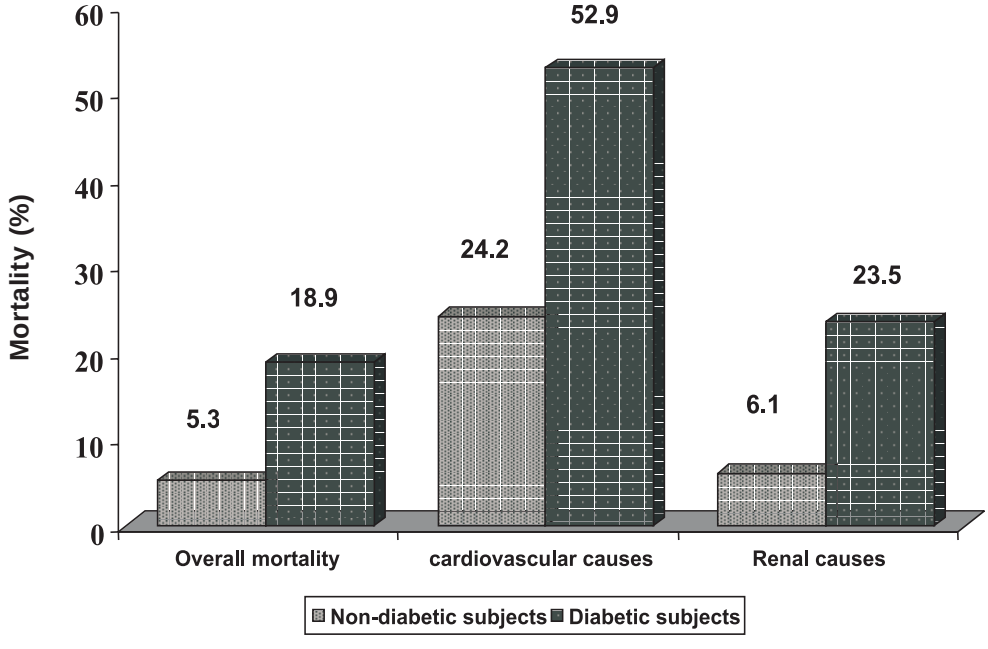

Fig. 6. Differences in mortality rates among diabetic and non-diabetic individuals - the Chennai urban population study (CUPS). *Source*: Ref. 36.

prevalence of microvascular complications appears to be lower than in Europeans.

A recent follow up of the original CUPS cohort showed that the overall mortality rates were nearly three-fold higher (18.9 per 1000 person-years) in people with diabetes compared to non diabetic subjects (5.3 per 1000 person-years, *P*=0.004)[36]. The hazard ratio (HR) for all cause mortality for diabetes was found to be 3.6 compared to non diabetic subjects. The study also showed that mortality due to cardiovascular (diabetic subjects: 52.9% vs. non diabetic subjects 24.2%, *P*=0.042) and renal (diabetic subjects 23.5% vs. non diabetic subjects 6.1%, *P*=0.072) causes was higher among diabetic subjects (Fig. 6).

Causes of the rise in prevalence of diabetes

Genetic predisposition: Several studies on migrant Indians across the globe have shown that Asian Indians have an increased risk for developing type 2 diabetes and related metabolic abnormalities compared to other ethnic groups[37-39]. Although the exact reasons are still not clear, certain unique clinical and biochemical characteristics of this ethnic group collectively called as the "Asian Indian phenotype" is considered to be one of the major factors contributing to the increased predilection towards diabetes[40,41]. Despite having lower prevalence of obesity as defined by body mass index (BMI), Asian Indians tend to have greater waist circumference and waist to hip ratios[42] thus having a greater degree of central obesity. Again, Asian Indians have more total abdominal and visceral fat for any given BMI[43] and for any given body fat they have increased insulin resistance[44]. Moreover, they have lower levels of the protective adipokine adiponectin and have increased levels of adipose tissue metabolites[45]. Studies on neonates suggested that Indian babies are born smaller but relatively fatter compared to Caucasian babies and are referred to as "the thin fat Indian baby"[46,47]. A recent study confirmed this finding and suggested that the "thin fat phenotype" in neonates persisted in childhood and could be a forerunner of the diabetogenic adult phenotype[48]. These findings suggest that Asian Indians are more prone to diabetes and related metabolic abnormalities. Genetic factors that determine body fat distribution and glucose metabolism have to be fully elucidated for the better understanding of the biochemical and molecular mechanisms behind the aetiopathogenesis of diabetes. Our studies have shown that while some genes seem to confer increased susceptibility to diabetes in Indians[49,50], some protective genes in Europeans do not appear to protect Indians[51]. These genetic issues are discussed elsewhere in the same issue[52].

The epidemiological transition

The dramatic rise in the prevalence of type 2 diabetes and related disorders like obesity, hypertension and the metabolic syndrome could be related to the rapid changes in life style that has occurred during the last 50 yr. Although this "epidemiological transition", which includes improved nutrition, better hygiene, control of many communicable diseases and improved access to quality healthcare have resulted in increased longevity, it has also led to the rapid rise of the new-age diseases like obesity, diabetes and heart disease. The intrusion of western culture into the lives of traditional indigenous communities has also had devastating results in terms of the rise in diabetes and related metabolic disorders. The explosion of type 2 diabetes in Native American and Pacific Island communities are classical examples of this phenomenon. Another way to explain the diabetes epidemic in these and other ethnic groups like Africans and Asian Indians is through Neel's 'thrifty genotype' hypothesis[53]. This hypothesis proposes that some genes are selected over previous millennia to allow survival in times of famine by efficiently storing all available energy during times of feast. However, these very genes lead to obesity and type 2 diabetes when exposed to a constant high energy diet. In virtually all populations, higher fat diets and decreased physical activity and sedentary

occupational habits have accompanied the process of modernization which has resulted in the doubling of the prevalence of obesity and type 2 diabetes in less than a generation.

Increase in the prevalence of type 2 diabetes may also result due to migration (a move from one environment to another, either external or internal), which brings with it marked social and cultural changes. Misra and colleagues[54] reported that migration from rural areas to urban slums in a metropolitan city in India led to obesity, glucose intolerance, and dyslipidaemia. Many epidemiological studies on diabetes in migrant populations, mostly in people originating from developing countries, have reported a higher prevalence of diabetes than the host populations of those countries.

'Fast food culture' and 'Sedentarinism'- The main drivers of diabetes epidemic in India

In order to assess the effect of affluence on the prevalence of diabetes in India, we undertook a population-based study in urban south Indians called the Chennai Urban Population Study (CUPS)[55]. Briefly, the CUPS is a population-based study involving two residential areas representing the lower and middle income group in Chennai (formerly Madras) in south India. All individuals aged more than 20 yr living in these two colonies were requested to participate in the study. Of the total of 1399 eligible subjects (age >20 yr), 1262 (90.2%) participated in the study. The study subjects underwent a glucose tolerance test (GTT) and were categorized as having normal glucose tolerance (NGT), IGT or diabetes.

The overall prevalence of diabetes was 12 per cent in the population above the age of 20 yr[56]. The age-standardized prevalence rate of diabetes was significantly higher in the middle income group compared to the lower income group (12.4 vs 6.5%, respectively). The prevalence of obesity and other cardiovascular risk factors were also markedly higher in the middle income group than the low income group. Moreover, the 'fast food culture' which has overwhelmed our cities and towns is also a major driver of the diabetes epidemic. The 'fast-foods' that are fat and calorie rich are easily available in the numerous food joints. As a majority of the immigrants in Indian cities depend on these unhealthy 'junk' foods, this may be a major factor in the rising prevalence of diabetes and cardiovascular diseases in urban slums. One point worth emphasizing is that diabetes can no longer be considered as a disease of the rich. The prevalence of diabetes is now rapidly increasing among the poor in the urban slum dwellers, the middle class and even in the rural areas. This is due to rapid changes in physical activity and dietary habits even among the poorer sections of the society. Unfortunately the poor diabetic subjects delay taking treatment leading to increased risk of complications[57]. Moreover, as the epidemic matures and reaches the next stage of transition, the rich and affluent will rapidly change their activity patterns and start making healthier food choices and ultimately the diabetes and heart disease will decrease in this section of the society. This has been demonstrated in the developed world where the prevalence of diabetes and cardiovascular diseases are higher among the lower socio-economic group and in rural areas compared to higher socio-economic group and urban areas[58-60].

The next factor driving the epidemic is what has been referred to as 'sedentarinism' or the adoption of sedentary behaviour. Over the past few decades, a huge number of the working population has shifted from manual labour associated with the agriculture sector to physically less demanding office jobs. With the advent of highly addictive computer and video games, sedentarinism is now affecting the children and youth as they tend to spend more time in front of television sets or computers than playing outdoors. The evidence for the effects of physical inactivity on the prevalence of diabetes and cardiovascular diseases can be seen in CUPS[61,62]. It was observed that the prevalence of diabetes was almost three times higher in individuals with light physical activity compared to those having

heavy physical activity (23.2 vs. 8.1%, $P<0.001$)[61]. It was also noted that prevalence of metabolic syndrome and hypertension was also significantly higher among people with light physical activity[62]. Overall, individuals with light-grade physical activity had 2.4 times higher chances of developing coronary artery disease compared to heavy grade physical activity group[62]. Hence early identification of the risk factors associated with diabetes and appropriate interventions aimed at preventing the onset of diabetes and its complications are urgently required.

Early identification and prevention - the Indian diabetes risk score (IDRS)

Several prospective studies have shown that measures of lifestyle modification help in preventing the onset of diabetes[63-65]. The Indian Diabetes Prevention Programme (IDPP), a preventive study done in India based on the Diabetes Prevention Program (DPP) has clearly documented the importance of physical activity in the prevention of diabetes[66]. Early identification of the high risk individuals would help in taking appropriate intervention in the form of dietary changes and increasing physical activity, thus helping to prevent, or at least delay, the onset of diabetes. This means that identification of at risk individuals is extremely important if we are to prevent diabetes in India. Recently, risk scores based on simple anthropometric and demographic variables have been devised to detect high risk individuals[67,68]. But it is also evident that a common risk score cannot be applied for all ethnic groups[69]. Hence ethnic specific risk scores are extremely important in identification of at risk individuals in a particular ethnic group.

We have recently developed the Indian Diabetes Risk Score (IDRS) using four simple variables namely, age, family history, regular exercise and waist circumference[70] (Table). The individuals were classified as having high risk (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 per cent for a cut-off >60 and can be used to do a selective screening for Indian population. A recent study showed that IDRS not only predicted diabetes, but also identified individuals with higher cardiovascular risk *i.e.*, those with metabolic syndrome even at a stage when they have normal glucose tolerance[71]. This simple and cost-effective IDRS could thus serve as a tool for a primary care physician or a health worker to identify at risk individuals for both diabetes and cardiovascular diseases.

Diabetes prevention through community empowerment

The CURES has demonstrated that the awareness about diabetes in urban areas is extremely low[72]. Nearly 25 per cent of the residents were not even

Table. Indian Diabetes Risk Score (IDRS)

Particulars	Score
Age (yr):	
< 35 (reference)	0
35-49	20
>50	30
Abdominal obesity:	
Waist <80 cm (female), <90 (male) (reference)	0
Waist ≥ 80-89 cm (female), ≥90-99 cm (male)	10
Waist ≥90 cm (female), ≥100 cm (male)	20
Physical activity:	
Vigorous exercise or strenuous (manual) labour at home/work	0
Mild to moderate exercise or mild to moderate physical activity at home/work	20
No exercise and sedentary activities at home/work	30
Family history:	
No family history (reference)	0
Either parent	10
Both parents	20
Minimum score	0
Maximum score	100

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

Source: Modified from Ref. 70

aware of a condition called diabetes. Moreover, even among the diabetic subjects, the knowledge and awareness about complications was poor and less than 50 per cent knew that diabetes in preventable.

A recent study has shown how increasing awareness and empowerment of community can possibly help in the prevention of diabetes and other non communicable disorders[72]. Mass awareness programmes like public lectures, video clippings and distribution of educational pamphlets were carried out in a residential colony in Chennai for three years continuously. A follow up study was done 7 yr after the baseline study. It was found that there was a 277 per cent increase in the proportion of walkers from baseline to follow up. The proportion of individuals who exercised increased from 14.2 to 58.7 per cent[73]. The colony residents motivated by the awareness programmes constructed a park with the help of civic authorities which is being now used regularly not only by the residents but also by neighbouring colonies.

Prevention Awareness Counseling and Evaluation (PACE) Diabetes programme is a large awareness and prevention programme underway in Chennai[74]. The aim of this programme which is funded by the Chennai Willingdon Corporate Foundation, a non governmental organization (NGO) in Chennai, is to create massive public awareness about diabetes and related disorders reaching out to about a million people and conduct large scale opportunistic screening of at least 100,000 people. Awareness programmes are being organized in public places like banks, shopping complexes, cinema halls, places of worship, bus stands, railway stations, schools, colleges, *etc*. The PACE project is already having a large impact in the form of increased diabetes awareness. Mass awareness programmes not only help in the prevention of diabetes, but also help in increasing the awareness about other non communicable diseases.

In conclusion, the past decades have witnessed a rapid rise in the prevalence of diabetes, especially in the urban areas. The fact that there is a shift in age of onset to younger age groups is alarming as this could have adverse effects on the nation's economy. Hence, the early identification of at risk individuals and appropriate intervention in the form of weight reduction, changes in dietary habits and increased physical activity could greatly help to prevent, or at least delay, the onset of diabetes and thus reduce the burden due to non communicable diseases in India.

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Reprint requests: Dr V. Mohan, Chairman & Chief of Diabetology, Madras Diabetes Research Foundation &
Dr Mohan Diabetes Specialities Centre, 4, Conran Smith Road
Gopalapuram, Chennai 600086, India
e-mail: mvdsc@vsnl.com