Epidemiology of Diabetes in India – Three Decades of Research

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Abstract

India has nearly 33 million diabetic subjects today, which is briefly contributed by the urban population. The scenario is changing rapidly due to socio-economic transition occurring in the rural areas also. Availability of improved modes of transport, and less strenuously as in the vicinity have resulted in decreased physical activities. Better economic conditions have produced changes in diet habits. The conditions are more favourable for expression of diabetes in the population, which already has a racial and genetic susceptibility of the disease. Recent epidemiological data show that the situations are similar throughout the country.

Prediabetic conditions like impaired glucose tolerance and impaired fasting glucose are also on the rise, indicating the possibility of further rise in the prevalence of diabetes. Metabolic syndrome, which is a constellation of cardiovascular risk factors, of which hyperglycaemia and insulin resistance are components, is also widely prevalent.

The conversion to diabetes is enhanced by the low thresholds for the risk factors, such as age, body mass index and upper body adiposity. Indians have a genetic phenotype characterized by low body mass index, but with high upper body adiposity, high body fat percentage and high level of insulin resistance.

With a high genetic predisposition and the high susceptibility to the environmental insults, the Indian population faces a high risk for diabetes and its associated complications. Early diagnosis of high risk groups and appropriate intervention by lifestyle modification may solution for the disease burden.

Rapid globalization and industrialization occurring in developing countries have produced many advancements in the social and economic front. Although it has resulted in economic prosperity and better living standards to many, it has also resulted in considerable increase in lifestyle related diseases.

South East Asian countries have the highest burden of diabetes. Table 1 shows report of the International Diabetes Federation on the estimated projections regarding diabetes and Impaired Glucose Tolerance (IGT) in South East Asians. India comprises 85% of the adult population of South East Asia and therefore the major contribution to diabetic population in South East Asia is from India. (Fig. 1)

RISING PREVALENCE OF DIABETES IN INDIA

The prevalence of diabetes is rising rapidly especially in the urban population in India. Since 1971 to 2000, a 10 fold increase has been observed (from 1.2% to 12.1%) (Table 2). As illustrated in the Fig. 2, cities like Chennai show a dramatic increase in prevalence of diabetes and IGT. (Fig. 2) The high prevalence of diabetes

Table 1: South East Asia – diabetes prevalence and future projections

<table>
<thead>
<tr>
<th></th>
<th>2003</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Adult Population (millions)</td>
<td>705</td>
<td>1081</td>
</tr>
<tr>
<td>No. with Diabetes (millions)</td>
<td>39.3</td>
<td>81.6</td>
</tr>
<tr>
<td>Diabetes Prevalence (%)</td>
<td>5.6</td>
<td>7.5</td>
</tr>
<tr>
<td>No. with IGT (millions)</td>
<td>93.4</td>
<td>146.3</td>
</tr>
<tr>
<td>IGT Prevalence (%)</td>
<td>13.2</td>
<td>13.5</td>
</tr>
</tbody>
</table>

has remained an urban phenomenon so far and all the previous epidemiological studies have illustrated a 4 fold difference in the prevalence of diabetes between the urban and rural population. Our recent data has illustrated the impact of socioeconomic transition occurring in rural India. It showed a 3 fold rise in the prevalence of diabetes in rural southern India. The transition had occurred during a period of 14 years and the prevalence had risen from 2.4% to 6.4% (Fig. 3). The contributing factors related were improved socioeconomic status which encompassed an increase in family income and educational status, motorized transport and a shift in occupational structure. Similar situation has been described from the neighboring countries such as Thailand, Malaysia, Bangladesh and Pakistan. This revelation of increasing prevalence of diabetes is important as majority of population in developing countries live in rural area and therefore it would be a major contributor to the emerging epidemic of diabetes in this part of the world.

A recent study by ‘Diabetes India’ group had estimated the prevalence of diabetes in urban and rural areas in India. The urban areas were designated as those having a population of 100,000. Small towns and villages with a deemed population under 100,000 were designated as rural areas. An overall diabetes prevalence of 4.3% was reported, the prevalence in urban and rural areas being 5.6% and 2.7% respectively. Total prevalence of IGT was 5.2%, urban being 6.3% and rural 3.7%.

The differences in the prevalence rates between the above report and the other reports in urban India shown in Table 2, is attributed to the difference in classification of urban/rural populations. A 4.3% of overall prevalence rate for diabetes seen in the ‘Diabetes India Study’ confirms the WHO estimate of 35 million adults with diabetes in India today.

**Table 2: Studies showing a rising trend in the prevalence of Type 2 diabetes in India**

<table>
<thead>
<tr>
<th>Year</th>
<th>Author</th>
<th>Place</th>
<th>Area</th>
<th>Prevalence (%) Urban</th>
<th>Prevalence (%) Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971</td>
<td>Tripathy et al</td>
<td>Cuttack (Central)</td>
<td>1.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1972</td>
<td>Ahuja et al</td>
<td>New Delhi (North)</td>
<td>2.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1979</td>
<td>Gupta et al</td>
<td>Multicentre</td>
<td>3.0</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>1984</td>
<td>Murthy et al</td>
<td>Tenali (South)</td>
<td>4.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1986</td>
<td>Patel</td>
<td>Bhandran (West)</td>
<td>3.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1988</td>
<td>Ramachandran et al</td>
<td>Kudremukh (South)</td>
<td>5.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1989</td>
<td>Kodali et al</td>
<td>Gangavathi (South)</td>
<td>2.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1989</td>
<td>Rao et al</td>
<td>Eluru (South)</td>
<td>1.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1991</td>
<td>Ahuja et al</td>
<td>New Delhi (North)</td>
<td>6.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1992</td>
<td>Ramachandran et al</td>
<td>Madras (South)</td>
<td>8.2</td>
<td>2.4</td>
<td></td>
</tr>
<tr>
<td>1997</td>
<td>Ramachandran et al</td>
<td>Madras (South)</td>
<td>11.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>Ramankutty et al</td>
<td>Kerala (South)</td>
<td>12.4</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>Ramachandran et al</td>
<td>National</td>
<td>12.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>Misra et al</td>
<td>New Delhi (North)</td>
<td>10.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>Mohan et al</td>
<td>Chennai (South)</td>
<td>12.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2004*</td>
<td>Shaukat et al</td>
<td>National</td>
<td>5.6</td>
<td>2.7</td>
<td></td>
</tr>
</tbody>
</table>

* Different sample selection criteria
Indians show a number of peculiar features which make them highly susceptible to diabetes. The high racial predisposition is evident from the studies in native Indians as well as migrant populations in any part of the world.\textsuperscript{7}

**Prevalence of Diabetes in India**

a. Urban Indians have shown a dramatic increase in diabetes.

b. Urban Indian adults have a prevalence of 12% while in most European population it is nearly 6%.

c. Indians also show a high prevalence of IGT and Metabolic Syndrome

**LOW RISK THRESHOLDS IN INDIANS**

Evidence have accumulated to show that the high interaction of genetic and environmental influences in the Indian populations could be attributed to genetic susceptibility and low thresholds for the acquired diabetogenic factors.

**Age**

Indians develop diabetes at a very young age, atleast 10-15 years earlier than the white population.\textsuperscript{8} The national urban diabetes survey in India showed that more than 50% of the diabetic cases had the onset below the age of 50 years.\textsuperscript{4} Indians show a significantly higher age - related prevalence when compared with white population in USA. Indians have several fold higher prevalence of diabetes at all age groups in comparison with the European population as shown by the International Diabetes Epidemiology Group.\textsuperscript{9} It is also shown that risk of diabetes starts to increase at very low levels of BMI.\textsuperscript{9,10}

**Obesity**

The risk of diabetes increases with small weight changes at a BMI above 22 kg/m\textsuperscript{2}. As shown in figure the cutoff value for healthy BMI in Indians is below 23 kg/m\textsuperscript{2}. (Fig. 4) It is interesting to note that the value for normal waist girth is also low in Indians (Men 85 cm, Women 80 cm) (Fig. 5). Despite having lean BMI an adult Indian has more chances of having abdominal obesity.\textsuperscript{11} The National Indian Survey showed that upper body adiposity was more common (50.3\%) than overweight as indicated by BMI of = 23 kg/m\textsuperscript{2} (30.8%).\textsuperscript{12} In Indians, central obesity shows a stronger association with glucose intolerance than generalized obesity. Studies from UK and USA\textsuperscript{11,13} have suggested that the insulin resistance in non-obese Asian Indians is due to the high percentage of visceral fat. This could also partly explain the higher prevalence of diabetes in them.

**High body fat content**

The higher insulin resistance may be partly due to high body fat content seen in the Indian population as shown in the Table 3. The body fat percentage of an Indian is significantly higher than a western counterpart with similar BMI and blood glucose levels. It has been hypothesized that excess body fat and low muscle mass may explain the high prevalence of hyperinsulinemia and the high risk of type 2 diabetes in Asian Indians. This may also be related to the high prevalence of metabolic syndrome seen among this population.\textsuperscript{14-16}

Internal or external migration to affluent habitats results in metabolic changes resulting in hyperglycaemia and its related abnormalities. The features of insulin resistance which includes hyperinsulinaemia, upper body adiposity and high body fat percentage are manifested at a young age in Indian subjects. Minor changes in weight or physical activity worsen insulin resistance.

**Low risk threshold for acquired diabetogenic factors**

a. Indians develop diabetes at a younger age.

b. The risk of diabetes starts at a lower BMI value.

c. Indians have central obesity despite having lean BMI

d. They also have a high hyperinsulinaemia suggesting the presence of insulin resistance.

e. Indians have high percentage of fat mass compared to Europeans

**Obesity in children**

The new generation of children and adolescents show unprecedented levels of obesity. This foretells not only an epidemic of obesity to be tackled, but also a great burden of treating weight-related chronic diseases such as diabetes and cardiovascular diseases. Several studies from India have highlighted that the epidemic of diabetes in urban India would become worse due to the rising trend in obesity in children.\textsuperscript{17,18} In urban southern India the prevalence of over weight among school children is above 16\%\textsuperscript{17} and it shows a strong association with lack of physical activity and high social stratum. Prevalence of type 2 diabetes in children is also escalating, probably due to the above phenomenon.

**Metabolic syndrome**

Many studies in Indians have highlighted that the risk of cardiovascular diseases is high among Indians and this could be related to the high prevalence of the metabolic syndrome.\textsuperscript{14-16} An epidemiological study

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**Table 3 : Comparison of body fat % and BMI in Indians and in white population**

<table>
<thead>
<tr>
<th>Race</th>
<th>BMI (kg/m\textsuperscript{2})</th>
<th>Fat %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asian Indian</td>
<td>$21.4 \pm 3.7$</td>
<td>$21.3 \pm 7.6$</td>
</tr>
<tr>
<td></td>
<td>$22.0^*$</td>
<td>$22.7^*$</td>
</tr>
<tr>
<td></td>
<td>$24.5 \pm 2.5$</td>
<td>$33 \pm 7.00$</td>
</tr>
<tr>
<td>White</td>
<td>$25.2 \pm 3.1$</td>
<td>$21.2 \pm 7.8$</td>
</tr>
<tr>
<td>Women</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asian Indian</td>
<td>$23.3 \pm 5.5$</td>
<td>$35.4 \pm 5.0$</td>
</tr>
<tr>
<td></td>
<td>$22.7^*$</td>
<td>$37.4^*$</td>
</tr>
<tr>
<td>White</td>
<td>$23.3 \pm 3.7$</td>
<td>$30.3 \pm 8.6$</td>
</tr>
</tbody>
</table>

* Median values
showed that the prevalence of metabolic syndrome among urban adults was 41%.14

It is interesting to note that although insulin resistance is common among Indians, it is not the major factor underlying the clustering of the cardiovascular risk factors namely hyperglycaemia, dyslipidemia, hypertension and upper body adiposity.19

**Significance of IFG and IGT in Indians**

India has the highest number of IGT, prevalence of IGT and IFG are also high in India, which is expected to increase from 85.6 million in 2003 to 132 million in 2025.2

These early stages of glucose intolerance are not only forerunners of diabetes but also carry high risk for cardiovascular diseases. They are highly insulin resistant conditions and show the presence of all other cardiovascular risk factors. IGT occurs at a much younger age in Indians.12

**Genetic Markers**

Our studies in South Indians showed the complex nature of genetic pathology in type 2 diabetes. Certain mutations of candidate genes related to insulin secretion and insulin action such as Calpain 10, Vitamin D, Insulin receptor substrate-1, UCP2, UCP3, Apolipoprotein D gene are associated with the disorder.20 However the nature of the major gene(s) responsible for the disease remains elusive.

**Future Challenges**

Countries like India have shown significant improvement in health care delivery in communicable disease sectors, but face severe problem due to the burden of non-communicable diseases like diabetes and cardiovascular diseases. India has the highest number of subjects with diabetes and the problem is likely to escalate due to the rapid urbanisation and related lifestyle changes and also to the existence of a large pool of susceptible individuals in the form of IGT. It is apparent that the racial and genetic predisposition in Indians is precipitated by lifestyle changes associated with urbanisation and industrialization. (Fig. 6)

Later half of the 20th Century has witnessed an unprecedented growth in urban population. According to the World Health Organisation estimate in the developing regions, the urban population will increase from 1.9 billion in 2000 to 3.9 billion in 2030.2 The rising trend in urbanisation in India is shown in Fig. 7. Maladaption to the rapidly changing environment is a major determinant of the rising prevalence of diabetes. The number of subjects with overweight or obesity is increasing.

The international obesity task force estimates that upto 1.7 billion people may be exposed to weight related health risks which includes Asian population with a BMI of 23 or more.21 It is estimated that in South East Asia the proportion of diabetes attributable to weight gain is nearly 28% in male and 50% in females aged 30 and above. Insulin resistance which is the characteristic of the population is getting worse due to overweight and upper body adiposity and also due to sedentary activity levels.

**Predictors of high prevalence of diabetes in India**

1. Increasing life expectancy.
2. High rate of urbanization and internal migration
3. High prevalence of IGT a prediabetes state with rapid conversion to diabetes

**Scope for Primary Prevention**

Identification of high risk group with IFG or IGT are possible by routine laboratory tests. The identification of the risk factors for diabetes have opened up the possibilities for early diagnosis of subclinical abnormalities, many of which are amenable to modifications. It is also possible to identify the high risk group by measuring simple parameters such as anthropometry, by questioning for the presence of the family history of diabetes and by assessing the physical activity.22 Subjects with a positive family history of diabetes, general or abdominal adiposity and with sedentary lifestyle are at a high risk and are therefore ideal candidates for primary prevention of diabetes.
The landmark studies such as the Diabetes Prevention Programme in USA, 23 the Finnish Diabetes Prevention Programme 24 and the Malmo study 25 have shown the efficacy of lifestyle modification in preventing diabetes in subjects with IGT. A similar prospective study is nearing its conclusion in Chennai which is expected to throw light on the possibility of prevention in the non obese, insulin resistant Indian population by using lifestyle modification and / or insulin sensitizers.

REFERENCES


Announcement

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Dr. Ajay Kumar
Org. Secretary, APICON 2006