DEVELOPMENT AND UPDATION OF THE DIABETES ATLAS OF INDIA

REPORT

Compiled by:

Dr. S. Sandeep, Mr. A. Ganesan, Dr. V. Mohan

Madras Diabetes Research Foundation

Chennai

Introduction- Why a Diabetes Atlas for India?

According to the World Health Organisation estimates, India had 32 million diabetic subjects in the year 2000 and this number would increase to 80 million by the year 2030 (1). The International Diabetes Federation (IDF) also reported that the total number of diabetic subjects in India is 41 million in 2006 and that this would rise to 70 million by the year 2025 (2). Studies on migrant Indians have shown that they have a higher predisposition to insulin resistance, type 2 diabetes and coronary artery disease compared to other ethnic groups (3-5). 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 (6,7). 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 thus having a greater degree of central obesity (8). Further, Asian Indians have more visceral fat for any given BMI (9) and for any given body fat they have greater insulin resistance (10). Studies on neonates reported that Indian babies are born smaller but relatively fatter compared to European babies and they are referred to as “thin fat Indian babies” (11, 12).

It is quite evident from the above observations that diabetes has become a major health problem in India. In order to assess the magnitude of the problem and its impact on the health and economy of the nation, the scattered data on the prevalence of type 2 diabetes needs to be compiled and analysed. In this pilot study, we have tried to establish a database of all the published data relating to diabetes and its complications in India.

We have classified this report under the following headings:

1. Prevalence of type 1 diabetes
2. Earlier studies on diabetes in India
3. Population based surveys of 1970s
4. Beginning of the rise in the prevalence of diabetes in India in the 1980s
5. Rapid rise in the prevalence of type 2 diabetes in India (1990s to 2007)
6. Urban Rural differences in the prevalence of diabetes
7. Serial studies in Chennai as an evidence of the rising prevalence
8. Lowering of age of onset of type 2 diabetes
9. Pre-diabetic states- Impaired Glucose Tolerance and Impaired Fasting Glucose
10. Gender differences in the prevalence of diabetes
11. Impact of socioeconomic status
12. Burden of diabetes related complications in India

Prevalence of type 1 diabetes

Although it is type 2 diabetes which is more prevalent and the main driver of the diabetes epidemic in India, it is noted that prevalence of type 1 diabetes in India is also on the rise (13). However, most of the data are from clinic based studies or registries (14-21) and there are few population based studies on the prevalence of type 1 diabetes in India. Table 1 shows the prevalence of type 1 diabetes among total diabetic patients attending clinics in various parts of India. In 1992, Ramachandran et al reported that the prevalence of type 1 diabetes in children aged less than 15 years was 0.26 per 1000(22). The same investigator showed that the incidence for the 4 year period was 10.5/100,000/year (13). However, Bai et al did not find any cases of type 1 diabetes in their studies in school and college students in Chennai (23, 24). Data from the Bangalore T1DM registry group reported an incidence rate of 1.68 per 10,000 in 1997(25). Table 2 shows the prevalence and incidence rates of type 1 diabetes in India.

Earlier studies on type 2 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 (26) has made an excellent compilation of all earlier studies in their article published in 1991. Table 3 is a compilation of studies on the prevalence of diabetes in India from 1938 to 2007 (27-91). The earliest documented study on prevalence of diabetes in India was done in Calcutta (now Kolkata) in 1938 (27). Out of the 96300 medical records checked, 1% was found to have diabetes diagnosed by glycosuria. Another hospital based study from Mumbai

reported a prevalence of 0.7% in 1959 (28). The first study done in South India was at Vellore in 1964 (31). This hospital based study done on 63,356 individuals showed a prevalence of 2.5%. In 1966, house to house surveys done in Chandigarh, Puducherry and Varanasi reported prevalence rates of 2.9, 0.7% and 2.7% respectively (35,41,43). In the same year, a study based on hospital records in Thiruvananthapuram reported a high prevalence of 8.7 % (42).

Population based surveys of 1970s

Population based surveys done in the early 1970s in different Indian cities and nearby rural areas reported prevalence of diabetes ranging from 1.2% to 2.5% (44-48). The first multicentric study in India was done by the Indian Council Of Medical Research (ICMR) between 1972 and 1975 (53). Screening was done in more than 34,000 individuals from six representative areas of India. Capillary blood glucose level of above 170 mg/dl was defined as diabetes. This study reported a prevalence of 3.0 % in urban areas and 1.3% in rural areas (53). From these reports, it is evident that till the 1970s, the prevalence of diabetes was less than 3.0% even in urban areas.

Beginning of the rise in the prevalence of diabetes in India in the '80s

The early signs of the looming diabetes epidemic were seen in the Tenali study of 1984 which reported a high prevalence of 4.7% in a small town in Andhra Pradesh (56). A prevalence of 3.8% was reported in 1986 from Bhadlan, a rural area in Haryana which was relatively higher compared to earlier surveys done in different cities in the previous decade (57). A study done in Kudremukh, a township in Karnataka revealed a prevalence of 5.0% (59). The Daryaganj diabetes survey done in an affluent neighbourhood of Delhi showed a prevalence of 3.1% of known

diabetes (60). In the same year, a survey in Rewa, rural Madhya Pradesh showed a prevalence of 1.9 % (61). The prevalence of known diabetes in Eluru survey, done in rural Andhra Pradesh was 1.5% (62). However, in individuals aged above 40yrs, the prevalence of known diabetes was 6.1% which was unexpectedly higher for a rural area (62).

A multicentric study was carried out in different regions of India by Ahuja et al (63). Rural areas from different parts of the country near Ahmedabad, Calcutta, Delhi and Trivandrum reported prevalence rates of 3.9%, 0.8%, 1.5% and 1.3% respectively (Figure 1). The remote high altitude area of Himachal Pradesh, Kalpa had a prevalence of 0.4%. The same study revealed that the prevalence of type 2 diabetes was 4.1% in an industrial neighbourhood of Delhi. In 1994, Wander et al (66) reported 5% prevalence of diabetes (criteria: random venous blood glucose >180mg/dl or history) among a rural population in Ludhiana, Punjab. Another study from North Arcot district in TamilNadu reported a prevalence of 4.9% in a rural area(67).

From these data, it appears that there is a rising pattern in the prevalence of type 2 diabetes in India both in the urban as well as the rural areas.

Rapid rise in the prevalence of type 2 diabetes in India (1990's to 2007)

Further evidence for the rise in prevalence of type 2 diabetes came from Chennai, as the prevalence of type 2 diabetes had risen to 11.6% in the same urban area which had a prevalence of 8.2% five years earlier (64,68). In 1998, a study from Guwahati reported a prevalence of 8.2 % (69). A study done in Kerala showed a very

high prevalence of 16.3% in 1999 (72).The Kashmir Valley study done in 2000 recorded a prevalence of 6.3% (73). 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 (73).

A study done in Mumbai in 2001 reported a prevalence of 7.5% according to ADA and 4.6% according to WHO criteria (76). Misra et al (77) reported a prevalence of 11.2% in a slum area in Delhi. The Chennai Urban Population Study (CUPS) which looked at the prevalence of diabetes in two socioeconomic classes in Chennai. The overall prevalence of type 2 diabetes was 12% in the population aged above 20 years. The middle income group had significantly higher prevalence of type 2 diabetes compared to the low income group (age standardised prevalence rates of 12.4% and 6.4% respectively) (78). Meanwhile, a study from Manipur reported a prevalence of 4.0% in a population aged above 15 years (79).

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 (80). The WHO criterion was used for diagnosis 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%) (80).

Gupta et al reported a prevalence of 16.8% from Jaipur in 2003(81). The Prevalence of Diabetes in India Study (PODIS) done in 108 centres of India reported a prevalence of 5.9% in the urban and 2.7% in rural areas according to the WHO criteria

(82). According to the ADA criteria, the prevalence rates were 4.6% and 1.9% in urban and rural areas respectively (83). A house to house survey done in a rural area near Mysore reported a prevalence of 3.8 %(84). The Chennai Urban Rural Epidemiology Study (CURES) showed a prevalence of 15.5% (age standardised 14.3%) in Chennai in 2006(85). 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% (86). The ADEPS has reported the highest prevalence of diabetes in a population in India. A recent study from rural Maharashtra showed a high prevalence of 9.3% (87). A very high prevalence of 13.2% was also reported in a rural population of Andhra Pradesh by Chow et al in 2006 (88). A muticentric study on industrial populations in different parts of India reported a prevalence of 10.1% (90). The prevalence of self reported diabetes was 5.6% in this study population (90).

A study on the camel milk consuming “raica” community of Rajastan reported an absence of diabetes in the community suggesting a protective effect of camel milk (92). Another caste based study from Rajastan reported a prevalence of 16.7% in the Bhargava community(93)

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 3.0% in urban and 1.3% in rural areas (53), a later study showed that the prevalence was three times higher among the urban (8.2%) compared to the rural population (2.4%) (64).

Ahuja et al, in 1991 reported that the prevalence of diabetes in an industrial setting in Delhi was 4.1% while the prevalence of diabetes in a rural locality near Delhi

was 1.5 % (63). A study done in Moradabad reported a prevalence of 6.0% in urban area and 2.8% in rural area (70). 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 divisions (2.5%) (74).

The Prevalence of Diabetes in India Study (PODIS) was carried out in 108 centres (49 urban and 59 rural) in different parts of India to look at the urban-rural differences in type 2 diabetes and glucose intolerance (82, 83). Diabetes was defined according to WHO and ADA criteria. According to ADA criteria, the prevalence of diabetes was 4.7% in the urban and 1.9% in the rural areas. The prevalence of diabetes according to WHO criteria was 5.6% and 2.7% among urban and rural areas respectively.

However, two recent studies, from rural areas of Maharashtra (87) and Andhra Pradesh (88) have reported very high prevalence rates which are almost equal to those reported in urban India.

Serial studies in Chennai as an evidence of the rising prevalence

Chennai is perhaps the only city in India where a series of population based studies have been done which has enabled the investigators to compare the prevalence rates. A study done in the same urban area after five years showed that the prevalence had risen to 11.6% (68). The CURES investigators had a unique opportunity to compare prevalence rates of diabetes in Chennai city with three earlier epidemiological studies carried out in the same city using similar methods (64, 68, 80). The overall crude prevalence of diabetes using WHO criteria in CURES was 15.5 per

cent (age standardized: 14.3%). 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 years, the prevalence of diabetes increased significantly by 72.3 per cent (Figure 2).

Lowering of age at onset of type 2 diabetes

It has been documented that Indians have a younger age of onset of diabetes compared to other ethnic groups (94). An increase in the prevalence of type 2 diabetes in the younger age group has been noted from the epidemiological studies. The Daryaganj survey done in Delhi in 1986 reported that none of the diabetics were aged less than 30 years (60). However, the NUDS done in 2001 showed that the prevalence of diabetes in those aged below 30 was 5.4% (80). The CURES investigators demonstrated a temporal shift in the age at diagnosis to a younger group when compared to the NUDS study published just five years earlier (80,85). A study from Delhi also reported a high prevalence of insulin resistance in children which was associated with excess body fat and adiposity (95). Hence it is increasingly becoming clear that type 2 diabetes has become prevalent even among younger age groups. This disturbing fact could have long lasting effects on the health of the nation and its economy.

Pre-diabetic states- Impaired Glucose Tolerance and Impaired Fasting Glucose.

Impaired glucose tolerance (IGT) and impaired fasting glucose (IFG) collectively called as prediabetic states, have a high risk of conversion to diabetes. Several studies have shown that these prediabetic states are also high risk stages for cardiovascular disease (96,97). Hence a compilation of data on IGT and IFG are

also important, as they are indicators of future diabetes prevalence and burden on the nation. Ramachandran et al reported a high prevalence of IGT in urban (8.7%) and rural (7.8%) areas in 1989 (64). It was interesting to note that the prevalence rates were almost similar despite a big difference in the prevalence of diabetes. Subsequent studies by the same investigator found that the prevalence of IGT had risen to 9.1% in 1995 and then to 16.8% in 2000(68, 80). The Kashmir valley study reported a high prevalence of 8.1% and it was also observed that the prevalence of IGT was significantly higher in women (73).

The NUDS results indicate that the prevalence of IGT was higher than that of type 2 diabetes in four out of six cities studied (80). 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 CURES, however has reported a decreased prevalence of IGT compared to earlier studies done in Chennai (16.8% in 2000 to 10.2% in 2004) (80,85). 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. Further support of this hypothesis came from the ADEPS which showed a lower prevalence of 4.2% of IGT (86). However, the ADEPS reported a high prevalence of IFG (11.2%). The PODIS investigators found a discrepancy in subjects having IFG or IGT. Of the subjects diagnosed as having IGT by the WHO criteria, only 51% would be diagnosed as having IFG (98).

Gender differences in the prevalence of diabetes

Some of the population based studies have reported that the prevalence was higher in females (64, 72). Majority of the population based studies multicentric studies like NUDS and PODIS reported similar prevalence of diabetes in males and females (80, 82, 83). However, a recent study from Manipur reported a higher prevalence in males than in females (79).

Impact of socio economic status

Diabetes has been generally considered a disease of the rich and affluent. The CUPS was done to assess the effect of socio-economic status on the prevalence of type 2 diabetes and related abnormalities (78). 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 20yrs. The age standardised prevalence was 12.4% in the middle income group compared to 6.4% in the lower income group (78). The prevalence of related metabolic abnormalities like obesity and cardiovascular risk factors were also markedly higher in the middle income group. Another study from New Delhi showed that even the slum dwellers had high prevalence of obesity, glucose intolerance and dyslipidemia (77). This suggests that diabetes is no longer a disease of the affluent or a rich man’s disease. It is becoming a problem even among the middle income and 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 (99). This presents an alarming picture as the por would find it more difficult to cope with the diabetes epidemic.

Burden of diabetes complications in India

There are very few studies from India which has looked at the microvascular complications of diabetes in a population. In 1996, Rema et al observed that the prevalence of diabetic retinopathy in a clinic based study to be 34.1 % (100). Dandona et al had reported a prevalence of 22.6% in an urban South Indian population in the year 1999 (101). Narendran (103) et al reported a higher prevalence of 26.8% in self reported diabetic subjects in Palakkad in Kerala state. The CURES Eye Study is the largest population based data on the prevalence of diabetic retinopathy which used four-field stereo retinal photographs and Early Treatment Diabetic Retinopathy Study (ETDRS) grading to document DR in the Indian population (104). This study reported a diabetic retinopathy prevalence of 17.6%, which is lower compared to the reports from the west (105). Table 4 shows the studies on diabetic retinopathy in India.

A few studies have looked at the prevalence of diabetic nephropathy in India. But most of these are clinic based reports. John et al in 1991 showed that the prevalence of microalbuminuria was 19.7% and diabetic nephropathy was 8.9% in a clinic based study from Vellore(106). Gupta et al found that the prevalence of microalbuminuria was 26.6 % (107). A study from Pune showed a prevalence of microalbuminuria to be 23% (108). Vijay et al reported a prevalence of 18.7% of proteinuria in a clinic based study from Chennai (109). The first population based prevalence of diabetic nephropathy in India was reported by Unnikrishnan et al in 2007 (110). The prevalence of overt nephropathy was found to be 2.2% and that of microalbuminuria was 26.9% (110). Thus the overall prevalence of microvascular complications appears to be lower in Indians compared to Europeans. The prevalence of neuropathy was found to be 27.5% (111) and 19.1 % (112) in two separate clinic based studies from Chennai. A

recent study reported a high prevalence of 29% of neuropathy in newly diagnosed diabetic subjects (113). Very recently, population based data from CURES was published which showed that the prevalence of neuropathy in urban population was 26.1% (114). A recent report showed that foot ulcers were more common among diabetic subjects in the rural area compared to their urban counterparts (115). They also found that the rates of amputations were higher in rural area compared to urban area (115).

The results from the CUPS study have provided population based data on the prevalence of macro vascular complications and mortality in relation to diabetes in India. The prevalence of coronary artery disease was 21.4% among diabetic subjects compared to 9.1% in subjects with normal glucose tolerance (116). 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 (117). The prevalence of peripheral vascular disease (PVD) was higher in type 2 diabetic subjects compared to (6.3% vs 2.7% $p<0.001$) (118). The CUPS also provided some evidence on the effect of type 2 diabetes on mortality rates in a population (119). 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). The hazards ratio (HR) for all cause mortality for diabetes was found to be 3.6 compared to non diabetic subjects (119).

Several clinic based studies from India have looked at the mortality trends in diabetes. CAD appears to be leading cause of death in majority of these studies (120-125). However, Bhansali et al (126) and Zargar et al (127) reported that infections were the leading cause of mortality in diabetic subjects. Chronic renal failure (CRF), Ketosis, stroke, hyperosmolar coma and hypoglycaemia are the other causes of mortality documented (120-125).

DEVELOPMENT OF THE DIABETES ATLAS

The diabetes atlas was designed to map the prevalence across the country using all relevant published literature on the subject.

Methods for data collection:

1. A thorough literature search was done using the library at the Madras Diabetes Research Foundation, Chennai
2. An online literature search was done on ‘Pubmed’ and ‘Google’ using the words “Diabetes, India, prevalence”.
3. Review articles published in peer reviewed journals and text books were used for data search. The review articles referred were:
    - Ramaiya KL, Kodali VR, Alberti KG. Epidemiology of diabetes in Asians of the Indian subcontinent. Diabetes Metab Rev.1990; 6:125 - 146.
    - Ahuja MMS. A decade of epidemiology of diabetes. Int J Diab Dev Ctries 1991; 11:2-4
    - Ramachandran A. Epidemiology of Diabetes in Indians. Int J Diab Dev Ctries 1993; 13:65-67
    - Gupta OP, Phatak S. Pandemic trends in the prevalence of diabetes mellitus and associated coronary artery disease in India. Their causes and prevention. Int J Diab Dev Ctries 2003; 23:37-49
    - Gupta R, MIsra A. Type 2 Diabetes in India: Regional Disparities. Br J Diabetes Vasc Dis. 2007; 7:12-16
    - Mohan V, Sandeep S, Deepa R, Shah B, Varghese C. Epidemiology of type 2 diabetes: Indian Scenario. Indian Journal of Medical Research. 2007; 125:217-230

4. Data from abstracts were used if full text of the article was not available.

Results:

A total of 116 studies were identified which had some data related to prevalence of diabetes in India.

Out of the 66 studies (1938 to 2007) have directly looked at the prevalence of diabetes. Of these,

- 12 studies were hospital or clinic based
- 4 studies had data collected from exhibitions/camps/mobile clinics
- 6 studies were done on specific groups like industrial populations, army personnel, textile workers, cancer patients and staff of a particular institution.
- **44 studies were population based or house to house surveys.**
- 2 studies looked at the prevalence in specific communities (not listed in the table)

Criteria used for diagnosis of diabetes

- 11 studies used glycosuria as the criteria for diagnosis
- 3 studies looked at only known cases of diabetes
- 49 studies used blood sugar for diagnosing diabetes
- Methodology could not be obtained in 3 older studies

Time period

Time period	Number of studies
1938-1950	1
1951- 1960	1
1961- 1970:	15
1971- 1980:	11
1981- 1990:	9
1991- 2000:	12
2001- 2007:	17
Total	**66**

Area of Study:

Urban: 26 studies

Rural: 15 studies

Both rural and urban/ not specified: 35

Preparation of maps:

For preparation of maps, only population-based studies that used blood sugar to diagnose diabetes were used. If there were two studies in the same period from the same state, the larger study was considered for mapping.

The studies were divided into time periods. The maps represent data from 1966 to 2007 in urban and rural areas.

Mapinfo software was used to prepare the maps

Maps were prepared for the following time periods and are shown as figures 3-8.

1966- 1975, 1976-1985, 1985-1991, 1992-1996, 1997-2001, 2002-2007.

10 year intervals were taken for studies up to 1985 as there were a few studies in that time period.

Specific colours were used to represent the prevalence reported from different states. The whole state was given uniform colour.

Green: 0- 3.9%

Yellow: 4- 6.9%

Orange: 7- 11.9%

Red: 12% and above.

Figure 1: PREVALENCE OF TYPE 2 DIABETES IN RURAL AREAS IN DIFFERENT PARTS OF INDIA IN 1991(ref:63)

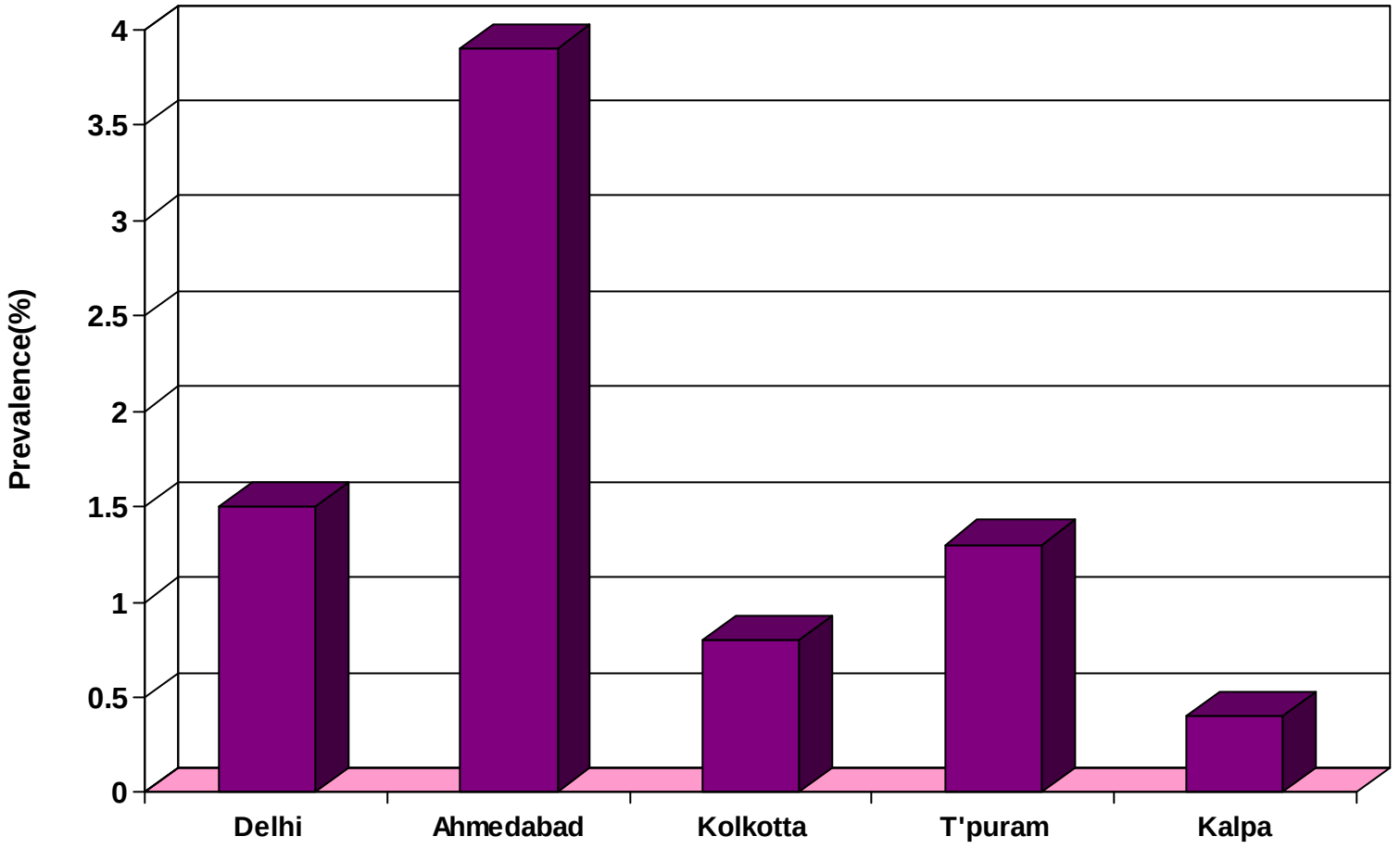


Figure 2: SERIAL STUDIES FROM CHENNAI SHOWING A RISE IN PREVALENCE OF TYPE 2 DIABETES.(ref:64,68,80,85)

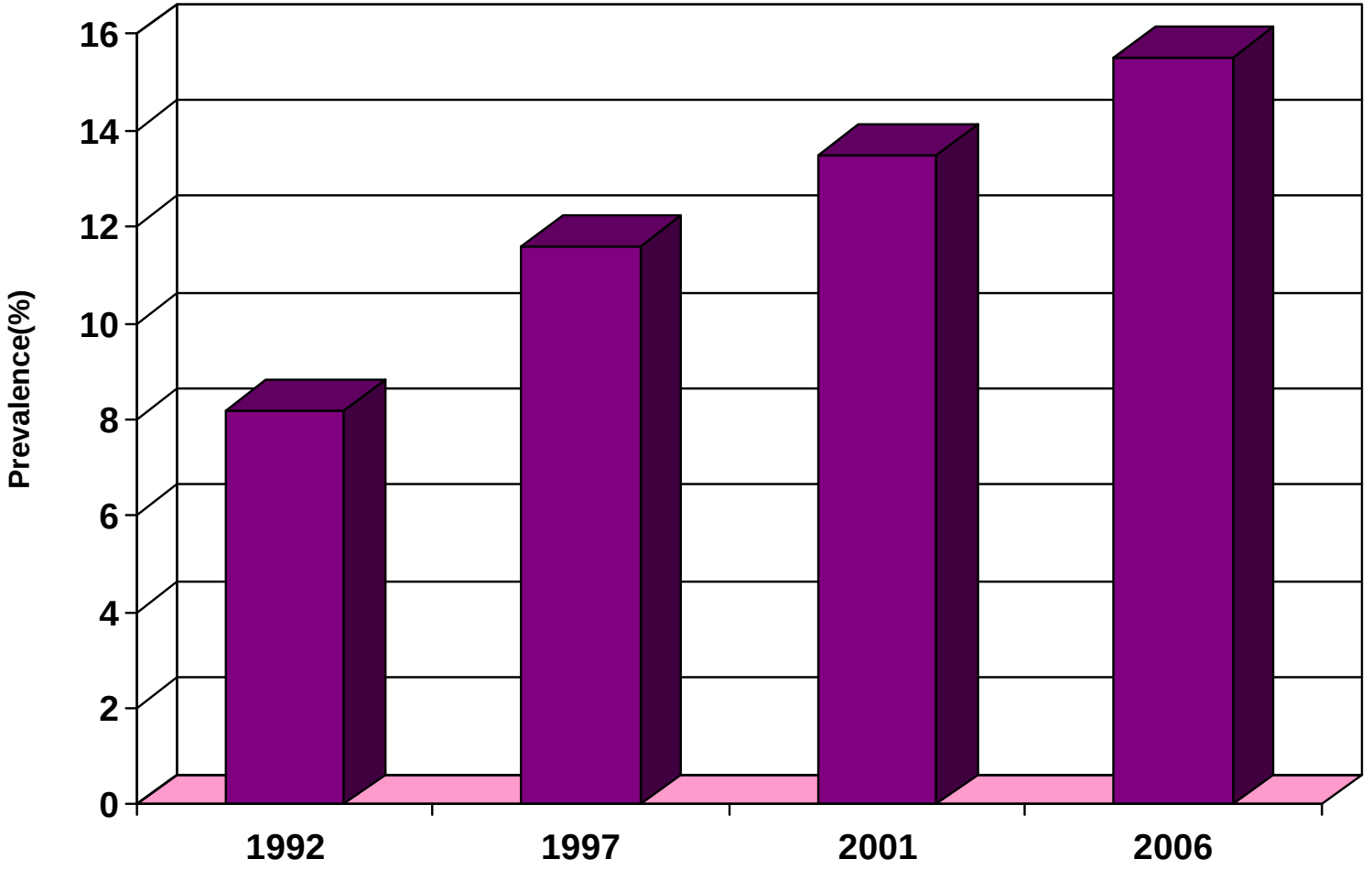


Figure 3: PREVALENCE OF DIABETES IN INDIA 1966- 1975

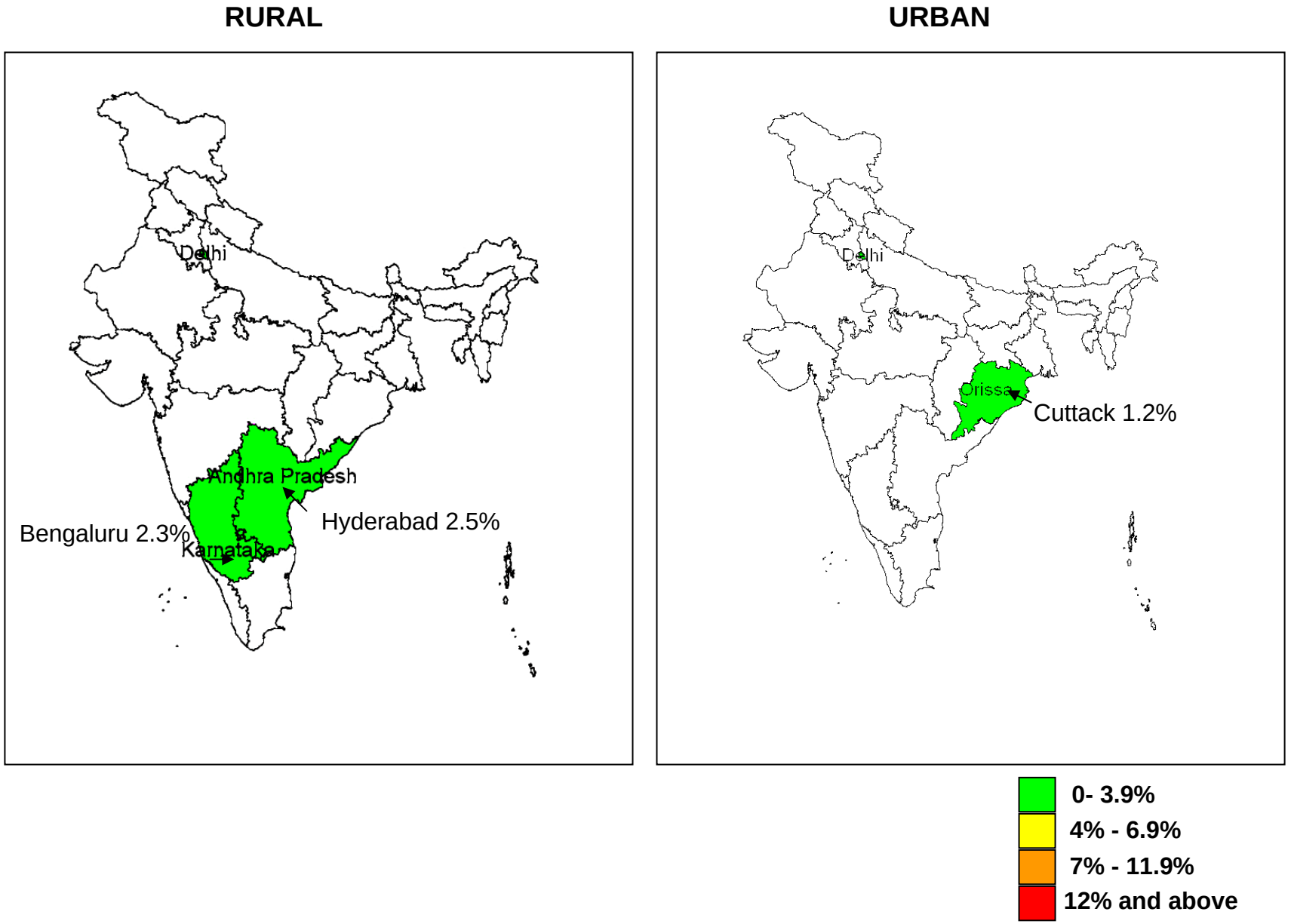
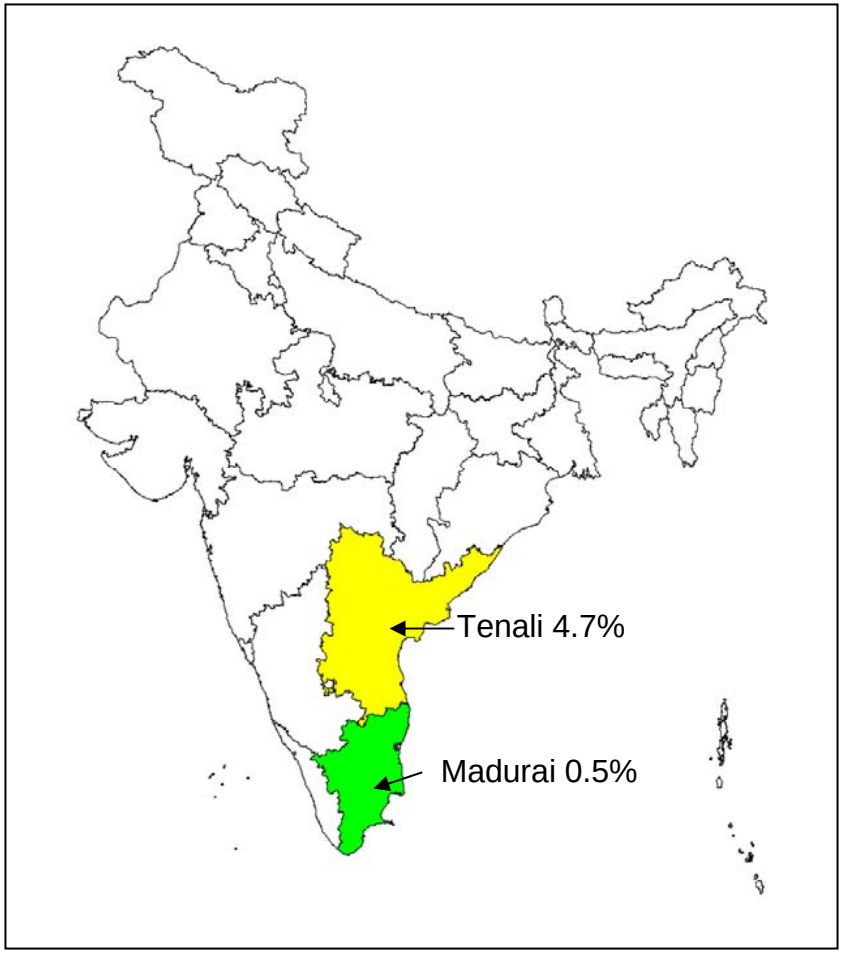


Figure 4: PREVALENCE OF DIABETES IN INDIA 1976- 1985

URBAN



0- 3.9%
4% - 6.9%
7% - 11.9%
12% and above

Figure 5: PREVALENCE OF DIABETES IN INDIA 1986- 1991

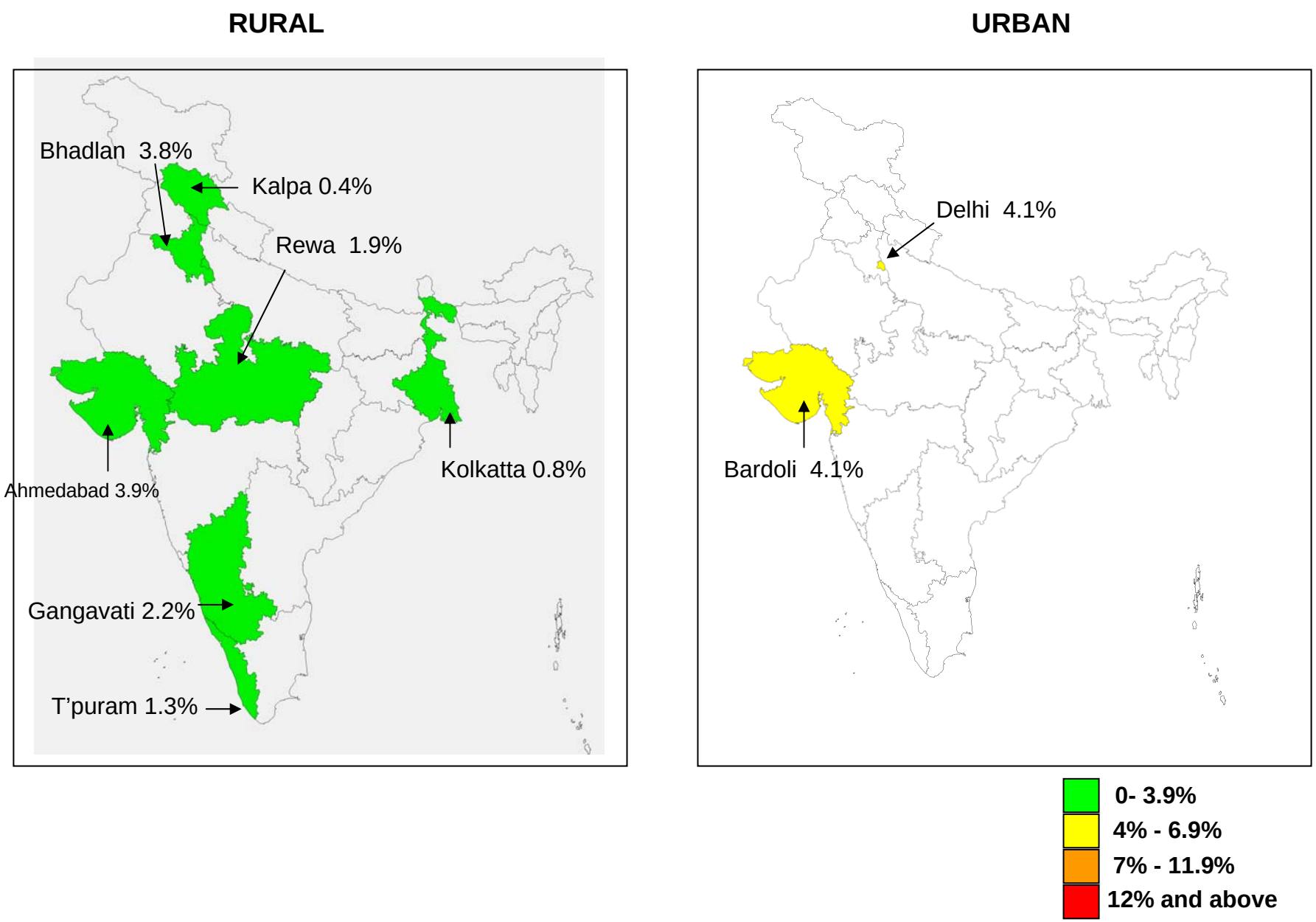
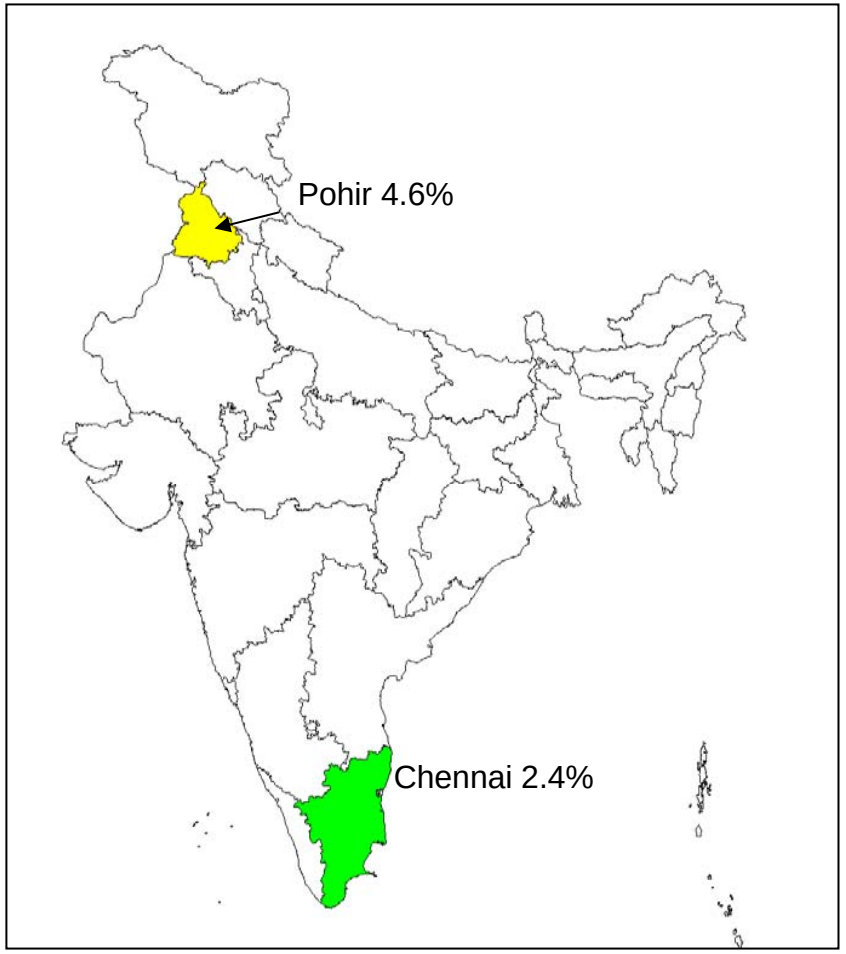
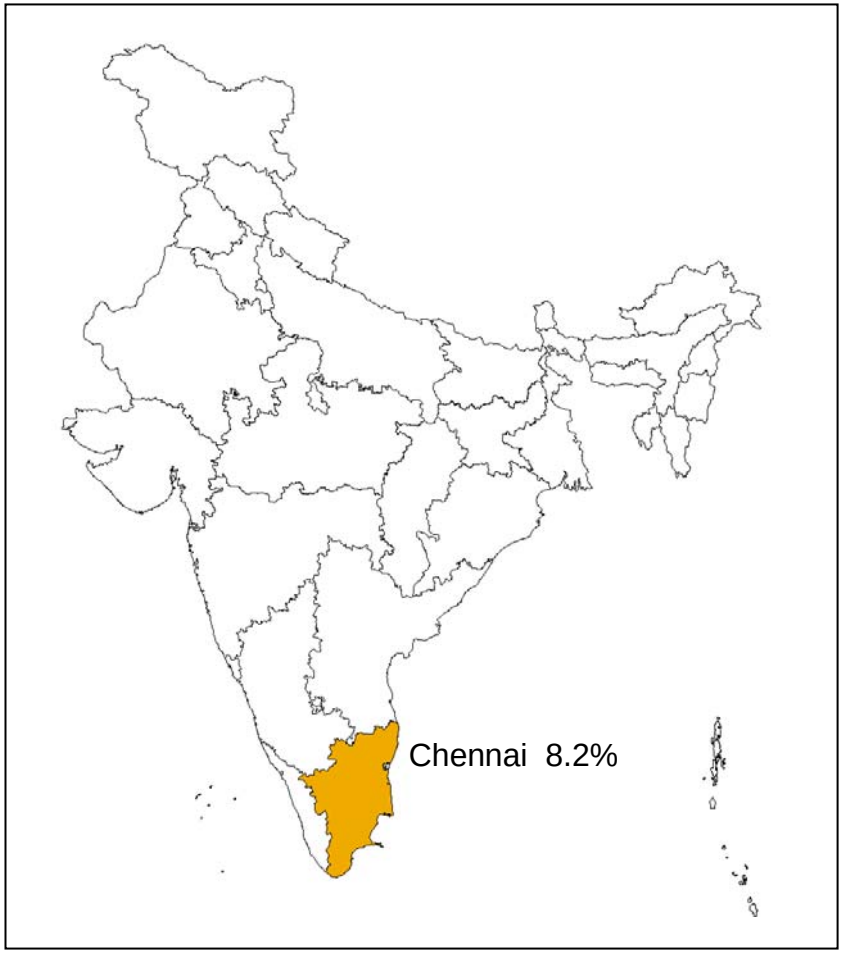


Figure 6: PREVALENCE OF DIABETES IN INDIA 1992- 1996

RURAL



URBAN



0- 3.9%
4% - 6.9%
7% - 11.9%
12% and above

Figure 7: PREVALENCE OF DIABETES IN INDIA 1997- 2001

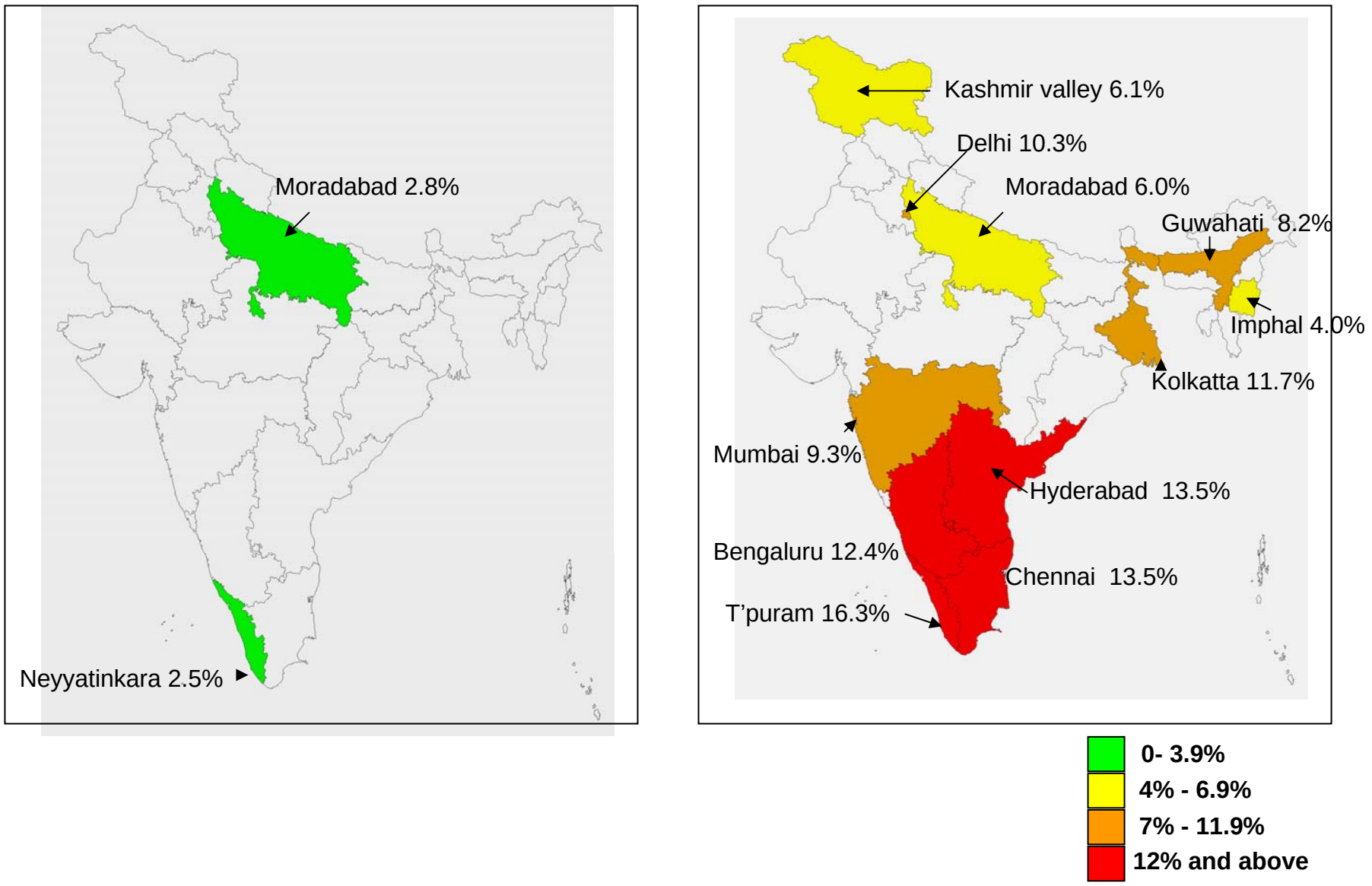
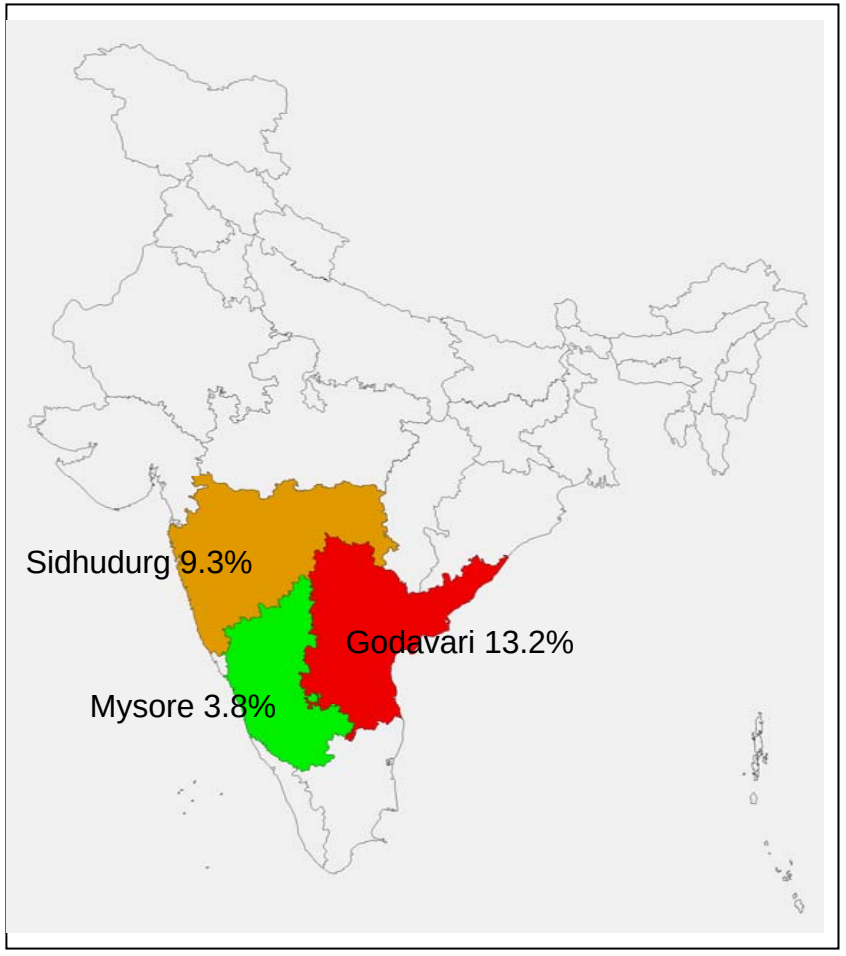
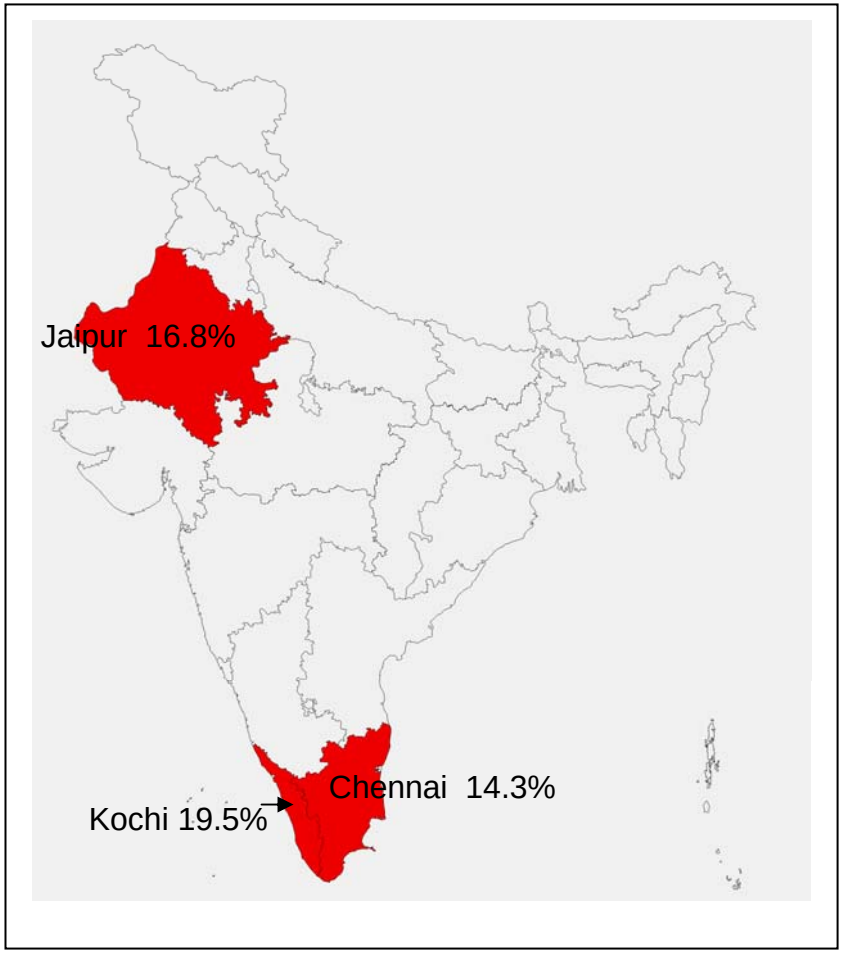


Figure 8: PREVALENCE OF DIABETES IN INDIA 2002- 2007

RURAL



URBAN



0- 3.9%
4% - 6.9%
7% - 11.9%
12% and above

References

1. Wild S, Roglic G, Green A, Sicree R, King H.Global prevalence of diabetes: Estimates for the year 2000 and projections for 2030. Diabetes Care 2004; 27: 1047-53.
2. Sicree R, Shaw J, Zimmet P. Diabetes and impaired glucose tolerance. In: Gan D, editor. Diabetes Atlas. International Diabetes Federation. 3rd ed. Belgium: International Diabetes Federation; 2006 p. 15-103.
3. McKeigue PM, Shah B, Marmot MG. Relation of centralobesity and insulin resistance with high diabetes prevalence and cardiovascular risk in South Asians. Lancet 1991; 337:382-6.
4. Mohan V, Sharp PS, Cloke HR, Burrin JM, Schumer B,Kohner EM. Serum immunoreactive insulin responses to a glucose load in Asian Indian and European Type 2 (noninsulin-dependent) diabetic patients and control subjects.Diabetologia 1986; 29: 235-7.
5. Abate N, Chandalia M. Ethnicity and type 2 diabetes: focus on Asian Indians. J Diabetes Complications 2001; 15:320-7.
6. Joshi R. Metabolic syndrome - Emerging clusters of the Indian phenotype. J Assoc Physicians India 2003; 51 :445-6.
7. Deepa R, Sandeep S, Mohan V. Abdominal obesity, visceralfat and type 2 diabetes- “Asian Indian phenotype. In: MohanV, Rao GHR, editors. Type 2 diabetes in South Asians:Epidemiology, risk factors and prevention. New Delhi:Jaypee Brothers Medical Publishers (P) Ltd; 2006p. 138-52.
8. Ramachandran A, Snehalatha C, Viswanathan V,Viswanatha M, Haffner SM. Risk of non insulin dependent diabetes mellitus conferred by obesity and central adiposity in different ethnic groups: a comparative analysis between Asian Indians, Mexican Americans and Whites. DiabetesRes Clin Pract 1997; 36: 121-5.
9. Raji A, Seely EW, Arky RA, Simonson DC. Body fatdistribution and insulin resistance in healthy Asian Indians and Caucasians. J Clin Endocrinol Metab 2001; 86: 5366-71.

10. Chandalia M, Abate N, Garg A, Stray-Gunderson J, Grundy SM. Relationship between generalized and upper body obesity to insulin resistance in Asian Indian men. J Clin Endocrinol Metab 1999; 84: 2329-35.
11. Yajnik CS. The lifecycle effects of nutrition and body size on adult adiposity, diabetes and cardiovascular disease.Obes Rev 2002; 3: 217-24.
12. Yajnik CS, Fall CH, Coyaji KJ, Hirve SS, Rao S, Barker DJ, et al. Neonatal anthropometry: the thin-fat Indian baby.The Pune Maternal Nutrition Study. Int J Obes Relat Metab Disord 2003; 27: 173-80.
13. Ramachandran A, Snehalatha C, Krishnaswamy CV. IDDM Registry in India. J Assoc Physicians India 1995;8-10
14. Gupta OP. Study of juvenile diabetes in Ahmedabad. J Assoc Phys India 1964; 12:89-94.
15. Ahuja MMS, Talwar GP, Verma VM, Kumar A.Diabetes mellitus in young Indians. Indian J Med Res 1965; 53: 1138-42.
16. Viswanathan M. Diabetes in young: a study of 166 cases. In: Diabetes in the Tropics, Eds. Patel JC, Dhirwani NC. Diabetes Association of India. Bombay 1966, p. 217.
17. Udani PM, Shah PM, Karani AN. Diabetes in children: clinical and biochemical aspects. Indian Pediatr 1968; 5:391-400.
18. Vaishnava H, Bhasin RC, Gulati PD, et al. Diabetes mellitus with onset under 40 years in North Iridia, Jr.Asso. Phys Ind 1974; 22:879-88.
19. Abraham A, Geevarghese PJ. Pattern of childhood diabetes in Central Kerala. Diabetes Bull 1989; 9 (Supp) : 6.
20. Samal KC, Das S, Tripathy BB, Nayak GC, Mishra PK. Clinical and biochemical analysis of diabetes in pediatric age group. Diabetes Bull 1989; 9 (Supp) :6-7.
21. Venkataraman S, Suresh S, Sundaram A, et al.Diabetes in the young: a profile. Diabetes Bull 1989 ;(Supp) 9: 9.

22. Ramachandran A, Snehalatha C, Abdul Khader OM, Joseph TA, Viswanathan M. Prevalence of childhood diabetes in an urban population in south India. Diabetes Res Clin Pract. 1992 Sep;17(3):227-31.
23. Bai PV, Krishnaswami CV, Chellamariappan M, Kumar GV, Subramaniam JR.Glycosuria and diabetes mellitus in children and adolescents in south India.Diabetes Res Clin Pract. 1991 Aug;13(1-2):131-5.
24. Bai PV, Krishnaswami CV, Chellamarippan M, Kumar GV, Subramaniam JR, Srivatwa A, Subramanyam B, Rao MB.Prevalence of diabetes in the young in south India.Indian Pediatr. 1995 Nov;32(11):1173-6.
25. Dharamlingam M, Prasanna Kumar KM, Arvind SR, Munichoodappa C. IDDM Registry-data from Bangalore. Prasanna Kumar K (Ed.) Endocrinology metabolism and diabetes: Proc. EMD-96. Print Comm, Bombay 1997;85-89.
26. Ramaiya KL, Kodali VR, Alberti KG. Epidemiology of diabetes in Asians of the Indian subcontinent. Diabetes Metab Rev.1990; 6:125 - 146.
27. Chakravarthy A: A study of diabetes and its treatment with special reference to Bengalees and their diet. Indan Med Rec 1938; 58:65.
28. Patel JC,and Dhirawani MK: Incidence of diabetes in Bombay: analysis of 8 years' case records of a general hospital, Indian J Med Sci 1959; 12(10) 10.Editorial. J Assoc Physicians India 1960; 8: 337.
29. Patel JC, Dhirawani MK, Nanavathi BH, Shah BH, and Aiyar AA: A sample survey to determine the incidence of diabetes in Bombay. I Indian Med Assoc 1963; 41: 448.
30. Ganguly MM, Prasad BG, and Bagchi SC: Asurvey of diabetes mellitus in the area of the rural health training centre Sarojini Nagar, Lucknow. Indian J Med Res 1964; 52: 398.
31. Vaishnava H, Dixit Ns, and Solomon SK: A Study in retrospect of hospitalized patients of diabetes mellitus in South India. J Assoc Physician India 1964; 12; 255.

32. Gupta OP, Phatak S. Pandemic trends in the prevalence of diabetes mellitus and associated coronary artery disease in India. Their causes and prevention. Int J Diab Dev Ctries 2003; 23:37-49
33. The K.E.M Hospital Group : incidence of diabetes. In Diabets in the Tropics. Patel JC, and Talwalker NG, Eds. Diabetic Association of India, Bombay 1966
34. Sainani GS, Bhimani VR, and Chabalani PV. In Diabetes in the Tropics. Patel JC, and Talwalker NG, Eds. Diabetic Association of India, Bombay, 1966, 44.
35. Berry JN, Malik K, and Gupta HD: Prevalence of postprandial glycosuria in an urban community. J Assoc Physicians India 1966; 14:519.
36. Ahuja MMS, Varma VM and Shankar U: A pilot study to determine the perevalence of diabetes mellitus in Delhi. J Indian Med Assoc 1966; 46; 415.
37. Shankar PS. In Diabetes in the Tropics. Patel JC, and Talwallker NG, Eds .Diabetic Association of India, Bombay, 1966, 48.
38. Rao PS, Naik BK, Saboo RV, Ramachandran A, Dandelia PR, and Parley K: Incidence of diabetes in Hyderabad. IN Diabetes in the Tropics. Patel JC, and Talwalker NG, Eds. Diabetic Association of India. Bombay, 1966,68.
39. Mirsa MP, Kohl Sc, Srivatsava BN, and De Mellow C: Incidence of diabetes in Jabalpur city and adjoining rural areas. In Diabetes in the Tropics . Patel JC, Talwalker NG, Eds Diabetic Association of India, Bombay, 1966,55.
40. Vishwanathan M, Moses SGP, and Krishnamoorty M: prevalence of diabetes in Madras. In Diabetes in the tropics. Patel JC, and Talwalker NG, Eds Diabetic Association of India, Bombay, 1966, 29.
41. Data SP, Verma NPS, Gopalakrishnan R, and Ghosh BN: Survey of diabetes mellitus in Pondicherry. In Diabetes in the Tropics. Patel JC, and Talwalker NG, Eds. Diabetic Association of India, Bombay, 1966, 33.

42. Pai KN, Roy VEM, and Jhon Ki: Incidence and pattern of diabetes in Trivandrum. In Diabetes in the Tropics. Pattel JC, and Talwalker NG, Eds. Diabetic Association of India. Bombay, 1966, 40.
43. Gour KN,; Epidemiological study of diabetes in the town of Varanasi. In Diabetes in the town of varanasi, In Diabetes in the Tropics. Patel JC, and Talwalker NG, Eds. Diabetic Association of India, Bombay, 1966, 76.
44. Tripathy BB, Panda NC, Tej SC, Sahoo GN, and Kar BK: Survey for detection of glycosuria, hyperglycaemia and diabetes mellitus in urban and rural areas of Cuttack district . J assoc Physicians India 1971:19:681.
45. Vigg BL, Hrishikesh P, and Sahay BK: Survey of diabetes in rural area. Madhumeh 1972;12:171.
46. Rao KSJ, Mukherjee NR, and Rao Kv: A Survey of diabetes mellitus in rural population of India. Diabetes 1972;21:1192
47. Ahuja MMS, Sivaji L, Garg VK, and Mitroo P: Prevalence of diabetes in northen India (Delhi area). Horn Metab res 1974;4:321.
48. Parameswara A: A diabetes survey. Antiseptic 1973; 70:435.
49. Mukherjee AB, Sen, S, Dey P: Epidemiological survey of diabetes mellitus in a mixed population of Calcutta. J Indian Med Assoc 1973; 61:17.
50. Data SN, Prasad BG, and Jain PC: an epidemiological study of diabetes mellitus in defence population in Lucknow Cantonment. J Indian Med Assoc 1973; 61: 23.
51. Varma RN, and Boparai MS: Prevalence of diabetes of diabetes mellitus in army personnel. Indian J Med Res 1974; 62: 1104.
52. Chhetri M.¯K, Raychaudhari B, and Bhattacharya B: Epidemiological study of diabetes mellitus in West Bengal. J Diabetic Assoc India 1975; 15: 97.
53. Gupta OP, Joshi MH, Dave Sk. Prevalence of diabetes in India. Adv Metab Dis 1978;9:147-165.
54. Johnson ES, Chandramohan M, Thiyagarajan AT, Manian PTKS, and Ayyappan A: Prevalence of diabetes mellitus in West Bengal. J Diabetic Assoc India 1975; 15: 97.

55. Govindaraj V, Das AK., Chandrasekar S: Prevalence of diabetes mellitus in a rural population of Pondicherry. J Diabetic Assoc India 1984; 24: 20.
56. Murthy PD, Pullaiah B, and Rao KV: Survey for detection of hyperglycemia and diabetes mellitus in Tenali. In Diabetes mellitus in Developing Countries. Bajaj Js Ed. Interprint, New-Delhi, 1984,55.
57. Patel JC; Prevalence of hypertension and diabetes mellitus in a rural village, J Diabetic Assoc India 1986; 26: 68.
58. Iyer SR, Chauhan RB, Khandwala RM. And Shah PC: Diabetes mellitus in and around Bardoli. J Diabetic Assoc India 1987; 27:11.
59. Ramachandran A, Jali MV, Mohan V, Snehalatha C, Viswanathan M. High prevalence of diabetes in an urban population in South India. Br Med J 1988; 297: 587 – 590.
60. Varma NPS,Mehta SP, Madhu SV, Mather HM, and Keen H: Prevalence of known diabetes mellitus in an urban Indian environment:: the Darya Ganji diabetes survey. Br Med J 1986; 293: 423.
61. Tiwari AK, and Bissaraya BN: An epidemiologic survey of diabetes mellitus in and around Rewa. Diabetes Res Clin Pract 5 (suppl 1): 1988,S 634.
62. Rao PV, Usabala P, seshaiah V, Ahuja MMS, and Mather HM: The Eluru Survey: Prevalence of known diabetes in a rural Indian population. Diabetes Res Clin Pract 1989; 7:29.
63. Ahuja MMS. Recent contributions to the epidemiology of diabetes mellitus in India. Int J Diab Developing Countries 1991;11:5-9
64. Ramachandran A, Snehalatha C, Dharmaraj D, Viswanathan M. Prevalence of glucose intolerance in Asian Indians. Urban-rural difference and significance of upper body adiposity. Diabetes Care. 1992; 15: 1348-55.
65. Bano P, Shahab SM.Incidence of NIDDM in rural central bihar.J Assoc Physicians India. 1994 Feb;42(2):175.
66. Wander GS, Khurana SB, Gulati R, Sachar RK, Gupta RK, Khurana S, Anand IS. Epidemiology of coronary heart disease and risk factors in a

rural Punjab population: prevalence and correlation with various risk factors. Ind Heart J 1994;46:319-23.

67. Patandin S, Bots ML, Abel R, Valkenburg HA. Impaired glucose tolerance and diabetes mellitus in a rural population in south India. Diabetes Res Clin Pract 1994;24:47-53
68. Ramachandran A, Snehalatha C, Latha E, Vijay V, Viswanathan M. Rising prevalence of NIDDM in urban population of India. Diabetologia 1997; 40:232-7
69. Shah SK, Saikia M, Barman NN, Snehalatha C, Ramachandran A. High prevalence of type 2 diabetes in urban population in north-eastern India. Int J Diab Dev Countries 1998;18:97-101
70. Singh RB, Bajaj S, Niaz MA, Rastogi SS, Moshiri M. Prevalence of type 2 diabetes mellitus and risk of hypertension and coronary artery disease in rural and urban population with low rates of obesity. Int J Cardiol. 1998 Sep 1;66(1):65-72.
71. Asha Bai PV, Krishnaswami CV, Chellamariappan M. Prevalence and incidence of type-2 diabetes and impaired glucose tolerance in a selected Indian urban population. J Assoc Physicians India 1999;47:1060-4.
72. Raman Kutty V, Joseph A, Soman CR. High prevalence of type 2 diabetes in an urban settlement in Kerala, India.Ethn Health 1999; 4 : 231-9.
73. Zargar AH, Khan AK, Masoodi SR, Laway BA, Wani AI,Bashir MI, et al. Prevalence of type 2 diabetes mellitus and impaired glucose tolerance in the Kashmir Valley of the Indian subcontinent. Diabetes Res Clin Pract 2000; 47 : 135-6.
74. Kutty VR, Soman CR, Joseph A, Pisharody R, Vijayakumar K. Type 2 diabetes in southern Kerala: variation in prevalence among geographic divisions within a region. Natl Med J India 2000;13:287-92.
75. Asha Bai PV, Murthy BN, Chellamariappan M, Gupte MD, Krishnaswami CV. Prevalence of known diabetes in Chennai City. J Assoc Physicians India 2000;49:974-81

76. Iyer SR, Iyer RR, Upasani SV, Baitule MN. Diabetes mellitus in Dombivli---an urban population study. J Assoc Physicians India 2001;49:713-16.
77. Misra A, Pandey RM, Devi JR, Sharma R, Vikram NK, Khanna N. High prevalence of diabetes, obesity and dyslipidaemia in urban slum population in northern India. Int J Obes 2001;25:1722-9.
78. Mohan V, Shanthirani CS, Deepa R. Glucose intolerance (diabetes and IGT) in a selected South Indian population with special reference to family history, obesity and lifestyle factors - the Chennai Urban Population Study. J Assoc Physicians India 2003;51:771-7.
79. Singh TP, Singh AD, Singh TB. Prevalence of diabetes mellitus in Manipur. In: Shah SK. Editor. Diabetes Update. Guwahati. North Eastern Diabetes Society. 2001;13-19.
80. Ramachandran A, Snehalatha C, Kapur A et al. High prevalence of diabetes and impaired glucose tolerance in India: National Urban Diabetes Survey. Diabetologia 2001;44:1094-101.
81. Gupta R, Sarna M, Thanvi J, Sharma V, Rastogi P, Kaul V, Gupta VP. High prevalence of multiple coronary risk factors in Punjabi Bhatia community. Ind Heart J 2004;56:646-52
82. Sadikot SM, Nigam A, Das S et al. The burden of diabetes and impaired glucose tolerance in India using the WHO 1999 criteria: prevalence of diabetes in India study (PODIS). Diabetes Res Clin Pract 2004;66:301-07.
83. Sadikot SM, Nigam A, Das S, Bajaj S, Zargar AH, Prasannakumar KM, et al. Diabetes India. The burden of diabetes and impaired fasting glucose in India using the ADA1997 criteria: prevalence of diabetes in India study (PODIS). Diabetes Res Clin Pract 2004; 66 : 293-300.
84. Basavanagowdappa H, Prabhakar AK, Prasannaraj P, Gurudev KC, Virupaksha, Suma. Study of prevalence of diabetes mellitus and impaired fasting glucose in a rural population. Int J Diab Dev Ctries 2005; 25:98-101
85. Mohan V, Deepa M, Deepa R, et al. Secular trends in the prevalence of diabetes and impaired glucose tolerance in urban South India-the Chennai

Urban Rural Epidemiology Study (CURES-17). Diabetologia. 2006;49:1175-1178

86. Menon VU, Kumar KV, Gilchrist A, Sugathan TN, Sundaram KR, Nair V, Kumar H.Prevalence of known and undetected diabetes and associated risk factors in central Kerala--ADEPS. Diabetes Res Clin Pract. 2006 Dec;74(3):289-94.
87. Deo SS, Zantye A, Mokal R, Mithbawkar S, Rane S, Thakur K. To identify the risk factors for high prevalence of diabetes and impaired glucose tolerance in Indian rural population. Int J Diab Dev Countries 2006;26:19-23
88. Chow CK, Raju PK, Raju R et al. The prevalence and management of diabetes in rural India. Diabetes Care 2006;29:1717-18.
89. Jali MV, Kambar S. Prevalence of diabetes amongst the family members of known diabetics. Int J Diab Dev Ctries 2006;26:81-85
90. Reddy KS, Prabhakaran D, Chaturvedi V *et al*, on behalf of the Sentinel Surveillance System for Indian Industrial Populations Study Group. Methods for establishing a surveillance system for cardiovascular diseases in Indian industrial populations. *Bull WHO* 2006;84:461-9.
91. Kokiwar PR, Gupta S, Durge PM. Prevalence of diabetes in a rural area of central India. Int J Diab Dev Ctries 2007;27:8-10
92. Agrawal RP, Singh G, Nayak KC, Kochar DK, Sharma RC, Beniwal R, Rastogi P, Gupta R. Prevalence of Diabetes in Camel-Milk Consuming 'RAICA' Rural Community of North-West Rajasthan. Int J Diab Dev Ctries 2004;24:109-14
93. Kothari B, Khinchi A, Pareek A. Prevalence of Diabetes Mellitus Amongst the Bhargavas in India. J. Hum. Ecol., 17(2): 137-141 (2005)
94. Mohan V, Ramachandran A, Snehalatha C, Rema M, Bharani G, Viswanathan M. High prevalence of maturity onset diabetes of the young (MODY) among Indians. Diabetes Care 1985; 8: 371-374.
95. Misra A, Vikram NK, Arya S, Pandey RM, Dhingra V,Chatterjee A, et al. High prevalence of insulin resistance in post-pubertal Asian Indian

children is associated with adverse truncal body fat patterning, abdominal adiposity and excess body fat. Int J Obes Relat Metab Disord 2004; 28 : 1217-26.

96. Novoa FJ, Boronat M, Saavedra P, Diaz-Cremades JM,Varillas VF, La Roche F, et al. Differences in cardiovascular risk factors, insulin resistance, and insulin secretion in individuals with normal glucose tolerance and in subjects with impaired glucose regulation: the Telde Study. Diabetes Care 2005; 28 : 2388-93.
97. Petersen JL, McGuire DK. Impaired glucose tolerance and impaired fasting glucose - a review of diagnosis, clinical implications and management. Diabetes Vasc Dis Res 2005; 2 : 9-15.
98. Sadikot SM, Nigam A, Das S, Bajaj S, Zargar AH, Prasannakumar KM et al. Diabetes India. Comparing the ADA 1997 and the WHO 1999 criteria: Prevalence of Diabetes in India Study. Diabetes Res Clin Pract. 2004 Dec; 66(3):309-15.
99. Ramachandran A, Snehalatha C, Vijay V, King H. Impact of poverty on the prevalence of diabetes and itscomplications in urban southern India. Diabet Med 2002; 19: 130-5.
100. Rema M, Ponnaiya M, Mohan V. Prevalence of retinopathy in non insulin dependent diabetes mellitus in southern India. Diab Res Clin Practice 1996;24: 29-36.
101. Dandona L, Dandona R, Naduvilath TJ, et al. Population based assessment of diabetic retinopathy in an urban population in southern India. Br J Ophthal. 1999; 83:937 - 940.
102. Ramachandran A, Snehalatha C, Satyavani K, Latha E, Sasikala R, Vijay V. Prevalence of vascular complications and their risk factors in type 2 diabetes. J Assoc Physicians India. 1999;47:1152 - 1156.
103. Narendran V, John RK, Raghuram A, Ravindran RD, Nirmalan PK, Thulasiraj RD. Diabetic retinopathy among self reported diabetics in southern India: a population based assessment. Br J Ophthalmol. 2002;86:1014 -1018

104. Rema M, Premkumar S, Anitha B, Deepa R, Pradeepa R, Mohan V. Prevalence of Diabetic Retinopathy in Urban India: The Chennai Urban Rural Epidemiology Study (CURES) Eye Study-1. Invest Ophthalmol Vis Sci. 2005;46:2328 - 2333.
105. Kohner EM, Aldington SJ, Stratton IM, et al. Diabetic retinopathy at diagnosis of non insulin dependent diabetes mellitus and associated risk factors. United Kingdom Prospective Diabetes Study, 30.Arch Ophthalmology. 1998;116:297–303.
106. John L, Sundar Rao PSS, Kanagasabhapathy AS. Prevalence of diabetic nephropathy in non insulin dependant diabetes mellitus. Indian J Med Res 1991;94:24-29.
107. Gupta DK, Verma LK, Khosla PK, Dash SC. The prevalence of microalbuminuria in diabetes: a study from north India. Diabetes Res Clin Pract. 1991;12:125 -128.
108. Yajnik CS, Naik SS, Raut KN, Khade AD, Bhat DS, Nagarkar VD, Deshpande JA, Shelgikar KM. Urinary albumin excretion rate (AER) in newly-diagnosed type 2 Indian diabetic patients is associated with central obesity and hyperglycaemia. Diabetes Res Clin Pract. 1992;17:55-60.
109. Vijay V, Snehalatha C, Ramachandran A, Viswanathan M. Prevalence of proteinuria in non-insulin dependent diabetes. J Assoc Physicians India. 1994 ;42:792 – 794
110. Unnikrishnan RI, Rema M, Pradeepa R, Deepa M, Shanthirani CS, Deepa R, Mohan V.Prevalence and risk factors of diabetic nephropathy in an urban South Indian population: the Chennai Urban Rural Epidemiology Study (CURES 45).Diabetes Care. 2007 Aug; 30(8):2019-24.
111. Ashok S, Ramu M, Deepa R,Mohan V. Prevalence of neuropathy in type 2 diabetic patients attending a diabetes centre in south India. Journal of Association of Physicians of India. 2002; 50: 546 - 550.
112. Ramachandran A, Snehalatha C, Satyavani K, Latha E, Sasikala R, Vijay V. Prevalence of vascular complications and their risk factors in type 2 diabetes. J Assoc Physicians India. 1999;47:1152 – 1156

113. Dutta A, Naorem S, Singh TP, Wangjam K. Prevalence of Peripheral Neuropathy In Newly Diagnosed Type 2 Diabetics Mellitus. Int J Diab Dev Ctries 2005;25:30-3
114. Pradeepa R, Rema M, Vignesh J, Deepa M, Deepa R, Mohan V. Prevalence and risk factors for diabetic neuropathy in an urban south Indian population– the Chennai Urban Rural Epidemiology study (CURES-55)
115. Viswanathan V, Madhavan S, Rajasekar S, Chamukuttan S, Ambady R.Urban-rural differences in the prevalence of foot complications in South-Indian diabetic patients.Diabetes Care. 2006 Mar;29(3):701-3
116. Mohan V, Deepa R, Rani SS, Premalatha G; Chennai Urban Population Study (CUPS No.5). Prevalence of coronary artery disease and its relationship to lipids in a selected population in South India: The Chennai Urban Population Study (CUPS No. 5). J Am Coll Cardiol 2001; 38 :682-7.
117. Mohan V, Ravikumar R, Shanthi Rani S, Deepa R. Intimalmedial thickness of the carotid artery in South Indian diabetic and non-diabetic subjects: the Chennai UrbanPopulation Study (CUPS). Diabetologia 2000; 43: 494-9.
118. Premalatha G, Shanthirani CS, Deepa R, Markovitz J, Mohan V. Prevalence and risk factors of peripheral vascular disease in a selected south Indian population – The Chennai Urban Population Study (CUPS). Diabetes Care. 2000;23:1295-1300.
119. Mohan V, Shanthirani CS, Deepa M, Deepa R, Unnikrishnan RI, Datta M.Mortality rates due to diabetes in a selected urban south Indian population--the Chennai Urban Population Study [CUPS--16]. J Assoc Physicians India. 2006 Feb; 54:113-7.
120. Patel JC, Dhirawani M, Despande NM. Causes of deaths in diabetes mellitus. Proc World Congress on Diabetes in Tropics. 1996;418-419.
121. Verma NPS, Gupta PS, Krishna PS, Khanijo V. Mortality in diabetes in Irwin Hospital,New Delhi. In Challenges of diabetes in developing countries RSSDI, October 30 1976.

122. Garg MK, Shah P, Virmani A. Retrospective analysis of hospital deaths in diabetics in last five years. Clin Proc Nizam`s Inst Med Sci 1994;9 (Suppl.1):38.
123. Sriniwasan G, Vrunda JP, Swarna Das, Prasanna Kumar KM. Clin Proc Nizam`s Inst Med Sci 1994;9 (Suppl.1):39.
124. Sahay R, Rao PV, Anita BT, Prashant T, Shantaram V. Gender differences in reduction of life expectation as related to morbidity at deaths in diabetes mellitus. Clin Proc Nizam`s Inst Med Sci 1994;9(Suppl.1):48.
125. Das S, Mishra RK, Jena BB, Mishra BK, Missra KC, Sarangi B. Mortality events amongst non-insulin dependant diabetes mellitus patients in orissa. J Assos Physicians India 1999; 47:1152-1156.
126. Bhansali A, Chattopadhyay A, Dash RJ. Mortality in diabetes: a retrospective analysis from a tertiary care hospital in North India.Diabetes Res Clin Pract. 2003; 60:119 - 124.
127. Zargar AH, Wani AI, Masoodi SR, Laway BA, Bashir MI. Mortality in diabetes mellitus – data from a developing region of the world. Diabetes Res. Clin. Practice. 1999; 43: 67-74.

TABLE 1: PREVALENCE OF TYPE 1 DIABETES AMONG DIABETIC SUBJECTS

No:	Year	Investigator	Location	Prevalence (%) (per 100 cases of diabetes)
1	1964	Gupta et al (14)	Ahmedabad	< 1
2	1965	Ahuja et al (15)	Delhi	2.4
3	1966	Viswanathan et al (16)	Chennai	0.8
4	1968	Udani et al (17)	Mumbai	1.4
5	1974	Vaishnava et al (18)	Delhi	2.1
6	1989	Abraham et al (19)	Kochi	3.6
7	1989	Samal et al (20)	Cuttack	2.0
8	1989	Venkataraman et al (21)	Chennai	0.9

TABLE 2: PREVALENCE AND INCIDENCE RATES OF TYPE 1 DIABETES IN INDIA

No:	Year	Investigator	Location	Incidence (per 10,000 per year)	Prevalence (per 10,000)
1	1991	Bai et al (23)	Chennai	-	nil
2	1995	Bai et al (24)	Chennai	-	nil
3	1995	Ramachandran et al (13)	Chennai	1.1	-
4	1997	Dharamlingam et al (17)	Bengaluru	1.7	-

TABLE 3: STUDIES ON THE PREVALENCE OF DIABETES IN INDIA

No	Year	Investigator	Location	Population	Urban/ Rural	Sample	Age group	Diagnostic criteria	Prevalence (%)
1	1938	Chakravarthy et al (27)	Kolkatta	Hospital rec.	R,U	96300	all	Glycosuria	1.0
2	1959	Patel et al (28)	Mumbai	Hospital rec.	R,U	48572	adults	Not mentioned	0.7
3	1963	Patel et al (29)	Mumbai	Exhibition	R,U	18243	all	Glycosuria	1.5
4	1964	Ganguly et al (30)	Lucknow	Hospital based	U	1446	all	Blood glucose	2.3
5	1964	Vaishnava et al (31)	Vellore	Hospital	R,U	63356	all	Blood glucose	2.5
6	1965	Ramadwar et al (32)	Nagpur	-	-	-	>20	Blood glucose	2.4
7	1966	KEM Hospital group(33)	Mumbai	Textile workers	-	3200	-	Blood glucose	2.1
8	1966	Sainani et al (34)	Mumbai	Cancer centre	R,U	1207	>20	Blood glucose	2.2
9	1966	Berry et al (35)	Chandigarh	House to house	U	3846	all	Glycosuria	2.9
10	1966	Ahuja et al (36)	Delhi	Hospital rec.	-	11216	-	Not mentioned	2.3
11	1966	Shankar et al (37)	Hubli	Hospital rec.	R,U	21232	all	Not mentioned	2.2
12	1966	Rao et al (38)	Hyderabad	Exhibition	R,U	21396	>20	Glycosuria	4.1
13	1966	Misra et al (39)	Jabalpur	Hospital based	R,U	4000	all	Glycosuria	1.7
14	1966	Viswanathan et al (40)	Chennai	Camp	U	5030	all	Glycosuria	5.6
15	1966	Data et al(41)	Puducherry	House to house	U	2694	>5	Glycosuria	0.7
16	1966	Pai et al(42)	T'puram	Hospital rec.	R,U	45267	all	Glycosuria	8.7
17	1966	Gour et al(43)	Varanasi	House to house	U	2572	>10	Glycosuria	2.7
18	1971	Tripathy et al(44)	Cuttack	House to house	R,U	2447	>10	Blood sugar	1.2
19	1972	Vigg et al(45)	Hyderabad	House to house	R	847	>10	Blood sugar	2.5
20	1972	Rao et al(46)	Hyderabad	House to house	R	2006	>20	Glycosuria	2.4
21	1972	Ahuja et al(47)	New Delhi	House to house	R,U	2783	>15	Blood sugar	2.3
22	1973	Parameswara et al (48)	Bengaluru	House to house	U	25273	>5	Blood sugar	2.3
23	1973	Mukherjee et al (49)	Kolkatta	Hospital rec.	U	593	>10	Blood sugar	12.7
24	1973	Data et al (50)	Lucknow	Army	U	2190	all	Blood sugar	1.1
25	1974	Varma et al (51)	New Delhi	Army	U	2291	>20	Blood sugar	2.7
26	1975	Chhetri et al (52)	Kolkatta	Mobile clinic	R,U	4000	>15	Blood sugar	2.3
27	1978	Gupta et al (53)	Multicentre	House to house	U		>15	WHO criteria	3.0
27	1978	Gupta et al (53)	Multicentre	House to house	R	35,000	>15	WHO criteria	1.3
28	1979	Johnson et al (54)	Madurai	House to house	U	9670	>4	Blood sugar	0.5

TABLE 3: STUDIES ON THE PREVALENCE OF DIABETES IN INDIA (CONTD)

29	1984	Govindaraj et al(55)	Puducherry	House to house	R	1982	>15	Glycosuria	1.8
30	1984	Murthy et al(56)	Tenali	House to house	U	848	>15	Blood sugar	4.7
31	1986	Patel et al(57)	Bhadlan	House to house	R	3374	>10	Blood sugar	3.8
32	1987	Iyer et al(58)	Bardoli	Hospital rec.	R,U	1348	all	Blood sugar	4.4
33	1988	Ramachandran et al(59)	Kudremukh	Clinic based	U	678	>20	Blood sugar	5.0
34	1988	Verma et al (60)	Delhi	House to house	U	6878	all	Known cases	3.1
35	1988	Tiwari et al(61)	Rewa	House to house	R	15000	-	Blood sugar	1.9
36	1989	Rao et al (62)	Eluru	Population based	R			Known cases	1.5
37	1989	Kodali et al (26)	Gangavati	House to house	R	765	>30	Blood sugar	2.2
38	1991	Ahuja et al (63)	Delhi	Industrial setting	U	2572	>20	WHO criteria	4.1
38	1991	Ahuja et al (63)	Delhi	Population based	R	992	>20	WHO criteria	1.5
38	1991	Ahuja et al (63)	Kolkatta	Population based	R	2375	>20	WHO criteria	0.8
38	1991	Ahuja et al (63)	T'puram	Population based	R	1488	>20	WHO criteria	1.3
38	1991	Ahuja et al (63)	Ahmedabad	Population based	R	1294	>20	WHO criteria	3.9
38	1991	Ahuja et al (63)	Kalpa	House to house	R	999	>20	WHO criteria	0.4
39	1992	Ramachandran et al(64)	Chennai	Population based	U	900	>20	WHO criteria	8.2
39	1992	Ramachandran et al(64)	Chennai	Population based	R	1083	>20	WHO criteria	2.4
40	1994	Bano et al (65)	Bihar	Elderly	R	49	>50	BS $\geq$ 180 mg/dl	2.0
41	1994	Wander et al (66)	Punjab	Population based	R	1100	>30	-	4.6
42	1994	Patadin et al (67)	North Arcot	Population based	R	467	>40	WHO	4.9
43	1997	Ramachandran et al(68)	Chennai	Population based	U	1081	>20	WHO	11.6
44	1998	Shah et al (69)	Guwahati	Population based	U	1016	>20	WHO	8.2
45	1998	Singh et al (70)	Moradabad	Population based	U	1806	25-64	WHO	6.0
45	1998	Singh et al (70)	Moradabad	Population based	R	1769	25-64	WHO	2.8
46	1999	Bai et al (71)	Chennai	Staff of IIT	U	1198	NA	Known +WHO	17.4
47	1999	Ramankutty et al (72)	T'puram	Population based	U	206		FBS	16.3
48	2000	Zargar et al (73)	Kashmir	Population based	R,U	6091	>40	Known +WHO	6.1
49	2000	Ramankutty et al (74)	Kerala	Population based	U		>20	WHO	12.4
49	2000	Ramankutty et al (74)	Kerala	Population based	R		>20	WHO	2.5
50	2001	Bai et al (75)	Chennai	Population based	U	26,066	>20	Known cases	4.9

TABLE 3: STUDIES ON THE PREVALENCE OF DIABETES IN INDIA (CONTD)

51	2001	Iyer et al (76)	Mumbai	Population based	U	520	>20	WHO ADA	4.6 7.5
52	2001	Misra et al (77)	Delhi	Population based	U	532	>18	ADA	11.2
53	2001	Mohan et al (78)	Chennai	Population based	U	1262	>20	WHO	12.0
54	2001	Singh et al (79)	Manipur	Population based	R,U	1664	>15	WHO	4.0
55	2001	Ramachandran et al (80)	New Delhi	Population based	U	2300	>20	WHO	10.3
55	2001	Ramachandran et al (80)	Mumbai	Population based	U	2084	>20	WHO	9.3
55	2001	Ramachandran et al (80)	Chennai	Population based	U	1668	>20	WHO	13.5
55	2001	Ramachandran et al (80)	Kolkatta	Population based	U	2378	>20	WHO	11.7
55	2001	Ramachandran et al (80)	Hyderabad	Population based	U	1427	>20	WHO	16.6
55	2001	Ramachandran et al (80)	Bangalore	Population based	U	1359	>20	WHO	12.4
56	2003	Gupta et al (81)	Jaipur	Population based	U	458	>20	ADA	16.8
57	2004	Sadikot et al (82)	National	Population based	U	10617	>25	WHO	5.9
57	2004	Sadikot et al (82)	National	Population based	R	7746	>25	WHO	2.7
58	2004	Sadikot et al (83)	National	Population based	U	21,516	>25	ADA	4.6
58	2004	Sadikot et al (83)	National	Population based	R	19,754	>25	ADA	1.9
59	2005	Basavanagowdappa et al(84)	Mysore	Population based	R	1961	>25	ADA	3.8
60	2006	Mohan et al (85)	Chennai	Population based	U	2350	>20	WHO	14.3
61	2006	Menon et al (86)	Kochi	Population based	U	3069	18-10	WHO	19.5
62	2006	Deo et al (87)	Sindhudurg	Population based	R	1022	>20	WHO	9.3
63	2006	Chow et al (88)	Andhra	Population based	R	4535	>30	ADA	13.2
64	2006	Jali et al (89)	Belagavi	Clinic based	U	513	-	ADA	M: 10.4 F: 7.7
65	2006	Reddy et al (90)	Multicentric	Industry population	U	19973	20-69	ADA	10.1
66	2007	Kokiwar et al (91)	Nagpur	Population based	R	924	>30	WHO	3.7

TABLE 4: STUDIES ON THE PREVALENCE OF DIABETIC RETINOPATHY IN INDIA

No:	Year	Investigator	Location	Sample	Prevalence
1	1996	Rema et al (100)	Chennai	Clinic based	34.1 %
2	1999	Dandona et al (101)	Hyderabad	Population based	22.6 %
3	1999	Ramachandran et al(102)	Chennai	Clinic based	23.7 %
4	2002	Narendran et al (103)	Palakkad	Population based	26.8 %
5	2005	Rema et al (104)	Chennai	Population based	17.6 %