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SHORT COMMUNICATION

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Secular trends in the prevalence of diabetes and impaired glucose tolerance in urban South India—the Chennai Urban Rural Epidemiology Study (CURES-17)

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Abstract *Aims/hypothesis:* The aim of this study was to determine the secular trends in prevalence of diabetes and IGT in urban India. *Materials and methods:* The Chennai Urban Rural Epidemiology Study (CURES) screened 26,001 individuals aged ≥20 years using the American Diabetes Association fasting capillary glucose criteria. The study population, which was representative of Chennai, was recruited by systematic random sampling. Every tenth subject from Phase 1 of CURES was invited to participate in Phase 3 for screening by World Health Organization (WHO) plasma glucose criteria. The response rate was 90.4% (2,350 responders from 2,600 potential subjects). The prevalences of diabetes and IGT in CURES were compared with three earlier studies: two conducted on a representative population of Chennai in 1989 and 1995, and the other the National Urban Diabetes Survey (NUDS) completed in 2000. *Results:* The overall crude prevalence of diabetes using WHO criteria in CURES was 15.5% (age-standardised 14.3%), while that of IGT was 10.6% (age-standardised 10.2%). Prevalence of diabetes increased by 39.8% (8.3–11.6%) from 1989 to 1995; by 16.3% (11.6–13.5%) between 1995 and 2000; and by 6.0% (13.5–14.3%) between 2000 and 2004. Thus within a span of 14 years, the prevalence of diabetes increased by 72.3% (χ^2 trend 22.23, $p<0.0001$). The prevalence of IGT increased by 9.6% from 1989 to 1995 and by 84.6% between 1995 and 2000 (χ^2 trend 52.9, $p<0.0001$). However, it decreased by 39.3% between 2000 and 2004 ($p<0.0001$). There was a shift in the age at diagnosis of diabetes to a younger age in CURES compared with NUDS. *Conclusions/interpretation:* Compared with earlier studies, the prevalence of diabetes in Chennai, representing urban India, has increased while that of IGT has decreased.

Keywords Asian Indians · Diabetes · Impaired glucose tolerance · Prevalence · South Asians

Abbreviations CURES: the Chennai Urban Rural Epidemiology Study · NUDS: National Urban Diabetes Survey · WHO: World Health Organization

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Introduction

According to a recent World Health Organization (WHO) report, India, with 32 million diabetic individuals, currently has the highest incidence of diabetes worldwide; these numbers are predicted to increase to 80 million by the year 2030 [1]. Projections such as these are often based on one or two available studies. To make these figures more robust, it is necessary to have more studies. This paper contributes new data on the prevalence of diabetes and IGT in Chennai (formerly Madras), the fourth largest city in India, and compares the secular trends in the same city over the last two decades.

Materials and methods

Study design

The Chennai Urban Rural Epidemiology Study (CURES) is a large ongoing epidemiological study on a representative population of Chennai, the methodology of which is published elsewhere [2]. Briefly, the city of Chennai is divided into 155 corporation wards representing a socioeconomically diverse group. In Phase 1 of CURES, individuals from 46 corporation wards were screened by a systematic sampling technique. The sample distribution

in each ward within these zones is based on the proportion of their population in that particular zone. A probabilistic proportionate sampling was adopted to select the number of individuals seen in each ward. Furthermore, within each ward, every third lane or road, following the right-hand rule, was surveyed. A total of 26,001 individuals aged ≥20 years were screened.

Phase 2 of CURES deals with studies on the prevalence of microvascular and macrovascular complications of diabetes in subjects with self-reported diabetes from Phase 1 of the study, and is not discussed further in the present article. In Phase 3 of CURES (conducted between January 2003 and June 2004), every tenth subject recruited in Phase 1 (n=2,600), was invited to our centre for an OGTT; known diabetic subjects had fasting and postprandial glucose tests. Venous plasma glucose was measured on a Hitachi-912 Autoanalyser (Hitachi, Mannheim, Germany) using commercial kits. This study deals only with Phase 3 of CURES.

In Phase 3, diagnosis of diabetes and IGT was based on WHO Consulting Group criteria, i.e. 2-h venous plasma glucose ≥11.1 mmol/l, and ≥7.8 and <11.1 mmol/l, respectively [3].

Studies selected for comparing secular trends in diabetes and IGT prevalence

We compared the prevalence rates obtained in this study with those in three earlier studies conducted in Chennai—the first in 1989 [4], the second in 1995 [5] and the third, the National Urban Diabetes Survey (NUDS) in 2000 in six cities, including Chennai [6]. All three studies used WHO criteria for the diagnosis of diabetes and IGT and were conducted on a representative population of Chennai which takes socio-economic diversity into account. The response rates of these studies ranged from 84 to 91%.

The prevalence rate obtained in the present study was age-standardised (1991 Chennai census) and compared with the age-standardised rates of the previous studies. A trends χ^2 test was used to compare the increase in prevalence of diabetes across the different studies. Since the prevalence of IGT decreased in CURES (2004) compared with the 2000 survey, χ^2 analysis of trends was restricted to data from 1989 to 2000. Prevalence of IGT in the years 2000 and 2004 was compared using a simple χ^2 test.

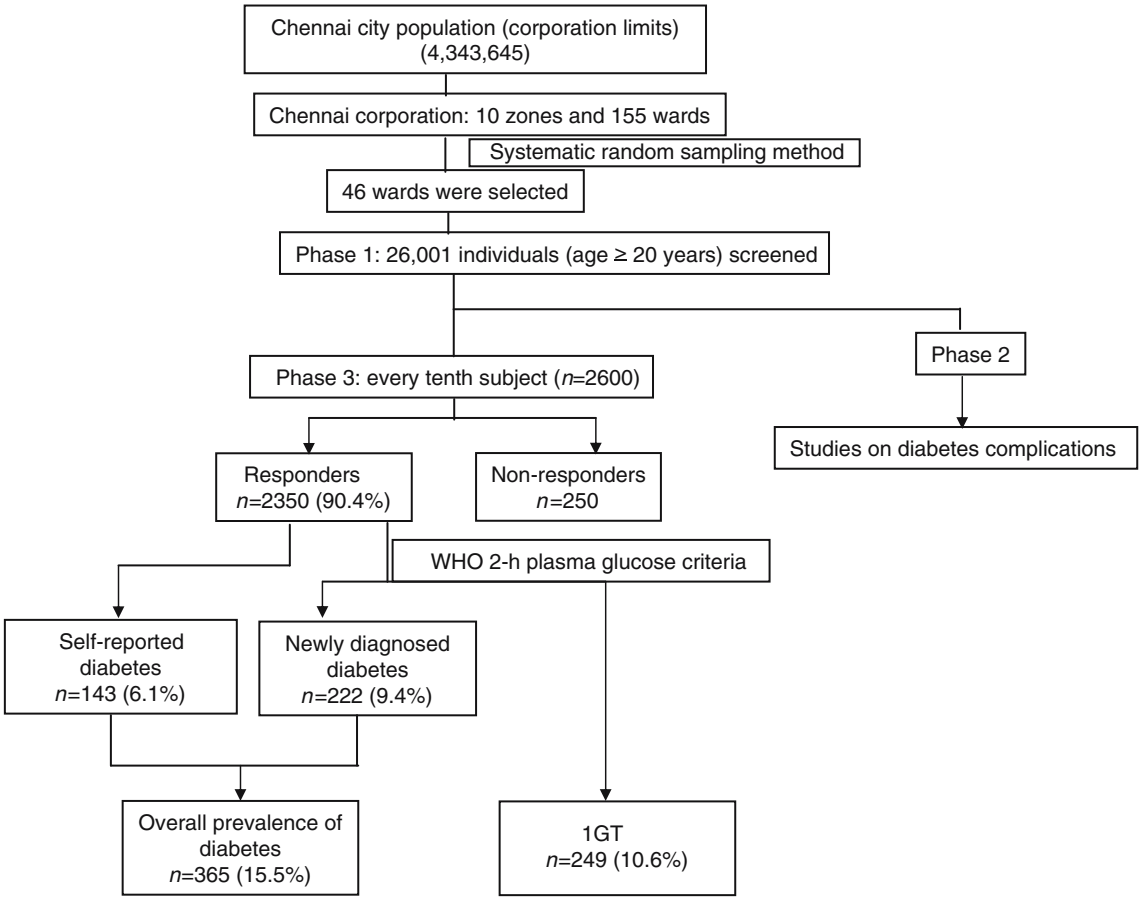

Fig. 1 Sampling protocol of CURES

Results

A total of 26,001 subjects participated in Phase 1 of CURES. Blood tests were performed in all but 184 subjects, giving 99.3% coverage.

Phase 3 had a response rate of 90.4% (2,350/2,600 subjects participated). Figure 1 presents the prevalence rates of diabetes and IGT. The crude prevalence of diabetes using WHO criteria was 15.5% (365/2,350), which comprised 6.1% known diabetic subjects (143/2,350) and 9.4% newly detected diabetic subjects (222/2,350). The crude prevalence of IGT was 10.6% (249/2,350).

Table 1 presents the age-standardised prevalences of diabetes and IGT at different time periods in Chennai using WHO 2-h glucose criteria. The mean age (range 38–41 years) and gender distribution (males 42–50%) were comparable in the different studies.

In 1989, the age-standardised prevalence of diabetes was 8.3%; this rose to 11.6% in 1995 and to 13.5% in 2000, while in the present study (2003–2004), it is 14.3%. Thus, within a span of 14 years, the prevalence of diabetes increased by 72.3% (trend χ^2 22.23, $p<0.0001$). From 1989 to 1995 it increased by 39.8%, between 1995 and 2000 by 16.3% and between 2000 and 2004 by 6.0%.

The age-standardised prevalence of IGT increased by 9.6% from 1989 to 1995 and by 84.6% between 1995 and 2000 (trend χ^2 52.9, $p<0.0001$). However, it decreased by 39.3% between 2000 and 2004 ($p<0.0001$).

NUDS also provides data on prevalence of diabetes at every age interval in six Indian cities. At every age interval, the prevalence of diabetes in CURES was higher than that reported in NUDS (CURES vs NUDS: 20–29 years: 3.7 vs 2.4%, $p=0.038$; 30–39 years: 10.2 vs 7.0%, $p=0.002$; 40–49 years: 20.5 vs 16.5%, $p=0.013$; 50–59 years: 29.7 vs 26.3%, $p=0.108$; 60–69 years: 33.6 vs 29.1%, $p=0.045$; and >69 years: 27.2 vs 25.9%, $p=0.413$).

There was a temporal shift in the age at diagnosis of diabetes to a younger age in CURES compared with NUDS (CURES vs NUDS, 20–29 years: 6.6 vs 5.4%, $p=0.192$; 30–39 years: 25.2 vs 19.7%, $p=0.010$; 40–49 years: 30.4 vs 29.0%, $p=0.298$; 50–59 years: 24.9 vs 26.8%, $p=0.224$; 60–69 years: 10.4 vs 13.8%, $p=0.039$; >69 years: 2.5 vs 5.0%, p=0.016).

Discussion

This study shows that the prevalence of diabetes in urban India (represented by Chennai) continues to rise and has now reached a figure of 14.3% (age-standardised), while the prevalence of IGT appears to be lower (10.6%) than that reported in 2000 (16.8%).

Though earlier studies have documented a rising prevalence of diabetes in India [5, 7], they have compared data from different regions of India or different parts within a state [7]. To compare secular trends, it would be more accurate to document the prevalence of diabetes within the same region. Chennai is the only city in India for which repeated, well-conducted epidemiological studies on the prevalence of diabetes are available, and hence we were able to compare the data obtained in our study with three earlier epidemiological studies carried out in the same city using similar methods. One of the advantages of comparing data from different studies in Chennai City is that, being a metropolitan city, the rate of migration from this city to other cities/rural areas is relatively low and hence the population is stable.

The age-standardised prevalence of diabetes in Chennai in this study is 72% higher than that reported in 1989, and 6% higher than the NUD study, carried out just 3 years earlier. Also there appears to be a temporal shift, with the younger age groups being more affected. It is well known that Asian Indians develop diabetes one or two decades earlier than Europeans [8]. It is therefore disturbing that over 20% of individuals in the 40–49 years age group, i.e. in the prime of their life, now have diabetes. The continuing increase in the prevalence of diabetes in India, combined with a shift to earlier ages, has great implications for both the nation's health and its economics and this calls for urgent preventive steps.

With regard to IGT, a marked increase was observed between 1989 and 2000, but this had decreased by 2004. The lower prevalence may be the result of methodological differences between the studies because NUDS used capillary blood glucose, while CURES estimated venous plasma glucose by autoanalyser. Two-hour capillary whole blood glucose value overestimates diabetes and IGT [9] and glucose meters have higher CVs compared with autoanalysers. However, in this study the prevalence of

Table 1 Secular trends in the prevalence of diabetes and IGT in Chennai, South India, using WHO criteria (2-h post glucose load values)

Year [reference]	Sample size (n)	Method of glucose estimation	Age group (years)	Age-standardised prevalence[a] (%) (95% CI)	
				Diabetes	IGT
1988–1989 [5]	900	Capillary whole blood	≥20	8.3 (6.5–10.1)	8.3 (6.5–10.1)
1994–1995 [6]	2,183	Venous plasma	≥20	11.6 (10.6–12.6)	9.1 (8.1–10.1)
2000 [7] NUDS	1,668	Capillary whole blood	≥20	13.5 (11.8–15.2)	16.8 (14.6–19.0)
2003–2004 CURES	2,350	Venous plasma	≥20	14.3 (12.9–15.8)	10.2 (9.0–11.5)
χ^2, p value				22.23, $p<0.0001$	52.9, $p<0.0001$[b]
					37.4, $p<0.0001$[c]

[a]Age standardisation based on 1991 Chennai census
[b]Trend χ^2 analysis: 1989 survey to 2000 survey
[c]χ^2 analysis: 2000 survey vs 2004 survey

diabetes increased while that of IGT decreased. Furthermore, a recent study suggested that the prevalence of diabetes determined by capillary blood glucose is not remarkably different from that using venous plasma glucose [10]. Thus it is likely that the decrease in prevalence of IGT may have two causes. First, increased conversion rates of IGT to diabetes could suggest a slowing of the epidemic of diabetes in urban India, as the IGT (prediabetic) pool begins to shrink. Second, 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. Prospective studies are required to assess the exact changes occurring with regard to the diabetes epidemic in India.

One of the limitations of this comparison is that the four studies involved used slightly different sampling strategies, (the 1989 and the present study used systematic sampling techniques with a random start; the 1995 study and NUDS sampling was carried out to get a representation of all socio-economic strata). However, because all studies were conducted on a representative population of Chennai, this is unlikely to substantially affect the results obtained.

In conclusion, this study demonstrates that the prevalence of diabetes in Chennai (representing urban India) has further increased, while that of IGT appears to have decreased.

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