

**PREVALENCE AND RISK FACTORS OF DIABETIC NEPHROPATHY IN AN URBAN SOUTH INDIAN POPULATION: *THE CHENNAI URBAN RURAL EPIDEMIOLOGY STUDY (CURES - 45)***

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***Running Title*** : Diabetic nephropathy in Asian Indians

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## ABSTRACT

**Objective:** The aim of this study was to determine the prevalence of diabetic nephropathy among urban Asian Indian type 2 diabetic subjects.

**Research design and Methods:** Type 2 diabetic subjects [n=1716], inclusive of 'known' diabetic (KD) subjects (1363/1529, response rate 89.1%) and randomly selected newly diagnosed diabetic (NDD) subjects [n=353] were selected from the Chennai Urban Rural Epidemiology Study (CURES). Microalbuminuria was estimated by immunoturbidimetric assay and diagnosed if albumin excretion was between 30 – 299  $\mu\text{g}/\text{mg}$  of creatinine and overt nephropathy if it was  $\geq 300$   $\mu\text{g}/\text{mg}$  of creatinine in the presence of diabetic retinopathy, which was assessed by stereoscopic retinal colour photography.

**Results:** The prevalence of overt nephropathy was 2.2% [95% confidence interval [CI]:1.51-2.91]. Microalbuminuria was present in 26.9% [95% CI:24.8-28.9]. Compared to the NDD subjects, KD subjects had greater prevalence rates of both microalbuminuria with retinopathy and overt nephropathy [8.4% vs. 1.4%,  $p < 0.001$  and 2.6% vs. 0.8%  $p = 0.043$ , respectively]. Logistic regression analysis showed that HbA1c [odds ratio [OR]:1.325, 95% CI:1.256-1.399,  $p < 0.001$ ], smoking [OR:1.464,  $p = 0.011$ ], duration of diabetes [OR:1.023,  $p = 0.046$ ], systolic blood pressure [OR:1.020,  $p < 0.001$ ] and diastolic blood pressure [OR:1.016,  $p = 0.022$ ] were associated with microalbuminuria. HbA1c [OR:1.483,  $p < 0.0001$ ], duration of diabetes [OR:1.073,  $p = 0.003$ ] and systolic blood pressure [OR:1.031,  $p = 0.004$ ] were associated with overt nephropathy.

**Conclusions:** The results of the study suggest that in urban Asian Indians, the prevalence of overt nephropathy was 2.2% and macroalbuminuria, 26.9%. Duration of diabetes, HbA1c and systolic blood pressure were the common risk factors for overt nephropathy and microalbuminuria.

**Introduction:**

Diabetic nephropathy is the leading cause of end-stage renal disease (ESRD) worldwide and it is estimated that around 20% of type 2 diabetic patients reach ESRD during their lifetime (1).

Kidney disease in diabetic patients is clinically characterized by increasing rates of urinary albumin excretion, starting from normoalbuminuria which progresses to microalbuminuria, macroalbuminuria and eventually to end stage renal disease. Microalbuminuria is the earliest clinically detectable stage of diabetic kidney disease at which appropriate interventions can retard, or reverse, the progress of the disease.

According to the most recent estimates published in the Diabetes Atlas 2006, India has the largest number of diabetic patients in the world, estimated to be around 40.9 million in the year 2007 and expected to increase to approximately 69.9 million by the year 2025 (2). Type 2 diabetes in Asian Indians differs from that in Europeans in several aspects-the onset is at a younger age, obesity is less common, and genetic factors appear to be more common (3). Some studies conducted in migrant Asian Indians in UK and Europe have reported increased prevalence of diabetic nephropathy compared to white Caucasians (4-6). The few studies published on the prevalence of diabetic nephropathy in India have all been clinic-based (7,8). Indeed, the Diabetes Atlas 2006 does not list a single population based study on diabetic nephropathy from South Asia (2). This paper reports on the first population-based data on the prevalence of diabetic nephropathy in India.

**Methods:**

Study subjects were recruited from the Chennai Urban Rural Epidemiology

Study (CURES), conducted on a representative population of Chennai (formerly Madras), in southern India, the fourth largest city in India with a population of about 5 million. The city of Chennai is divided into 155 corporation wards representing a socio- economically diverse group. The methodology of the study has been published elsewhere (9). Briefly, in Phase 1 of CURES [urban component], 26001 individuals aged  $\geq 20$  years were screened for diabetes using systematic sampling technique from 46 corporation wards representative of the various social tiers in Chennai. The selection criterion was taken as 20 years of age due to younger age at onset of type 2 diabetes in Indians (9). Self reported diabetic subjects identified in Phase 1 (n=1529) were classified as 'known diabetic subjects' (KD). Fasting capillary blood glucose was determined using a One Touch Basic glucose meter (LifeScan, Johnson & Johnson, Milpitas, California, USA) in all subjects. Diabetes was diagnosed using ADA criteria (10).

In Phase 2 of CURES, all the KD subjects (n=1529) were invited to our centre for detailed studies on vascular complications and 1363 consented for both retinal examination and estimation of microalbuminuria (response rate: 89.1%).

In addition, 15% percent of subjects with impaired fasting glucose, and 10% of subjects with normal fasting glucose in Phase 1 were requested to undertake oral glucose tolerance test [OGTT]. Thirty seven of the former group and 14 of the latter group who were detected to have diabetes according to WHO consulting group criteria [2 hour plasma glucose  $\geq 11.1$  mmol/L] (11) were added to the 320 randomly chosen newly detected diabetic [NDD] subjects from Phase 1 of the study. Of the total 371 NDD subjects, 353 consented for this study [response rate:95.1%]. Thus the

final study numbers were 1716 diabetic subjects [KD:1363+NDD:353].

The institutional ethics committee approval was obtained and informed consent was obtained from all study subjects.

*Clinical and biochemical studies:* Measurements of weight, height and waist circumference were obtained using standardized techniques. The body mass index (BMI) was calculated using the formula: weight(kg)/height(m<sup>2</sup>). Blood pressure was recorded in the sitting position in the right arm with a mercury sphygmomanometer (Diamond Deluxe Industrial Electronics and Products, Pune, India) and rounded off to the nearest 2mmHg. Two readings were taken 5 minutes apart and the mean of the two was taken as the final blood pressure reading.

A fasting blood sample was taken for estimation of plasma glucose and serum lipids using a Hitachi 912 autoanalyser (Roche Diagnostics GmbH, Mannheim, Germany). Glycated hemoglobin (HbA1c) was measured by the High Performance Liquid Chromatography (HPLC) method using the Variant machine (BIORAD, Hercules, California).

*Estimation of Microalbuminuria:* Microalbumin concentration was measured in a fasting urine sample using immunoturbidometric assay (Hitachi 902 autoanalyser, Roche Diagnostics, Mannheim, Germany). The mean inter and intra assay co-efficients of variation were 3.5% and 4.2% respectively.

### **RETINOPATHY:**

The ocular fundi were photographed using four-field stereo color retinal photography [Zeiss FF 450 plus camera]. Photographs were graded by ophthalmologist [RM]. The minimum criterion for diagnosis of DR was the

presence of at least one definite microaneurysm in any field photographed. Photographs were assessed and assigned a retinopathy level and the final diagnosis for each patient was determined from the grading of the worse eye according to the ETDRS criteria for severity of individual eye (12).

### **DEFINITIONS:**

**Hypertension:** Subjects with self-reported hypertension and those who had a systolic blood pressure (SBP) of 140 mmHg or greater and/or diastolic blood pressure (DBP) of 90 mmHg or greater (13) were considered to have hypertension.

**Smoking:** Individuals were classified as non-smokers and current smokers.

**Microalbuminuria:** Microalbuminuria was diagnosed if the albumin excretion was between 30–299 µg/mg of creatinine (8). **Overt nephropathy:** Overt nephropathy was diagnosed if albumin excretion was ≥ 300 µg/mg of creatinine in the presence of diabetic retinopathy.

### **Statistical Analysis:**

Numbers were expressed as mean ± standard deviation. Student's "t" test or one-way ANOVA [Tukey's Honestly Significant Difference comparison] was used to compare continuous variables and chi square test was used to compare proportions among groups. Logistic regression analysis was done using either microalbuminuria or overt nephropathy as the dependent variable to identify the risk factors. Subjects were also categorized based on presence of retinopathy to study the risk factors for albuminuria with and without retinopathy. p<0.05 was considered significant. All analysis was done using Windows based SPSS statistical package (Version 10.0, Chicago, IL).

## Results:

There were no significant differences in the baseline values between the 1363 'responders' and the 166 'non-responders' among the KD subjects [responders vs non-responders, age (years): $52\pm 11$  vs  $51\pm 12$ ,  $p = 0.27$ ; male(%): $46.3$  vs  $51.7$ ,  $p=0.20$ ; fasting plasma glucose (mmol/l): $9.3\pm 4.3$  vs  $9.5\pm 4.4$ ,  $p=0.43$ ; systolic blood pressure (mm Hg):  $131\pm 22$  vs  $130\pm 22$ ,  $p=0.581$ ; diastolic blood pressure (mm Hg): $78\pm 12$  vs  $77\pm 11$ ,  $p=0.31$ ].

The mean age of the total study population [ $n=1716$ ] was  $51 \pm 11$  years and  $44.7\%$  ( $n = 744$ ) were males. Of the total of 1716 diabetic subjects studied, 462 [ $26.9\%$ , 95% confidence interval[CI]: $24.8-28.9$ ] had microalbuminuria, 38 [ $2.2\%$ , 95% CI: $1.51-2.91$ ] had overt nephropathy (i.e., macroalbuminuria with retinopathy) and 53 [ $3.1\%$ , 95% CI: $3.27-3.91$ ] had macroalbuminuria without retinopathy (Table 1). Compared to the NDD subjects, KD subjects had greater prevalence rates of both microalbuminuria with retinopathy and overt nephropathy [ $8.4\%$  vs.  $1.4\%$ ,  $p<0.001$  and  $2.6\%$  vs.  $0.8\%$   $p=0.043$ , respectively].

Table 2 presents the clinical and biochemical characteristics of the study subjects. Subjects with overt nephropathy were older and had a longer duration of diabetes [ $p$  for trend  $<0.0001$ ]. Systolic and diastolic blood pressure, fasting plasma glucose and HbA1c values were highest among the overt nephropathy group, followed by microalbuminurics and normoalbuminurics [ $p$  for trend  $<0.0001$ ]. Prevalence of hypertension was higher among subjects with microalbuminuria and overt nephropathy compared to the normoalbuminuric group [ $p<0.0001$ ]. Subjects with microalbuminuria who had retinopathy

had lower body mass index [ $23.54\pm 3.71$  kg/m<sup>2</sup> vs  $25.51\pm 4.45$  kg/m<sup>2</sup>], and waist circumference [ $88\pm 9$  cm vs  $92\pm 11$  cm], but higher fasting plasma glucose [ $12.1\pm 4.3$  vs  $9.6\pm 3.6$  mmol/l] and HbA1c values [ $10.6\pm 2.0$  % vs  $9.2\pm 2.2$  %] and longer duration of diabetes [ $8 \pm 6$  years vs  $5 \pm 5$  years] compared to those without retinopathy. Other parameters like age and blood pressure did not vary significantly between the study groups.

Prevalence of microalbuminuria and overt nephropathy was computed in relation to duration of diabetes and HbA1c. There was an increase in the prevalence of microalbuminuria with increase in duration of diabetes [duration of diabetes  $<1.0$  year: $22.3\%$ , 1-5 years: $25.7\%$ , 6-10 years: $33.5\%$ ,  $>10$  years: $30.2\%$ ,  $p$  for trend  $<0.001$ ]. There was a significant increase in the prevalence of overt nephropathy with increase in duration of diabetes [duration of diabetes,  $<1.0$  year:  $0.7\%$ , 1-5 years: $1.1\%$ , 6-10 years: $3.5\%$ ,  $>10$  years: $7.7\%$ ,  $p$  for trend  $<0.001$ ]. Prevalence of both microalbuminuria [HbA1c  $< 7.0\%$ :  $14.5\%$ ,  $7.0-8.9\%$ :  $22.6\%$ ,  $9-10.9\%$ :  $35.1\%$ ,  $>10.9\%$ :  $43.4\%$ ], and overt nephropathy [HbA1c  $< 7.0\%$ :  $0.2\%$ ,  $7.0-8.9\%$ :  $1.1\%$ ,  $9-10.9\%$ :  $3.5\%$ ,  $>10.9\%$ :  $5.5\%$ ] increased with increase in HbA1c levels [ $p$  for trend  $<0.001$ ].

Prevalence of microalbuminuria and overt nephropathy was computed in relation to use of antihypertensive drugs. Of the 1716 subjects, 425 were on antihypertensives. Prevalence of microalbuminuria and overt nephropathy [antihypertensive drug users vs others: microalbuminuria: $33.9\%$  vs  $24.6\%$ ,  $p<0.001$ , overt nephropathy: $6.6\%$  vs  $0.8\%$ ,  $p<0.001$ ] were higher in antihypertensive users. Subjects on antihypertensives were further categorized as Angiotensin Converting Enzyme Inhibitors / Angiotensin Receptor

Blocker[ACEI/ARB] users[n=121] and others. There was no significant difference between these two groups with respect to microalbuminuria whereas overt nephropathy was higher in those on ACEI/ARB [ACEI/ARB users vs others, microalbuminuria: 35.5%vs 33.2%,p=0.26,overt nephropathy:11.6% vs 4.6%, p=0.004].

There were 23 subjects, 21 with KD and 2 NDD who had renal insufficiency, defined as serum creatinine levels  $\geq 1.5$  mg/dl. Retinopathy was present in 7/21 (33.3%) of KD subjects which included non proliferative diabetic retinopathy(NPDR) in 4 and proliferative diabetic retinopathy(PDR) in 3 subjects. Neither of the NDD subjects with renal insufficiency, had retinopathy.

Regression analysis revealed that HbA1c [p<0.001], smoking [p=0.010], duration of diabetes [p=0.046], systolic blood pressure [p<0.0001] and diastolic blood pressure [p=0.022] were associated with microalbuminuria. Regression analysis was carried out after categorizing microalbuminuric patients with and without retinopathy. HbA1c and systolic blood pressure were common risk factors for microalbuminuria with retinopathy [HbA1c-odds ratio(OR):1.528,95% confidence interval(CI):1.393–1.676,p<0.001;systolic blood pressure-OR:1.020,95% CI:1.006–1.035,p = 0.007] as well as without retinopathy [HbA1c-OR:1.238,95% CI:1.165–1.315,p<0.001;systolic blood pressure-OR:1.021,95% CI:1.012–1.031,p<0.001]. Smoking[OR:1.613,95% CI:1.152–2.259,p=0.005] and diastolic blood pressure[OR:1.018,95% CI:1.002–1.034,p=0.028] showed association only with microalbuminuria without retinopathy while duration of diabetes[OR:1.085, 95% CI:1.047–1.124,p<0.001] showed an association only with microalbuminuria with retinopathy.

Overt nephropathy showed significant association with HbA1c [p<0.0001], duration of diabetes

[p=0.003] and systolic blood pressure [p=0.004][Table 3]. None of the risk factors except diastolic blood pressure showed an association with macroalbuminuria without retinopathy [odds ratio:1.034,95% CI:1.002–1.068,p=0.048] [Table 3].

Table 4 compares the prevalence of microalbuminuria and nephropathy in different populations (14-19). The prevalence of overt nephropathy in Indians appears to be lower, while that of microalbuminuria is comparable to that reported earlier studies in other populations.

### **Discussion:**

This, to our knowledge, is the first population-based study from India on the prevalence of, and risk factors for, diabetic nephropathy. The main findings of this study are that in urban Asian Indians [i] prevalence of overt diabetic nephropathy was 2.2% and that of microalbuminuria, 26.9% [ii] risk factors for diabetic nephropathy include HbA1c, duration of diabetes and systolic blood pressure while for microalbuminuria, additionally smoking and diastolic blood pressure were also risk factors.

We compared our prevalence rates with other population-based studies on diabetic nephropathy. Prevalence of nephropathy was extremely high among Nauruans [75% in self-reported diabetic subjects and 63% in newly detected diabetic subjects] (20) and Pima Indians [47%] (21). A population-based study in Egypt recorded a prevalence of albuminuria of 21% among known diabetic subjects (22). It had been earlier reported that migrant Indians have higher prevalence of diabetic nephropathy compared to the host populations (4-6,23). Compared to these studies and others presented in Table 4, our study shows lower prevalence of diabetic nephropathy.

The large differences observed in prevalence of nephropathy among different studies could be attributed to the differences in study design and methodologies adopted for defining the disease. Many of the studies were clinic-based and this could have introduced a referral bias. In addition, most of these studies have not included retinopathy in the definition for diagnosis of diabetic nephropathy. The strength of our study is that it is population-based and has included diabetic retinopathy in the definition with the latter diagnosed using retinal colour photography. These differences in methodologies used could probably explain the lower prevalence of overt nephropathy observed in our study. However, one cannot rule out the possibility of true ethnic difference in the prevalence of nephropathy due to decreased susceptibility to microvascular disease in native Asian Indians. In support of this, in an earlier study we had reported that the prevalence of diabetic retinopathy is lower in Indians compared to other ethnic groups (24). These findings, if confirmed by future studies, would be of great interest as Asian Indians are known to have much higher rates of premature coronary artery disease compared to other ethnic groups (25). There could be several explanations for the lower prevalence of microvascular complications noted in our studies. It is possible, that due to wide publicity of the Diabetes Control and Complications Trial(DCCT) and the United Kingdom Prospective Diabetes Study(UKPDS) results, control of diabetes is improving globally including in India, which could have resulted in lower rates of microvascular complications. Secondly, the prevalence of hypertension is known to be lower in native south Asians and this may afford a relative protection against diabetic kidney disease (26). Finally, consequent to the greater awareness of nephroprotective action of

ACEI and ARBs, usage of these drugs for preventing nephropathy has increased. This could also affect the prevalence rates of nephropathy compared to older studies. These are however purely speculative and need to be addressed by future studies, preferably longitudinal, studies.

The criteria used for diagnosis of overt nephropathy in this study included retinopathy as it makes the diagnosis of diabetic nephropathy more specific. We however compared the risk factors for albuminuria with and without retinopathy to highlight the possible differences in risk factors. Poor glycemic control, long duration of diabetes and systolic blood pressure were the risk factors for overt nephropathy. This is similar to that reported in several other studies (1,27).

In the subset of individuals who had macroalbuminuria without retinopathy [possibly suggestive of non-diabetic renal disease], diastolic blood pressure was the only associated risk factor. Moreover the fact that the prevalence of this entity was higher among the newly detected diabetic subjects suggests that a significant proportion of these individuals could have non specific proteinuria/macroalbuminuria associated with uncontrolled hyperglycemia. However some may indeed have diabetic nephropathy, as studies have shown that some patients in this category have histological changes of diabetic nephropathy (28,29).

The prevalence of microalbuminuria in this study was not remarkably different from that reported in other studies. For microalbuminuria, the risk factors were similar to those for overt nephropathy, but smoking and diastolic blood pressures were additional risk factors.

The major limitation of the study is that being an epidemiological study, due to

logistic reasons, only one measure of albuminuria was done in spot urine. However, this may not alter the inferences drawn as most epidemiological studies have only used a single measure. The prevalence of microalbuminuria could however have been lower if repeated measurements of albumin were done as has been shown in clinic based studies (30). Another limitation is that renal biopsies were not performed, as it is difficult to carry out these procedures in population-based studies due to logistic and ethical reasons.

This study is of importance given the growing epidemic of diabetes in India. It is estimated that as of the year 2007, there are 40.9 million diabetic individuals in India (2). The prevalence of overt nephropathy in this study i.e 2.2%, when translated into numbers would imply that over 850,000 individuals in India have overt nephropathy. Most patients with macroproteinuria eventually reach the stage of end stage renal disease, ESRD (1,31). The cost of a renal transplant in India is ~4760 USD [Rs.2,00,000] which is unaffordable to the majority of people in India (32). The absolute number of subjects with diabetic nephropathy thus presents an economic burden to both the

individual and the society. The large pool of microalbuminuria also suggests that there could be large increases in overt nephropathy with time, unless aggressive control of diabetes and hypertension is initiated.

In conclusion, the results of this study suggest that the prevalence of overt diabetic nephropathy in Asian Indians is lower, while that of microalbuminuria is comparable to that reported in other ethnic groups. Risk factors for overt nephropathy are found to be poor glycemic control, long duration of diabetes and systolic blood pressure while for microalbuminuria, smoking and diastolic blood pressure were additional risk factors. There is an urgent need to launch a national diabetes control programme to tackle the potential economic burden due to diabetic nephropathy in India.

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**Table 1: Prevalence of microalbuminuria and macroalbuminuria in the study population**

| <b>Groups</b>                                                        | <b>Overall Diabetes<br/>(n = 1716)</b> | <b>NDD<br/>(n = 353)</b> | <b>KD<br/>(n = 1363)</b> | <b>p value for<br/>KD vs NDD</b> |
|----------------------------------------------------------------------|----------------------------------------|--------------------------|--------------------------|----------------------------------|
| <b>Microalbuminuria</b>                                              |                                        |                          |                          |                                  |
| <b>Overall</b>                                                       | 462 [26.9%]                            | 84 [23.8%]               | 378 [27.7%]              | NS                               |
| <b>With retinopathy</b>                                              | 119 [6.9%]                             | 5 [1.4%]                 | 114 [8.4%]               | < 0.001                          |
| <b>Without retinopathy</b>                                           | 343 [20.0%]                            | 79 [22.4%]               | 264 [19.4%]              | NS                               |
| <b>Overt nephropathy<br/>[Macroalbuminuria<br/>with retinopathy]</b> | 38 [2.2%]                              | 3 [0.8%]                 | 35 [2.6%]                | 0.043                            |
| <b>Macroalbuminuria<br/>without retinopathy</b>                      | 53 [3.1%]                              | 10 [2.8%]                | 43 [3.2%]                | NS                               |

**NDD = Newly diagnosed diabetic subjects**  
**KD = Known diabetic subjects**

**Table 2 : Clinical and biochemical characteristics of the study population**

| Parameters                           | Normo-albuminuria<br>(n = 1163) | Micro-albuminuria<br>(n = 462) | Overt nephropathy<br>[macro-albuminuria with retinopathy]<br>(n = 38) | p value for trend |
|--------------------------------------|---------------------------------|--------------------------------|-----------------------------------------------------------------------|-------------------|
| Age (years)                          | 50 ± 11                         | 52 ± 11 *                      | 57 ± 9 **#                                                            | < 0.0001          |
| Sex, Male n (%)                      | 503 [43.3%]                     | 225 [48.7%]                    | 16 [42.1%]                                                            | 0.181             |
| Duration of diabetes (years)         | 4 ± 5                           | 5 ± 6 ***###                   | 10 ± 6 ***###                                                         | < 0.0001          |
| Smoking n (%)                        | 183 [15.7%]                     | 100 [21.6%]                    | 7 [18.4%]                                                             | 0.044             |
| Body mass index (kg/m <sup>2</sup> ) | 25.41 ± 4.24                    | 25.00 ± 4.35                   | 23.61 ± 5.04 *                                                        | 0.004             |
| Waist circumference (cm)             | 90 ± 10                         | 91 ± 10                        | 89 ± 14                                                               | 0.864             |
| Systolic blood pressure (mm Hg)      | 126 ± 18                        | 135 ± 24 ***                   | 142 ± 24 ***                                                          | < 0.0001          |
| Diastolic blood pressure (mm Hg)     | 76 ± 11                         | 80 ± 12                        | 79 ± 14                                                               | < 0.0001          |
| Fasting plasma glucose (mmol/l)      | 8.2 ± 3.6                       | 10.2 ± 3.9 ***###              | 12.6 ± 4.3 ***###                                                     | < 0.0001          |
| HbA1c (%)                            | 8.2 ± 2.1                       | 9.5 ± 2.3 ***###               | 11.0 ± 2.3 ***###                                                     | < 0.0001          |
| Hypertension (%)                     | 40.8%                           | 59.7%                          | 86.8%                                                                 | < 0.001           |

\* p < 0.05, \*\* p < 0.01, \*\*\* p < 0.001 compared to normals

# p < 0.05, ## p < 0.01, ### p < 0.001 compared to microalbuminuria

**Table 3 : Multiple logistic regression analysis**

| <b>Parameters</b>                            | <b>OR</b> | <b>95% CI</b> | <b>p value</b> |
|----------------------------------------------|-----------|---------------|----------------|
| <b>Dependant variable: Overt nephropathy</b> |           |               |                |
| Age                                          | 1.023     | 0.983-1.065   | 0.263          |
| Smoking [yes=1, no=0]                        | 1.221     | 0.512 -2.914  | 0.652          |
| HbA1c                                        | 1.483     | 1.297-1.695   | <0.0001        |
| Duration of diabetes                         | 1.073     | 1.024-1.125   | 0.003          |
| Systolic blood pressure                      | 1.031     | 1.010-1.053   | 0.004          |
| Diastolic blood pressure                     | 0.973     | 0.936-1.011   | 0.165          |
| <b>Dependant variable: Microalbuminuria</b>  |           |               |                |
| Age                                          | 1.002     | 0.990-1.015   | 0.731          |
| Smoking [yes=1, no=0]                        | 1.464     | 1.091 -2.914  | 0.011          |
| HbA1c                                        | 1.325     | 1.256-1.399   | <0.0001        |
| Duration of diabetes                         | 1.023     | 1.001-1.047   | 0.046          |
| Systolic blood pressure                      | 1.020     | 1.012-1.028   | <0.0001        |
| Diastolic blood pressure                     | 1.016     | 1.002-1.031   | 0.022          |

**Table 4: Prevalence of nephropathy and microalbuminuria in type 2 diabetes in different population based studies**

| <b>Author (Reference)</b>          | <b>Place, Year</b>   | <b>Sample size, Type of study</b> | <b>Prevalence of Microalbuminuria (Criteria)</b>                                    | <b>Prevalence of Macroalbuminuria (Criteria)</b>                                              |
|------------------------------------|----------------------|-----------------------------------|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| Bruno et al (14)                   | Italy, 1996          | 1574, Population based            | 32.1%<br>(20 - 200 µg/min)                                                          | 17.6%<br>(>200 µg/min)                                                                        |
| Gatling et al (15)                 | Poole, UK, 1988      | 450, Population based             | -                                                                                   | 7.0%<br>(> 300 mg/g creatinine)                                                               |
| Neil et al (16)                    | Oxford, UK, 1993     | 246, Population based             | 15%<br>(>40 mg/L)                                                                   | 4%<br>(>200 mg/L)                                                                             |
| Wirta et al (17)                   | Finland, 1995        | 188, Population based             | Newly diagnosed: 29%<br>Self reported: 27%<br>(30 - 300 mg/24 hours)                | Newly diagnosed: 4%<br>Self reported: 7%<br>(>300 mg/24 hours)                                |
| Collins et al (18)                 | Western Samoa, 1995  | 162, Population based             | Newly detected diabetes: 22.0%<br>Self reported diabetes: 17.2%<br>(30 - 299 µg/ml) | Newly detected diabetes: 3.9%<br>Self reported diabetes: 6.3%<br>(≥300 µg/ml)                 |
| Klein et al (19)                   | Wisconsin, USA, 1993 | 798, Population based             | 25.9%<br>(30 - 299 mg/ L)                                                           | 16.0%<br>(>300 mg/ L)                                                                         |
| Unnikrishnan et al (Present study) | Chennai, India, 2004 | 1716, Population based            | 26.9%<br>(Albumin excretion: 30 - 299 µg/mg of creatinine)                          | 2.2%<br>(Albumin excretion ≥ 300 µg/mg of creatinine in the presence of diabetic retinopathy) |