



## PREVALENCE OF DIABETIC NEPHROPATHY AMONGST TYPE 2 DIABETIC PATIENTS ATTENDING TERTIARY HOSPITAL OF HYDERABAD, SINDH, PAKISTAN

Noshaba Zaheer Khan<sup>1</sup>, Tahira Jabeen Ursani<sup>1</sup>, Jawaaid Ahmed Khokhar<sup>1\*</sup>, Samina Malik<sup>1</sup>, Muhammad Junaid Khilji<sup>1</sup>, Shadab Kaka<sup>1</sup>, Khalid Hussain Dhilloo<sup>2</sup>, Sabina Shaikh<sup>1</sup>

<sup>1</sup>Department of Zoology, University of Sindh, Jamshoro- 76080 Pakistan

<sup>2</sup>Department of Entomology, Faculty of Crop Protection, Sindh Agriculture University Tandojam, 70060, Pakistan

\*Corresponding author: [jawaaid.khokhar@usindh.edu.pk](mailto:jawaaid.khokhar@usindh.edu.pk)

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### ABSTRACT

Diabetic nephropathy (DN) is a common health problem; increasing with high proportion that results in significant reduction in life span of diabetic patients. This study was made in order to determine the prevalence of DN in patients having type 2 diabetes in major tertiary hospitals of Hyderabad and Adjoining areas. The progression of DN in Type 2 diabetic mellitus was gathered through pre-tested questionnaire from patients. During study period, 150 of DN patients were interviewed on the basis of their medical history including period of disease, blood sugar test, renal impairment, hypertension, cardiovascular and family background reports. While the measurement of albumin to creatinine ratio and uric acids in a random urine sample were evaluated with biochemical blood/urine test and immunological assays. It was found that out of 150 diabetes patients, 123 have DN and among them male and female ratio was 81: 42 respectively. According to the parameters, the diabetic mellitus were in both DN and non diabetic nephropathy (NDN) patients, as far as the circulating level of sugar level in both DN and NDN is concern it was noted that range of fasting blood sugar was high  $232.86 \pm 15.85$  mg /dl as compared to the normal value 80-120. The level of blood glucose in the NDN it was  $136.25 \pm 10.85$  around 100 mg/dl lesser than the values in DN patients. It was further observed that the smoking and hypertension played main role in the prevalence of the disorder.

**Key words:** Prevalence; Diabetic; Nephropathy; Type 2 Diabetic; Patients; Tertiary Hospital; Hyderabad, Sindh, Pakistan

### INTRODUCTION

Diabetic mellitus is a state of disorder which is chronically develops the increased concentration of glucose. The reason of this increase glucose level in the blood is the absolute relative of the insulin. This means the insulin is not being produced from the force (pancreas) or there is insufficient insulin available as per requirement (Davidson *et.al.*, 1975 and William and Pickup, 1999). It has also been reported that the diabetic mellitus is associated with the chronic complications. However, these complications can occur after many years of the disease. These may destroy the small blood vessels, microangiopathy in the kidneys. Microangiopathy is thought to be related to the length of the period of the illness and its severity. It has also been reported by many workers that the diabetic mellitus is a metabolic disorder caused by the disturbance fat metabolism. These disturbances are the results of the defects in the insulin secretion action of the insulin (Boucek, P, 1997). The diabetic mellitus has been categorized in two types, the IDDM and NIDDM, IDDM is called as type-1diabetic mellitus and NIDDM is noninsulin dependent called type-2 diabetes The first are IDDM

is the characterized of by the autoimmune destruction of beta cells that responsible to produce insulin. Whereas, is characterized by insulin resistance and insulin deficiency and account for 90-95% cases of type-2 diabetes (Caramori *et al.*, 2000). Diabetic nephropathy (DN) is the main cause of the final stage of renal disease. The diagnostic characterized of the DN type-2 patients is characterized by hypertension which results in the complication called diabetic nephropathy. Albuminuria / microalbuminuria can be measured soon after diagnosis Krolewski and Warram 1995. It has also been reported by (Dinneen and Gerstein, 1995, Adler *et al.*, 2023) that the diabetic patients' type-2 with albuminuria will be expired due to cardiovascular disease instead of progressing diabetic nephropathy. The increase of albumin excretion along with decreased in the glomerular filtrate rate (GFR) has been described by (ADA, 2005, Kramer *et al.*, 2023). Whereas decrease GFR in the absence of higher excretion of urine albumin in adult of type-2 diabetic patient (Tsalamandris, 1994). Thus, the reported studied suggest that decline NGFR may occur in the absence of increased urine albumin excretion in type-2 patient. Tubular interstitial changes and vascular changes besides chronic

condition have been also reported in the older type-2 subjects (Ruggenti and Remuzzi 2000, Gambari *et al.*, 1993). Hypertension is very common in the type-2 patient with two times more than in the non-diabetic subjects (Epstein and Sowers, 1992). It has been claimed that the hypertension is highly prevailed in the patient with urinary problems. High risk of cardiovascular problems in diabetics increased with systolic pressure (Stamler *et al.*, 1993). Obesity and its increasing pattern along with inactive lifestyle are also the main reason in the prevalence of the diabetic type-2. Due to the adverse effects of microalbuminuria (MAU) Screening and other programs to check and control the damage condition providing due to microalbuminuria (MAU). In this context central screening of the microalbuminuria is recommend by diabetic association (Dinneen and, Gerstein, 1997 and Spooren *et al.*, 1992). It has also been noted that the large number of diabetic patient with increased microalbuminuria. In this context, vary from studies have been carried and with represented to microalbuminuria (MAU) in the Asia countries (Mather *et al.*, 1998 and Lee *et al.*, 2001). The purpose of the presented study was to understand the possible impact of microalbuminuria/ diabetic nephropathy on the patients' type-2 diabetes mellitus particular in the urban and rural population of the Hyderabad districts. The proposed studies will definitely provide the knowledge about the problem that can be used to take the preventive increase to save them from this fatal physiological problem which ultimately takes the person to the end of life.

## MATERIALS & METHODS

These works contribute their part in scientific community by briefly elaborate the prevalence of DN its causes, and risk factors by attempting authenticated and advance format. Such kind of work may encourage the researchers to diagnose and analyzed different diseases among their communities to aware them.

**Collection & Evaluation of Data:** The data was collected on pre-designed Performa and frequency, percentages, mean $\pm$ SD were analyzed and calculated statistically. During research period, 150 patients in total (97 male and 53 females) of type-2 diabetes mellitus were evaluated and monitored for diabetic nephropathy. Out of them 123 patients were reported as diabetic nephropathy patients. 78 / 63% of them were from the rural population and 45 / (37%) were from urban population. The reported proportions for family history of diabetes, hypertension, smoking and alcoholism were, 113 (75%), 95 (63%), 58 (39%) and 43 (29%). 47 (31%) DN patients were on hemodialysis, while the mean  $\pm$  SD (yrs) for duration of diabetes mellitus and hypertension was done as 18.72 $\pm$ 5.73 and 13.85  $\pm$ 4.72 respectively. Regarding

the laboratory variables the mean  $\pm$ SD for fasting blood sugar (132.86  $\pm$ 5.85 mg/dL), random blood sugar (276  $\pm$ 20.86 mg/dL) serum urea (189 $\pm$ 7.23 mg/dL) and creatinine (7.98 $\pm$ 1.93 mg/dL), hemoglobin (6.97 $\pm$ 1.95 mg/dL), spot urine test for protein (31.86 $\pm$ 4.76mg/dL), albumin creatinine ratio (301 $\pm$ 15.76 mg/dL), hemoglobin A1c (10.86  $\pm$ 2.75 %) and eGFR (41.86 $\pm$ 7.53 ml/min). The diabetic nephropathy was detected in 123 (82%) patients from which 81 (69%) males and 42 (34%) were females. Majority of patients had terminal End Stage Renal Disease (ESRD) and they were on insulin therapy, while 33 patients were on oral hypoglycemic drugs. The prevalence of DN in type 2 diabetic patients was found to be highly alarming. So there is an imperative need for habitual renal screening in diabetic population is recommended.

Consistent with the basic goals of examine analysis, the points of this work is to generate summary data, expressed variations in diabetic nephropathy epidemiology, resolve inconsistency in findings, and identify areas of upcoming research.

**Cross Sectional Evaluation of Data:** The current cross sectional work is conducted to estimate the hospital based prevalence of diabetic nephropathy and scrutinize the risk factors associated with Diabetic Nephropathy in tertiary hospitals, Diabetic OPDs of Hyderabad. General patients in Diabetes Mellitus Type2 of public hospitals incorporated through simple random sampling technique and their glycaemic control history.

Evaluated risk factors associated with Diabetic nephropathy, a pre-tested questionnaire was filled from all the latest and already enrolled patients. Consent was taken from all the participants of the research.

Albumin to creatinine ratio measured and Uric acid in a random urine sample evaluated. Biochemical blood/urine test and Immunological assays subject to requirement and diagnosis revealing was documented.

All over visit verbal consent was taken from the Diabetic nephropathy with T2DM gender wise patients and pre-planned feedback from concerning the nephropathy was filled out by inquiring questions to the medical OPD and interior patients of hospital. Out of 150 diabetic nephropathy patients were interviewed from above revealed hospital during the period. All patients were asked about their medical history especially about the period of disease and simultaneously blood sugar test, renal impairment. Hypertension, cardiovascular and family background data of related patients was also noted. Consent was also gathered from the total diabetic population. Questionnaire associated to age group of the patients was also developed mentioned below.

Serial No: \_\_\_\_\_

### PROFORMA

#### DIABETIC NEPHROPATHY IN TYPE 2 DIABETES MELLITUS

Name: \_\_\_\_\_ S/W/D: \_\_\_\_\_

Age: \_\_\_\_\_ Gender: Male [ ☐ ] Female [ ☐ ]

Date of Admission: \_\_\_\_\_ Hospital Registration # \_\_\_\_\_

Residence: ☐ Urban ☐ Rural Ward: \_\_\_\_\_

History of hypertension: ☐ Yes ☐ No BMI: \_\_\_\_\_ Kg/m<sup>2</sup>

History of smoking: ☐ Yes ☐ No History of alcohol: ☐ Yes ☐ No

Family history of Diabetes: ☐ Yes ☐ No On hemodialysis: ☐ Yes ☐ No

Duration of Diabetes mellitus: \_\_\_\_\_ Duration of hypertension: \_\_\_\_\_

#### SYMPTOMATOLOGICAL EVALUATION:

Nocturia: \_\_\_\_\_ Tiredness: \_\_\_\_\_ Headaches: \_\_\_\_\_

Nausea: \_\_\_\_\_ Vomiting: \_\_\_\_\_ Leg swelling: \_\_\_\_\_

Loss of appetite: \_\_\_\_\_ itchy skin: \_\_\_\_\_ Frequent daytime urination: \_\_\_\_\_

#### INVESTIGATIONAL EVALUATION:

Fasting blood sugar: \_\_\_\_\_ mg/dL Random blood sugar: \_\_\_\_\_ mg/dL.

Serum urea and creatinine: \_\_\_\_\_ Anemia (Hb level): \_\_\_\_\_

Microalbuminuria: ☐ Yes ☐ No Macroalbuminuria: ☐ Yes ☐ No

Spot urine test for protein: \_\_\_\_\_ Spot urine test for creatinine: \_\_\_\_\_

Protein or Albumin Cr ratio: \_\_\_\_\_ Hemoglobin A1C: \_\_\_\_\_ %

eGFR level: \_\_\_\_\_ Stage of chronic kidney disease: \_\_\_\_\_

#### TREATMENT EVALUATION:

Treatment of diabetes: On insulin \_\_\_\_\_ On Oral hypoglycemic: \_\_\_\_\_

Any other associated micro/macrovacular complication: \_\_\_\_\_

Any additional co-morbidity: \_\_\_\_\_

DIABETIC NEPHROPATHY: ☐ Yes ☐ No Remarks: \_\_\_\_\_

Figure 1. Questionnaire

## RESULTS

Total 150 patients of diabetic mellitus patients were examined and interviewed according to the quaries mentioned in the questionnaire from LUMS,

ISRA, Hilal Ahmer, Maaji, and Bhatti, hospitals from all these 150 patients, out of them 53 were females and 97 were males (Table.1).

**Tables.1.** Showing gender wise number in diabetic patients Type-II and their percentage from Different Tertiary Hospitals of Hyderabad

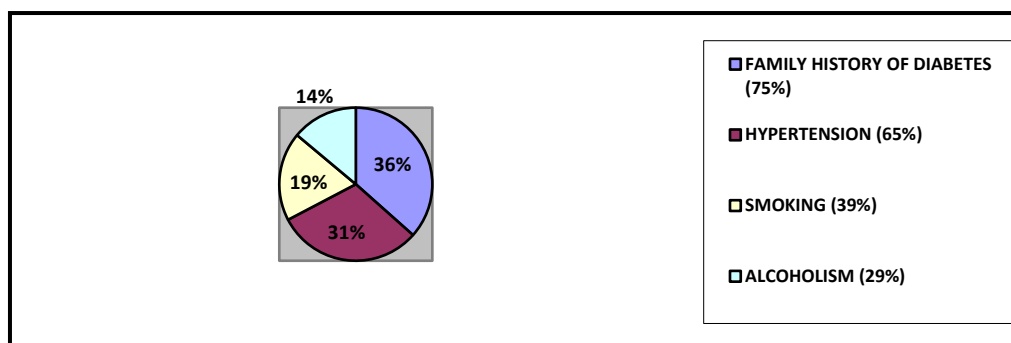
| Gender Wise Frequency of Dn |            |            |            |
|-----------------------------|------------|------------|------------|
| Gender                      | Female     | MALE       | Total      |
|                             | 53         | 97         | 150        |
| <b>Percentage</b>           | <b>35%</b> | <b>65%</b> | <b>100</b> |

As far as the age of the DN patients was concerned, the male age was between ranges of 41- 69, while female age range was 40-72 (Table .2). Regarding the risk factors associated with the diabetic mellitus type 2 populations, it was noted that from all the cases

examined 113 had the family history of the disorder; it means they got the diabetic nephropathy from their elders (hereditary). Amongst them 95 was hypertensive while 58 had smoking habits and 47 were alcohol addicts

**Table.2.** Showing percentages of risk factors among the patients

| Risk Factors                     | Number of Patients (N=150) | Percentage % |
|----------------------------------|----------------------------|--------------|
| Family History of Diabetes (75%) | 113                        | 75           |
| Hypertension (65%)               | 95                         | 63           |
| Smoking (39%)                    | 58                         | 39           |
| Alcoholism (29%)                 | 43                         | 29           |



**Figure. 2.** Pie chart showing the percentages of risk factors in diabetic patients

Out of 150 diabetic patients, 123 were having diabetic nephropathy type 2 (DNT 2) and rest of 27 patients though being diabetic they were lacking diabetic nephropathy (Table 4). As far as their place of living

is concerned, 78 out of 123 nephropathy patients were from rural areas and 45 belonged to the urban areas of surrounding Hyderabad (Table 3).

**Table 3.** Showing number and percent of Urban and Rural areas Diabetes Type II Population reported and examined

| Areas        | No. of Patient | Percent (%) |
|--------------|----------------|-------------|
| Urban        | 45             | 37          |
| Rural        | 78             | 63          |
| <b>Total</b> | <b>123</b>     | <b>100</b>  |

The data of actual diabetic nephropathy had further examined according to the gender, out of 123 DN patients, 81(69%) were male and 42(34%) were female. Out of 81 Male diabetic nephropathy Patients

21 belonged to urban and 60 belonged to rural areas of Hyderabad while out of 42 DN females 10 belonged to urban and rest of 32 belonged to rural areas (Table.4,5).

**Table 4.** Gender wise prevalence of diabetic nephropathy in study population

| Gender Wise Diabetic Nephropathy (N-123) |            | PERCENT % |
|------------------------------------------|------------|-----------|
| Male                                     | 81         | 69        |
| Female                                   | 42         | 34        |
| <b>Total (N-123)</b>                     | <b>123</b> | <b>64</b> |

**Table 5.** Gender wise patients in urban and rural population

| Areas        | No. Of Patient N=123 | Percent    |
|--------------|----------------------|------------|
| Urban        | Male                 | 21         |
|              | Female               | 10         |
| Rural        | Male                 | 60         |
|              | Female               | 32         |
| <b>Total</b> | <b>123</b>           | <b>100</b> |

As far as the treatment/medication of patients is concerned, out of 123 DN patients, 90 were insulin dependent, and the rest of the 33 were using another medication other than insulin. However, of the

remaining 27 patients who had no 5.73t DN and were diabetic, 4 were insulin dependent, and 23 were non-insulin dependent (Table 6).

**Table 6.** Mode of treatment in diabetes mellitus in study population

|            | Diabetic Nephropathics 82% (N-123) | Non Dn 18% (N-27) |
|------------|------------------------------------|-------------------|
| Insulin    | 90                                 | 4                 |
| Oral Drugs | 33                                 | 23                |

Duration of diabetic mellitus / hypertension and fasting blood sugar in the patients of diabetic nephropathy (DN) and non diabetic nephropathy

(NDN) has been tabulated in (Table 7). The diabetic mellitus in the DN was  $18.72 \pm 5.73$ , where as in NDN it was  $18.72 \pm 3.73$ . The duration of /

hypertension in DN was  $13.85 \pm 6.72$  and in NDN was 3.72. Fasting blood sugar in DN patients was  $232.86 \pm 15.85$ . Where is in NDN it was recorded as  $136.25 \pm 10.85$ . However, normal fasting blood sugar

is 80.120. Random blood sugar was also recorded in DN and NDN patients. The mean blood sugar random is DN patients was  $336 \pm 40.84$  and in NDN  $239.0 \pm 18.0$  Normal range of random blood sugar is 140.180.

**Table 7.** Mean  $\pm$  SD of quantitative variables and blood sugar levels of study population with highly significant difference ( $P < 0.01$ )

| Parameter                           | Duration/ Normal Range)<br>Mean $\pm$ Sd | Results Mean $\pm$ Sd Dn | Results Mean $\pm$ Sd Ndn |
|-------------------------------------|------------------------------------------|--------------------------|---------------------------|
| Duration Of Diabetes Mellitus (YRS) | -----                                    | 13.72 $\pm$ 5.73         | 10.72 $\pm$ 3.73          |
| Duration Of Hypertension (Yrs)      | -----                                    | 13.85 $\pm$ 6.72         | 10.15 $\pm$ 3.72          |
| Fasting Blood Sugar (Mg/Dl)         | 70-99 Mg/Dl<br>80-130                    | 232.86 $\pm$ 15.85       | 136.25 $\pm$ 10.85        |
| Random Blood Sugar Mg/Dl            | Optimum 140<br>Maximum < 180             | 336 $\pm$ 40.86          | 239 $\pm$ 18.00           |

Different biochemical parameters, like urea, creatinine, hemoglobin, spot urine test, albumin creatinine, ratio, haemoglobin A1C and GFR were

also recorded in the DN and NDN patients which are tabulated in (Table 8).

**Table 8.** Mean  $\pm$  SD of different biochemical parameters of study population

| Parameters                          | Normal (Range) Mean $\pm$ sd | Results Mean $\pm$ sd |
|-------------------------------------|------------------------------|-----------------------|
| Serum urea (mg/dl)                  | 10-80                        | 189 $\pm$ 7.23        |
| Serum creatinine (mg/dl)            | 0.7-1.2                      | 7.98 $\pm$ 1.1        |
| Hemoglobin (g/dl)                   | 14-16                        | 6.97 $\pm$ 1.95       |
| Spot urine test for protein (mg/dl) | < 30                         | 31.86 $\pm$ 4.76      |
| Albumin creatinine ratio (mg/dl)    | 200 -300                     | 301 $\pm$ 15.76       |
| Hemoglobin a1c (%)                  | < 5.70% in diabetics < 7%    | 10.86 $\pm$ 2.75      |
| Egfr (ml/min)                       | > 90                         | 41.86 $\pm$ 7.53      |

Serum urea recorded in the patients of diabetic nephropathy was  $189.0 \pm 7.23$  where as normal values of serum urea are 10-18 mg / dl. Serum creatinine recorded in DN patients was  $7.98 \pm 1.1$  where is the normal range of the Serum creatinine level is 0.7 - 1.2 mg / dl. In DN patients the hemoglobin, was  $6.97 \pm 1.95$  whereas the normal value of hemoglobin are 14 – 16 mg / dl. Spot urine test for the investigation of protein was also carried out as per result tabulated in Table 4.11. The spot urine test in the DN patients was  $31.86 \pm 4.76$  whereas the normal values are  $\leq 30$ . As far as the albumin creatinine ratio is concerned, it was  $301.0 \pm 15.76$  mg / dl in DN patients. The normal values albumin creatinine ratio is 200 – 300 / mg / dl. In DN patients of investigation the hemoglobin A1C recorded was  $10.86 \pm 2.75$  where normal values are 6%. eGFR was also recorded in the diabetic nephropathy patients that was  $\geq 41.86 \pm 7.53$  ml-min. the normal value are  $\geq 90$  ml - min.

## DISCUSSION

The diabetic nephropathy (DN) has been frequently claimed as end stage disorder in the human in this context several workers have reported their studies (Huang *et al.*, 2007, Saiki *et al.*, 2005, Ahmedani *et al.*, 2005). In the same way this relevant study carried out on 150 patients having diabetic mellitus, from these 150 DM patients, 123 patients were having nephropathic. Amongst 123 DN patients,

81 were male and 42 were female. It was noted that diabetic nephropathy was found in on males and female. From all the 123 DN patients 36% belong to urban population. According to the parameters in the present study, the duration of diabetic mellitus / hypertension, fasting blood sugar in DN and NDN patients. The diabetic mellitus were in both DN and NDN patients, as far as the circulating level of sugar level in both DN and NDN is concern it was noted that range of fasting blood sugar was high  $232.86 \pm 15.85$  mg /dl as compared to the normal value 80-120. The level of blood glucose in the NDN it was  $136.25 \pm 10.85$  around 100 mg/dl lesser than the values in DN patients. However in the past study undertaking as the DN and NDN patients it was 341 in the absence of micro albuminuria and 362 in the presence of micro albnuria (Wu A, *et al.*, 2005, Graziella and Franco, 2003).

In the present study it was noted that 47 patients of DN out of 123 were on dialysis whereas rest of patients were not in the dialysis (Khanfri *et al.*2002)also have reported about the hemo dialysis in the diabetic nephropathy. They also suggest that diabetic nephropathy ultimately ends in the hemo dialysis. Survivals in diabetic patients have been indicated by. They are of the view the survival of DN patients is shorter as compared to the patients on dialysis/kidney transplant. Different biochemical parameters like circulating level of urea/creatinine/hemoglobin, albumin creatinine ratio

hemoglobin A1C has recorded in DN and non DN patients. Circulating level of urea in the DN patients was  $189.0 \pm 7.23$  as compared to normal values 10-18mg/dl. Many workers have also reported that diabetic nephropathy can be detected by the urine albumin levels (ADA, 2005, Snyder and Berns, 2004). In the present study the hemoglobin A1C in the DN patients recorded was  $10.86 \pm 2.75$  their normal value 6%. in general recommended value for the diabetic central are less than 7% (Vitolins *et al.*, 2009). The GFR recorded in DN patients was  $\geq 41.86 \pm 7.53$  whereas normal value is  $\geq 90$ ml-min. These result when watched with the earlier study reported that GFR is between 10-15 ml/mn independent type of insulin type being used to avoid kidney failure (Retnakaran *et al.*, 2005). With the reference to spot urine test for the investigation of protein urea and albumin crinine ration was done. According to the present study the protein ration in the urine of the DN patient was  $31.86 \pm 4.76$  whereas normal values less than 30. As for as the albumin creatinine ratio is concern it was  $301 \pm 15.76$ mg/dl in DN with normal values are 200-300mg/dl. In the study carried by (De Jong and Curhan, 2006) found that 36 % of the people diagnosed with the prevalence of albuminuria progressed to develop impairment. As for as the risk factor are concerned it was noted from the previous studies that smocking, hypertension are the indirect cause of DN, with smocking hypoxia occur in diabetic patient that lead to the diabetic nephropathy (Telmer *et al.*, 1984, Rossing *et al.*, 2004, Chuahirun *et al.*, 2003, Hovind *et al.*, 2003). According to present study it was also noted that smocking and hypertension are the cause of the DN and play a role in the prevalence of the disorder. However study undertaking does not confirm the association of the smocking with decreased GFR ratio in DN patients.

## REFERENCES

- Adler, A. I., Stevens, R. J., Manley, S. E., Bilous, R. W., Cull, C. A., Holman, R. R., & Ukpds Group. (2003). Development and progression of nephropathy in type 2 diabetes: the United Kingdom Prospective Diabetes Study (UKPDS 64). *Kidney international*, **63**(1), 225-232.
- ADA, (2015). Microvascular complications and foot care. Sec. 9. In standards of medical care in diabetes - 2015. *Diabetes Care*. Vol. **38**:58-66.
- Afghahi, H., Cederholm, J., Eliasson, B., Zethelius, B., Gudbjörnsdottir, S., Hadimeri, H. and Svensson, M.K., 2011. Risk factors for the development of albuminuria and renal impairment in type 2 diabetes—the Swedish National Diabetes Register (NDR). *Nephrology Dialysis Transplantation*, **26**(4), pp.1236-1243.
- American Diabetes Association. (2004). Nephropathy in diabetes. *Diabetes care*, **27**(suppl\_1), s79-s83.
- Boucek, P., (1997). Care of patients with diabetic nephropathy. *Casopis Lekaru Ceskych*, **136**(22), pp.689-692.
- Caramori, M.L., Fioretto, P. and Mauer, M., (2000). The need for early predictors of diabetic nephropathy risk: is albumin excretion rate sufficient? *Diabetes*, **49**(9), 1399-1408.
- Caramori, M. L., Kim, Y., Huang, C., Fish, A. J., Rich, S. S., Miller, M. E., ... & Mauer, M. (2002). Cellular basis of diabetic nephropathy: 1. Study design and renal structural-functional relationships in patients with long-standing type 1 diabetes. *Diabetes*, **51**(2), 506-513.
- Chuahirun, T., Khanna, A., Kimball, K., & Wesson, D. E. (2003). Cigarette smoking and increased urine albumin excretion are interrelated predictors of nephropathy progression in type 2 diabetes. *American journal of kidney diseases*, **41**(1), 13-21.
- Davidson S, Passmore S, Brock JF, Truswell AS, (1975), Human nutrition and diabetes. Longman Group Ltd. New York, USA, 412-32. 1975.
- De Jong, P.E. and Curhan, G.C., 2006. Screening, monitoring, and treatment of albuminuria: Public health perspectives. *Journal of the American Society of Nephrology*, **17**(8), pp.2120-2126.
- De Zeeuw, D., Remuzzi, G., Parving, H. H., Keane, W. F., Zhang, Z., Shahinfar, S., & Brenner, B. M. (2004). Proteinuria, a target for renoprotection in patients with type 2 diabetic nephropathy: lessons from RENAAL. *Kidney international*, **65**(6), 2309-2320.
- Dinneen, S. F., & Gerstein, H. C. (1997). The association of microalbuminuria and mortality in non—insulin-dependent diabetes mellitus: a systematic overview of the literature. *Archives of internal medicine*, **157**(13), 1413-1418.
- Dinneen, S. F., & Gerstein, H. C. (1997). The association of microalbuminuria and mortality in non—insulin-dependent diabetes mellitus: a systematic overview of the literature. *Archives of internal medicine*, **157**(13), 1413-1418.
- Gambara, V., Mecca, G., Remuzzi, G., & Bertani, T. (1993). Heterogeneous nature of renal lesions in type II diabetes. *Journal of the American Society of Nephrology*, **3**(8), 1458-1466.
- Bruno, G., Merletti, F., Biggeri, A., Bargero, G., Ferrero, S., Pagano, G., & Perin, P. C. (2003). Progression to overt nephropathy in type 2 diabetes: the Casale Monferrato Study. *Diabetes care*, **26**(7), 2150-2155.
- Hovind, P., Rossing, P., Tarnow, L., & Parving, H. H. (2003). Smoking and progression of diabetic nephropathy in type 1 diabetes. *Diabetes care*, **26**(3), 911-916.
- Huang, F., Yang, Q., Chen, L., Tang, S., Liu, W., & Yu, X. (2007). Renal pathological change in patients with type 2 diabetes is not always

- diabetic nephropathy: a report of 52 cases. *Clinical nephrology*, **67**(5), 293-297.
- Krolewski, A. S. (1995). Natural history of diabetic nephropathy. *Diabetic Rev*, **3**, 446-459.
- Kramer, H. J., Nguyen, Q. D., Curhan, G., & Hsu, C. Y. (2003). Renal insufficiency in the absence of albuminuria and retinopathy among adults with type 2 diabetes mellitus. *Jama*, **289**(24), 3273-3277.
- Krolewski, M., Eggers, P. W., & Warram, J. H. (1996). Magnitude of end-stage renal disease in IDDM: a 35-year follow-up study. *Kidney international*, **50**(6), 2041-2046.
- Lee, W. R. W., Lim, H. S., Thai, A. C., Chew, W. L. S., Emmanuel, S., Goh, L. G., & Yeo, J. P. (2001). A window on the current status of diabetes mellitus in Singapore-the Diabcare-Singapore 1998 study. *Singapore medical journal*, **42**(11), 501-507.
- M Y Ahmedani, M Z I Hydrie, A Iqbal, A Gul, W B Mirza, and A Basit. (2005). Prevalence of microalbuminuria in Type 2 Diabetic patients in Karachi: Paksitan A Multi-canter study. *J Pak Med Assoc*, Vol 55, issue.9, 20.
- Retnakaran, R., Cull, C. A., Thorne, K. I., Adler, A. I., Holman, R. R., & UKPDS Study Group. (2006). Risk factors for renal dysfunction in type 2 diabetes: UK Prospective Diabetes Study 74. *diabetes*, **55**(6), 1832-1839.
- Rossing K, Christensen PK, Hovind P, (2004). Progression of nephropathy in type 2 diabetic patients". *Kidney Int* 66: 1596–605.
- Ruggenenti, P., & Remuzzi, G. (2000). Nephropathy of type 1 and type 2 diabetes: diverse pathophysiology, same treatment?. *Nephrology Dialysis Transplantation*, **15**(12), 1900-1902.
- Snyder, R. W., & Berns, J. S. (2004, September). Reviews: use of insulin and oral hypoglycemic medications in patients with diabetes mellitus and advanced kidney disease. In *Seminars in dialysis* (Vol. 17, No. 5, pp. 365-370). Oxford, UK: Blackwell Science Inc.
- Stalder, G., & Schmid, R. (1959, September). Severe functional disorders of glomerular capillaries and renal hemodynamics in treated diabetes mellitus during childhood. In *Annales paediatrici. International review of pediatrics* (Vol. 193, pp. 129-138).
- Tsalamandris, C., Allen, T. J., Gilbert, R. E., Sinha, A., Panagiotopoulos, S., Cooper, M. E., & Jerums, G. (1994). Progressive decline in renal function in diabetic patients with and without albuminuria. *Diabetes*, **43**(5), 649-655.
- Vitolins, M.Z., Anderson, A.M., Delahanty, L., Raynor, H., Miller, G.D., Mobley, C., Reeves, R., Yamamoto, M., Champagne, C., Wing, R.R. and Mayer-Davis, E., 2009. Action for Health in Diabetes (Look AHEAD) trial: baseline evaluation of selected nutrients and food group intake. *Journal of the American Dietetic Association*, **109**(8), 1367-1375.
- William G, Pickup, JC, (1999). *Handbook of diabetes* (second edition), WC1N 2BL: 1-206.
- Wu, A. Y. T., Kong, N. C. T., De Leon, F. A., Pan, C. Y., Tai, T. Y., Yeung, V. T. F., & MAPS Investigators. (2005). An alarmingly high prevalence of diabetic nephropathy in Asian type 2 diabetic patients: the MicroAlbuminuria Prevalence (MAP) Study. *Diabetologia*, **48**, 17-26.

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