

Urinary NAG, AAP and Microalbuminuria as Indicators of Hypertensive Disease

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Abstract. In the current study certain kidney biochemical markers were measured in the urine of Saudi patients suffering from diabetes mellitus.

Two enzyme markers, N-acetyl- β -D-glucosaminidase (NAG), a lysosomal enzyme in the catalysis of glycoprotein and alanine aminopeptidase (AAP) a brush border enzyme of the proximal tubules involved in amino acid metabolism, have been reported to be sensitive indicators of renal damage.

The established marker, microalbuminuria was also measured, as it is productive of overt nephropathy and renal diseases.

The results showed that in diabetes mellitus high levels of urinary NAG activity were associated with high microalbuminuria and elevated AAP levels; NAG activity was high in the normotensive IDDM patients. Microalbuminuria was higher in hypertensive patients than in normotensive patients. In hypertensive patients lower total protein values were associated with IDDM but not with NIDDM.

NAG assay, AAP and microalbuminuria may be useful markers for early detection of kidney damage and as an alternative measurements for renal dysfunction, although they may not be useful in diagnosing late stage of kidney failure.

Keywords: Diabetic Nephropathy, Urinary N-acetyl- β -D-glucosaminidase, Alanine Amino Peptidase, Microalbuminuria Hypertension, Insulin Dependent Diabetes (IDDM), Non-insulin Dependent Diabetes (NIDDM).

Introduction

Evaluation of urinary enzymes is a valuable tool in the diagnosis of impaired renal function^[1,2]. Renal damage initially occurs in a specific region of the nephron^[3] and in most instances the damage is irreversible^[4]. Most commonly used renal function tests are insensitive and fail to identify early lesion and biopsy sampling is not recommended in most cases except in the presence of well-established renal disease. Therefore, a sensitive, non-invasive marker required for early detection of renal injury^[4].

The assessment of the lysosomal N-acetyl- β -D-glycosaminidase (NAG) in urine can be used as a sensitive indicator for toxic renal damage and has been used extensively to monitor renal disease^[5]. Also NAG may provide a useful indicator of renal involvement in hypertension and early warning of rejection crises^[6,7].

Increased urinary NAG reflects glomerular secretion levels^[8], while the brush border enzyme of the proximal tubules involved in amino acid metabolism, alanine aminopeptidase (AAP), reflects renal dysfunction and tubular damage^[9].

Proteinuria could be an indicator of glomerular or tubular disease while microalbuminuria shows elevated excretion of albumin above the reference range (< 200 mg/l) for healthy non-diabetic subjects and is undetectable by albus-tic test^[10,11]. Thus microalbuminuria is of glomerular origin and associated with normal tubular function^[12-14].

In Saudi Arabia the prevalence of diabetes mellitus is very high^[15] and it will increase rapidly and becomes 40-50% in 2020. Especially there is a high prevalence of obesity in school children^[16]. Renal complications have received little attention^[15] and detailed information on diabetes mellitus in Saudi Arabia is not yet available, therefore, further studies are required^[17]. However, thrifty gene hypothesis, increased energy intake (Kcal/day) and first cousin marriage could provide a reasonable explanation for this dramatic rise in DM in Saudi Arabia^[16].

In the current study, two urinary enzymes were evaluated as sensitive indicators of the development of renal disease together with established indicators of incipient nephropathy in diabetic and in control normal Saudi population. Groups of NIDDM and IDDM patients were compared with a control group, and since hypertension is known to influence the development of complication^[18], patients were also subdivided on the basis of blood pressure.

Materials and Methods

Control Subjects

The control group consisted of one hundred and fifty-five normal subjects (96 females, 59 males), aged 19-30 \pm 1.34 years, who were attending King Abdulaziz University, University Hospital and King Fahad General Hospital in Jeddah for a

routine medical check-up and who had no evidence of renal disease, hypertension or diabetes mellitus. None were receiving medications or a smoker. Their body mass index was $24.14 \pm 2.36 \text{ kg/m}^2$ (males) and $22.36 \pm 4.44 \text{ kg/m}^2$ (females).

Diabetic Patients

Two hundred diabetic patients were studied; one hundred females (51 IDDM, 49 NIDDM) and one hundred males (37 IDDM, 63 NIDDM). The age of the diabetic subjects was 48.88 ± 13.1 years. The majority of patients attended King Fahad General Hospital, King Fahad Military Hospital or Al-Aziziah Center of Diabetes and Hypertension. Their body mass index was $27.40 \pm 5.85 \text{ kg/m}^2$ for males and $24.8 \pm 3.73 \text{ kg}$ for females. Eighty-four patients from the diabetic population were hypertensive (46 males and 38 females) and their blood pressure ranged between 160/100 to 200/120 mmHg. HbA_{1c} values were $6.25 \pm 0.53 \text{ mg/dl}$ for males and $5.96 \pm 0.44 \text{ mg/dl}$ for females.

Both control subjects and patients provided a mid-day urine sample. Control subjects were requested to provide a brief medical history, which included personal details. Data obtained for each individual included body mass index, temperature, blood pressure and heart beat rate.

Clinical and Laboratory Methods

Urine samples were divided into three aliquots, one (5 ml) was stored at -20°C until required, the second (3 ml) was stored in 30% glycerol for the assay of alanine aminopeptidase (AAP) and the remainder was used immediately without storage for NAG assay.

Analytical Method

Urinary NAG activity ($\mu\text{mol/MNP}$ released /h/L) was assayed in fresh samples (*i.e.* non frozen samples) as described by Yuen *et al.* (6) using a commercially available colorimetric kit assay based on MNPGLcNAc substrate (PPR Diagnostic Ltd, London E1 9AT, UK).

The developed colour was measured using a Novaspec II spectrophotometer (Pharmacia Ltd). Urinary creatinine (Cr) concentration (mmol/l) was determined using the Bonsens and Taussky method^[19] based on the Jafee' reaction^[20]. The determination of creatinine was carried out in order to correct for variations caused by change in urine flow^[21]. AAP activity ($\mu\text{mmol Cr}$) was carried out according to the method of Mattenheimer *et al.*^[22]. Total protein (mg/mmol Cr) was assayed according to the method of Bradford^[23], using Coomassie Brilliant Blue G-250 and BSA as a standard (BDH Chemicals Ltd, Poole, England). Microalbuminuria (mg/L) was detected by the Micral-test strips (Boehringer). This test allows specific detection of human albumin ($< 200 \text{ mg/L}$) and the intensity of the

dye after exactly 5 min is directly proportional to the albumin content of the urine. Urine pH, glucose (mg/L) and albumin (mg/L) were detected using Combur-Test strips (Boehringer). Haemoglobin A_{1c} was determined using Abbot IMX glucated haemoglobin test^[24,25], the reference range used for HbA_{1c} (%) is 4.4-6.9 mg/dl.

Results

Urine sample from healthy subjects without any history of renal disease, hypertension or diabetes mellitus were free of glucose, had normal pH values, NAG, AAP, microalbuminuria and total protein values. No significant differences in these parameters were found between males and females (Table 1).

When using samples from diabetic subjects were analyzed and compared to normal subjects, there were significant differences in NAG, AAP and microalbuminuria levels. While, there were no significant differences in urinary pH and creatinine (Table 2).

The diabetic patients were subdivided into four categories, normotensive IDDM, NIDDM and hypertensive IDDM and NIDDM.

In a comparison between the four subgroups of the diabetic patients and the control subjects there were significant differences in all parameters investigated except for urinary creatinine (Table 3).

When hypertensive patients were compared to normal subjects there were significant differences in NAG, AAP and microalbuminuria levels (Table 4).

In a comparison between the four subgroups the data obtained for the four subgroups is given in Table 5. All four groups had elevated blood sugar and urinary enzyme activities; both subgroups were compared with each other. Little differences were observed between the values for the individual subgroups. There was an indication from protein and microalbuminuria data that hypertensive may have had an additive effects. Haemoglobin A_{1c} levels was found to be 6.25 ± 0.53 mg/dl for males and 5.96 ± 0.44 mg/dl for females.

The Distribution of NAG/Cr, AAP/Cr and Microalbuminuria/Cr in Normotensive and Hypertensive Diabetic Patients

Figure 1(a) shows elevation of NAG/Cr in IDDM or NIDDM especially after the 75th percentile. The elevation of AAP/Cr was steady in normal subjects in IDDM and NIDDM (Fig. 1b) however AAP was higher in IDDM than in other groups as indicated from Fig. 1(b).

In normal subjects the increase in microalbuminuria/Cr was steady (Fig. 1c) while IDDM and NIDDM patients showed elevation in microalbuminuria especially after the 50th percentile (Fig. 1c).

Table 1. Percentile for normal Saudi males and females at 2.5% and 97.5%. The means, standard deviations, upper and lower limits and reference intervals. Males (n = 59), Cr = creatinine.

Parameters	Males			Females			Reference range for normal Saudi males and females	Normal males & females
	Mean ± SD 14.14 ± 0.7	Lower limits of normal 2.5%	Upper limits or normal 97.5%	Mean ± SD	Lower limits of normal 2.5%	Upper limits of normal 97.5%		
Creatine (mmol/l)	14.14 ± 0.7	3.0	26.5	13.46 ± 0.6	3.23	29.59	2.2-31	13.7 ± 0.5
NAG (µmol/h/mol Cr)	10.75 ± 0.9	2.0	31.5	13.52 ± 0.76	2.84	36.94	3-45	12.5 ± 0.6
AAP (U/mmol Cr)	1.18 ± 0.4	0.0	2.01	1.3 ± 0.65	0.0	2.24	0.41-2.3	1.3 ± 0.6
Total protein (mg/mmol Cr)	6.41 ± 0.5	2.25	21.35	7.39 ± 0.51	2.4	24.09	1.3-42	7.0 ± 0.4
Microalbuminuria (mg/mmol Cr)	0.91 ± 1.9	0.0	0.9	0.9 ± 2	0.0	0.9	0-6	0.86 ± 1.8
Glucose (mg/dl)	< 50	-	-	< 50	-	-	-	< 50
pH	5.24 ± 0.09	-	-	5.25 ± 0.07	-	-	-	5.25 ± 0.07

Table 2. Comparison between normal subjects and diabetic patients. The means, standard deviation and P-values of the studied parameters for the overall diabetic population (n = 200), male (n = 100), as well as the normal population (n = 155).

Parameters	Normal Males & females	Diabetics			P-value
		Females	Males	Males & females	
		Mean ± SD	Mean ± SD	Mean ± SD	
Creatinine (mmol)	13.7 ± 0.5	11.4 ± 6.5	14.2 ± 9.8	13.9 ± 8.5	0.38
NAG (µmol/h/mmol Cr)	12.5 ± 0.6	55.5 ± 73.0	56.7 ± 61.3	56.8 ± 56.0	< 0.001
AAP (U/mmol Cr)	1.3 ± 0.6	2.4 ± 1.6	2.98 ± 2.8	2.7 ± 2.4	< 0.001
Total protein (mg/mmol Cr)	7.0 ± 0.4	28.9 ± 43.1	12.8 ± 21.8	20.9 ± 33.9	> 0.001
Microalbuminuria (mg/mmol Cr)	0.86 ± 1.8	3.24 ± 4.29	3.06 ± 4.8	3.15 ± 4.5	> 0.001
Glucose (mg/dL)	All < 50	167 ± 178	91.7 ± 30.9	128 ± 130	> 0.001
pH	5.25 ± 0	5.20 ± 0.6	5.50 ± 0.8	5.3 ± 0.8	NS

Cr = creatinine

Table 3. Comparison between normal controls and normotensive and hypertensive IDDM and patients. P-values of the studied parameters. For normotensive IDDM (n = 50) and NIDDM (n = 65) patients, as well as hypertensive IDDM (n = 38) and NIDDM (n = 46) patients, versus the normal population (n = 159).

Parameters	P-value		
	Normotensive IDDM vs Normal	Normotensive NIDDM vs Normal	Hypertensive IDDM vs Normal
Creatinine (mmol/l)	0.3500	0.8200	0.0500
NAG (µmol/mmol Cr)	0.0001	0.0001	0.0001
AAP (U/mmol Cr)	0.0100	0.0200	0.0030
Total protein (mg/mmol Cr)	0.0003	0.0070	0.0001
Microalbuminuria (mg/mmol Cr)	0.0001	0.0001	0.0001
Glucose (mg/dl)	0.0001	0.0001	0.0001
pH	0.0500	0.1800	0.2200

Cr = creatinine

Table 4. Comparison between control subjects and hypertensive diabetic patients. The means standard deviations and P-values of the studied parameters for control subjects (n = 155) and hypertensive diabetic patients (n = 84). Males (n = 46) and females (n = 38).

Parameters	Control subjects Mean \pm SD	Hypertensive Mean \pm SD	P-value
NAG (μ mol/mmol Cr)	12.46 \pm 0.6	54.02 \pm 6.3	> 0.001
AAP (U/mmol Cr)	1.3 \pm 0.58	2.94 \pm 0.4	> 0.001
Total protein (mg/mmol Cr)	7.01 \pm 0.37	22.67 \pm 5.4	> 0.001
Microalbuminuria (mg/l)	0.9 \pm 1.8	5.7 \pm 5.3	> 0.001
Glucose (mg/dl)	< 50	125.1 \pm 38.8	> 0.001
pH	5.25 \pm 0.1	5.36 \pm 0.2	NS

Cr = creatinine NS = not significant

Table 5. Comparison between normotensive and hypertensive for both IDDM and NIDDM diabetic patients for some variables. The means, standard deviations and P-values of the studied parameters for IDDM (N=88) and NIDDM (n=112).

Parameters	Normotensive			Hypertensive		
	IDDM Mean ± SD	NIDDM Mean ± SD	P-value	IDDM Mean ± SD	NIDDM Mean ± SD	P-value
Creatinine (mmol/l)	12.36 ± 1.15	14.21 ± 1.05	0.24	12.48 ± 1.61	12.36 ± 1.09	0.95
NAG (µmol/h/mmol Cr)	71.39 ± 13.05	47.36 ± 6.14	0.07	54.79 ± 5.47	53.39 ± 7.08	0.90
AAP (U/mmol Cr)	2.75 ± 0.38	2.15 ± 0.15	0.12	2.68 ± 0.27	3.23 ± 0.58	0.40
Total protein (mg/mmol Cr)	21.58 ± 6.03	16.97 ± 4.49	0.54	30.33 ± 8.33	14.67 ± 1.94	< 0.05
Microalbuminuria	3.0 ± 3.8	1.7 ± 2.7	0.18	5.0 ± 6.2	6.5 ± 17.0	0.38
Glucose (mg/dl)	100 ± 49.72	167 ± 22.82	0.46	152.86 ± 44.22	102.38 ± 10.62	0.38
pH	5.26 ± 0.1	5.11 ± 0.07	0.20	5.39 ± 0.16	5.35 ± 0.14	0.82

Cr = creatinine

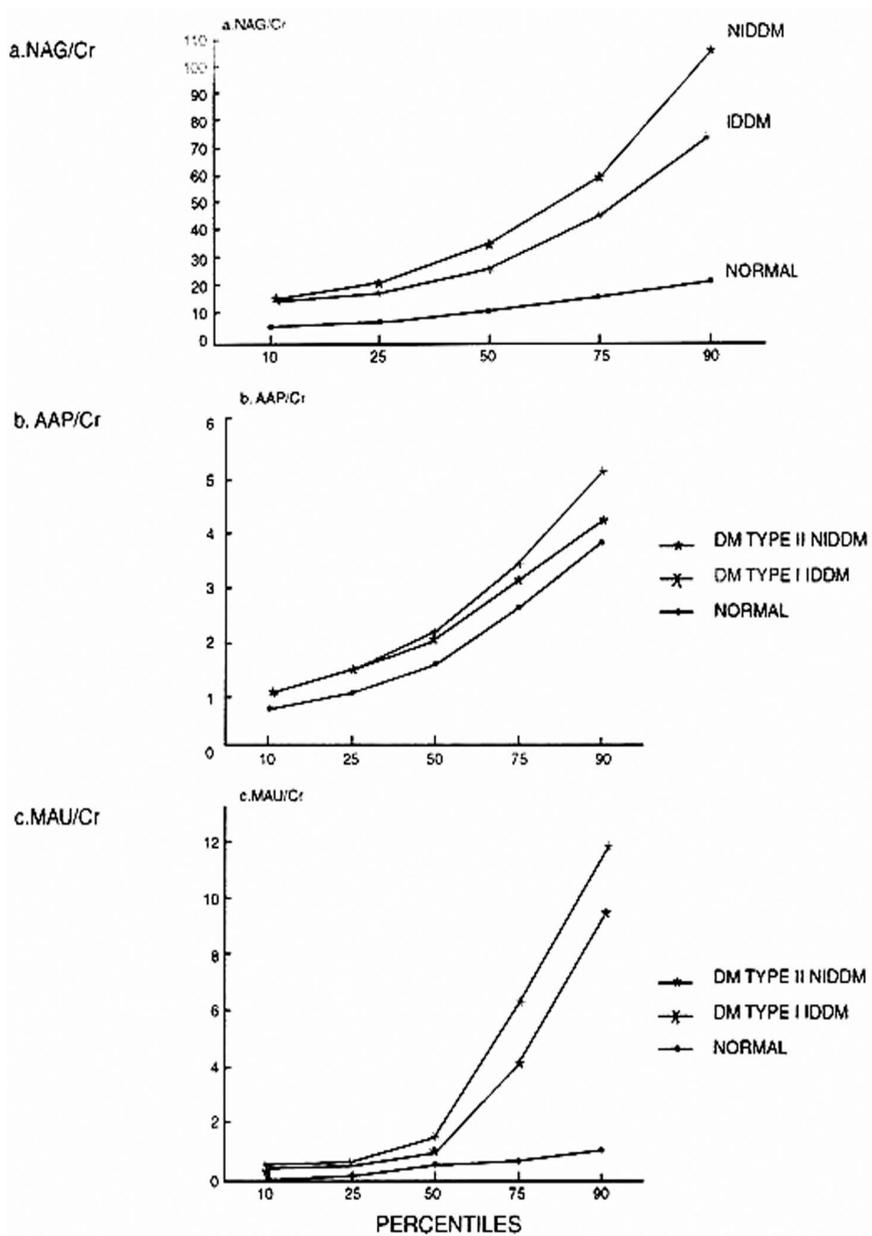


Fig. 1. Distribution of NAG/Cr AAP/Cr AAP/Cr and MAU/Cr in normal and diabetic patients.

Urinary NAG/Cr was highly elevated in normotensive and hypertensive patients (Fig. 2a), while urinary AAP/Cr was elevated in hypertensive group than in normotensive group after the 50th percentile (Fig. 2b). Microalbuminuria was higher in hypertensive group than in normotensive group, and the elevation started after the 50th percentile.

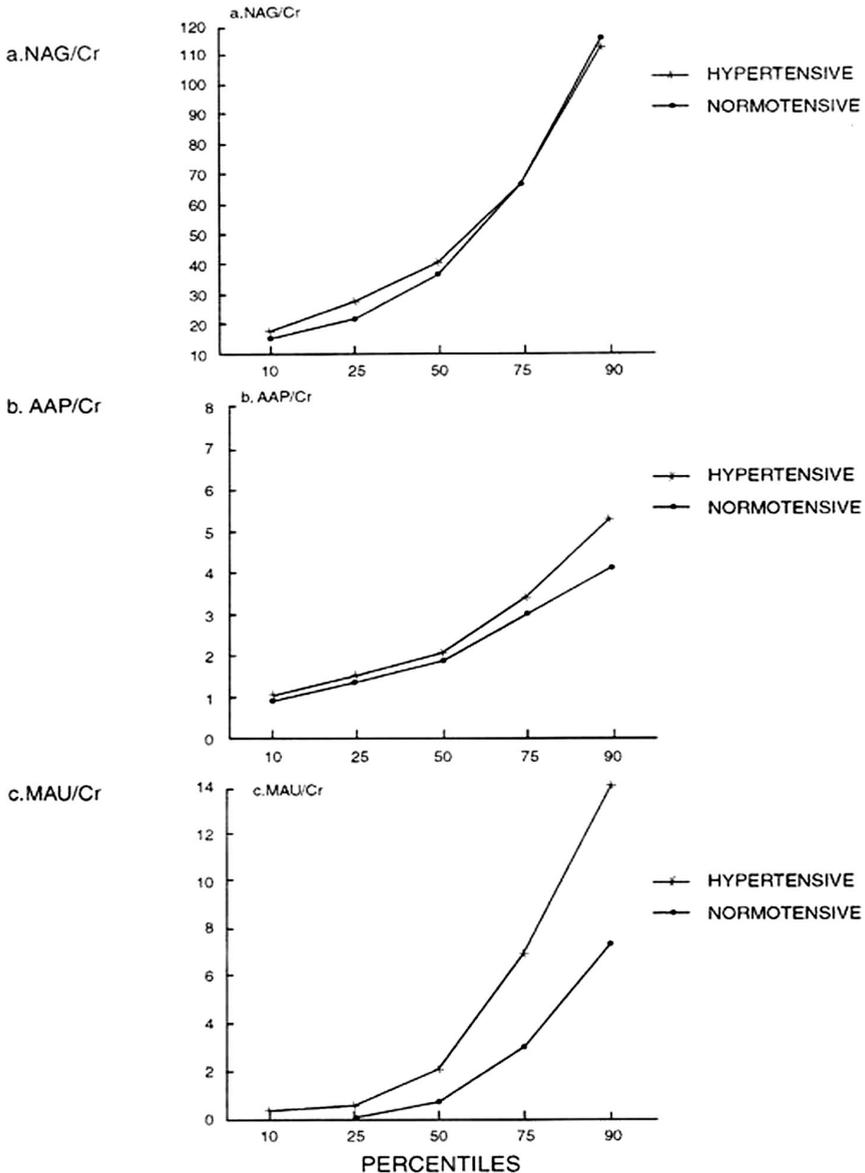


Fig. 2. Distribution of NAG/Cr AAP/Cr and MAU/Cr in normotensive and hypertensive diabetic patients.

The Relationship between Urinary NAG/Cr, AAP/Cr and Microalbuminuria (MAU/Cr) in Control Subjects, IDDM and NIDDM

Control Subjects

Increased levels of NAG/Cr was associated with an increase in microalbuminuria/Cr as shown from Fig. 3; as microalbuminuria (mg/mmol Cr) increased NAG (U/mmol Cr/h) has also increased and correlation coefficient was found to be 0.709, *i.e.*, there is fairly strong relationship between the two parameters.

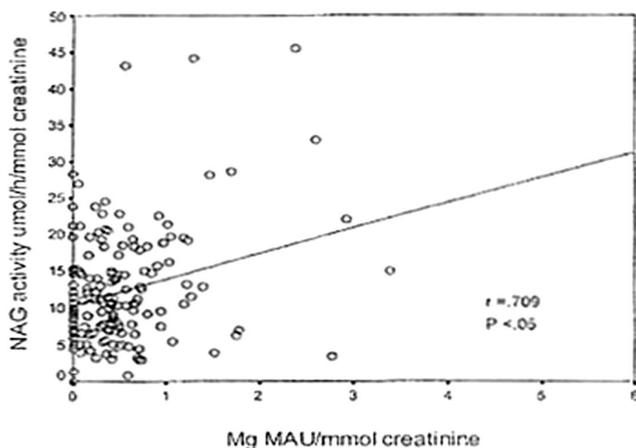


Fig. 3. NAG/Cr and microalbuminuria (MAU)/Cr in normal subject. Scattered plots of NAG/Cr (y axis) as MAU (x axis) in control subjects. Correlation coefficient was calculated to be 0.709 ($p < 0.05$).

Diabetic Patients

NAG/Cr and AAP/Cr values in IDDM and NIDDM were almost in the same range, *i.e.*, Fig. 4(a), $r = 0.724$ ($P < 0.05$) and 4d $r = 0.435$ ($p < 0.05$) although in IDDM the relationship between NAG/Cr and AAP/Cr is stronger than in NIDDM. Thus, increased levels of NAG/Cr were associated with increased levels of AAP/Cr in IDDM patients especially in normotensive patients, Fig. (4)b, $r = 0.829$ ($p < 0.05$). This group showed significant higher relationship compared to their counterpart the normotensive NIDDM as shown from Fig. 4(c), $r = 0.352$ ($p < 0.05$). As for hypertensive IDDM and NIDDM patients, the relationship between NAG/Cr and AAP/Cr is stronger in NIDDM than in IDDM. Thus in a comparison between hypertensive IDDM versus NIDDM; as AAP/Cr increased NAG/Cr increased in both types Fig. 4(c), IDDM $r = 0.229$ ($p > 0.05$) and Fig. 4(f), NIDDM $r = 0.609$ ($p < 0.05$). Although the increased in NIDDM was higher than in IDDM. In IDDM and NIDDM NAG/Cr showed increased levels of NAG/Cr associated with increased levels of microalbuminuria/Cr Fig.

5(a), IDDM $r = 0.045$ ($p > 0.05$) and Fig. 5(d) NIDDM: $r = 0.081$ ($p > 0.05$). No statistical significance was recognized between the two groups. In normotensive IDDM and NIDDM the relationship between NAG/Cr and Mau/Cr is stronger in IDDM than in NIDDM. Fig. 5(b) IDDM $r = 0.273$ ($p < 0.05$) and Fig. 5(e) NIDDM $r = 0.012$ ($p > 0.05$). In hypertensive the relationship between NAG/Cr and microalbuminuria/Cr showed no statistical significance between the two types of diabetes mellitus, Fig. 5(c) $r = 0.127$ ($p > 0.05$) and Fig. 5(f) $r = 0.127$ ($p > 0.05$).

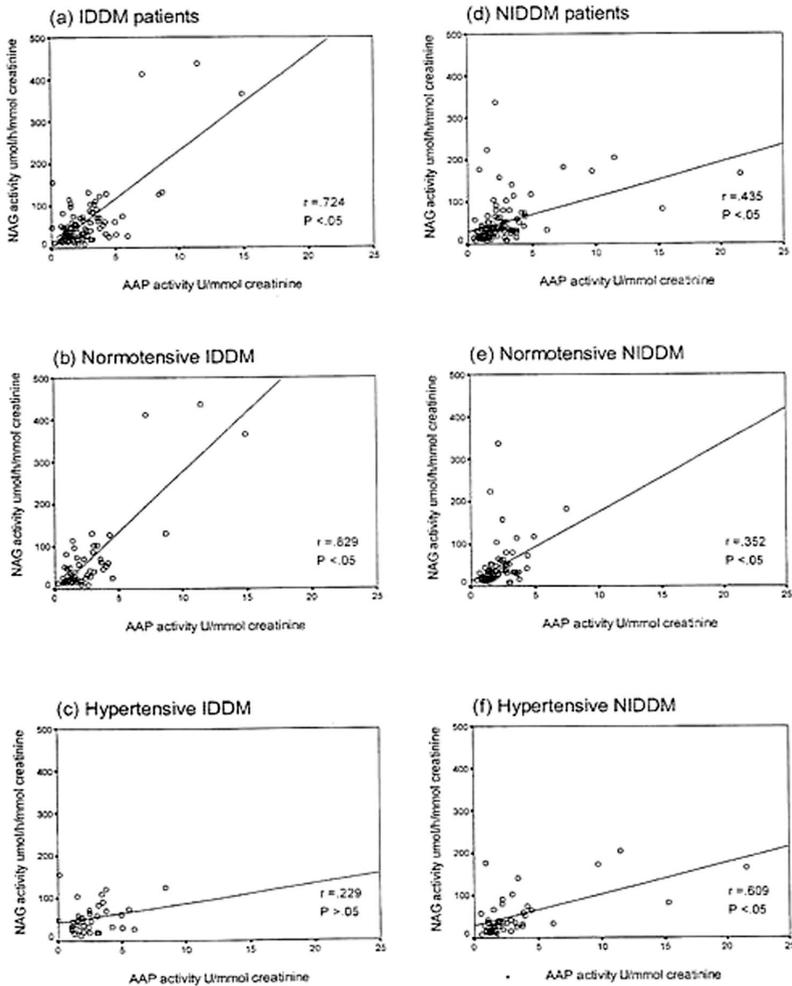


Fig. 4. NAG/Cr and AAP/Cr in IDDM and NIDDM. Scattered plots of NAG/Cr (y axis) to AAP/Cr (x axis) in patients suffering from diabetes mellitus IDDM and NIDDM for normotensive and hypertensive patients.

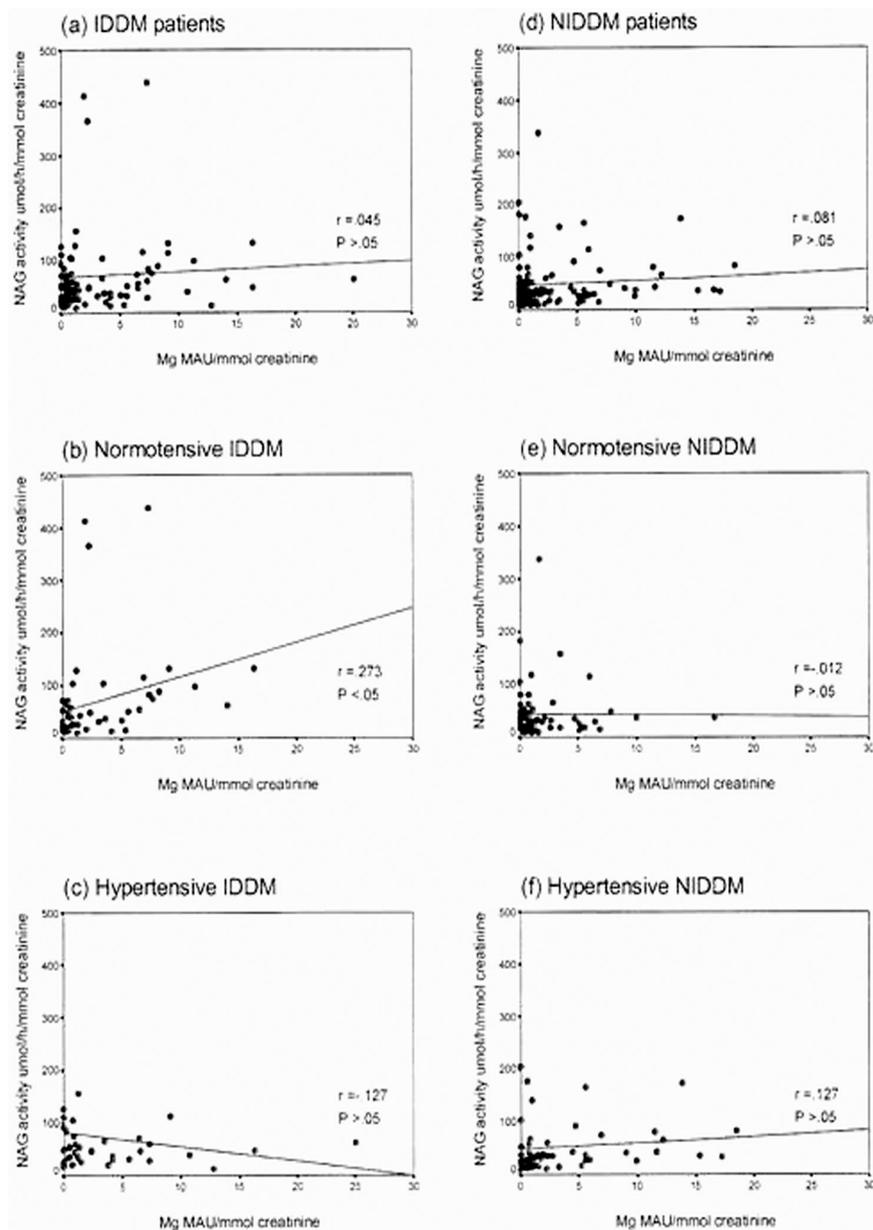


Fig. 5. NAG/Cr and MAU/Cr in IDDM and NIDDM. Shows scatter plots of NAG/Cr (y axis) to MAU/Cr (x axis) in patients suffering from diabetes mellitus IDDM and NIDDM for normotensive and hypertensive patients.

Urinary Protein Profile

SDS-polyacrylamide gel electrophoresis (SDS-PAGE) was performed with urine samples concentrated in a rotary concentrator (1:100).

The urinary protein profile for normal subjects was characterized by the presence of a main band at 69 KD (corresponding to albumin), with some band lower than 50 KD (Fig. 6). As for diabetic individuals, urinary protein profile was also characterized by a main band at 69 KD corresponding to albumin and lower bands at 50 KD possibly as a result of tubular damage or degraded proteins (Fig. 7).



Fig. 6. Urinary protein profile in control subjects. SDS page was performed with urine from control subjects concentrated in rotary concentrator 1:100 as described in materials and methods. Lane 1 and 15: Rainbow molecular weight markers.

Where:

- | | |
|-------------------------|-----------|
| 1. Myosin | = 200 KD |
| 2. Phosphorylase b | = 92.5 KD |
| 3. Bovine serum albumin | = 69 KD |
| 4. Ovalbumin | = 46 KD |
| 5. Carbonic anhydrase | = 30 KD |
| 6. Trypsin inhibitor | = 21.5 KD |
| 7. Lysozyme | = 14.3 KD |

Lane 2 to 15: Urine from control subjects.

Discussion

Diabetic nephropathy is one of the most devastating kidney diseases, its incidence is increasing and its treatment is expensive^[26]. The influence of ethnicity on the prevalence of, for example, microalbuminuria in NIDDM is interesting^[27].

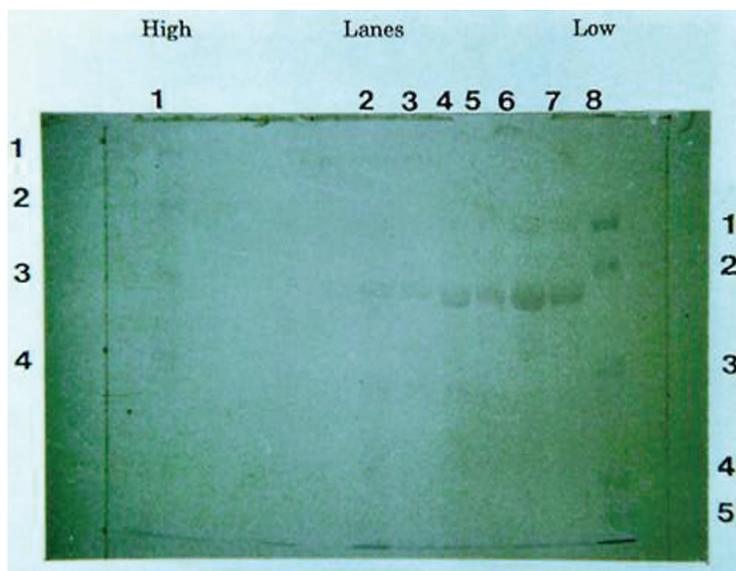


Fig. 7. Urine protein profile in diabetics. SDS-PAGE was performed with urine from diabetics as described in materials and methods.

Lane 1: High molecular weight markers.

1. Myosin	= 205 KD
2. β -galactosidase	= 116 KD
3. Bovine serum albumin	= 80 KD
4. Ovalbumin	= 49 KD

Lane 2, 3, 4, 5, 6, 7: Urine from diabetics.

Lane 8: Low molecular weight marker.

1. Phosphorylase b	= 1065 KD
2. Bovine serum albumin	= 80 KD
3. Ovalbumin	= 49.5 KD
4. Carbonic anhydrase	= 32.5 KD
5. Soybean trypsin inhibitor	= 27.5 KD
6. Lysozyme	= 18.5 KD

There is evidence that the Saudi population would also provide a model for future research but overriding that is the need to provide effective treatment for a population in which ESRD is common.

Urinary NAG has also been shown to vary in different populations, and may also be an indicator of early hypertensive disease^[28]. Screening of all diabetic patients for early indicators of diabetic nephropathy has been advocated^[29]. It is now known that improved blood glucose control^[30], together with anti-hypertensive therapy^[31], both preserved renal function and are highly cost effective, because treatment of ESRD is so expensive. Little information is

available on diabetes mellitus in Saudis, although it is believed to have a high prevalence^[32,33]. Extensive studies are therefore required to determine the exact prevalence, incidence genetics and the nature of the complications, and importantly the treatment and prognosis of diabetes in the Saudi population.

In the present study, a number of markers for diabetic nephropathy have been assayed in Saudi controls and diabetic patients. The parameters used for investigation are considered to be useful markers for diseases and are used for the first time among the Saudi population. To our knowledge, this is the first report of studies to define possible early markers of nephropathy in the assessment of diabetic nephropathy in Saudi Arabia.

The values found for urinary enzymes in normal subjects were similar to those defined in other studies^[34,35]. No significant differences were found between normal males and females. Both NAG and AAP activities were found to be highly elevated in the urine of normotensive and hypertensive IDDM or NIDDM patients, when compared to normal reference range of males and females. Several studies have indicated that urinary NAG changes prior to any significant variation in microalbuminuria^[36,37] suggesting that the known sequence of events that occur in the kidney^[38] may be reflected by qualitative and quantitative changes in markers in the urine. Previous studies have shown a relationship between urinary NAG and retinopathy^[39], and microalbuminuria and NAG with retinopathy^[40,41].

Elevation of NAG and microalbuminuria in all the diabetic patients investigated hypertensive or normotensive suggests that they have a high risk of developing diabetic nephropathy, with the possibility of progressing the ESRD. There was an elevation of microalbuminuria in hypertensive individuals, especially IDDM. Hypertensive NIDDM showed raised levels of microalbuminuria, when compared to normotensive NIDDM. Previous work^[18] had also suggested that microalbuminuria should be higher in the hypertensive individuals. Viberti and Messent^[42], have correlated microalbuminuria, subsequent proteinuria and incipient nephropathy with increased blood pressure. The prevalence of hypertensive increased with increasing microalbuminuria^[43,44].

Several studies have correlated increased blood pressure in IDDM diabetes with a progression to microalbuminuria and incipient or overt nephropathy, which occurs either at an early stage or during progression^[38, 45]. It was found that there is a strong correlation between NAG/Cr and AAP/Cr especially in normotensive IDDM than in NIDDM. In hypertensive group; the correlation however is stronger in NIDDM more than in IDDM. In normotensive there is also a strong correlation between NAG/Cr, and microalbuminuria/Cr especially in normotensive IDDM more than in NIDDM. In hypertensive diabetic patients

this correlation showed no statistical difference between IDDM and NIDDM. Vascular complications may be protected by maintenance of lower diastolic blood pressure^[46] and the life expectancy in diabetes with hypertensive is less when compared to the life expectancy for non diabetic hypertensive^[47].

The data presented here suggests that diabetic nephropathy may be more prevalent in Saudi Arabia than hitherto, though, and that its relationship to hypertensive in a defined Saudi population is worth of more detailed investigation. Such a study should include the assay of urinary enzymes, and a wider selection of proteins than just albumin. This would enable a decision to be made as to which groups of tests are the most appropriate, and to fully characterize nephropathy and the effect of hypertensive in a defined ethnic group from the Middle East.

Acknowledgement

We acknowledge the support of Professor Ossama Shobokshi, (Minister of Health, Kingdom of Saudi Arabia) for his continuous help and support and Dr. Adel Mohamed Ali, Director of Genetics and Immunology Technologies Laboratory for providing the glycated haemoglobin data. We also acknowledge Professor R.G. Price, King's College London for his support and advice.

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المؤشرات الأنزيمية (NAG, AAP) والميكروالبيومين يوريا في بول مرضى السكر ذوي الضغط المرتفع

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المستخلص. في محاولة لدراسة بعض المؤشرات البيوكيميائية للتشخيص المبكر لأمراض الكلى وغيرها من الأمراض، شملت آفاق البحث دراسة هذه المؤشرات في بول الأصحاء وبول مرضى السكر البالغين من السعوديين.

تمت الدراسة على أنزيم جلو كوز أمينيديز، الذي يعمل على الجليكوبروتين وأنزيم الألانين أمينو بيتيديز، الذي يعمل على أيض الأحماض الأمينية، وكلاهما يعتبر مؤشراً حساساً للكشف عن أمراض الكلى وغيرها من الأمراض، وقد تم قياس البروتين الكلوي، الميكروالبيومين، كمؤشر للتشخيص المبكر لأمراض الكلى، وقد تم أيضاً قياس اليوريا والكرياتينين والجلوكوز والأس الهيدروجيني.

أظهرت نتائج البحث أن هذه المؤشرات توجد بنسبة طبيعية في الأصحاء السعوديين في الحدود المتفق عليها عالمياً، ولا يوجد هناك اختلاف بين الإناث والذكور.

بالنسبة لمرضى السكر، فقد لوحظ ارتفاع ملحوظ في أنزيم جلو كوز أمينيديز مصاحباً لارتفاع أنزيم الألانين أمينو بيتيديز، وكذلك في الميكرو البيومين يوريا.

بالنسبة لمرضى السكر الذين يعتمدون على الأنسولين، ذوي ضغط الدم الطبيعي، فقد لوحظ ارتفاع في نشاط الأنزيم جلو كوز أمينيديز. أما بالنسبة لمرضى السكر الذين يعتمدون على الأنسولين، والذين لا يعتمدون على الأنسولين، فلم يحدث هذا النشاط في ذوي ضغط الدم المرتفع.

وقد لوحظ ارتفاع نسبة الميكروألبومين يوريا لدى مرضى السكر الذين يعتمدون على الأنسولين، ويعانون من ارتفاع في ضغط الدم، بينما لم يحدث ذلك في المجموعة ذوي ضغط الدم الطبيعي.

أما نسبة البروتين الكلي، فقد ارتفع في مرضى السكر ذوي ضغط الدم المرتفع، من مرضى السكر الذين يعتمدون على الأنسولين عن غيرهم من الذين لا يعتمدون على الأنسولين.

ومن خلال هذه النتائج يمكن الاستدلال على أنه يمكن استخدام أنزيم الجلوكوز أمينيداز والألانين أمينو بيتيداز والميكرو ألبومين يوريا كمؤشرات في التشخيص المبكر للأمراض الكلوية، وأمراض الكلى المصاحبه لارتفاع ضغط الدم.

إذ يجب استخدام هذه المؤشرات مبكراً، وقد لا يفيد ذلك في حالات الأمراض المتأخرة، وعند تلف الكلى تماماً وفوات الأوان. وأنه من الضروري التعرف على التطورات المحتملة للمرض ومتابعة نتيجة العلاج من خلال قياس هذه المؤشرات.