

# Causes of The Nephrotic Syndrome In Sweden 2014-2019 Depending On Clinical Presentation And Demographics

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## Research Article

**Keywords:** Epidemiology, Nephrotic syndrome, Albuminuria, Glomerulonephritis, Membranous nephropathy, Diabetic Nephropathy, Membranoproliferative glomerulonephritis, IgA nephropathy, Focal segmental glomerulosclerosis.

**Posted Date:** September 24th, 2021

**DOI:** <https://doi.org/10.21203/rs.3.rs-720668/v1>

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# Abstract

**Background:** Many different pathological processes can affect the integrity of the glomerular capillary wall and cause massive leakage of protein resulting in the Nephrotic Syndrome (NS). The prognosis and response to therapy differs depending on diagnosis, but renal biopsy cannot always be performed promptly. There is insufficient knowledge to which extent clinical parameters can predict the diagnosis.

**Methods:** Age, gender, haematuria, proteinuria, plasma creatinine, plasma albumin and final diagnosis were retrieved for all adult patients with NS as indication for biopsy or massive albuminuria in conjunction with a low plasma albumin from the biopsy module of the Swedish Renal Registry (SRR) between 2014 and 2019. A basic calculator was developed to demonstrate the importance of clinical presentations in relation to the likelihood of having a specific diagnosis.

**Results:** 913 unique patients were included in the study. Overall membranous nephropathy (17%) was the most common diagnoses, but when studying those <50 years old or women minimal change nephropathy (21 and 17 %) was the most frequent diagnosis. When examining those between 50 and 70 years-old, those with chronic kidney disease (CKD) 4 and those with negative dipstick tests for hematuria diabetic nephropathy (23, 30 and 21 %) was the most common underlying disease. Among those with high grade hematuria (grade 3-4 on dipsticks) Membranoproliferative glomerulonephritis was most common (14%), closely followed by IgA nephropathy (13%). Focal segmental glomerulosclerosis (9.7%) was less common than in many comparable studies.

**Conclusions:** Clinical parameters have a profound impact on the likelihood of different diagnoses in adult patients with NS. Differences in clinical practice, inclusion criteria in studies and probably genetic background are important to account for when comparing data from different parts of the world.

## Background

Massive leakage of proteins in the kidneys associated with oedema is referred to as nephrotic syndrome (NS) (1). NS is relatively common in renal practice with an incidence of 3–4 new cases per 100 000 each year (2–4) and is in many reports the most frequent indication for renal biopsy (5). In a recent study (6) on patients' perspectives of suffering from NS we found that it is perceived as a highly complex condition to grasp. Many patients describe the illness experience as being a stranger in an unfamiliar world of symptoms and medical treatments. This perception is at least partly shared by the physicians as the heterogeneity of the condition is a problem. Understanding how different clinical presentations are associated with different diagnoses and pathological processes is important.

The distribution of causes of NS varies between countries and over time which hampers comparisons. Membranous nephropathy (MN) was the most common cause of NS in India (7), Spain(8) and Denmark (9). Focal segmental glomerulosclerosis (FSGS) was the most common cause in USA (10) while IgA nephropathy (IgAN) was the most cause common in Czech Republic (11) and mesangial proliferative glomerulonephritis (MPGN) in Lebanon (12).

There are studies based on national registers (4, 9, 11, 13), on regional registries (8, 14) and on data from single centres (7, 10). Most of these studies did not focus specifically at examining diagnoses behind NS and many are scarce on clinical data. In some studies, secondary causes of NS such as diabetic nephropathy (DN) and systemic lupus erythematosus (SLE) were excluded (15, 16). There are few attempts to analyse how demographic factors and clinical presentation affect the likelihood of different diagnoses among adult patients with NS. The aim of this study was to describe the causes of NS in the Swedish population and to analyse how the spectrum is dependent on factors readily available before return of biopsy results. To this end we have retrieved data on biopsy indication, albuminuria, haematuria, CKD stage, age and gender from the renal biopsy module of the Swedish Renal Registry.

## Methods

## Data source

Data was retrieved from the biopsy module of the Swedish Renal Registry (SRR-biopsy). The organisation of the SRR is described in previous publications (17) and the biopsy module was launched in 2015 for prospective registration of biopsies from native renal kidneys (18). It is also possible to enter older biopsies retrospectively, and it has been done in a systematic fashion at some hospitals for 2013 and 2014. For biopsy indication one of the following five alternatives has to be chosen: nephrotic syndrome, acute nephritic syndrome, other acute kidney injury, CKD 1–2 and CKD 3–5. The result of the biopsy is entered both with a SNOMED (Systematized Nomenclature of Medicine) code from the pathologist and with an ERA-EDTA (European Renal Association – European Dialysis and Transplant Association) code for primary renal disease chosen by the nephrologist when combining clinical features, laboratory results along with biopsy results. When there are multiple findings in the biopsy the one best explaining the biopsy indication should be entered as main diagnosis.

## Study population

We included data from biopsies performed between January 1, 2014 and December 31, 2019. Three searches were performed in the SRR-biopsy (i) biopsy indication nephrotic syndrome, (ii) urine albumin/creatinine > 300 mg / mmol and (iii) urine albumin > 3.5 g/24 hours. Data retrieved from the registry at time of biopsy included patient age, gender, weight, renal diagnosis, blood pressure, dipstick haematuria, plasma creatinine, eGFR (CKD-EPI), plasma CRP and plasma albumin, urine albumin/creatinine, urine albumin (24 h collection), serum haemoglobin. Patients' biopsy indication other than NS were excluded from the study if plasma albumin was > 30 g/L.

If a patient had multiple biopsies clinical data was collected from the time of the first biopsy, but the diagnosis was taken from the latest biopsy if performed on the same indication. The reason for performing a repeat biopsy is most often that the initial biopsy yielded insufficient material and unable to provide a clear diagnosis. We grouped the ERA-EDTA codes version 2018 for primary renal diseases into 12 groups (19) (Table 1).

Table 1  
Grouping of renal disease and ERA-EDTA diagnosis codes.

Renal disease	ERA-EDTA Codes
Focal segmental glomerulosclerosis (FSGS)	1061, 1267, 1308, 1320, 1354
IgA nephropathy (IgAN)	1128, 1144, 1515
Membranoproliferative glomerulonephritis (MPGN)	1222, 1233, 1246
Membranous nephropathy (MN)	1185, 1192, 1205, 1214
Minimal change nephropathy (MCN)	1100
Other glomerulonephritis	1251, 1331, 1349, 1365, 1377
Diabetic nephropathy (DN)	2328, 2337, 2344
Systemic lupus erythematosus (SLE)	1493
Plasma cells dyscrasias (PCD)	2521, 2584, 2597, 2606
Vascular disease	2359, 2363, 2385, 2411, 2448
Vasculitis	1383, 1401, 1417, 1429, 1472
Other renal diagnosis	1570, 1591, 1897, 1930, 2014, 2257, 2288, 2509, 2513, 2623, 2634, 2668, 2681, 2760, 3380, 3398, 3419, 3442, 3564

## Statistical analysis

All analysis was performed using IBM SPSS software (version 26.0 SPSS Inc.) for Mac. Categorical variables (gender, grade of haematuria) were expressed as frequencies and percentages. Chi-square or Fisher's exact test when appropriate, were used to compare group differences between categorical variables. Parametric continuous variable (age) was expressed as mean  $\pm$  standard deviation (SD). Independent Sample t-test was used to compare groups. Non-parametric continuous variables (laboratory parameters, weight and blood pressure) were expressed as medians and interquartile ranges. Mann-Whitney test was used to compare the two independent groups (NS and other indication). P values < 0.05 were considered to be statistically significant.

## Results

### Study population

Our primary search criteria generated a total of 1734 biopsies entries. After removal of duplicates, repeat biopsies, incomplete data sets and patients not fulfilling inclusion criteria, 913 unique patients were included in the analyses (Fig. 1). There were 735 patients with biopsy indication NS and 178 patients who had laboratory parameters compatible with NS but the main biopsy indication was not NS. In this "other indication group" the most common indication for biopsy was CKD 3–5 (48.3%) followed by acute nephritic syndrome (30.9%), CKD 1–2 (11.2%) and acute kidney injury (9.6%).

### NS vs. other indication

There were only small and insignificant differences in age and gender distribution (Table 2) between those with biopsy indication NS and those with other indication. There were, however, a substantial difference in plasma creatinine concentration, where the other indication group had more than twice the level compared to the NS group, with reciprocal results regarding eGFR. The NS group also had lower systolic blood pressure (median 135 vs. 140 mmHg), lower proportion of patients with hematuria of grade 3–4 (26.2 vs. 43.5%) and higher blood haemoglobin (median 126 vs. 113 g/L).

Table 2  
Demographic data and clinical characteristics at time of biopsy.

Variables	All patients ( <i>n</i> = 913)	Indication NS ( <i>n</i> = 735)	Other indication ( <i>n</i> = 178)	<i>p</i> value
Age, mean years ± SD	56.3 ± 17.56	56.3 ± 17.74	56.7 ± 16.83	0.250 <sup>a</sup>
Gender, % ( <i>n</i> )				
Male	57.8 (528)	57.1 (420)	60.7 (108)	0.221 <sup>b</sup>
Female	42.2 (385)	42.9 (315)	39.3 (70)	
Plasma creatinine (µmol/L)	122 (80–210)	106 (77–179)	233 (139–460)	< 0.001 <sup>c</sup>
eGFR (ml/min/1.73m <sup>2</sup> )	48 (25–75)	56 (31–80)	24 (11–41)	< 0.001 <sup>c</sup>
Plasma albumin, g/L	24 (18–28)	23 (17–28)	25 (21–28)	0.065 <sup>c</sup>
Urine albumin/creatinine (mg/mmol)	486 (331–728)	477 (310–724)	530 (374–742)	0.021 <sup>c</sup>
Blood haemoglobin (g/L)	123 (107–138)	126 (109–141)	113 (100–130)	< 0.001 <sup>c</sup>
Weight (kg)	80 (68–95)	79 (68–94)	84 (69–98)	0.068 <sup>c</sup>
Systolic blood pressure, (mmHg)	135 (123–149)	135 (121–147)	140 (130–150)	0.001 <sup>c</sup>
Diastolic blood pressure, (mmHg)	79 (70–85)	78 70–85	80 (71–85)	0.125 <sup>c</sup>
Grade of haematuria, % ( <i>n</i> )				
0	22.1 (188)	23.3 (159)	17.1 (29)	< 0.001 <sup>b</sup>
1–2	48.2 (411)	50.4 (344)	39.4 (67)	
3–4	29.7 (253)	26.2 (179)	43.5 (74)	

Overall, the three most common diagnoses were DN (17.5%), MN (17.2 %) and Minimal change nephropathy (MCN) (15.3%). The biggest difference between the NS and the other indication group was seen for MCN (18.2 vs. 2.2%). Large differences in the same direction were noted also for MN, FSGS and SLE. The differences in the opposite direction were seen for IgAN, vasculitis and vascular diseases (Table 3).

**Table 3.** Causes of NS depending on indication for biopsy

Diagnosis	Overall	Indication	Other indication
	% (n)	NS % (n)	% (n)
	n = 913	n = 735	n = 178
FSGS	8.4(77)	9.7(71)	3.4(6)
IgAN	6.7(61)	4.9(36)	14.0(25)
MPGN	5.7(52)	5.4(40)	6.7(12)
MN	17.2(157)	19.0(140)	9.6(17)
MCN	15.3(140)	18.5(136)	2.2(4)
Other glomerulonephritis	3.0(27)	2.7(20)	3.9(7)
DN	17.5(160)	16.5(121)	21.9(39)
SLE	3.9(36)	4.5(33)	1.7(3)
PCD	6.6(60)	7.1(52)	4.5(8)
Vascular diseases	5.7(52)	4.4(32)	11.2(20)
Vasculitis	3.1(28)	1.8(13)	8.4(15)
Other renal diagnosis	6.7(61)	5.3(39)	12.4(22)
No diagnosis	0.2(2)	0.3(2)	0.0(0)

Next, we compared those within the NS group that had laboratory features compatible with NS (n = 487) with those not fulfilling the proteinuria (urine albumin/creatinine > 300 mg / mmol or dU-albumin > 3.5 g) and/or albumin criteria (plasma albumin ≤ 30 g/L) set up in this study at the time of biopsy (n = 248). There were only very minor differences regarding clinical parameters such as age, gender, renal function and hematuria between the groups (data not shown). When comparing diagnosis among patients not fulfilling laboratory criteria they tended to be similar to the other indication group i.e. there are less MN and MCN and more IgAN and vasculitis. However, opposite to the other indication group they tended to have more SLE and FSGS (data not shown).

## Demographics

The two diagnoses that increased most with age are vascular diseases (from 1.3% among 18–49 years to 10.0% above 70 years) and plasma cell dyscrasias (PCD) (1.0 to 13.4%). Diseases that decreased with age included IgAN, MCN and SLE. DN showed the highest proportion in the middle age group (50–70 years) with 22.8%, being lower both among the youngest and highest age groups. The diagnosis with the most stable proportion in the different age groups was MPGN.

Overall men outnumbered women 1.5/1, in relative terms. The largest difference in diseases more common in men were DN (20.5 vs 13.5%) and MN (19.5 vs. 14.0%). Diagnoses more common in women included SLE (8.3 vs. 0.8%), MPGN (7.3 vs. 4.5%) and MCN (17.4 vs. 13.8%) (Table 4).

**Table 4.** Causes of nephrotic syndrome in different subgroups as age groups, sex, grade of hematuria and CKD. Data are presented as percentages (numbers) in columns for each subgroup \*CKD (Chronic kidney disease). CKD stages 1-2 = eGFR >= 60ml; CKD stage 3 = eGFR 30-59ml; CKD stage 4 = eGFR 15-29ml; CKD stage 5 = eGFR <15ml.

Diagnosis	Age groups			Gender		Grade of haematuria			Stages of CKD*			
	% (n)			% (n)		% (n)			% (n)			
	18–49 year. (n = 304)	50–70 year. (n = 378)	> 70 year. (n = 231)	Male (n = 528)	Female (n = 385)	0 (n = 188)	1–2 (n = 411)	3–4 (n = 253)	1–2 (n = 362)	3 (n = 265)	4 (n = 188)	5 (n = 98)
FSGS	11.8 (36)	6.9 (26)	6.5 (15)	8.3 (44)	8.6 (33)	11.7 (22)	8.8 (36)	6.7(17)	10.8 (39)	9.4 (25)	6.4 (12)	1.0 (1)
IgAN	12.2 (37)	4.5 (17)	3.0 (7)	7.0 (37)	6.2 (24)	2.1 (4)	4.6 (19)	13.4 (34)	5.8 (21)	6.8 (18)	8.5 (16)	6.1 (6)
MPGN	5.3 (16)	5.8 (22)	6.1 (14)	4.5 (24)	7.3 (28)	2.1 (4)	1.9 (8)	14.2 (36)	2.8 (10)	6.4 (17)	10.1 (19)	6.1 (6)
MN	13.8 (42)	18.5 (70)	19.5 (45)	19.5 (103)	14.0 (54)	11.2 (21)	23.4 (96)	13.4 (34)	26.0 (94)	15.5 (41)	10.6 (20)	2.0 (2)
MCN	20.7 (63)	13.8 (52)	10.8 (25)	13.8 (73)	17.4 (67)	22.3 (42)	15.3 (63)	9.1 (23)	27.1 (98)	9.1 (24)	7.4 (14)	4.1 (4)
Other GN	3.0 (9)	2.6 (10)	3.5 (8)	2.3 (12)	3.9 (15)	2.7 (5)	1.2 (5)	5.1 (13)	2.2 (8)	3.4 (9)	1.1 (2)	8.2 (8)
DN	13.2 (40)	22.8 (86)	14.7 (34)	20.5 (108)	13.5 (52)	21.3 (40)	20.7 (85)	5.9 (15)	6.6 (24)	21.5 (57)	29.8 (56)	23.5 (23)
SLE	9.2 (28)	1.1 (4)	1.7 (4)	0.8 (4)	8.3 (32)	3.2 (6)	3.4 (14)	5.9 (15)	6.1 (22)	4.2 (11)	0.5 (1)	2.0 (2)
PCD	1.0 (3)	6.9 (26)	13.4 (31)	6.6 (35)	6.5 (25)	6.9 (13)	8.0 (33)	4.7 (12)	6.6 (24)	8.7 (23)	5.3 (10)	3.1 (3)
Vascular diseases	1.3 (4)	6.6 (25)	10.0 (23)	6.6 (35)	4.4 (17)	10.1 (19)	6.3 (26)	2.4 (6)	1.7 (6)	6.4 (17)	10.1 (19)	10.2 (10)
Vasculitis	1.0 (3)	4.0 (15)	4.3 (10)	3.0 (16)	3.1 (12)	0.0 (0)	0.5 (2)	9.5 (24)	0.3 (1)	2.6 (7)	2.1 (4)	16.3 (16)
Other renal diagnosis	7.6 (23)	6.3 (24)	6.1 (14)	6.8 (36)	6.5 (25)	6.4 (12)	5.6 (23)	9.5 (24)	3.9 (14)	5.7 (15)	8.0 (15)	17.3 (17)
No diagnosis	0.0 (0)	0.3 (1)	0.4 (1)	0.1 (1)	0.3 (1)	0.0 (0)	0.2 (1)	0.0 (0)	0.3 (1)	0.4 (1)	0.0 (0)	0.0 (0)

## Hematuria and CKD stage

When dividing the patients based on the level of dipstick haematuria increasing proportions along with increasing haematuria was seen for vasculitis (0%, 0.5% and 9.5%), MPGN (2.1%, 1.9% and 14.2%) and IgAN (2.1%, 4.6% and 13.4%). Decreasing proportions along with increasing haematuria was seen with DN (21.3, 20.7 and 5.9%) and MCN (22.3, 15.3 and 9.1%). For MN the highest relative proportion was seen among those with moderate levels of haematuria (23.4%), compared to 11.2% among those with negative dipstick test and 13.4% among those with grade 3–4 haematuria.

When comparing relative proportions among those with a biopsy at CKD 1–2 with those with CKD stage 5 the largest decrease was seen for MN (26.0 to 2.0%) and MCN (27.1 to 4.1%). Going in the other direction the largest differences were seen for vasculitis (0.3 to 16.3 %) and other vascular diseases (1.7 to 10.2%) and DN exhibited an increase from 6.6% in CKD 1–2 to 29.8% in CKD 4, but fell back to 23.5% in CKD 5. A relatively stable proportion in different CKD stages was seen for IgAN, being highest in CKD 4 with 8.5% and lowest in CKD1-2 with 5.8% (Table 4).

## Nephrosis diagnosis calculator

When combining demographical and basal clinical chemistry data a calculator can be constructed (suppl 1). When age, gender, level of hematuria and CKD stage are entered the calculator provides the likelihood of different diagnoses and how the percentage change compared to no knowledge of clinical data.

For example, for a 30-year-old female with 3+ haematuria and CKD 2, SLE will be the most common diagnosis (50% chance) followed by IgAN (13%) and MCN (9%). If the same patient was male, the most probable diagnosis becomes IgAN (29%) followed by MCN and FSGS (14% each). Four other examples are shown in Fig. 2. To evaluate the calculator all patients with complete data were entered into the calculator. The biopsy verified diagnosis was found among the top three diagnoses in 62% of the cases, ranging from 22% for the collective diagnosis group "Other renal diagnoses" to 85% for vasculitis.

## Discussion

In this study we present data on the causes of the nephrotic syndrome in Sweden and how this is affected by the clinical presentation, basic clinical features and demographic factors. These data facilitate the identification of the most probable diagnosis in cases when biopsy must be delayed or cannot be performed due to contraindications. Clinical practice, for instance differing indication for biopsy, will affect the reported patterns as well. In a cohort of Swedish patients that have performed a renal biopsy with the indication NS based on current clinical practice the most frequent diagnoses are MN (19%), MCN (18.5%) followed by DN (16.5%). However, the proportion varies considerably when subsets based on certain clinical parameters are studied.

## Main findings and comparison with previous studies

Definitions of disease and inclusion criteria are always crucial in studies concerning disease incidence. In our study MN and MCN were the most common diagnoses in patients with NS as indication for biopsy. In patients with heavy albuminuria but other indication for biopsy DN and IgAN were the most frequent diagnoses. This is in line with other studies (4, 7–9, 20–23). In contrast, a study from Lebanon (12) showed that MPGN was the most common diagnosis in NS, accounting for 27% of the cases.

There are differences in disease pattern on a regional and national level, due to socioeconomic factors and ethnicity (10). Compared with some other studies (7, 10, 12, 15, 16) we found a high proportion of patients with DN and low share of FSGS. It is well known that FSGS is correlated both to obesity (24) and to African ancestry (10, 16). The SRR database contains no information on ethnicity, but in the general Swedish population approximately 18% have non-European ancestry, with a large population coming from the middle east, which might explain some of these differences.

Clinical practice, for instance differing indication for biopsy, will affect the reported patterns as well. DN was a common cause of NS (16.5%) and the most common diagnosis in patients with heavy albuminuria with other indication for biopsy (21.9%). We believe that this high share is explained by differences in clinical practice, and inclusion criteria for studies. Bandi et al. (7) described a wide spectrum of kidney diseases in a South Indian population. A low number of patients with CKD or acute kidney injury were diagnosed with DN and only 1.4% of patients with NS had DN as main diagnosis. This may reflect a different preference when it comes to renal biopsy and in contrast to other diagnoses, DN does not require biopsy for diagnosis. A difference in clinical practice is suggested also by the large difference in mean age of patients, being 23.3 years (7) and 56.3 in our study, respectively. The cause of NS also varies with patient age. Among younger patients (< 50 years) MCD, IgAN and SLE was relatively common. In older patients (> 50 years) MN, DN and PCD increased. This result is in agreement with most other studies (4, 20–22). In patients older than 80 years PCD and MN were more frequent than in other age group (data not shown).

Data limitations and differing inclusion criteria should also be considered when comparing studies. Haas et al. (15) and Korbet et al. (16) excluded secondary causes such as diabetes mellitus, SLE and vasculitis. O'Shaughnessy et al. (10) studied an American population and selected biopsies with glomerular disease diagnoses divided into nephritic and nephrotic subtypes, not considering clinical parameters and not including less common causes of NS (IgAN, vasculitis, lupus nephritis,

tubulointerstitial nephritis, hypertensive nephropathy, Alport syndrome and preeclampsia). Approximately 25% of patient in our study would have been excluded using the same criteria

## Haematuria

Haematuria was common in all groups and diagnoses. In patients with NS as indication for biopsy only 22% of patients had no haematuria and 30% had high grade of haematuria (grade 3–4). In the latter group MPGN, IgAN, MN and vasculitis were the four most frequent diagnoses. Haematuria is thus not a discriminator for NS and there appears to be an overlap between nephritic and nephrotic syndrome. For example, IgAN, a common cause of nephritic syndrome was the seventh most common diagnosis in patients with NS as indication for biopsy.

## Diagnosis calculator

To demonstrate the usefulness of clinical data to predict the diagnosis for individual patients, we developed a basic calculator. By calculating the probability of the different diagnoses based on four clinical parameters (age, gender, haematuria and CKD), we can show the probabilities based on the distribution within these subgroups. As shown in Fig. 2 these probabilities exhibit substantial differences. Nonetheless, it is important to keep in mind that the calculator calculate probabilities and should not be used to set a diagnosis. Adding data from other cohorts would make it possible to enter more parameters such as serology, proteinuria or previous disease history (e.g. diabetes mellitus) and refine the results. It may be further developed by using machine learning to calculate different weighting of the entered parameters and could potentially be used to find the diagnosis in cases when it is not possible to perform a biopsy.

## Limitations

This study has several limitations. The cohort stems from a single country with a primarily Caucasian population, and we do not have data on ethnicity. Indication for biopsy is entered at the discretion of individual clinicians and has not been validated. For instance, 4% of the patients with the indication NS had only moderate proteinuria (U-albumin/creatinine < 100 g/mol), even if time may have elapsed from the day the indication was set until the biopsy was actually performed and their cases with rapid response to therapy, we cannot exclude mistakes in the registration procedures. The study also has important merits. It contains a large number of cases collected over a relatively short time period, and thus reflects the current situation in our country. We provide data both on patients with a defined set of laboratory values and of patients with a clinical diagnosis of NS and compare the differences between these two inclusion criteria. We thereby provide the entire spectrum of the NS.

## Abbreviations

<b>CKD:</b>	Chronic kidney disease
<b>DN:</b>	Diabetic nephropathy
<b>ERA-EDTA:</b>	European Renal Association – European Dialysis and Transplant Association
<b>FSGS:</b>	Focal segmental glomerulosclerosis
<b>IgAN:</b>	IgA nephropathy
<b>MCN:</b>	Minimal change nephropathy
<b>MN:</b>	Membranous nephropathy
<b>MPGN:</b>	Mesangial proliferative glomerulonephritis
<b>NS:</b>	Nephrotic Syndrome

<b>PCD:</b>	Plasma cell dyscrasias
<b>SLE:</b>	Systemic lupus erythematosus
<b>SNOMED:</b>	Systematized Nomenclature of Medicine
<b>SRR:</b>	Swedish Renal Registry

## Declarations

### Ethics approval and consent to participate

This study was performed in line with the principles of the Declaration of Helsinki. The Swedish Renal Registry is a national health care registry under the auspice of the National Board of Health and Welfare. Ethical approval was obtained from the Regional ethical approve board in Stockholm, Sweden (Reference number: 2018/1591-31/2). All patients received written and oral information before inclusion, and they were given the opportunity to opt-out at any time point without providing any reason for opting out. Therefore, informed consent was confirmed from all participants by using 'opt-out method'. Information stored in the registry may after ethical approval be the SRR be used for research.

### Consent for publication

Not applicable. The manuscript contains no individual person's data in any form.

### Availability of data and materials

All data on a grouped level as well as the calculator are available upon request to the corresponding author.

### Competing interests

None of the authors have any competing interests.

### Funding

Swedish Kidney Foundation and Alfred Österlunds Stiftelse.

### Authors' contributions

AJ, KD and MS set up the retrieval strategy and retrieved data from the SNR. AJ, KD, MS and TH analysed the data. AJ, TH, AF, MS and KD contributed to the design of the study and wrote the manuscript. All authors have read and approved the manuscript.

### Acknowledgements

SRR – and all clinicians that have contributed with patient data.

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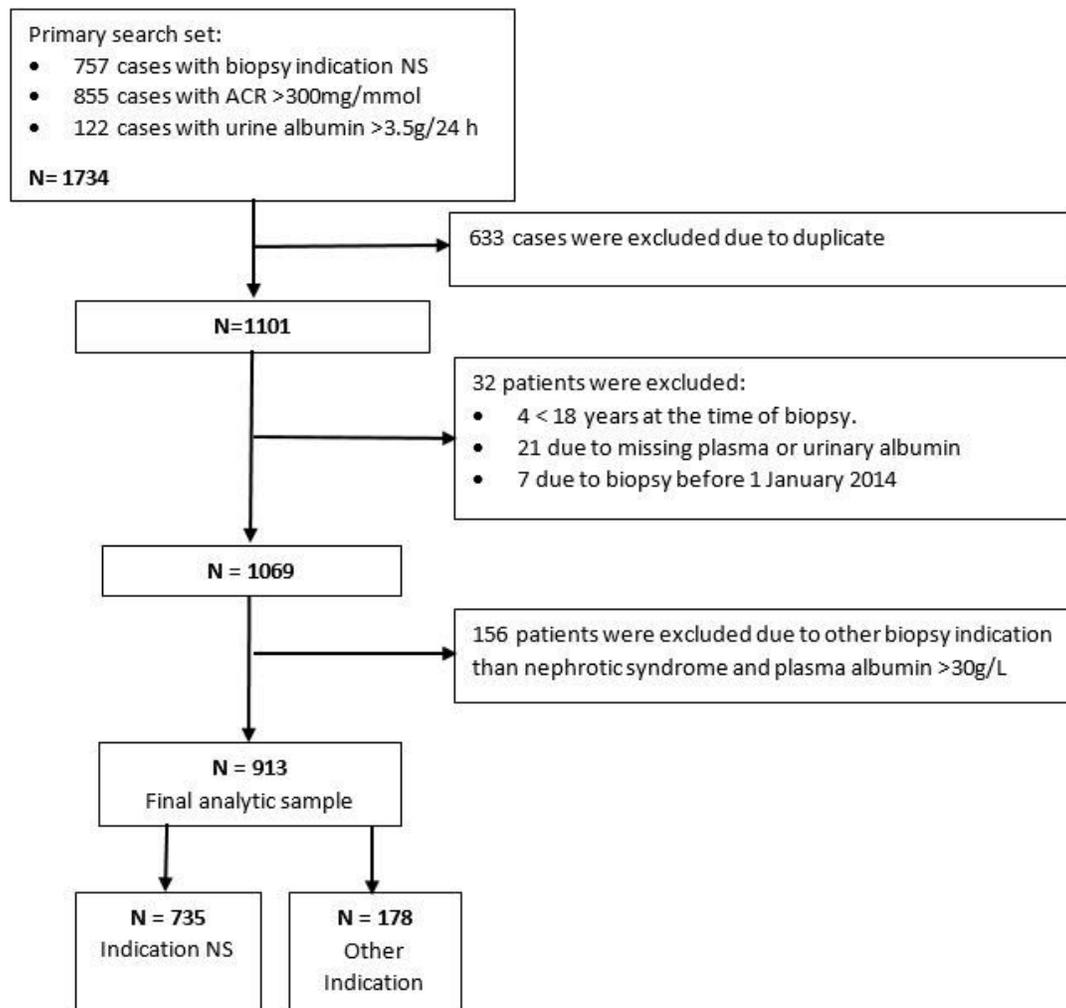
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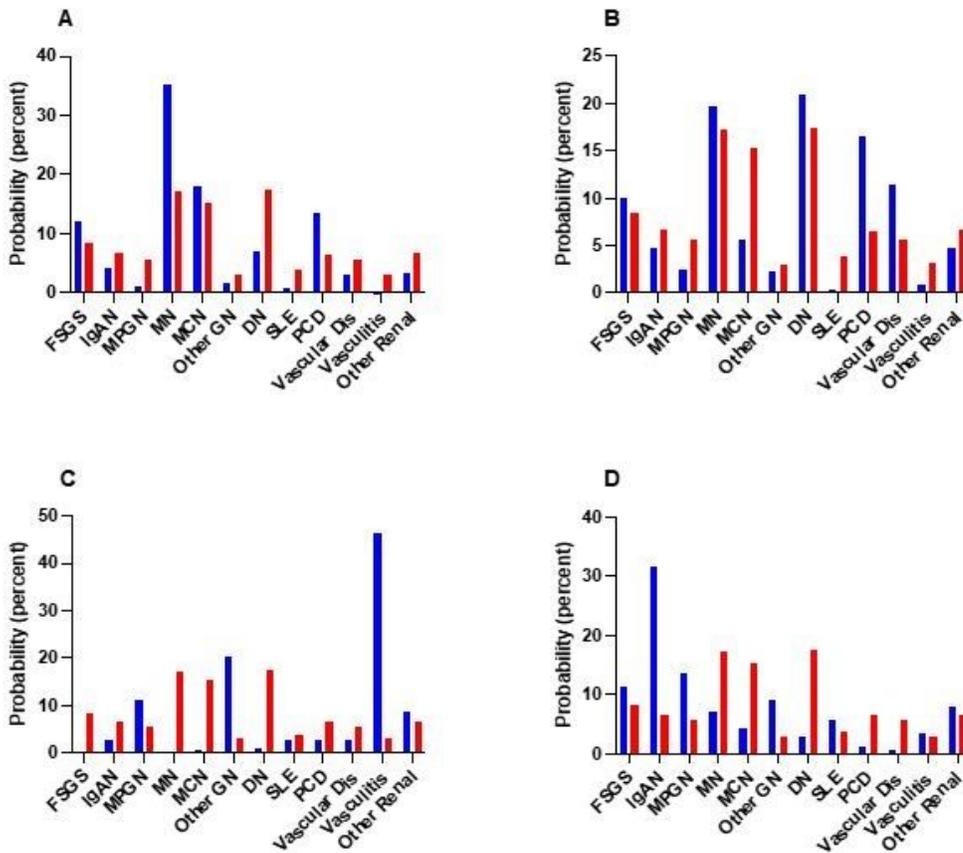
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## Figures



**Figure 1**

Flow chart of study population



**Figure 2**

Calculated probabilities for 4 different patients. The red bars indicate the overall probability without entering any specific patient data and the blue bars shows the calculated probabilities. A) a 64-year-old male with 2+ haematuria and CKD 1 shows that the most likely diagnosis is MN followed by MCN and PCD. B) a 58-year-old male with 2+ haematuria and CKD 3 shows that the most likely diagnosis is DN and almost the same probabilities for MN and PCD. C) a 73-year-old female with 3+ haematuria and CKD 5 shows a very high probability for vasculitis followed by other GN and MPGN. D) a 21-year-old male with 4+ haematuria and CKD 3 shows that the most likely diagnosis is IgAN followed by MPGN and FSGS.

## Supplementary Files

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