

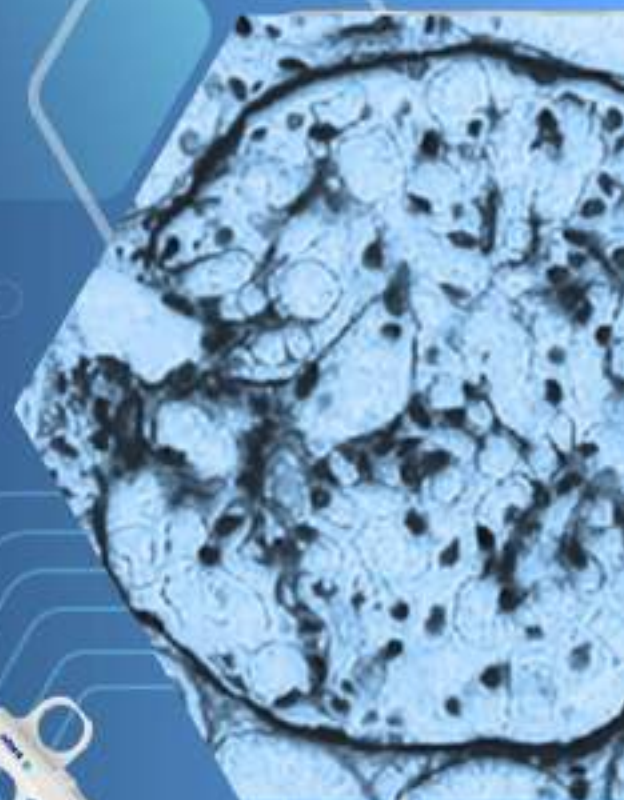
# 8th REPORT OF THE MALAYSIAN REGISTRY OF RENAL BIOPSY 2022

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# **8<sup>th</sup> REPORT OF THE MALAYSIAN REGISTRY OF RENAL BIOPSY 2022**

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Thank you for participating in the Registry.  
The success of the Registry depends on you.**

**The Ministry of Health, Malaysia.**

**National Institutes of Health, in particular Mr. Ridwan Sanaudi for their tireless effort  
in supporting the work of registries**

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# ABOUT MALAYSIAN REGISTRY OF RENAL BIOPSY

Renal biopsy remains the main investigation in the diagnosis of renal diseases. In addition, it plays a major role in determining the management and prognosis of parenchymal renal disease. The collection of demographics, clinical and laboratory data at the time of biopsy and the set-up of a database are useful tools for studying renal parenchymal diseases.

The development of a renal biopsy registry in each country promotes many advantages and these include comparison in incidence of renal diseases, identification of different policies and practices in renal biopsy in different areas, linkage with other registries such as dialysis or transplant registry and identification of rare renal diseases. Thus, the registry is a source of epidemiological data and would provide useful information in the planning of health care and in organizing prospective clinical studies.

The incidence of glomerular disease varies according to population, demographic characteristics, environmental factors, socio-economic status, and the prevalence of infectious diseases. At present, there is limited information on the prevalence and incidence of glomerular disease, its potential disease burden and the temporal trend in Malaysia. Hence, the Malaysian Registry of Renal Biopsy (MRRB) was set up in 2005 to address this deficiency.

The MRRB collects information about patients who undergo renal biopsy in Malaysia. The MRRB is a new component of National Renal Registry (NRR), which has been operating the Malaysian Dialysis and Transplant Registry (MDTR) since 1993.

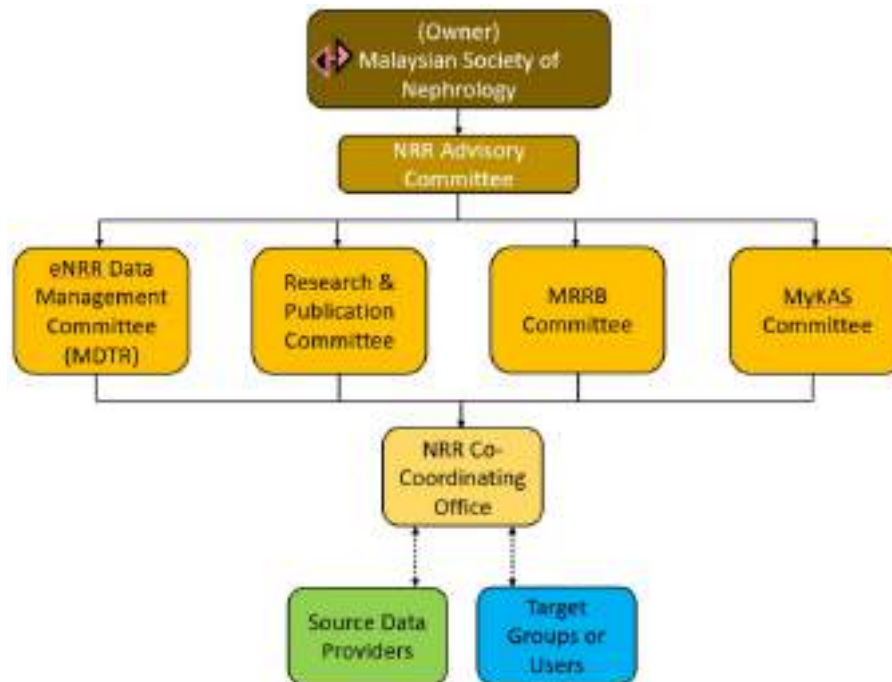
## Objectives

The objectives of the MRRB registry are to:

1. Determine the disease burden attributable to glomerular disease (GD) by quantifying its incidence and prevalence, and its geographic and temporal trends in Malaysia.
2. Identify subgroups in the population at high risk of GD to whom preventive efforts should be targeted.
3. Identify potential causal and risk factors involved in GD.
4. Describe the clinical presentation and spectrum of GD.
5. Stimulate and facilitate basic, clinical and epidemiological research on GD.
6. Identify causes of allograft failure in our renal transplant population.
7. To audit the renal biopsy procedure, monitor both complications and quality of specimens in addition to identifying risk factors associated with complications.

## Organization

The NRR organization is as follows:



### NRR Advisory Committee

This is the committee appointed by the sponsors. The NRR Advisory Committee's role is to ensure that the MRRB stay focused on its objectives and to assure its continuing relevance and justification.

### MRRB Committee

The MRRB Committee supervises the operation of this registry.

### National Renal Registry office

The NRR coordinating office is the designated coordinating center. It coordinates the data provided by the Source Data Providers (SDPs).

### Source Data Providers (SDP)

These are centres that contribute data to the registry. The SDP collects and enters data directly through the on-line web-based system. The pilot phase of the registry consists of SDPs from the Ministry of Health.

Throughout this initial phase, we have refined and improved the database. In 2008, the registry expanded to a national level and included participation from all nephrologists in Malaysia who perform renal biopsies. It is hoped that the nephrology community will continue to support the registry by submitting data, which is crucial to eventually improve the management of patients with glomerular disease.

## **To participate in MRRB**

Centres interested to participate in this registry please write in to NRR officially via email [nrr@msn.org.my](mailto:nrr@msn.org.my).

The following documents need to be completed and returned to facilitate participation.

- Centre Participation Self Reply Form (NRR Borang 4: New MRRB Centre Registration Form) [https://app.msn.org.my/enrr/fwbPage.jsp?fwbPageId=zAu\\_RegistrationForm](https://app.msn.org.my/enrr/fwbPage.jsp?fwbPageId=zAu_RegistrationForm))
- Authorization Form
- Information Security Policy/User Agreement. One form per nominee as listed in the Authorization form. Users must have a personal mobile phone to received SMS authentication.

Upon receiving these documents, the centre shall be registered and each of the users of the MRRB shall be notified via their e-mail address.

## **Methodology**

All patients from participating centres who undergo any kidney biopsy (native or graft) are to be enrolled into the registry.

On-line data submission is through MRRB web application. The data variables collected include demography, clinical presentation, indications of biopsy, renal function, and laboratory data at presentation and at the time of biopsy, serological markers, virology status and histopathological result. In addition, an update on outcomes in terms of significant end-points such as end stage renal disease or death will be recorded annually.

## LIST OF SOURCE DATA PROVIDERS

Adult Centre Name	Sector	1st Report	2nd Report	3rd Report	4th Report	5th Report	6th Report	7th Report	8th Report
96 Hospital Angkatan Tentera Lumut	Armed force		√	√	√	√	√	√	√
Ampang Hospital	MOH							√	√
Hospital Pakar Sultanah Fatimah Muar	MOH				√	√	√	√	√
Hospital Seri Manjung	MOH								√
Hospital Sultanah Nora Ismail	MOH						√	√	√
Kajang Hospital	MOH						√	√	√
Kuala Lumpur Hospital	MOH	√	√	√	√	√	√	√	√
Kulim Hospital	MOH						√	√	√
Melaka Hospital	MOH	√	√	√	√	√	√	√	√
Miri Hospital	MOH						√	√	√
Pulau Pinang Hospital	MOH	√	√	√	√	√	√	√	√
Queen Elizabeth Hospital	MOH	√	√	√	√	√	√	√	√
Raja Perempuan Zainab II Hospital	MOH	√	√	√	√	√	√	√	√
Raja Permaisuri Bainun Hospital	MOH	√	√		√	√	√	√	√
Sarawak General Hospital	MOH	√	√	√	√	√	√	√	√
Seberang Jaya Hospital	MOH						√	√	√
Selayang Hospital	MOH	√	√	√	√	√	√	√	√
Serdang Hospital	MOH		√	√	√	√	√	√	√
Sibu Hospital	MOH								√
Sultan Abdul Halim Hospital	MOH							√	√
Sultan Haji Ahmad Shah Hospital	MOH						√	√	√
Sultan Ismail Hospital	MOH								√
Sultanah Aminah Hospital	MOH	√	√	√	√	√	√	√	√
Sultanah Bahiyah Hospital	MOH	√	√	√	√	√	√	√	√
Sultanah Nur Zahirah Hospital	MOH	√	√	√	√	√	√	√	√
Sungai Buloh Hospital	MOH								√
Taiping Hospital	MOH						√	√	√
Tengku Ampuan Afzan Hospital	MOH	√	√	√	√	√	√	√	√
Tengku Ampuan Rahimah Hospital	MOH	√	√	√	√	√	√	√	√
Tuanku Ja'afar Hospital	MOH	√	√	√	√	√	√	√	√
Bukit Tinggi Medical Centre	Private								√
Fan Medical Renal Clinic	Private		√	√	√	√	√	√	√
Ipoh Specialist Hospital	Private		√	√	√	√	√	√	√
Klinik Perubatan & Nefrologi Fauziah	Private						√	√	√
KPJ Ampang Puteri Specialist Hospital	Private		√	√	√	√	√	√	√
KPJ Selangor Specialist Hospital	Private		√						
Lam Wah Ee Hospital	Private		√	√	√	√	√	√	√
Loh Guan Lye Specialist Centre	Private					√	√	√	√
Metro Specialist Hospital	Private		√	√	√	√	√	√	√
Normah Medical Specialist Centre	Private		√	√	√	√	√	√	√
Prince Court Medical Centre	Private			√	√	√	√	√	√
Pusat Perubatan Sunway Velocity	Private								√
Puteri Specialist Hospital	Private						√	√	√
Seremban Specialist Hospital	Private						√	√	√
Sunway Medical Centre	Private		√	√	√	√	√	√	√
Teo Kidney Specialist Clinic	Private			√	√	√	√	√	√
Timberland Medical Centre	Private			√	√	√	√	√	√
Tung Shin Hospital	Private		√	√	√			√	√
Hospital Pengajar UPM	University								√
Pusat Perubatan Universiti Kebangsaan Malaysia	University					√	√	√	√
University Malaya Medical Centre	University		√	√	√	√	√	√	√
Universiti Sains Malaysia Hospital	University			√	√	√	√	√	√
All		13	26	28	30	31	41	44	51

<b>Paediatric Centre Name</b>	<b>Sector</b>	<b>1st Report</b>	<b>2nd Report</b>	<b>3rd Report</b>	<b>4th Report</b>	<b>5th Report</b>	<b>6th Report</b>	<b>7th Report</b>	<b>8th Report</b>
Hospital Tunku Azizah, Kuala Lumpur	MOH	√	√	√	√	√	√	√	√
Hospital Wanita Dan Kanak-kanak Sabah	MOH	√	√	√	√	√	√	√	√
Pulau Pinang Hospital	MOH	√	√	√	√	√	√	√	√
Selayang Hospital	MOH	√	√	√	√	√	√	√	√
Sultan Ismail Hospital	MOH	√	√	√	√	√	√	√	√
Tengku Ampuan Afzan Hospital	MOH	√	√					√	√
Tuanku Ja'afar Hospital	MOH	√	√	√	√	√	√	√	√
<b>All</b>		<b>7</b>	<b>7</b>	<b>6</b>	<b>6</b>	<b>6</b>	<b>6</b>	<b>7</b>	<b>7</b>

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# REPORT SUMMARY

## CHAPTER 1: OVERVIEW OF RENAL BIOPSY IN MALAYSIA

This 8<sup>th</sup> report of Malaysian Registry of Renal Biopsy 202 reports on renal biopsies performed from 1<sup>st</sup> January 2005 to 31<sup>st</sup> December 2022.

- There were 58 participating centres from the years 2005-2022.
- There was a total of 25376 biopsies reported.
- The number of renal biopsies performed had been steadily increasing over the years, ranged 1500-1800 cases yearly from year 2011 onwards.
- The paediatric (age <15 years old) biopsies accounted for about 5-6 % of the total biopsies for 2020-2022.
- There was a consistent ratio trend of female to male patients that underwent renal biopsies of 3:2 for the last 2 decades.
- The racial distribution were Malays (59.5%), Chinese (21.7%), Indian (6.1%) and others (12.8%).
- Asymptomatic urine abnormalities was the main reason for renal biopsies each year, around 35-38%. This was followed by nephrotic syndrome in 30% and nephritic nephrotic in 20% of the cases.
- The main primary GN in Malaysia were FSGS (30%) followed by minimal change nephropathy (28.9%) and IgA nephropathy (23.8%). However, there was slight change in trend in 2022, with IgA nephropathy becoming the leading cause of primary GN.
- Lupus nephritis remained the most common secondary GN, accounting for 70-80% of the cases.

## CHAPTER 2: PRIMARY GLOMERULONEPHRITIS

- From 2015-2022, the commonest primary glomerulonephritis found on adult kidney biopsies were as follows: focal segmental glomerulosclerosis (29.2%), minimal change disease (26.7%), Ig A nephropathy (25.5%) and idiopathic membranous nephropathy (10.7%).
- Minimal change disease was the commonest glomerulonephritis in adults in previous decade (2005-2014).
- The incidence of IgA nephropathy had increased, making it the most common primary GN from 2020-2022, followed closely by FSGS.

### Focal Segmental Glomerulosclerosis (FSGS)

- Between 2005 to 2022, a total of 2612 FSGS cases were reported to the registry.
- The mean age of diagnosis was 35.9 ±14.93 years.
- Nephrotic syndrome was the most common clinical presentation of FSGS (49.5%).
- The prevalence of hypertension and impaired renal function increased with age.

### Minimal Change Disease (MCD)

- A total of 2392 cases of MCD were reported to the registry from 2005 to 2022.
- It was mainly diagnosed in young patients, with a mean age of  $31.5 \pm 14.30$  years at the time of biopsy.
- MCD was more common in males (62.3%).
- Nephrotic syndrome accounted for over two-thirds of clinical presentation of MCD (68.7%).
- Around 20% of patients were hypertensive at biopsy.
- Most patients (67.4%) with MCD had eGFR more than 60mls/min/1.73m<sup>2</sup> with half having eGFR more than 90mls/min/1.73m<sup>2</sup>.

### IgA nephropathy (IgAN)

- There were 2281 reported cases of IgAN from 2005 to 2022.
- There was slight female preponderance (60.3%) in our cohort.
- The mean age at biopsy was  $34.2 \pm 12.16$  years.
- Asymptomatic urine abnormalities was the most common presentation of IgAN (49.3%).
- Nearly half (49.3%) of patients with IgAN were hypertensive at presentation.
- There was increased risk of renal impairment with increasing age.

### Membranous nephropathy (MN)

- There were 953 reported cases of MN.
- Patients with MN were older with a mean age of  $47.2 \pm 15.57$  years at biopsy and majority (57.6%) were more than 45 years old.
- Nephrotic syndrome was the most common presentation of MN (56.3%).
- Hypertension was observed in 48.2%.
- About 27% had eGFR <60mls/min/1.73m<sup>2</sup>.

## CHAPTER 3: SECONDARY GLOMERULONEPHRITIS

The commonest secondary biopsy-proven glomerular diseases reported in adults was lupus nephritis (78.7%), followed by diabetic nephropathy (15%).

### Lupus nephritis

- Mean age at the time of biopsy in adult lupus nephritis was 31.4 years old  $\pm 11.32$  years with a median of 29.11 years old.
- Female to male ratio was 9:1.
- The most common clinical presentation for LN was asymptomatic urinary abnormalities, followed by nephrotic syndrome and then nephrotic-nephritic syndrome.
- The commonest histopathological finding was WHO or ISN/RPS class IV or IV+V (51.9%).
- Hypertension was a feature in 35-43% of patients with class III/ IV LN, with or without class V.
- The prevalence of impaired renal function also correlated with histopathological findings. Impaired eGFR (<60ml/min/1.73m<sup>2</sup>) occurred most frequently in Class VI LN (55.0%).

## CHAPTER 4: PAEDIATRIC RENAL BIOPSY

- A total of 2491 renal biopsies were performed in 2463 children.
- The average number of renal biopsies yearly was 110-140.
- The mean age at biopsy was 9.91 years.
- The racial distribution was as follows: Malays (66.1%) Chinese (15.9%) and Indians (5.5%)
- The most frequent clinical presentation at biopsy was nephrotic syndrome (51.0%), followed by asymptomatic urine abnormalities (18.5%).
- Minimal change disease and FSGS together accounted for the largest diagnostic group, comprising 44.9%.
- Lupus nephritis was diagnosed in 25.1%. The histologic class was proliferative GN (74.3%) and advanced sclerosing lupus nephritis (5.1%).
- Common histological findings in patients presenting with severe kidney injury (requiring dialysis) were lupus nephritis (25.5%) and post-infectious GN (23.6%).
- The renal survival for lupus nephritis was 90.6% at 3 years and 87.5% at 5 years.
- Children with FSGS showed much poorer renal survival compared to MCD; 77.9% versus 91.0% and 72.3% versus 87.9% at 3 and 5 years respectively.
- Renal survival for patients with lupus nephritis was 92% and 89% at 3 and 5 years respectively.

## CHAPTER 5: RENAL ALLOGRAFT BIOPSY

- A total of 34 centres performed renal allograft biopsies.
- UMMC contributed to more than a quarter (26.9%) of all allograft biopsies between 2005 to 2022, followed by HKL (Adult) 21.4%.
- There were more male (65.2%) had allograft biopsies.
- Majority of renal allograft biopsies were performed in the age group 25-54 years.
- Allograft biopsies performed after 1-year post-transplantation were 42%, 55% and 44% respectively, for 2020, 2021 and 2022.
- Almost two-third (65.4%) of all allograft biopsies were performed for abnormal allograft function, of which 46% were “Creeping creatinine” and 19.4% were “Acute deterioration”.
- For the last three years, the reported histological diagnosis of borderline rejection superseded acute rejection histology, with reported cases of 20.8%, 9.8% and 17% in 2020, 2021 and 2022, respectively.



# **CHAPTER 1**

# **OVERVIEW OF RENAL BIOPSY IN MALAYSIA**

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### 1.1 Introduction

- The Malaysian Registry of Renal Biopsy (MRRB) was established in 2005 with the main objective of determining the disease burden attributable to glomerular disease.
- It was initiated with data contributions from Ministry of Health (MOH) hospitals (2005-2007). In 2008, other institutions including Ministry of Education, Ministry of Defence and private hospitals were invited to participate.
- Since its inception in 2005, seven reports have been published.
- In this report, the number of renal biopsies performed was reported every 5 yearly. However, the data for the last 3 years were reported yearly.
- This chapter reports data on native renal biopsy.

### 1.2 Renal biopsy

- There has been an increasing number of participating centres. Nine new centers participated in this report.
- There is a total of 58 centres: 36 Ministry of Health (MOH), 4 Ministry of Education (MOE), 1 Ministry of Defense (MOD) and 17 private hospitals.
- There was a total of 25376 biopsies reported from 2005 till 2022.
- The number of renal biopsies performed had been steadily increasing over the years, ranged 1500-1800 cases yearly from year 2011 onwards.
- However, there was a slight reduction in the total number of biopsies in 2020-2021 likely due to the Covid-19 pandemic (Figure 1.2).

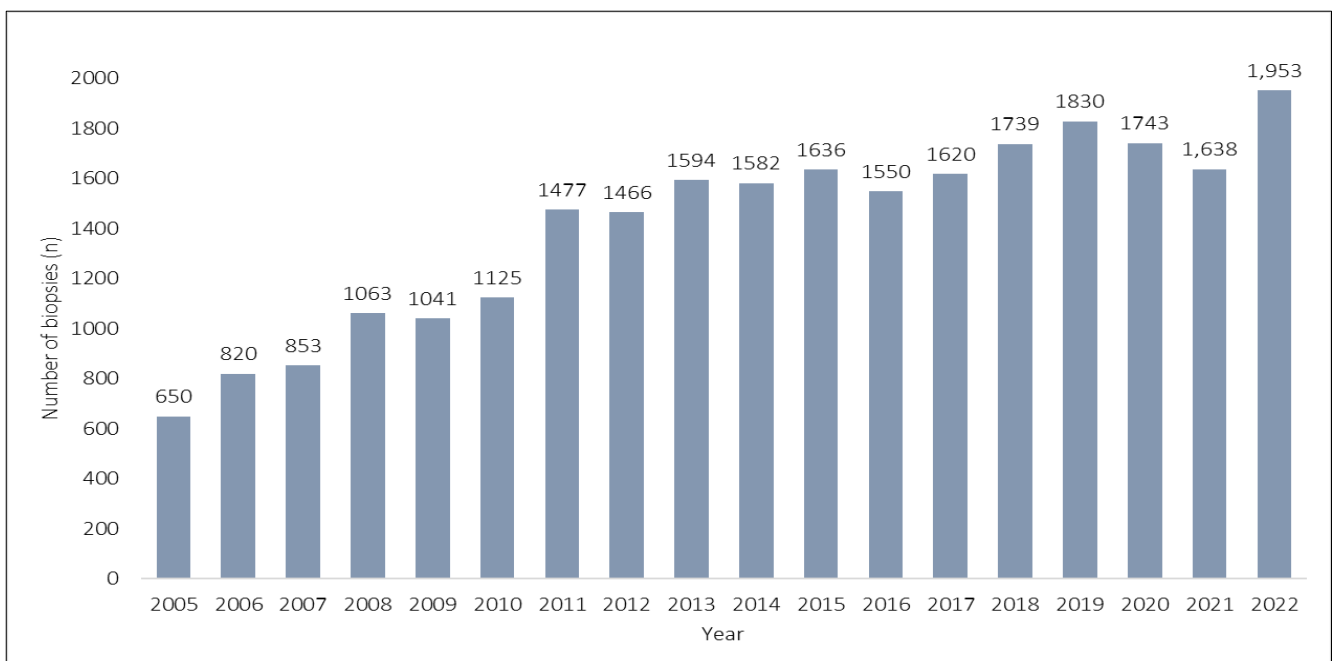


Figure 1.2: Distribution of reported renal biopsies by centre, 2005-2022

### 1.3 Number of episodes of renal biopsy

- Majority (85%) of the renal biopsies performed were first episode (Figure 1.3).
- Repeat biopsies accounted for the remaining 15%, with a 2<sup>nd</sup> biopsy performed in 11.5% of cases, a 3<sup>rd</sup> in 2.7%, and a 4<sup>th</sup> in 0.8%.

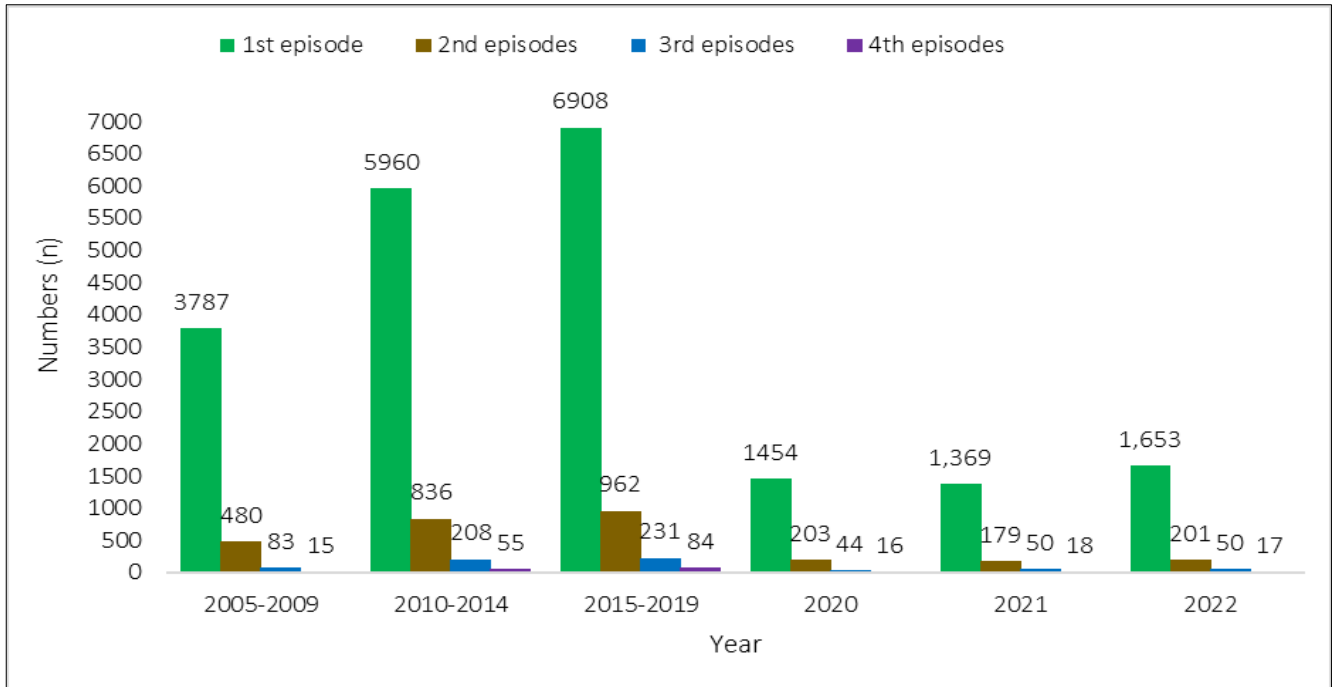


Figure 1.3: Distribution of renal biopsy in patients by number of episodes, 2005-2022

### 1.4 Demographic distribution of renal biopsy

#### 1.4.1 Age distribution

- Most of the patients who underwent renal biopsies for the last two decades were adults (age  $\geq 15$  years old).
- The paediatric (age <15 years old) biopsies accounted for about 5-6 % of the total biopsies for 2020 - 2022 (Figure 1.4.1.1).
- The greatest number of the patients who had renal biopsies were reproductive young adults, aged between 15 to 45 years old with the peak age of 25-35 years old with reported data of 457 (26.2%), 399 (24.4%) and 528 (27.0%) cases for 2020, 2021 and 2022 respectively (Figure 1.4.1.2).

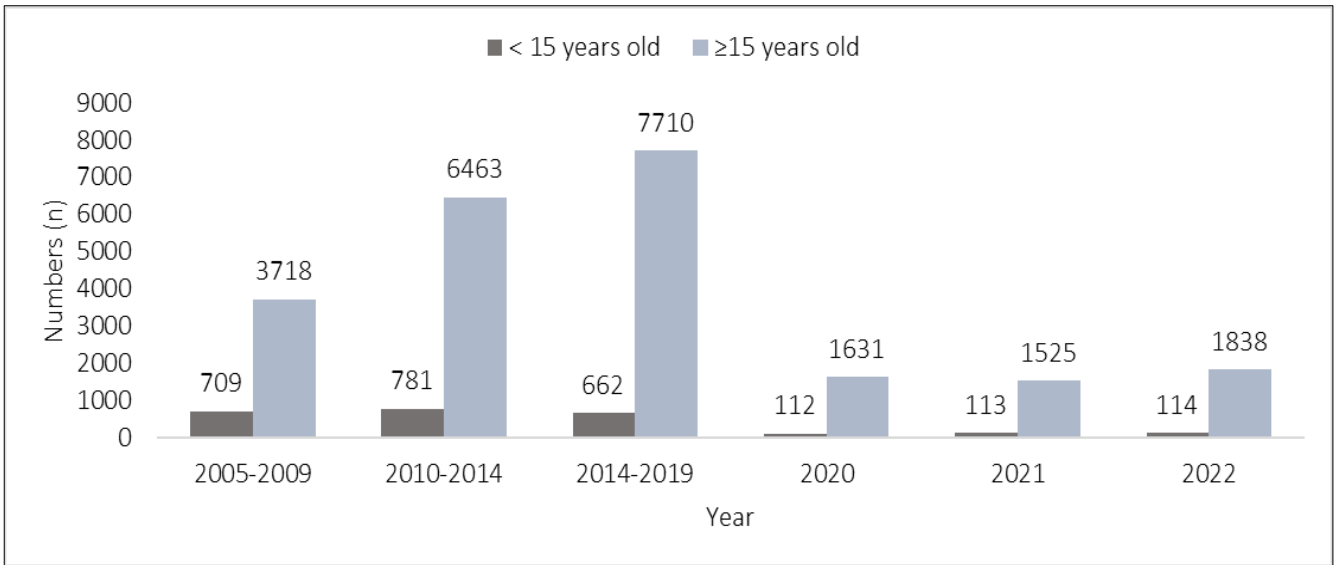


Figure 1.4.1.1: Distribution of renal biopsy in the paediatric and adult age groups, 2005-2022

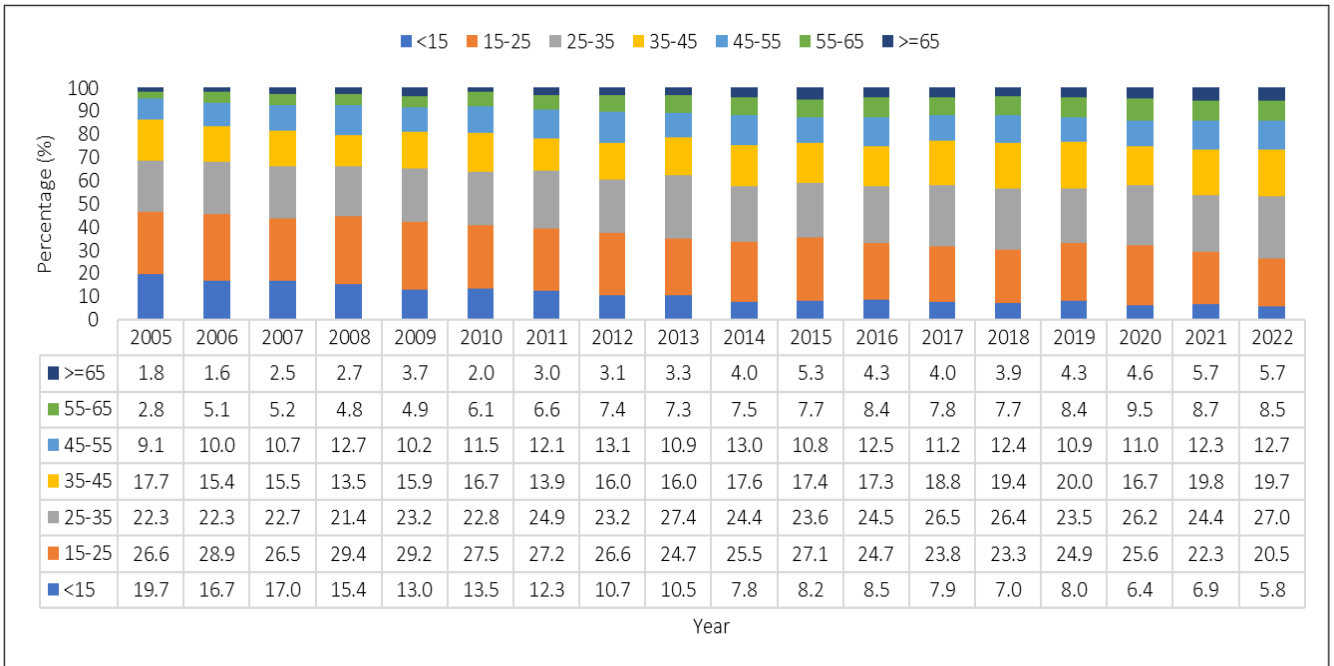


Figure 1.4.1.2: Age distribution of renal biopsy, 2005-2022

### 1.4.2 Age distribution by state

- Johor and Selangor consistently reported the highest number of renal biopsies in the paediatric age group.
- Every year, Johor contributed >20% of the total paediatric biopsies, followed by Selangor which contributed about 12-18% per year.
- In adults, Selangor reported the highest number of renal biopsies 18.9%, 15.6% and 21.5% for 3 consecutive years from 2020 to 2022 respectively (Tables 1.4.2.1 and 1.4.2.2)

Table 1.4.2.1: Renal biopsies by state in patients age < 15, 2005-2022

Year	2005-2009 (n=709)		2010-2014 (n=781)		2015-2019 (n=662)		2020 (n=112)		2021 (n=113)		2022 (n=114)		Total (n=2491)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Johor	167	23.6	141	18.1	145	21.9	30	26.8	26	23.0	21	18.4	530	21.3
Kedah	49	6.9	79	10.1	47	7.1	10	8.9	8	7.1	9	7.9	202	8.1
Kelantan	19	2.7	41	5.2	12	1.8	3	2.7	0	0	1	0.9	76	3.1
Melaka	16	2.3	16	2.0	11	1.7	2	1.8	3	2.7	10	8.8	58	2.3
Negeri Sembilan	38	5.4	24	3.1	27	4.1	8	7.1	10	8.8	7	6.1	114	4.6
Pahang	29	4.1	14	1.8	21	3.2	6	5.4	4	3.5	5	4.4	79	3.2
Penang	41	5.8	38	4.9	26	3.9	3	2.7	8	7.1	6	5.3	122	4.9
Perak	43	6.1	74	9.5	42	6.3	10	8.9	9	8.0	2	1.8	180	7.2
Perlis	7	1.0	3	0.4	6	0.9	1	0.9	1	0.9	1	0.9	19	0.8
Sabah	51	7.2	50	6.4	61	9.2	4	3.6	7	6.2	13	11.4	186	7.5
Sarawak	64	9.0	60	7.7	53	8.0	7	6.3	5	4.4	3	2.6	192	7.7
Selangor	123	17.3	160	20.5	144	21.8	15	13.4	13	11.5	13	11.4	468	18.8
Terengganu	16	2.3	18	2.3	19	2.9	2	1.8	15	13.3	7	6.1	77	3.1
WP KL	40	5.6	58	7.4	40	6.0	10	8.9	4	3.5	7	6.1	159	6.4
Not available	0	0	0	0	0	0	0	0	0	0	9	7.9	9	0.4
Non-Malaysian	6	0.8	5	0.6	8	1.2	1	0.9	0	0	0	0	20	0.8

Table 1.4.2.2: Renal biopsies by state in patients age > 15, 2005-2022

Year	2005-2009 (n=3718)		2010-2014 (n=6463)		2015-2019 (n=7710)		2020 (n=1631)		2021 (n=1525)		2022 (n=1838)		Total (n=22885)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Johor	433	11.6	586	9.1	641	8.3	133	8.2	147	9.6	172	9.4	2112	9.2
Kedah	301	8.1	562	8.7	530	6.9	96	5.9	132	8.7	119	6.5	1740	7.6
Kelantan	107	2.9	249	3.9	194	2.5	83	5.1	50	3.3	66	3.6	749	3.3
Melaka	103	2.8	128	2.0	204	2.6	65	4.0	34	2.2	45	2.4	579	2.5
Negeri Sembilan	118	3.2	261	4.0	411	5.3	134	8.2	119	7.8	62	3.4	1105	4.8
Pahang	167	4.5	287	4.4	433	5.6	87	5.3	75	4.9	84	4.6	1133	5.0
Penang	293	7.9	363	5.6	446	5.8	114	7.0	89	5.8	69	3.8	1374	6.0
Perak	191	5.1	550	8.5	605	7.8	158	9.7	150	9.8	163	8.9	1817	7.9
Perlis	25	0.7	28	0.4	45	0.6	6	0.4	2	0.1	5	0.3	111	0.5
Sabah	164	4.4	177	2.7	603	7.8	104	6.4	125	8.2	204	11.1	1377	6.0
Sarawak	388	10.4	545	8.4	701	9.1	112	6.9	100	6.6	166	9.0	2012	8.8
Selangor	889	23.9	1445	22.4	1787	23.2	308	18.9	238	15.6	256	13.9	4923	21.5
Terengganu	64	1.7	146	2.3	200	2.6	42	2.6	30	2.0	34	1.8	516	2.3
WP KL	420	11.3	1015	15.7	847	11.0	184	11.3	83	5.4	72	3.9	2621	11.5
Not available	0	0	1	0	3	0	1	0.1	66	4.3	297	16.2	368	1.6
Non-Malaysian	55	1.5	120	1.9	60	0.8	4	0.2	85	5.6	24	1.3	348	1.5

### 1.4.3 Gender distribution

- There was a consistent ratio trend of female to male patients that underwent renal biopsies of 3:2 for the last 2 decades.
- Female patients made up 61.2% of all renal biopsies in 2022 (Table 1.4.3.1 and Figure 1.4.3.1).
- This is likely due to higher proportion of female patients with lupus nephritis.

Table 1.4.3.1: Gender distribution of renal biopsy, 2005-2022

Gender	2005-2009 (n=4427)		2010-2014 (n=7244)		2015-2019 (n=8372)		2020 (n=1743)		2021 (n=1638)		2022 (n=1952)		Total (n=25376)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Male	1772	40	2872	39.6	3176	37.9	669	38.4	618	37.7	749	38.4	9856	38.8
Female	2655	60	4372	60.4	5196	62.1	1074	61.6	1020	62.3	1203	61.6	15520	61.2

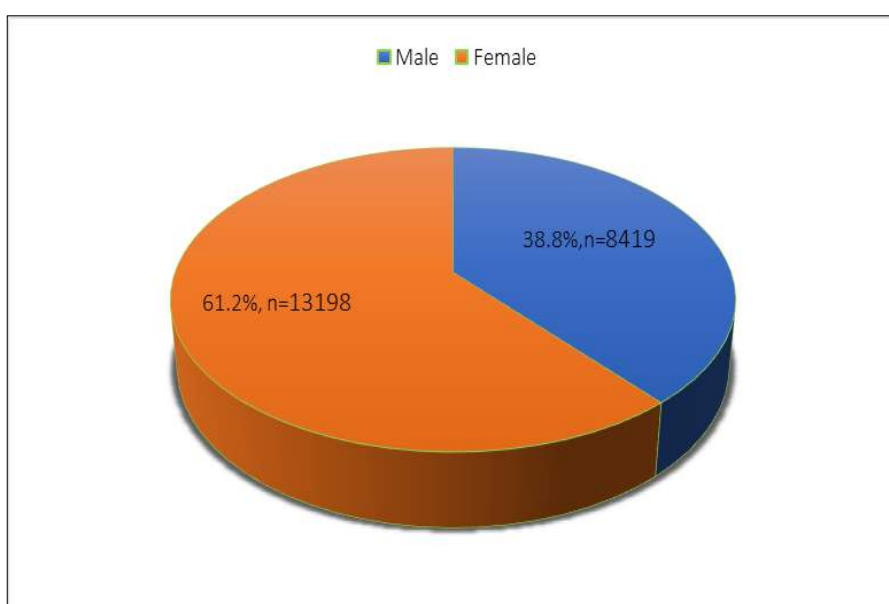


Figure 1.4.3.1: Gender distribution of renal biopsy, 2005-2022

### 1.4.4 Ethnicity distribution

- Malay was the predominant ethnicity among patients who underwent renal biopsies over the last twenty years (60%) followed by Chinese 21.7% (2022) and others 12.8% (2022). Indian ethnicity had the lowest number of reported cases each year (Table 1.4.4.1 and Figure 1.4.4.1).
- This is consistent with the racial distribution in our country.

Table 1.4.4.1: Racial distribution of renal biopsy, 2005-2022

Race	2005-2009 (n=4427)		2010-2014 (n=7244)		2015-2019 (n=8372)		2020 (n=1743)		2021 (n=1638)		2022 (n=1952)		Total (n=25376)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Malay	2483	56.1	4250	58.7	5008	59.8	1115	64.0	1072	65.4	1173	60.1	15101	59.5
Chinese	1128	25.5	1723	23.8	1734	20.7	297	17.0	244	14.9	370	19.0	5496	21.7
Indian	313	7.1	438	6.0	474	5.7	117	6.7	111	6.8	90	4.6	1543	6.1
Others	503	11.4	833	11.5	1156	13.8	214	12.3	211	12.9	319	16.3	3236	12.8

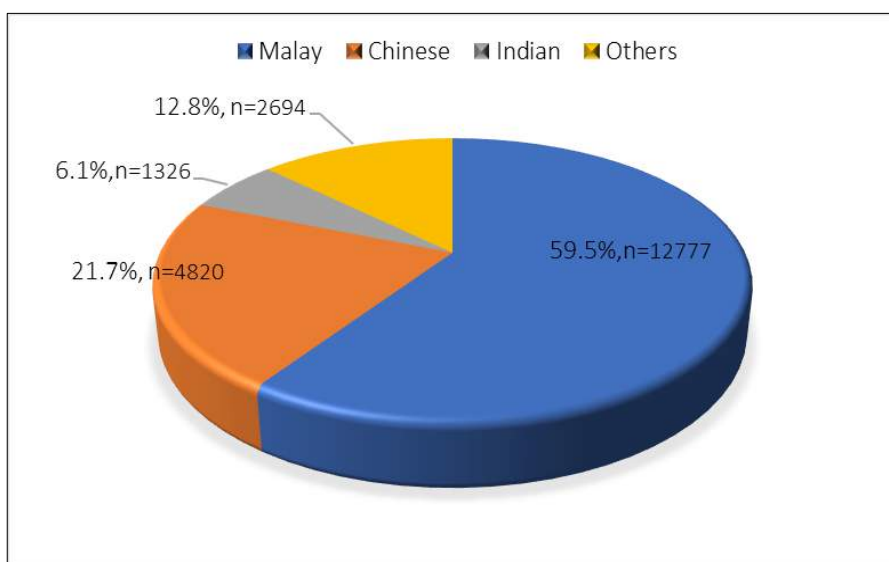


Figure 1.4.4.1: Racial distribution of renal biopsy, 2005-2022

### 1.5 Biopsy characteristics and Complications

#### 1.5.1 Number of glomeruli on biopsy

- Majority of renal biopsy sample were considered adequate which is defined as at least 10 glomeruli.
- Inadequate glomeruli in biopsy were reported in less than 20% of the biopsy each year.
- There were increasing number of missing information in the last 3 years being reported (Figure 1.5.1). This reflects the quality of data entered into the registry.

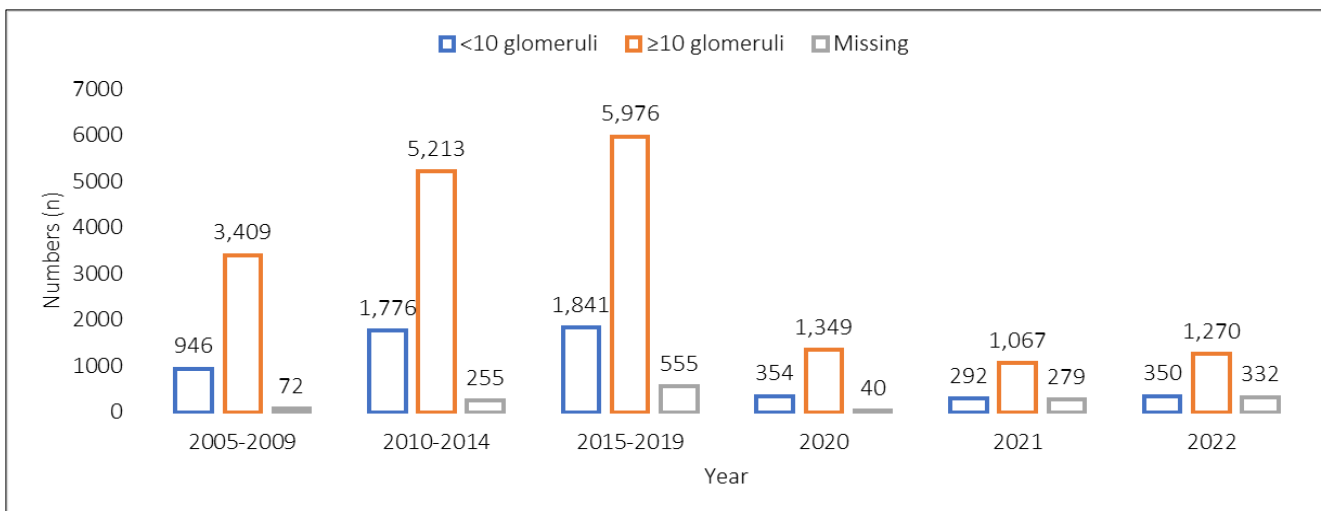


Figure 1.5.1: Number of glomeruli obtained at each renal biopsy by centres, 2005-2022

#### 1.5.2 Operator of biopsy

- Over the years, the number of renal biopsies performed by nephrologist had declined with the lowest in 2021 to almost 10%. However, the figure had increased to 25% in 2022.
- The procedures were performed mainly by the trainee nephrologist as part of the training requirement.
- However, there were significant numbers of around 600 cases per year that did not report the operator (Figure 1.5.2).

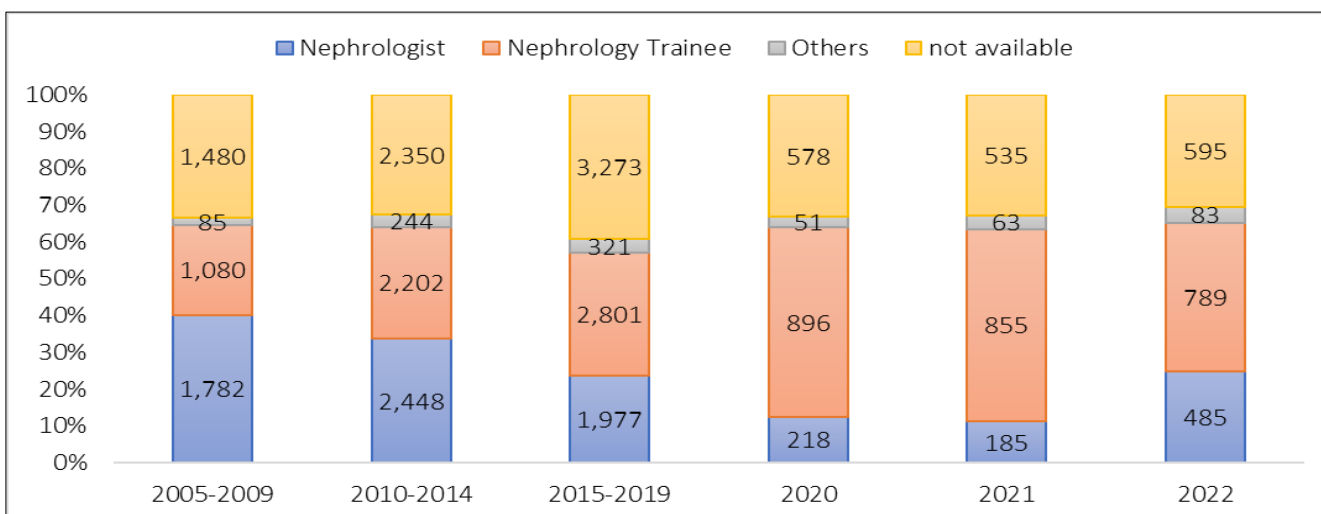


Figure 1.5.2: Operator of biopsy, 2005-2022

### 1.5.3 Complications of biopsy

- The rate of reported biopsy complications ranged from 1.5 to 2% for the last twenty years except in 2021 where the rate was higher at 3.7%.
- However about 36% of the cases did not report biopsy complications (Table 1.5.3 and Figure 1.5.3).

Table 1.5.3: Complications of biopsy, 2005-2022

Complication	2005-2009 (n=4427)		2010-2014 (n=7244)		2015-2019 (n=8372)		2020 (n=1743)		2021 (n=1638)		2022 (n=1952)		Total (n=25376)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Yes	92	2.1	144	2.0	123	1.5	35	2.0	61	3.7	42	2.2	497	2.0
No	2767	62.5	4655	64.3	4886	58.4	1095	62.8	1016	62.0	1271	65.1	15690	61.8
Not Available	1568	35.4	2445	33.8	3363	40.2	613	35.2	561	34.2	639	32.7	9189	36.2

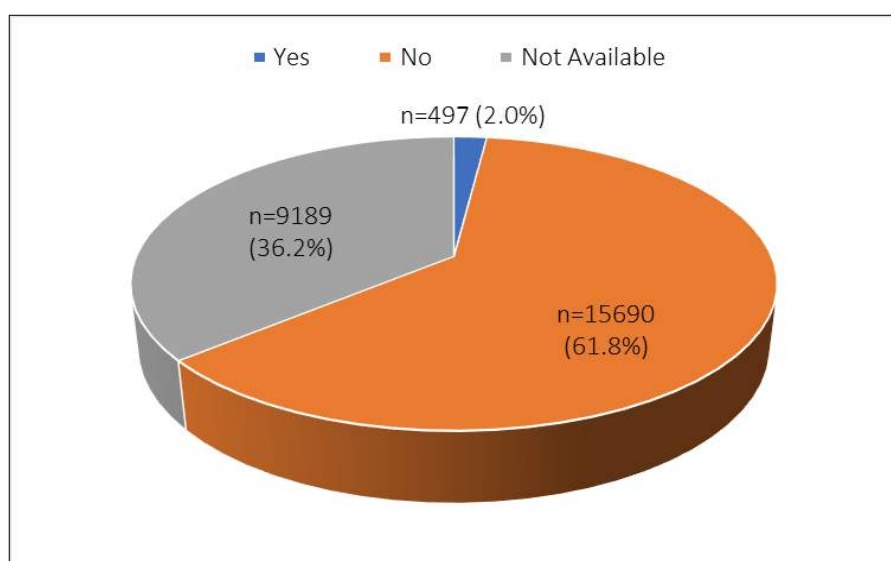


Figure 1.5.3: Complications of biopsy, 2005-2022

### 1.5.4 Types of biopsy complications

- The commonest biopsy complication was bleeding (64.8%), followed by perirenal collection (20.9%) and hypotension (2%) (Table 1.5.4 and Figure 1.5.4).

Table 1.5.4: Types of complications of biopsy, 2005-2022

Complication	2005-2009 (n=91)		2010-2014 (n=162)		2015-2019 (n=111)		2020 (n=30)		2021 (n=54)		2022 (n=44)		Total (n=492 <sup>^</sup> )	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Bleeding	51	56.0	114	70.4	76	68.5	23	76.7	22	40.7	33	75.0	319	64.8
Perirenal collection	33	36.3	35	21.6	35	31.5	6	20	32	59.3	11	25.0	152	30.9
Infection	1	1.1	1	0.6	0	0	0	0	0	0	0	0	2	0.4
AVM	1	1.1	3	1.9	0	0	0	0	0	0	0	0	4	0.8
Hypotension	4	4.4	6	3.7	0	0	0	0	0	0	0	0	10	2.0
Other	1	1.1	3	1.9	0	0	1	3.3	0	0	0	0	5	1.0

<sup>^</sup>Patients may have more than once complications; 36 patients with no complication records

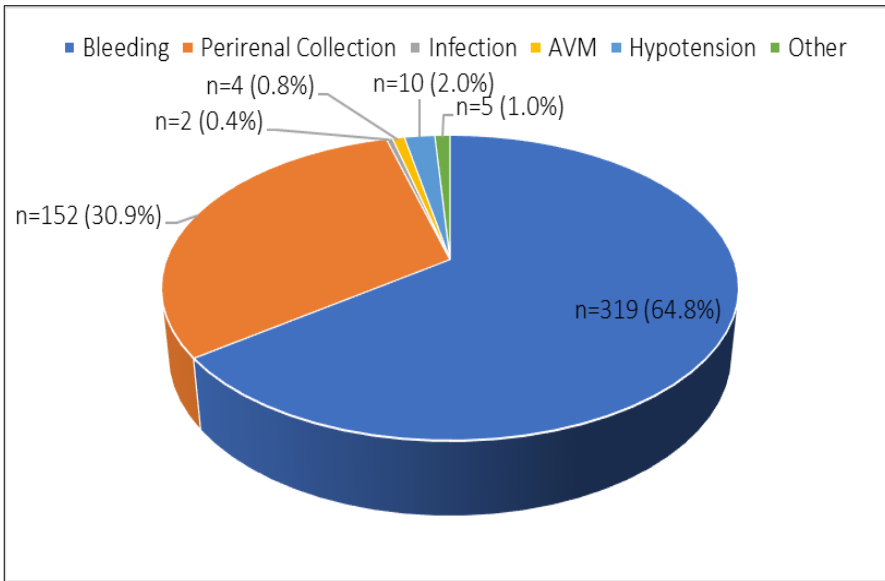


Figure 1.5.4: Types of complications of biopsy, 2005-2022

### 1.5.5 Intervention for biopsy complications

- A total of 118 (23.7%) biopsy procedures required intervention following complications.
- Three-quarters required only blood transfusion while 21.3% needed radiological intervention.
- Only 2.8% patients received surgical intervention to manage the biopsy complication (Figure 1.5.5).

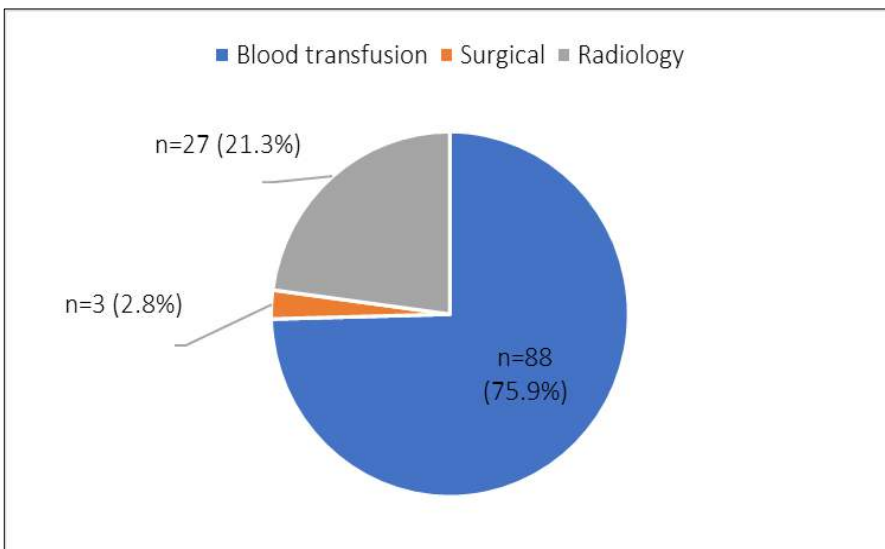


Figure 1.5.5: Intervention for biopsy complications, 2005-2022

### 1.6 Histopathological Lab

- The in-house laboratories provided histopathological services in two third of the biopsy samples while remaining one third were sent to the external laboratories (Table 1.6.3 and Figure 1.6.1).

Table 1.6.3: Summary of biopsies received by in-house and external laboratories, 2005-2022

Summary of biopsies received	2005-2009 (n=4427)		2010-2014 (n=7244)		2015-2019 (n=8372)		2020 (n=1743)		2021 (n=1638)		2022 (n=1952)		Total (n=25376)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
In house	2100	47.4	4649	64.2	5822	69.5	1261	72.3	1025	62.6	1230	63.0	16087	63.4
External	2291	51.8	2412	33.3	2116	25.3	317	18.2	294	17.9	440	22.5	7870	31.0
Not available	36	0.8	183	2.5	434	5.2	165	9.5	319	19.5	1230	63.0	1419	5.6

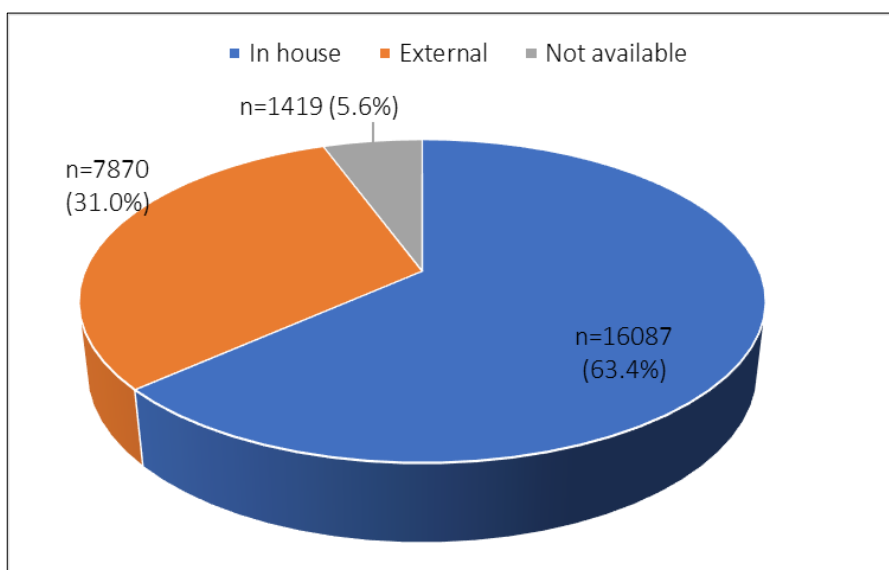


Figure 1.6.1: Summary of biopsies received by in-house and external laboratories, 2005-2022

### 1.7 Clinical Indications of renal biopsy

- Asymptomatic urine abnormalities was the main reason for renal biopsies each year (around 35-38%).
- This was followed by nephrotic syndrome in 30% and nephritic nephrotic in 20% of the cases (Figure 1.7.1).

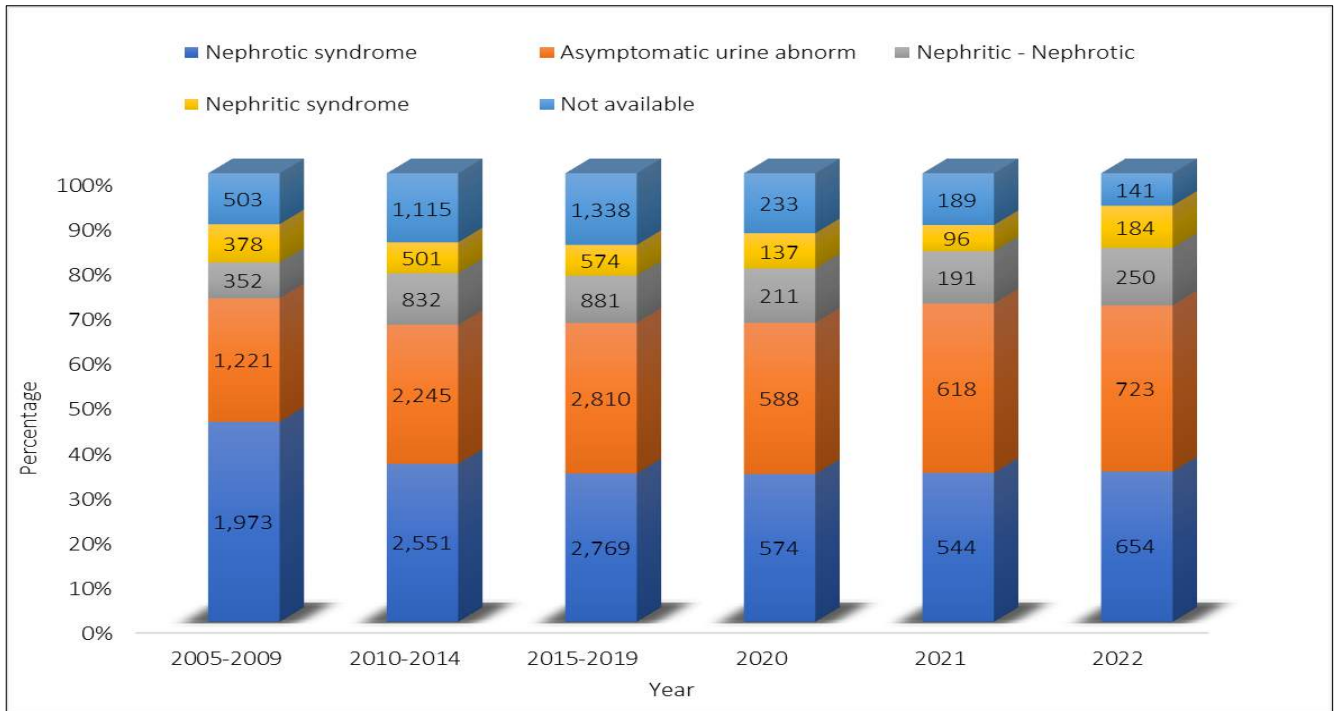


Figure 1.7.1: Indications for native renal biopsies, 2005-2022

## 1.8 Renal function at time of biopsy

- Approximately 31% of patients had normal kidney function with eGFR  $\geq 90$ mls/min/m<sup>2</sup> at the time of renal biopsy.
- About 10% of those with impaired kidney function of eGFR  $< 15$ mls/min/m<sup>2</sup> were biopsied (Table 1.8.1).

Table 1.8.1: Renal function at time of biopsy, 2005-2022

eGFR (mls/min/1.73m <sup>2</sup> )	2005-2009 (n=4457)		2010-2014 (n=7244)		2015-2019 (n=8372)		2020 (n=1743)		2021 (n=1638)		2022 (n=1952)		Total (n=25376)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
< 15	440	9.9	737	10.2	750	9.0	175	10.0	174	10.6	223	11.4	2499	9.8
15 to < 30	415	9.4	710	9.8	874	10.4	196	11.2	174	10.6	213	10.9	2582	10.2
30 to < 60	831	18.8	1243	17.2	1463	17.5	300	17.2	298	18.2	383	19.6	4518	17.8
60 to < 90	904	20.4	1243	17.2	1389	16.6	280	16.1	253	15.4	331	17.0	4400	17.3
$\geq 90$	1446	32.7	2303	31.8	2598	31.0	530	30.4	464	28.3	568	29.1	7909	31.2
Not available	391	8.8	1008	13.9	1298	15.5	262	15.0	275	16.8	234	12.0	3468	13.7

## 1.9 Histopathological Diagnosis

- Histopathological diagnoses were divided into primary, secondary glomerulonephritis, tubulointerstitial disease, vascular, hereditary kidney disease, advanced GN and others.

### 1.9.1 Histopathological diagnosis overview

- The main primary GN in Malaysia were FSGS (30%) followed by minimal change nephropathy (28.9%) and IgA nephropathy (23.8%).
- However, there was slight change in trend in 2022, with IgA nephropathy becoming the leading cause of primary GN (Table 1.9.1 and Figure 1.9.1).
- Lupus nephritis remained the most common secondary GN, accounting for 70-80% of the cases.

Table 1.9.1: Histopathology of all native renal biopsies, 2005-2022

Type / Histopathological Diagnosis	2005-2009 (n=2017)		2010-2014 (n=3045)		2015-2019 (n=3302)		2020 (n=726)		2021 (n=547)		2022 (n=675)		Total (n=10312)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
<b>Primary GN</b>														
FSGS	665	33.0	901	29.6	1006	30.5	194	26.7	152	27.8	171	25.3	3089	30
Minimal Change	680	33.7	958	31.5	851	25.8	187	25.8	138	25.2	167	24.7	2981	28.9
IgA nephropathy	355	17.6	695	22.8	839	25.4	198	27.3	158	28.9	212	31.4	2457	23.8
Membrano-proliferative	42	2.1	44	1.4	59	1.8	13	1.8	8	1.5	7	1.0	173	1.7
Membranous nephropathy	165	8.2	257	8.4	342	10.4	87	12.0	63	11.5	74	11.0	988	9.6
Mesangial Prol: non-IgA	67	3.3	101	3.3	77	2.3	25	3.4	10	1.8	14	2.1	294	2.9
Idiopathic Crescentic GN	29	1.4	33	1.1	27	0.8	4	0.6	2	0.4	1	0.1	96	0.9
Crescentic ANCA	9	0.4	21	0.7	24	0.7	11	1.5	9	1.6	17	2.5	91	0.9
Not Available	5	0.2	35	1.1	77	2.3	7	1.0	7	1.3	12	1.8	143	1.4
<b>Secondary GN</b>														
Lupus Nephritis	1590	83	2413	78	2648	78	516	71	377	72	476	71	8020	78
Diabetic nephropathy	167	8.7	373	12.1	443	13.1	157	21.7	113	21.7	162	24.2	1415	13.7
Post Infectious GN	80	4.2	170	5.5	135	4.0	18	2.5	10	1.9	11	1.6	424	4.1
Amyloidosis	9	0.5	21	0.7	23	0.7	8	1.1	7	1.3	2	0.3	70	0.7
Anti GBM disease	0	0	4	0.1	8	0.2	3	0.4	2	0.4	1	0.1	18	0.2
Henoch-Schonlein Purpura	29	1.5	21	0.7	29	0.9	5	0.7	4	0.8	2	0.3	90	0.9
HUS / TTP	3	0.2	5	0.2	5	0.1	3	0.4	0	0	0	0	16	0.2
Immunotactoid / fibrillary	0	0	1	0	2	0.1	1	0.1	0	0	1	0.1	5	0
Light / Heavy chain deposit disease	2	0.1	2	0.1	6	0.2	1	0.1	0	0	2	0.3	13	0.1
Malignancy	4	0.2	4	0.1	2	0.1	0	0	0	0	0	0	10	0.1
Multiple myeloma	8	0.4	4	0.1	7	0.2	1	0.1	0	0	2	0.3	22	0.2
Other infection	8	0.4	19	0.6	17	0.5	4	0.6	0	0	3	0.4	51	0.5
Systemic vasculitis	8	0.4	15	0.5	12	0.4	0	0	1	0.2	2	0.3	38	0.4
Not Available	4	0.2	36	1.2	48	1.4	6	0.8	7	1.3	6	0.9	107	1.0
<b>Tubulointerstitial disease</b>														
Acute tubular necrosis	152	47.2	159	34.0	151	29.7	35	31.8	28	22.4	42	34.7	567	34.3
Acute interstitial nephritis	64	19.9	157	33.5	157	30.8	28	25.5	29	23.2	26	21.5	461	27.9
Chronic interstitial nephritis	102	31.7	142	30.3	153	30.1	35	31.8	62	49.6	44	36.4	538	32.5
Missing	4	1.2	10	2.1	48	9.4	12	10.9	6	4.8	9	7.4	89	5.4

Type / Histopathological Diagnosis	2005-2009 (n=63)		2010-2014 (n=157)		2015-2019 (n=228)		2020 (n=76)		2021 (n=90)		2022 (n=80)		Total (n=694)	
<b>Vascular</b>	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Athero-embolic disease	0	0	2	1.3	2	0.9	0	0	1	1.1	0	0	5	0.7
Benign / Malignant Hypertension	58	92.1	130	82.8	193	84.6	75	98.7	84	93.3	77	96.3	617	88.9
Systemic sclerosis	2	3.2	14	8.9	9	3.9	1	1.3	2	2.2	0	0	28	4.0
Not Available	3	4.8	11	7.0	24	10.5	0	0	3	3.3	3	3.8	44	6.3
Type / Histopathological Diagnosis	2005-2009 (n=10)		2010-2014 (n=14)		2015-2019 (n=17)		2020 (n=2)		2021 (n=90)		2022 (n=80)		Total (n=43)	
<b>Hereditary</b>	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Alport's syndrome	3	30	2	14.3	4	23.5	0	0	0	0	0	0	9	19.6
Thin Basement Membrane disease	5	50	3	21.4	3	17.6	0	0	0	0	0	0	11	23.9
Others	2	20	2	14.3	0	0	0	0	0	0	0	0	4	8.7
Not Available	0	0	7	50	10	58.8	2	100	3	100	0	0	22	47.8
Type / Histopathological Diagnosis	2005-2009		2010-2014		2015-2019		2020		2021		2022		Total	
<b>Advance GN</b>	122		137		108		26		17		17		436	
Type / Histopathological Diagnosis	2005-2009		2010-2014		2015-2019		2020		2021		2022		Total	
<b>Others</b>	38		199		338		67		55		55		752	

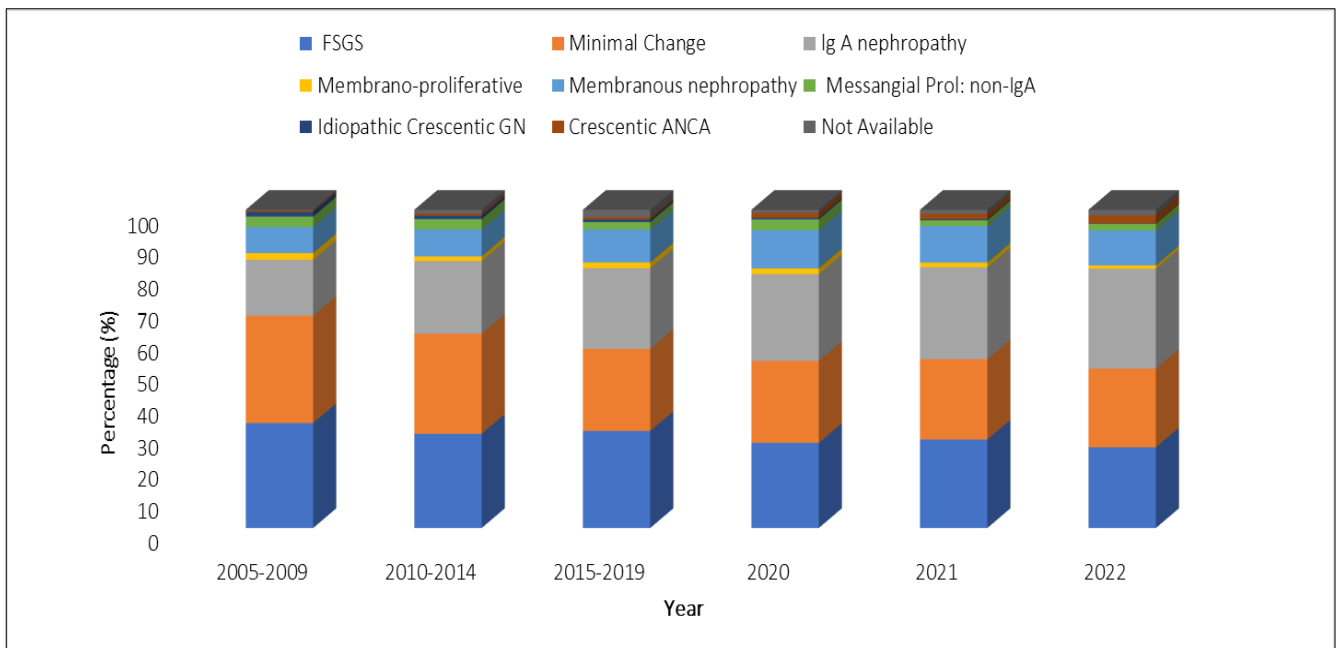


Figure 1.9.1: Histopathology of primary glomerulonephritis on native renal biopsies, 2005-2022

**1.9.2 Histopathology findings in common clinical presentation****1.9.2.1 Nephrotic syndrome**

- Minimal change nephropathy (41.8%) and FSGS (33%) were the leading causes of nephrotic syndrome due to primary GN. About 10% of nephrotic syndrome were due to membranous nephropathy.
- Lupus nephritis (73.6%) followed by diabetic nephropathy (19.4%) were the most common causes of secondary GN causing nephrotic syndrome (Table 1.9.2.1).

Table 1.9.2.1: HPE diagnosis in patients presenting with Nephrotic Syndrome, 2005-2022

Type	Histopathological Diagnosis	n	%
Primary GN	FSGS	1703	33.0
	Minimal Change	2158	41.8
	Membranous nephropathy	559	10.8
	IgA nephropathy	518	10
	Idiopathic Crescentic GN	16	0.3
	Membrano-proliferative	67	1.3
	Mesangial Proliferative GN-non-IgA	93	1.8
	Crescentic ANCA	5	0.1
	Not available	46	0.9
	<b>Sub total</b>	<b>5165</b>	<b>59.2</b>
Secondary GN	Lupus Nephritis	1974	73.6
	Diabetic nephropathy	521	19.4
	Post Infectious GN	73	2.7
	Amyloidosis	34	1.3
	Henoch-Schonlein Purpura	8	0.3
	HUS / TTP	2	0.1
	Light / Heavy chain deposit disease	4	0.2
	Malignancy	3	0.1
	Multiple myeloma	2	0.1
	Anti GBM disease	1	0
	Other infection	27	1.0
	Systemic vasculitis	4	0.2
	Immunotactoid / fibrillary GN	1	0
	Not Available	28	1.0
	<b>Sub total</b>	<b>2682</b>	<b>30.7</b>
Others	Others	876	10
<b>Total</b>		<b>8723</b>	<b>100</b>

1.9.2.2 Nephritic syndrome

- Secondary GN contributed to more than half of all those who presented with nephritic syndrome.
- Ig A nephropathy is the most common histopathological diagnosis among those who presented with nephritic syndrome (11.4%).
- In the secondary GN group, majority were diagnosed with lupus nephritis, 45.4%. (Table 1.9.2.2)

Table 1.9.2.2: HPE diagnosis in patients presenting with nephritic syndrome, 2005-2022

Type	Histopathological Diagnosis	n	%
Primary GN	FSGS	140	25.2
	Minimal Change	102	18.4
	Membranous nephropathy	39	7.0
	IgA nephropathy	180	32.4
	Idiopathic Crescentic GN	17	3.1
	Membrano-proliferative	17	3.1
	Mesangial Proliferative GN-non-IgA	28	5.0
	Crescentic ANCA	22	4.0
	Not available	11	2.0
	<b>Sub total</b>	<b>556</b>	<b>31.0</b>
Secondary GN	Lupus Nephritis	712	75.7
	Diabetic nephropathy	71	7.6
	Post Infectious GN	112	11.9
	Henoch-Schonlein Purpura	13	1.4
	HUS / TTP	2	0.2
	Amyloidosis	2	0.2
	Anti GBM disease	5	0.5
	Systemic vasculitis	9	1.0
	Malignancy	1	0.1
	Other infection	1	0.1
	Not Available	4	0.4
	<b>Sub total</b>	<b>941</b>	<b>52.5</b>
Others	Others	295	16.5
<b>Total</b>		<b>1568</b>	<b>100</b>

**1.9.2.3 Asymptomatic Urine Abnormalities**

- Among patient who presented with asymptomatic urine abnormalities, lupus nephritis was the main aetiology followed by Ig A nephropathy which accounted for 29.5% and 15.7% respectively (Table 1.9.2.3).

Table 1.9.2.3: HPE diagnosis in patients presenting with asymptomatic urine abnormalities, 2005-2022

Type	Histopathological Diagnosis	n	%
Primary GN	IgA nephropathy	1190	43.5
	FSGS	702	25.7
	Minimal Change	388	14.2
	Membranous nephropathy	227	8.3
	Idiopathic Crescentic GN	25	0.9
	Membrano-proliferative	34	1.2
	Mesangial Proliferative GN-non-IgA	104	3.8
	Crescentic ANCA	26	1.0
	Not Available	41	1.5
	<b>Sub total</b>	<b>2737</b>	<b>36.1</b>
Secondary GN	Lupus Nephritis	2993	80.9
	Diabetic nephropathy	485	13.1
	Post Infectious GN	55	1.5
	Henoch-Schonlein Purpura	46	1.2
	Amyloidosis	20	0.5
	Systemic vasculitis	13	0.4
	Multiple myeloma	10	0.3
	Other infection	10	0.3
	Light / Heavy chain deposit disease	3	0.1
	Anti GBM disease	6	0.2
	HUS / TTP	5	0.1
	Malignancy	1	0
	Immunotactoid / fibrillary GN	1	0
	Not Available	50	1.4
	<b>Sub total</b>	<b>3698</b>	<b>48.8</b>
Others	Others	1148	15.1
<b>Total</b>		<b>7583</b>	<b>100</b>

**1.9.2.4 Nephritic-nephrotic syndrome**

- Lupus nephritis was the predominant cause of patients presenting with nephritic nephrotic syndrome 43.6%, followed by IgA nephropathy (10%) and FSGS (8.7%) (Table 1.9.2.4).

Table 1.9.2.4: HPE diagnosis in patients presenting with nephritic-nephrotic syndrome, 2005-2022

Type	Histopathological Diagnosis	n	%
Primary GN	FSGS	232	26.9
	IgA nephropathy	266	30.8
	Minimal Change	149	17.3
	Membranous nephropathy	84	9.7
	Mesangial Proliferative GN-non-IgA	39	4.5
	Membrano-proliferative	32	3.7
	Idiopathic Crescentic GN	19	2.2
	Crescentic ANCA	29	3.4
	Not Available	13	1.5
	<b>Sub total</b>	<b>863</b>	<b>32.4</b>
Secondary GN	Lupus Nephritis	1162	79.4
	Post Infectious GN	131	9.0
	Diabetic nephropathy	114	7.8
	Henoch-Schonlein Purpura	17	1.2
	Other infection	8	0.6
	HUS / TTP	2	0.1
	Malignancy	2	0.1
	Immunotactoid / fibrillary GN	1	0.1
	Light / Heavy chain deposit disease	1	0.1
	Multiple myeloma	1	0.1
	Amyloidosis	5	0.3
	Anti GBM disease	4	0.3
	Systemic vasculitis	8	0.6
	Not Available	8	0.6
	<b>Sub total</b>	<b>1464</b>	<b>54.9</b>
Others	Others	338	12.7
<b>Total</b>		<b>2665</b>	<b>100</b>

\* Patients may have either one or more histopathology or not have any histopathology

\*\*Others = Tubular disease + Vascular + Advance GN + Others + Hereditary

**1.9.3 Primary GN according to age groups**

- Minimal change disease (43%) and FSGS (34.9%) were the commonest GN affecting paediatric age group (<15 years old) whereas, membranous nephropathy predominantly affected the elderly (≥55 years old) in 55.5% of the cases.
- On the other hand, IgA nephropathy affected mostly the young adults between 25-45 years old (64.8%) (Table 1.9.3 and Figure 1.9.3).

Table 1.9.3: Primary glomerulonephritis according to the various age group, 2005-2022

Age group	<15 (n=1368)		15-<25 (n=2669)		25-<35 (n=2357)		35-<45 (n=1608)		45-<55 (n=1104)		55-<65 (n=764)		≥65 (n=422)		Total (n=10312)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
FSGS	477	34.9	742	27.8	711	30.2	499	31.0	312	28.3	203	26.6	145	32.8	3089	30
Minimal Change	589	43.1	1080	40.5	569	24.1	293	18.2	223	20.2	154	20.2	73	16.5	2981	28.9
IgA nephropathy	176	12.9	576	21.6	771	32.7	516	32.1	255	23.1	122	16.0	41	9.3	2457	23.8
Membrano-proliferative	17	1.2	39	1.5	44	1.9	34	2.1	18	1.6	14	1.8	7	1.6	173	1.7
Membranous nephropathy	35	2.6	105	3.9	136	5.8	163	10.1	217	19.7	205	26.8	127	28.7	988	9.6
Mesangial Prol: non-IgA	45	3.3	64	2.4	73	3.1	59	3.7	26	2.4	20	2.6	7	1.6	294	2.9
Idiopathic Crescentic GN	11	0.8	23	0.9	18	0.8	15	0.9	14	1.3	10	1.3	5	1.1	96	0.9
Crescentic ANCA	5	0.4	6	0.2	9	0.4	7	0.4	15	1.4	24	3.1	25	5.7	91	0.9
Not Available	13	1.0	34	1.3	26	1.1	22	1.4	24	2.2	12	1.6	12	2.7	143	1.4

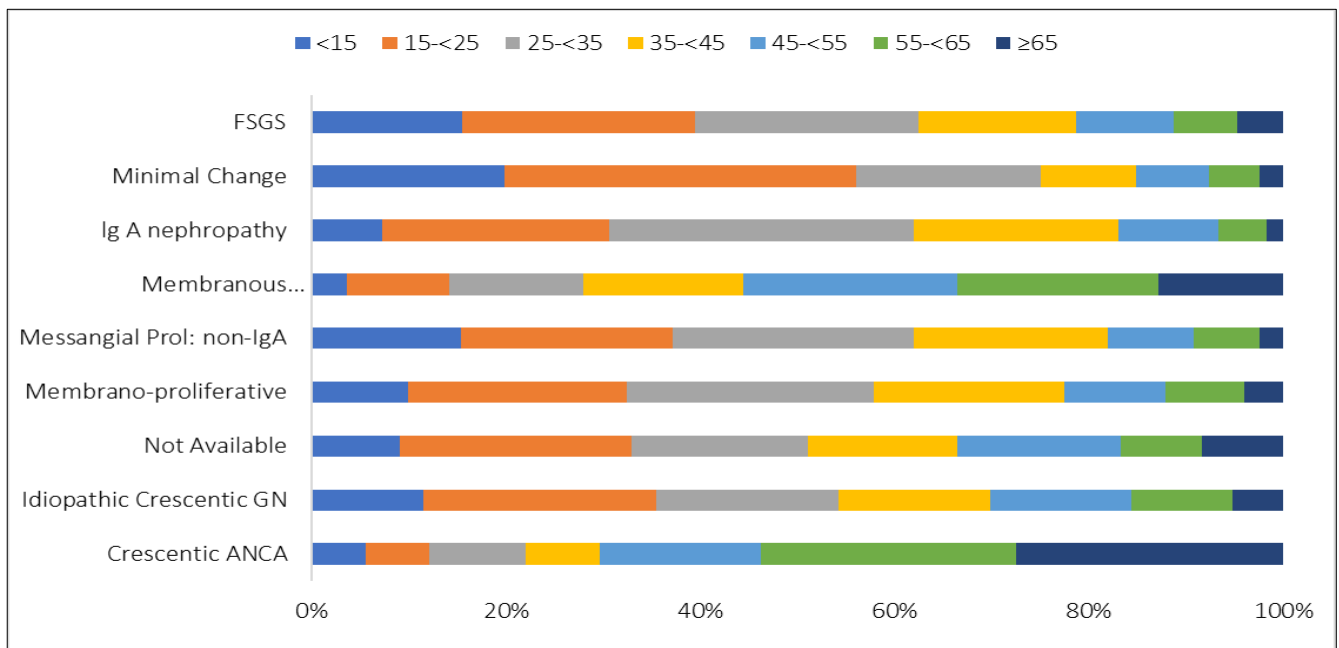


Figure 1.9.3: Primary glomerulonephritis according to the various age group, 2005-2022

**1.9.4 Secondary GN according to age groups**

- The two most common causes of secondary GN were lupus nephritis and diabetic nephropathy.
- As mentioned in the literature worldwide, lupus nephritis affected predominantly those in their reproductive age group and the incidence started to reduce in patients ≥ 55 years old.
- In contrast to diabetic nephropathy the incidence started to increase by the age of 45 years and older (Table 1.9.4).

Table 1.9.4: Secondary glomerulonephritis according to the various age group, 2005-2022

Age group	<15 (n=863)		15-<25 (n=2815)		25-<35 (n=2742)		35-<45 (n=1866)	
Histopathological Diagnosis	n	%	n	%	n	%	n	%
Lupus Nephritis	596	69.1	2652	94.2	2431	88.7	1415	75.8
Diabetic nephropathy	0	0	43	1.5	193	7.0	328	17.6
Post Infectious GN	172	19.9	79	2.8	67	2.4	52	2.8
Henoch-Schonlein Purpura	71	8.2	8	0.3	1	0	2	0.1
Amyloidosis	1	0.1	0	0	1	0	8	0.4
Other infection	1	0.1	5	0.2	12	0.4	15	0.8
Systemic vasculitis	8	0.9	3	0.1	7	0.3	4	0.2
Multiple myeloma	0	0	0	0	0	0	3	0.2
HUS / TTP	6	0.7	2	0.1	4	0.1	3	0.2
Light / Heavy chain deposit disease	0	0	1	0	1	0	1	0.1
Anti GBM disease	1	0.1	3	0.1	2	0.1	5	0.3
Malignancy	1	0.1	1	0	0	0	2	0.1
Immunotactoid / fibrillary GN	0	0	1	0	0	0	0	0
Not Available	6	0.7	17	0.6	23	0.8	28	1.5

Age group	45-<55 (n=1190)		55-<65 (n=601)		≥65 (n=222)		Total (n=10299)	
Histopathological Diagnosis	n	%	n	%	n	%	n	%
Lupus Nephritis	688	57.8	196	32.6	42	18.9	8020	77.9
Diabetic nephropathy	413	34.7	316	52.6	122	55.0	1415	13.7
Post Infectious GN	29	2.4	17	2.8	8	3.6	424	4.1
Henoch-Schonlein Purpura	6	0.5	1	0.2	1	0.5	90	0.9
Amyloidosis	18	1.5	27	4.5	15	6.8	70	0.7
Other infection	7	0.6	8	1.3	3	1.4	51	0.5
Systemic vasculitis	6	0.5	6	1.0	4	1.8	38	0.4
Multiple myeloma	5	0.4	8	1.3	6	2.7	22	0.2
HUS / TTP	0	0	1	0.2	0	0	16	0.2
Light / Heavy chain deposit disease	3	0.3	3	0.5	4	1.8	13	0.1
Anti GBM disease	2	0.2	2	0.3	3	1.4	18	0.2
Malignancy	1	0.1	3	0.5	2	0.9	10	0.1
Immunotactoid / fibrillary GN	0	0	2	0.3	2	0.9	5	0
Not Available	12	1.0	11	1.8	10	4.5	107	1.0

**1.9.5 Histology of repeat biopsies**

- The majority of repeat renal biopsies were performed in patients with lupus nephritis; 54.3% required 2 biopsies, 69.3% had 3 biopsies and 72.6% required 4 biopsies.
- The other histology of repeat biopsies included FSGS, Ig A nephropathy, minimal change, chronic interstitial nephritis and Others.
- About 5% of the repeated biopsies revealed a non-conclusive diagnosis (Figure 1.9.5 (a) to (c)).

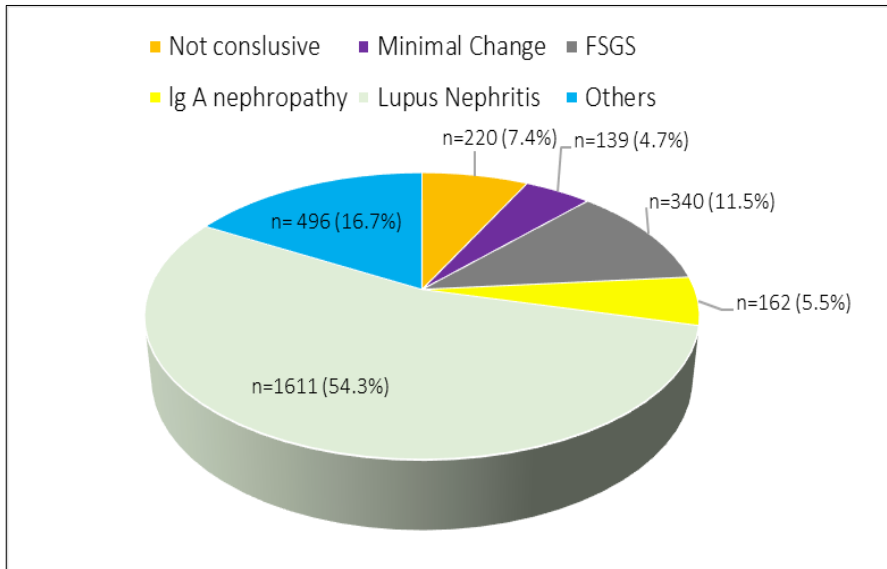


Figure 1.9.5 (a): Histopathological diagnosis of repeat biopsies (2<sup>nd</sup> episode), 2005-2022

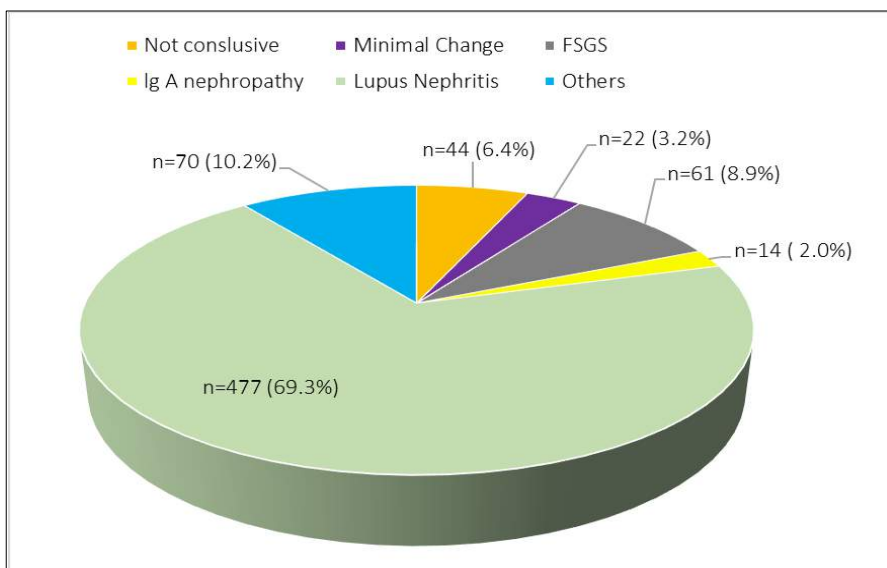


Figure 1.9.5 (b): Histopathological diagnosis of repeat biopsies (3<sup>rd</sup> episode), 2005-2022

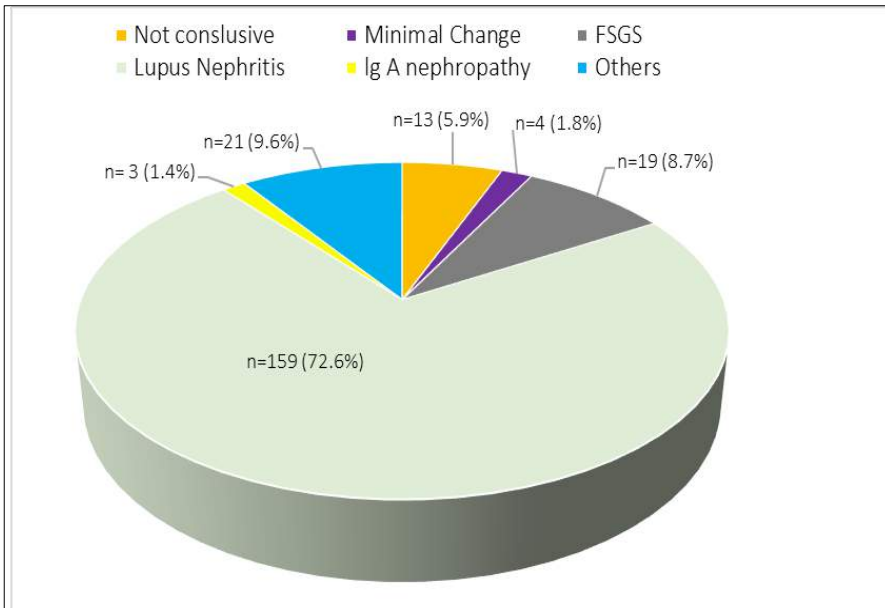


Figure 1.9.5 (c): Histopathological diagnosis of repeat biopsies (4<sup>th</sup> episode and above), 2005-2022



# **CHAPTER 2**

# **PRIMARY GLOMERULONEPHRITIS**

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## 2.1 Introduction

- Chapter 2 reports the primary glomerulonephritis (GN) in adults (defined as age  $\geq 15$ ) from the years 2005-2022.
- There appeared to be changing trends in the frequency of primary GN.
  - This may be due to increased CKD awareness, changing practices in CKD screening and renal biopsy.
  - There was an increasing incidence of IgA nephropathy from 19.6% in 2005-2009 period to 33.7% in 2022.
  - Minimal change disease was the commonest glomerulonephritis in adults in previous decade (2005-2014).
  - However, from 2015 to 2022, the incidence of IgA nephropathy had increased, making it the most common primary GN from 2020-2022, followed closely by FSGS.
  - Membranous nephropathy accounted for only 10.7% of all biopsy-proven primary GN. There was a slight increase in the incidence of patients with membranous nephropathy, rising from 9.2%-9.6% between years 2005-2014 to 11.3%-13.3% between years 2015-2022.
  - The other types of primary GN were relatively uncommon (Table 2.1).

Table 2.1: Primary Glomerulonephritis, 2005-2022

Histopathological Diagnosis	2005-2009 (n=1627)		2010-2014 (n=2640)		2015-2019 (n=2931)		2020 (n=656)		2021 (n=481)		2022 (n=609)		Total (n=8944)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
FSGS	489	30.1	782	29.6	888	30.3	169	25.8	128	26.6	156	25.6	2612	29.2
MCD	539	33.1	786	29.8	682	23.3	154	23.5	103	21.4	128	21.0	2392	26.7
IgAN	319	19.6	629	23.8	786	26.8	191	29.1	151	31.4	205	33.7	2281	25.5
Membranous nephropathy	156	9.6	243	9.2	331	11.3	87	13.3	63	13.1	73	12.0	953	10.7
MPGN	34	2.1	38	1.4	58	2.0	12	1.8	8	1.7	6	1.0	156	1.7
Mesangial Prol (Non IgA)	54	3.3	79	3.0	70	2.4	23	3.5	10	2.1	13	2.1	249	2.8
Idiopathic Crescentic	24	1.5	31	1.2	24	0.8	3	0.5	2	0.4	1	0.2	85	1.0
Crescentic ANCA	8	0.5	20	0.8	23	0.8	11	1.7	9	1.9	15	2.5	86	1.0
Not available/Missing	4	0.2	32	1.2	69	2.4	6	0.9	7	1.5	12	2.0	130	1.5

### Abbreviation

*FSGS: Focal Segmental Glomerulosclerosis*

*MCD: Minimal Change Disease*

*IgAN: IgA nephropathy*

*MPGN: Membranoproliferative GN*

*Mesangial Prol: Mesangial Proliferative GN*

## 2.2 Focal Segmental Glomerulosclerosis (FSGS)

### 2.2.1 Introduction

- Focal segmental glomerulosclerosis is a histological diagnosis and is defined by the presence of segmental glomerular capillary tufts obliteration with increased mesangial matrix deposition, intra-capillary hyaline deposits and focal adhesions of the capillary tuft to Bowman’s capsule.
- Differentiating idiopathic FSGS changes from secondary FSGS clinically can be challenging as electron microscopy is not readily available in Malaysia.

### 2.2.2 Patient Population and Characteristics

- Between 2005 to 2022, a total of 2612 FSGS cases were reported to the registry.
- FSGS was slightly more common in males (57.2%) (Figure 2.2.2(a))
- FSGS tended to be diagnosed in younger patients with mean age 35.9 ±14.93 years (Figure 2.2.2(b)).

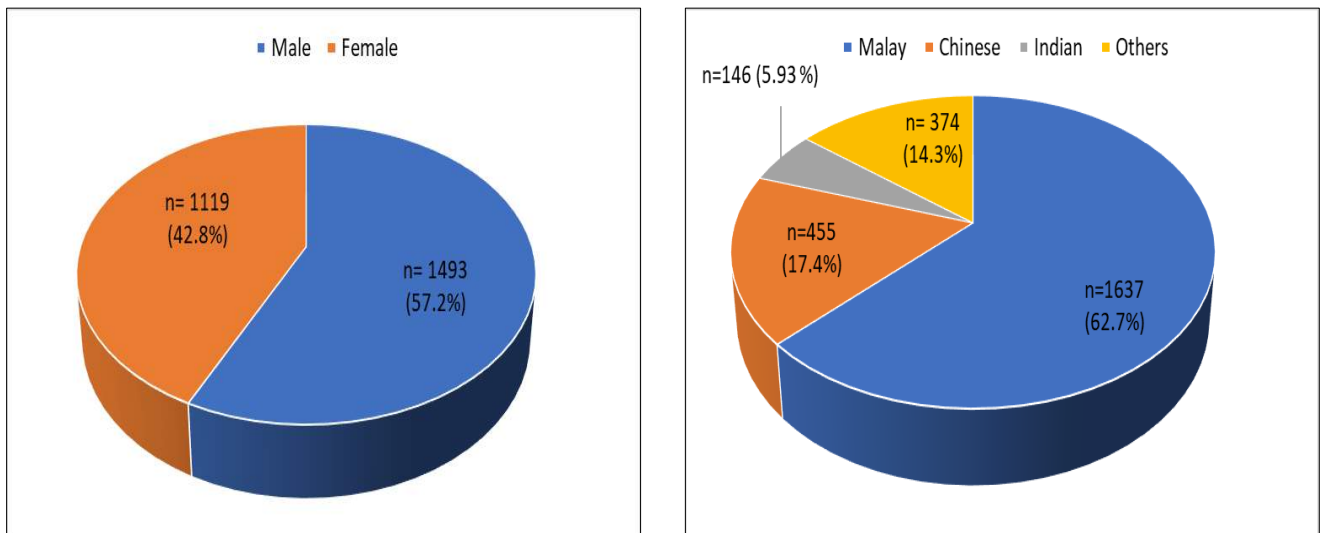


Figure 2.2.2 (a): Demographic characteristics for FSGS, 2005-2022

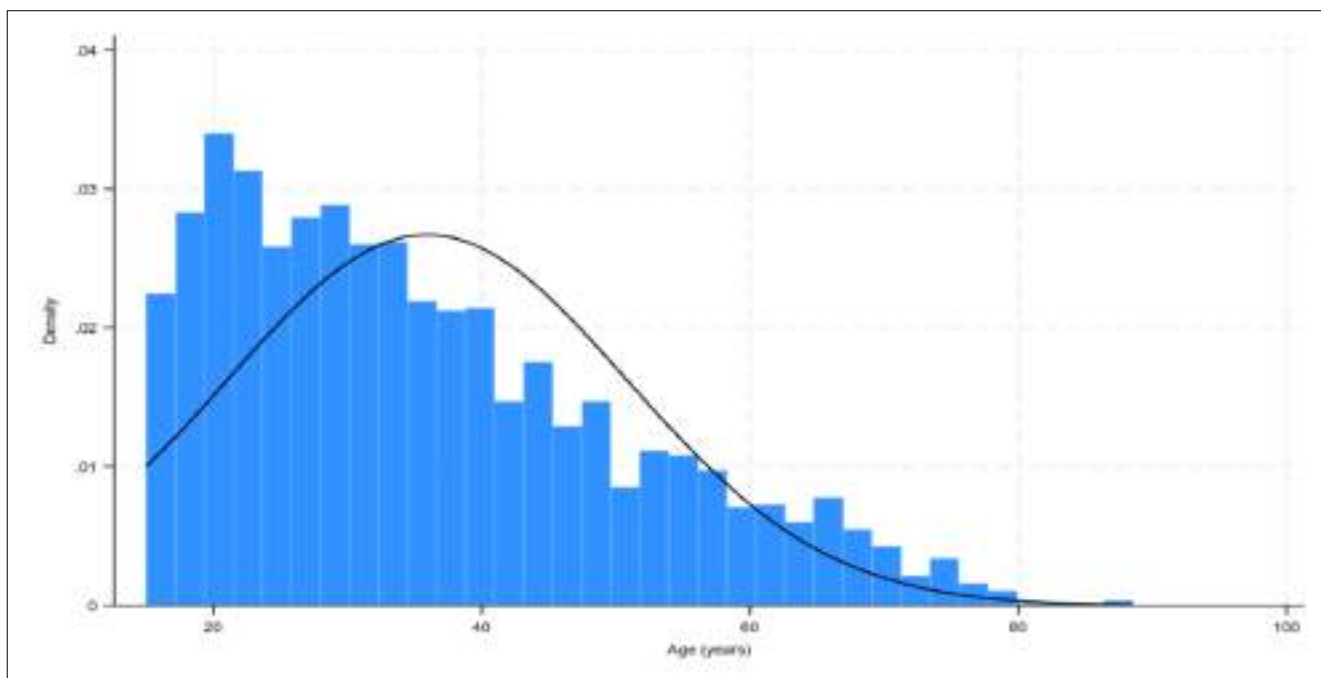


Figure 2.2.2 (b): Age at time of biopsy (years) FSGS, 2005-2022

### 2.2.3 Clinical presentation

- Nephrotic syndrome was the most common clinical presentation of FSGS (49.5%) followed by asymptomatic urine abnormalities (26.4%) (Table 2.2.3(a)).
- Nephrotic syndrome was the commonest presentation of FSGS regardless of the gender (Figure 2.2.3(a)) and age (Figure 2.2.3(b)).
- Females with FSGS were more likely to present with asymptomatic urine abnormalities compared to males (Figure 2.2.3(a)).

Table 2.2.3 (a): Clinical presentation for FSGS, 2005-2022

Clinical Presentation	2005-2009 (n=489)		2010-2014 (n=782)		2015-2019 (n=888)		2020 (n=169)		2021 (n=128)		2022 (n=156)		Total (n=2612)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Nephrotic syndrome	298	60.9	379	48.5	395	44.5	77	45.6	58	45.3	85	54.5	1292	49.5
Asymptomatic urine abnormalities	112	22.9	202	25.8	241	27.1	52	30.8	42	32.8	41	26.3	690	26.4
Nephritic-Nephrotic	22	4.5	61	7.8	89	10.0	13	7.7	15	11.7	13	8.3	213	8.2
Nephritic	24	4.9	30	3.8	47	5.3	5	3.0	6	4.7	9	5.8	121	4.6
Not available	33	6.7	110	14.1	116	13.1	22	13.0	7	5.5	8	5.1	296	11.3

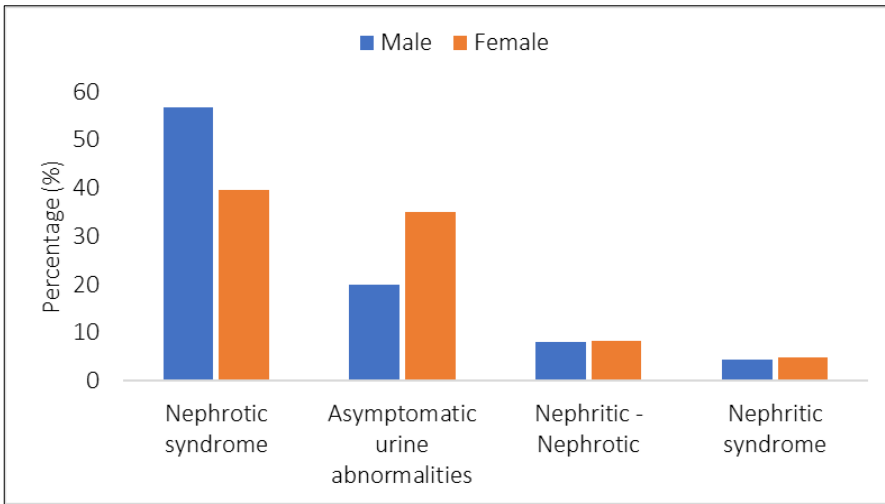


Figure 2.2.3 (a): Clinical presentation by gender for FSGS, 2005-2022

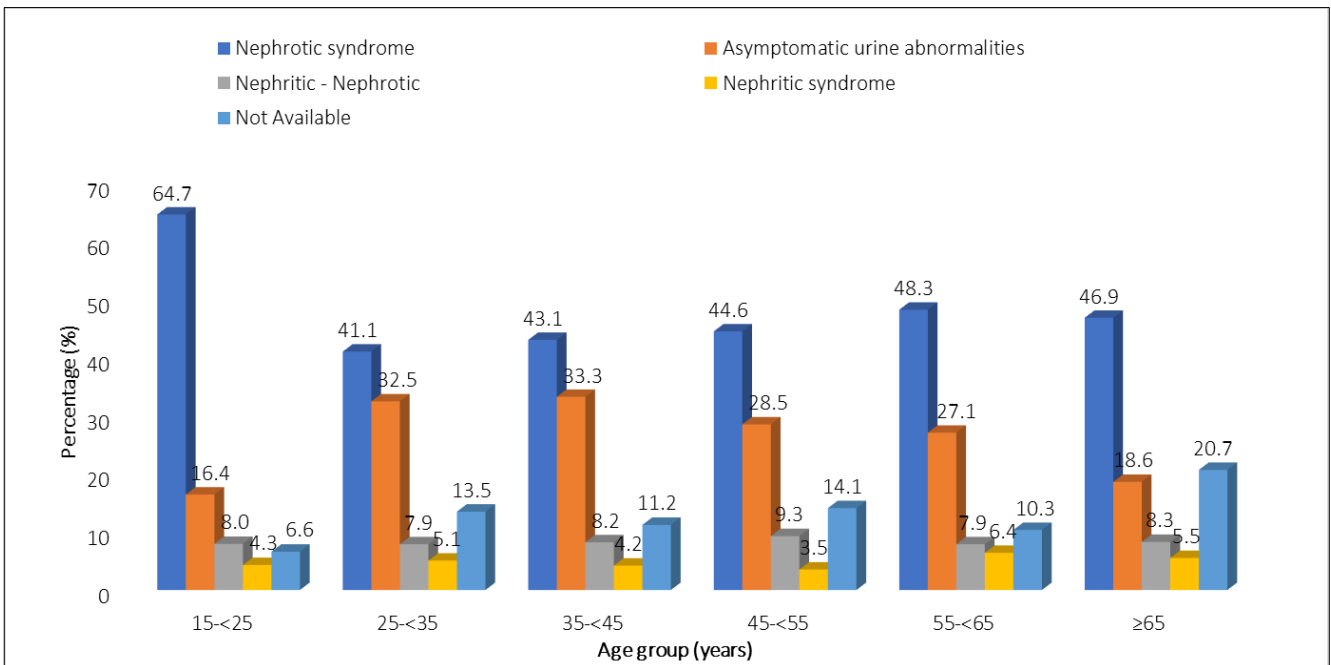


Figure 2.2.3 (b): Clinical presentation by age group for FSGS, 2005-2022

**2.2.4 Hypertension**

- One thousand and ninety-seven patients (42%, n=1097) with FSGS had hypertension at presentation.
- The prevalence of hypertension in FSGS was similar in both genders: males: 621/1493 (41.6%) and females 476/1119 (42.5%) (Figure 2.2.4(a)).
- Older patients were more likely to be hypertensive. (Figure 2.2.4(b)). This could be related to natural history of onset of hypertension and may also be contributed by the decline in renal function in the older patients.

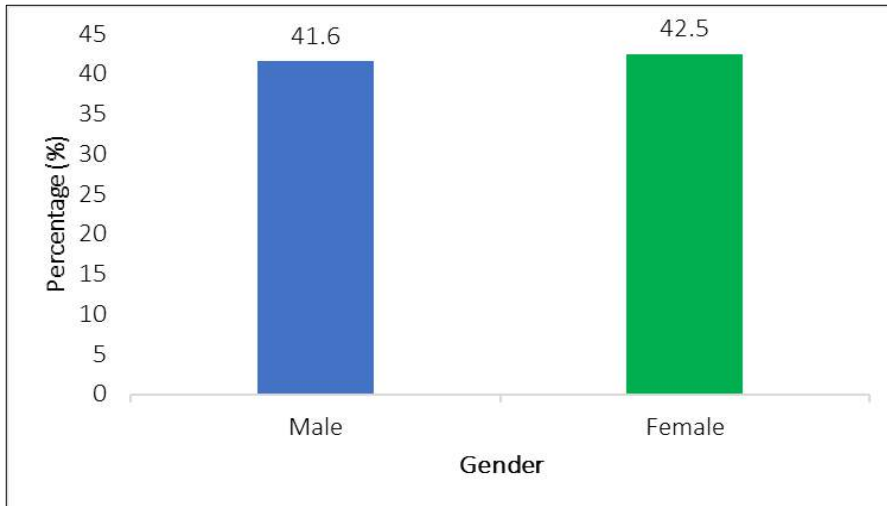


Figure 2.2.4 (a): Hypertension by gender for FSGS, 2005-2022

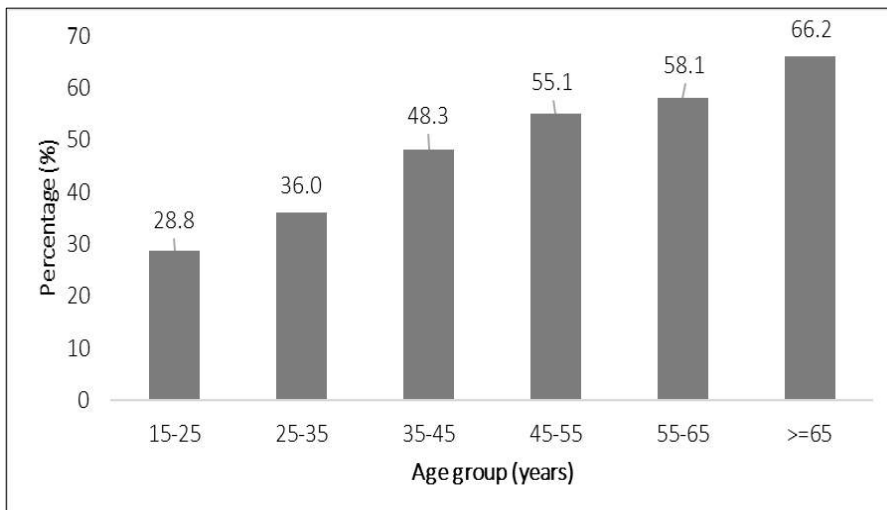


Figure 2.2.4 (b): Hypertension by age group for FSGS, 2005-2022

### 2.2.5 Renal function

- Over a quarter of patients had eGFR  $\geq 90$  ml/min/1.73m<sup>2</sup>, while 17% of patients had severely impaired renal function of less than 30 ml/min/1.73m<sup>2</sup> (Table 2.2.5(a)).
- There were no differences in renal function at presentation between the genders (Figure 2.2.5(a)).
- Older patients had lower eGFR which is in keeping with the prevalence of CKD in the general population (Figure 2.2.5(b)).

Table 2.2.5 (a): Renal function in FSGS, 2005-2022

eGFR (mls/min/ 1.73m <sup>2</sup> )	2005-2009 (n=489)		2010-2014 (n=782)		2015-2019 (n=888)		2020 (n=169)		2021 (n=128)		2022 (n=156)		Total (n=2612)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
< 15	21	4.3	46	5.9	55	6.2	6	3.6	7	5.5	9	5.8	144	5.5
15 to < 30	63	12.9	89	11.4	98	11.0	22	13.0	16	12.5	11	7.1	299	11.5
30 to < 60	120	24.5	186	23.8	225	25.3	38	22.5	23	18.0	47	30.1	639	24.5
60 to < 90	104	21.3	143	18.3	181	20.4	34	20.1	21	16.4	28	18.0	511	19.6
$\geq 90$	142	29.0	217	27.8	211	23.8	45	26.6	37	28.9	39	25.0	691	26.5
Not available	39	8.0	101	12.9	118	13.3	24	14.2	24	18.8	22	14.1	328	12.6

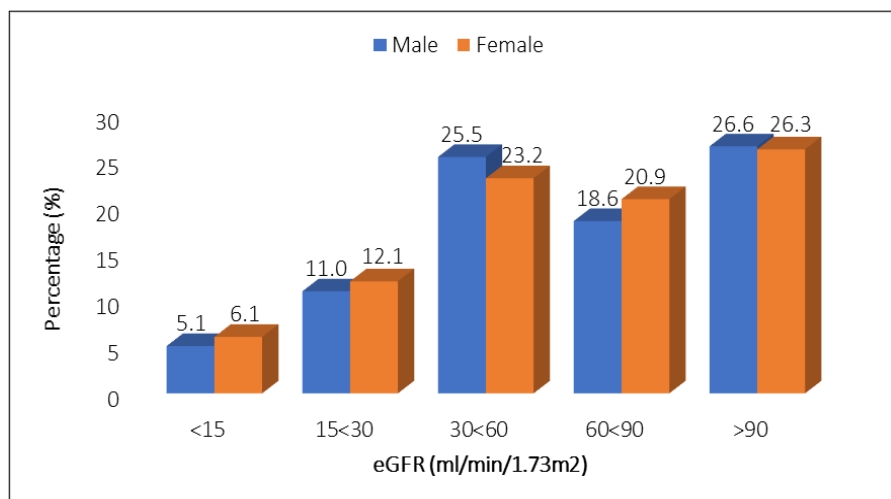


Figure 2.2.5 (a): Renal function by gender for FSGS, 2005-2022

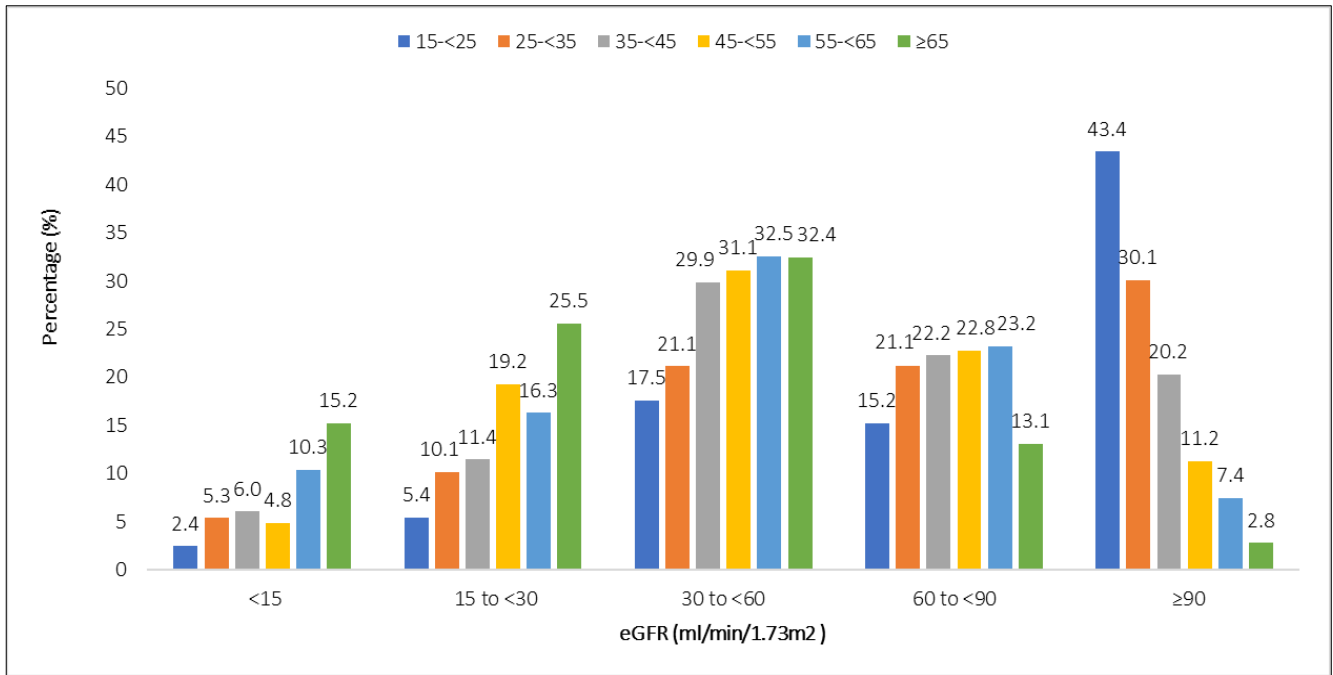


Figure 2.2.5 (b): Renal function at presentation by age group for FSGS, 2005-2022

**2.2.6 Outcome**

- The 5-year and 10-year renal survival was 83.6% and 75.6% respectively and this was higher than the reported outcome worldwide (Figure 2.2.6(a)).
- We noted that most of the patients with FSGS had good kidney function at the time of presentation.
- Patient survival at 5 and 10 years were 88.3% and 85.0% respectively. (Figure 2.2.6(b)).

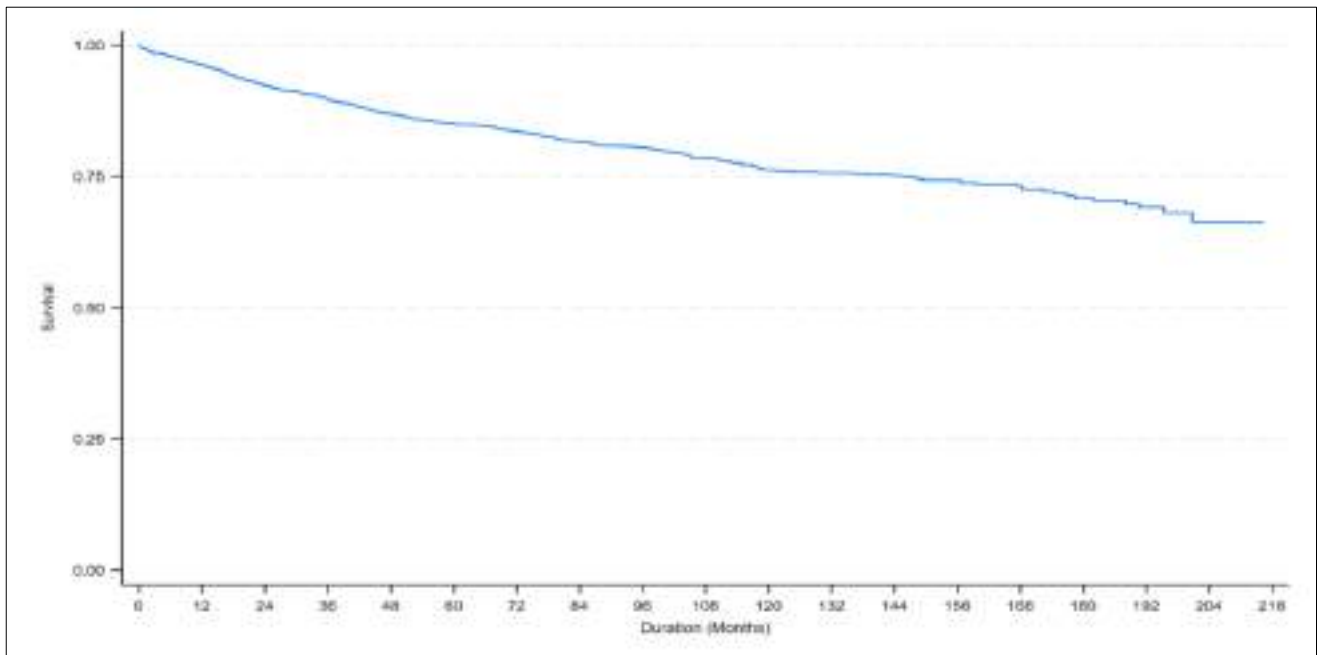


Figure 2.2.6 (a): Renal Survival estimates for FSGS, 2005-2022

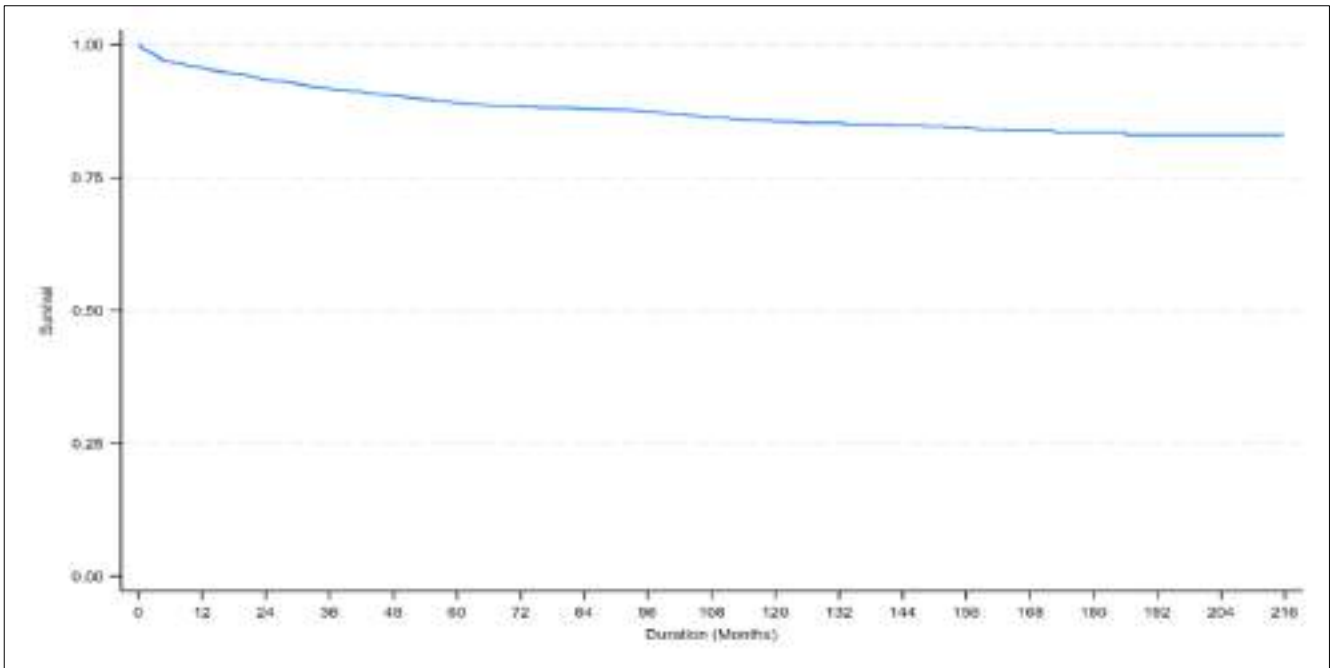


Figure 2.2.6 (b): Patient Survival estimates for death in FSGS, 2005-2022

## 2.3 Minimal Change Disease (MCD)

### 2.3.1 Introduction

- Minimal change disease is a major cause of nephrotic syndrome in both children and adults.
- MCD is typically characterized by normal appearing glomeruli by light microscopy and absence of complement or immunoglobulin deposits on immunofluorescence microscopy. Glomerular size is usually normal by standard methods of light microscopy, although enlarged glomeruli may be observed. On electron microscopy, there is diffuse effacement (“fusion”) of the epithelial foot processes.
- The biopsy sampling size/location may affect the diagnosis of MCD/FSGS.
- Electron microscopy service is not readily available.

### 2.3.2 Patient Population and Characteristics

- A total of 2392 cases of MCD were reported to the registry from 2005 to 2022.
- MCD was more common in males (62.3%) (Figure 2.3.2(a)).
- There was no obvious racial predilection observed in our cohort (Figure 2.3.2(a)).
- MCD was mainly diagnosed in young patients, with a mean age of 31.5 ± 14.30 years at the time of biopsy (Figure 2.3.2(b)).
- Traditionally MCD is known to have a bimodal distribution. However, this trend was not seen in our cohort with the higher proportion of younger patients presenting with MCD.

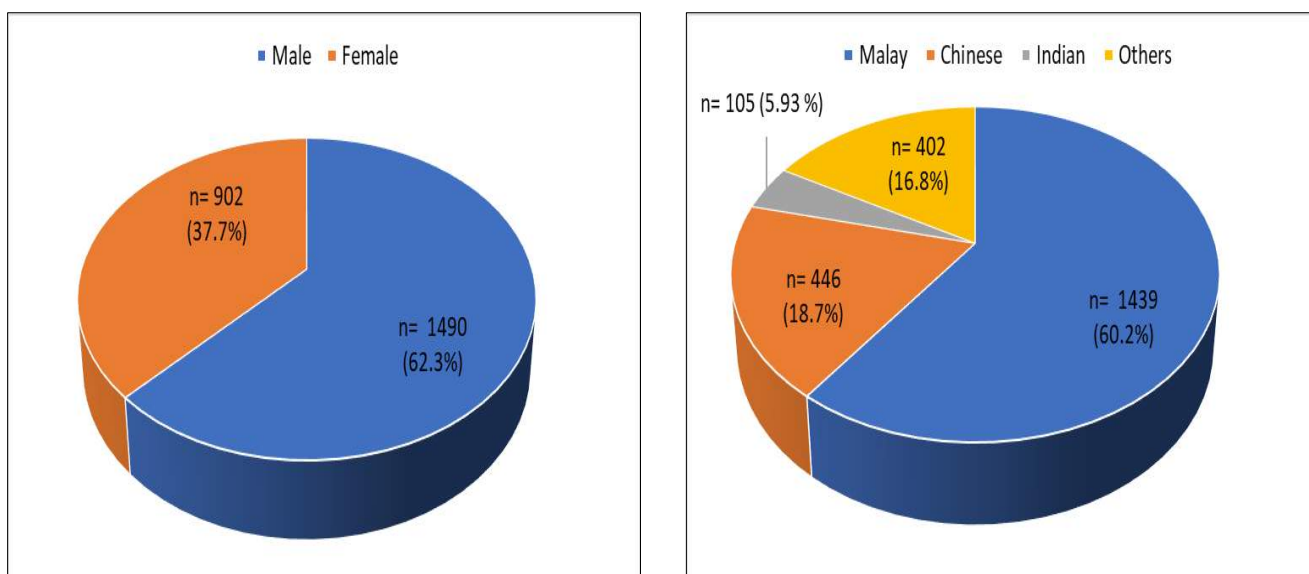


Figure 2.3.2 (a): Demographic characteristics for MCD, 2005-2022

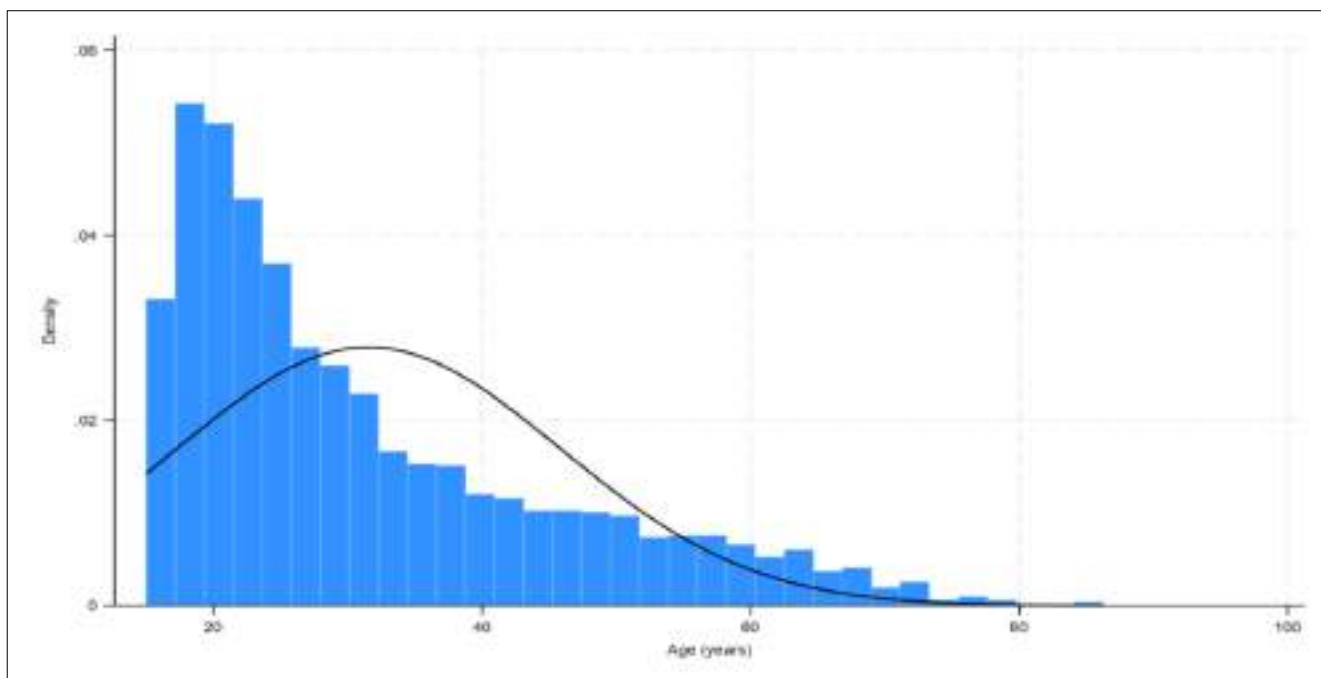


Figure 2.3.2 (b): Age at time of biopsy (years) MCD, 2005-2022

### 2.3.3 Clinical presentation

- Nephrotic syndrome accounted for over two-thirds of clinical presentation of MCD (68.7%) (Table 2.3.3(a)).
- Nephrotic syndrome remained the commonest presentation of MCD regardless of the gender (Figure 2.3.3(a)) and age (Figure 2.3.3(b)).

Table 2.3.3 (a): Clinical presentation for MCD, 2005-2022

Clinical Presentation	2005-2009 (n=539)		2010-2014 (n=786)		2015-2019 (n=682)		2020 (n=154)		2021 (n=103)		2022 (n=128)		Total (n=2392)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Nephrotic syndrome	425	78.8	529	67.3	437	64.1	101	65.6	65	63.1	87	68.0	1644	68.7
Asymptomatic urine abnormalities	60	11.1	132	16.8	98	14.4	24	15.6	23	22.3	24	18.8	361	15.1
Nephritic-Nephrotic	19	3.5	34	4.3	46	6.7	11	7.1	9	8.7	10	7.8	129	5.4
Nephritic	20	3.7	27	3.4	29	4.3	5	3.2	3	2.9	3	2.3	87	3.6
Not available	15	2.8	64	8.1	72	10.6	13	8.4	3	2.9	4	3.1	171	7.1

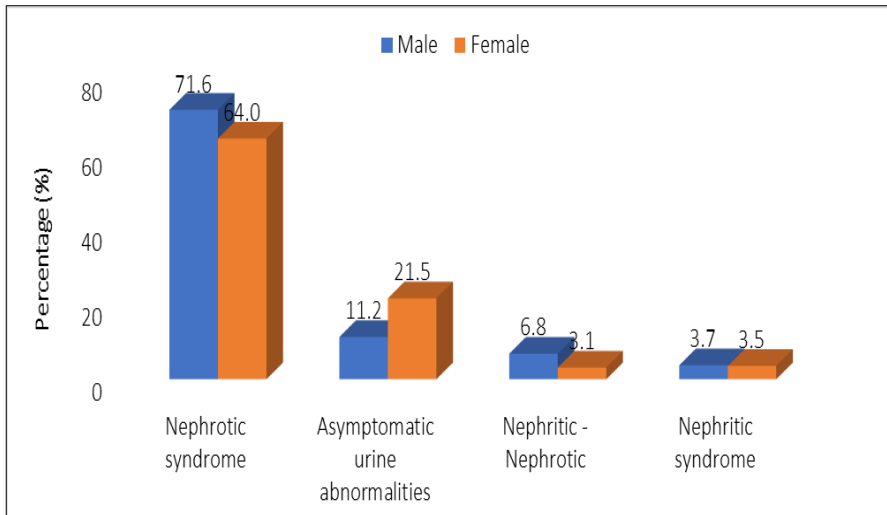


Figure 2.3.3 (a): Clinical presentation by gender for MCD, 2005-2022

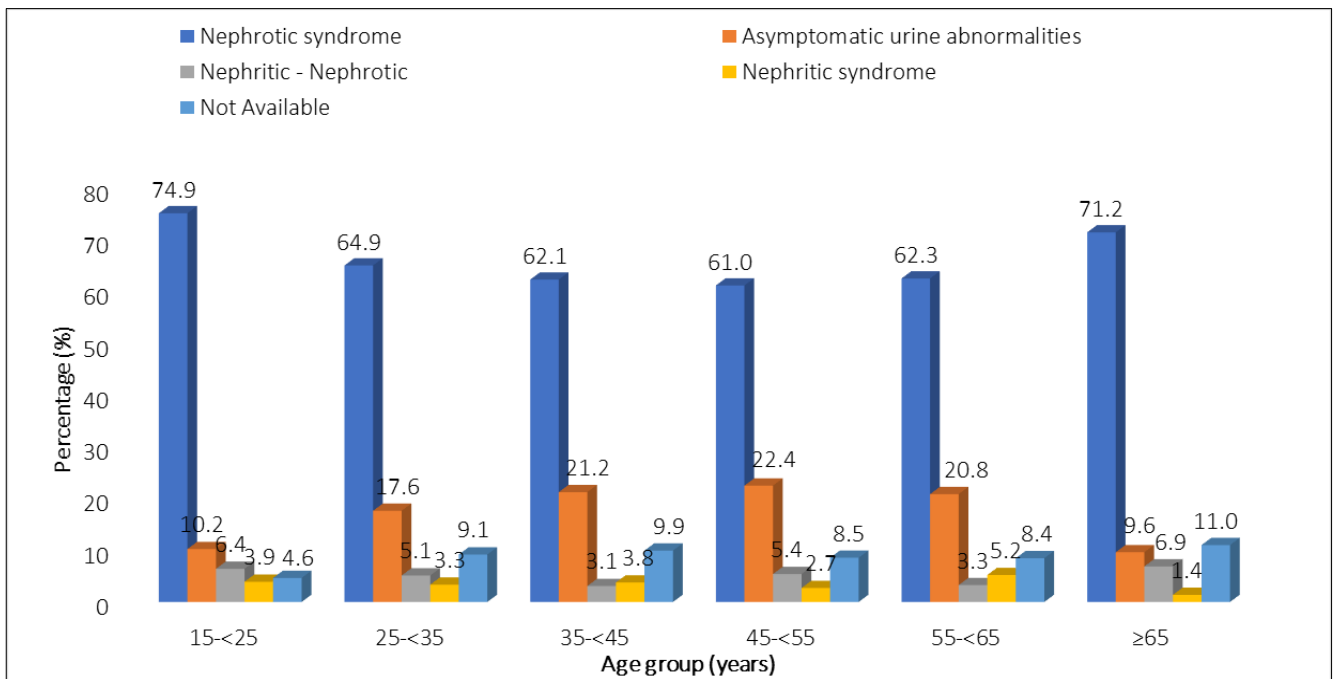


Figure 2.3.3 (b): Clinical presentation by age group for MCD, 2005-2022

**2.3.4 Hypertension**

- Four hundred and eighty-four patients (20.2%) with MCD were hypertensive at presentation.
- The prevalence of hypertension was similar between the two genders, 20.6% in males and 19.6% in females (Figure 2.3.4(a)).
- One third of the patients above the age of 45 years were hypertensive at presentation (Figure 2.3.4(b)). This could be related to natural onset of hypertension and also decline in renal function in the older patients.

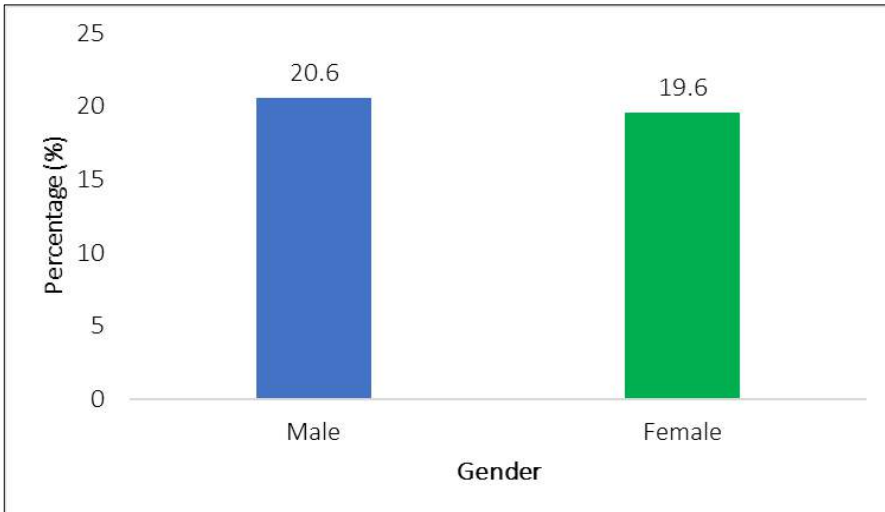


Figure 2.3.4 (a): Hypertension by gender for MCD, 2005-2022

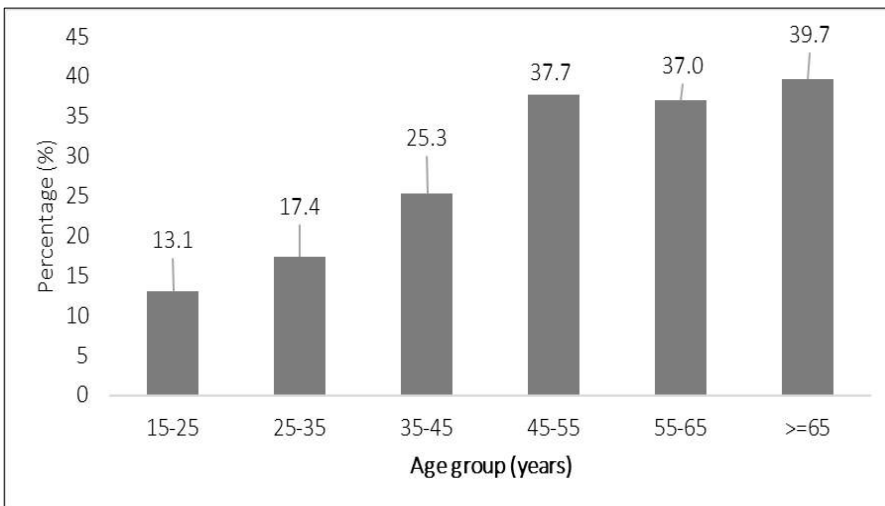


Figure 2.3.4 (b): Hypertension by age group for MCD, 2005-2022

### 2.3.5 Renal function

- Most patients (67.4%) with MCD had eGFR more than 60mls/min/1.73m<sup>2</sup> with half having eGFR more than 90mls/min/1.73m<sup>2</sup>.
- There were no differences in renal function by gender (Figure 2.3.5(a)).
- Older patients had lower eGFR at presentation and this was in keeping with the prevalence of CKD in the general population (Figure 2.3.5(b)).

Table 2.3.5 (a): Renal function in MCD, 2005-2022

eGFR (mls/min/1.73m <sup>2</sup> )	2005-2009 (n=539)		2010-2014 (n=786)		2015-2019 (n=682)		2020 (n=154)		2021 (n=103)		2022 (n=128)		Total (n=2392)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
< 15	7	1.3	16	2.04	9	1.3	2	1.3	2	1.9	0	0	36	1.5
15 to < 30	18	3.3	35	4.45	28	4.1	12	7.79	1	1.0	6	4.69	100	4.2
30 to < 60	69	12.8	98	12.47	66	9.7	16	10.39	19	18.5	19	14.84	287	12.0
60 to < 90	118	21.9	138	17.56	101	14.8	19	12.34	22	21.4	25	19.53	423	17.7
≥ 90	294	54.6	392	49.87	322	47.2	81	52.6	37	35.9	62	48.44	1188	49.7
Not available	33	6.1	107	13.61	156	22.9	24	15.58	22	21.4	16	12.5	358	15.0

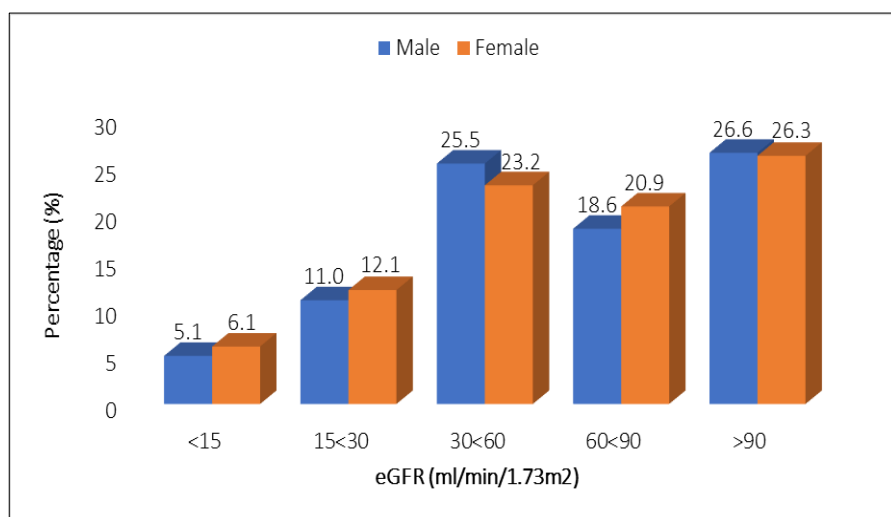


Figure 2.3.5 (a): Renal function by gender for MCD, 2005-2022

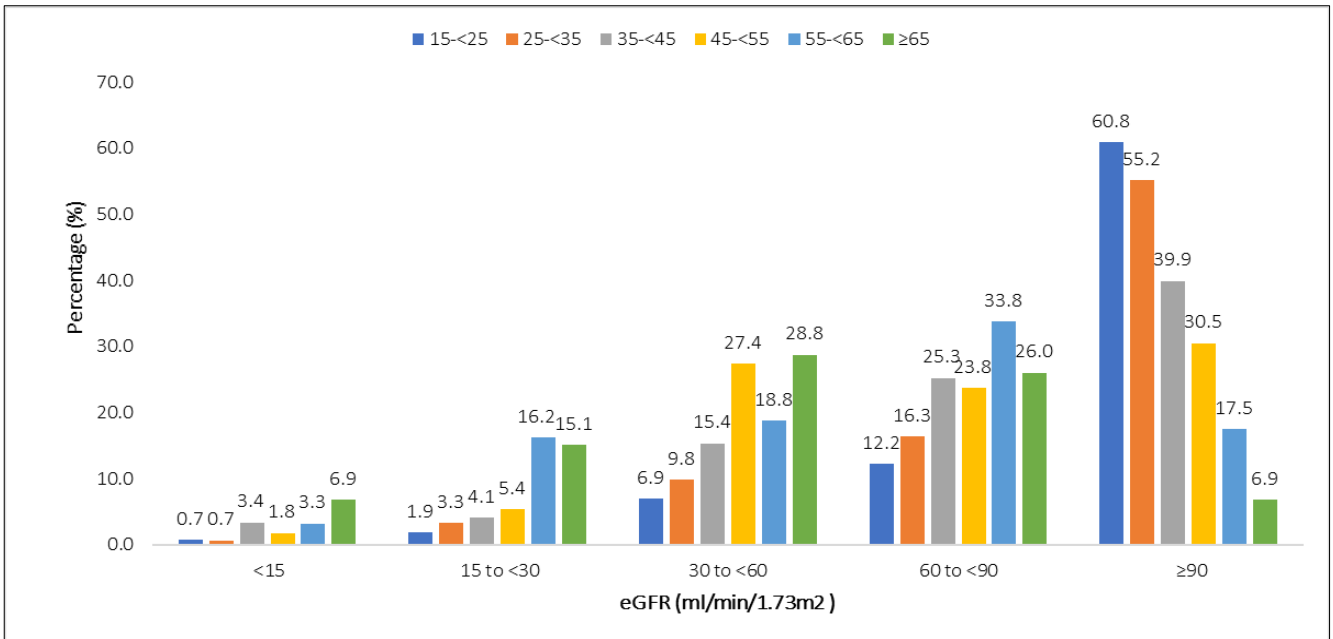


Figure 2.3.5 (b): Renal function at presentation by age group for MCD, 2005-2022

**2.3.6 Outcome**

- The 5-year and 10-year renal survival were 98.1% and 96.7% respectively (Figure 2.3.6(a)).
- The 5-year and 10-year patient survival of MCD were 93.7% and 91.0% respectively (Figure 2.3.6(b)).
- Mortality rate for MCD is usually low. However it may occur due to complications of nephrotic syndrome itself (such as infection and thrombosis) or complications following treatment with infection being the predominant one or cardiovascular disease.

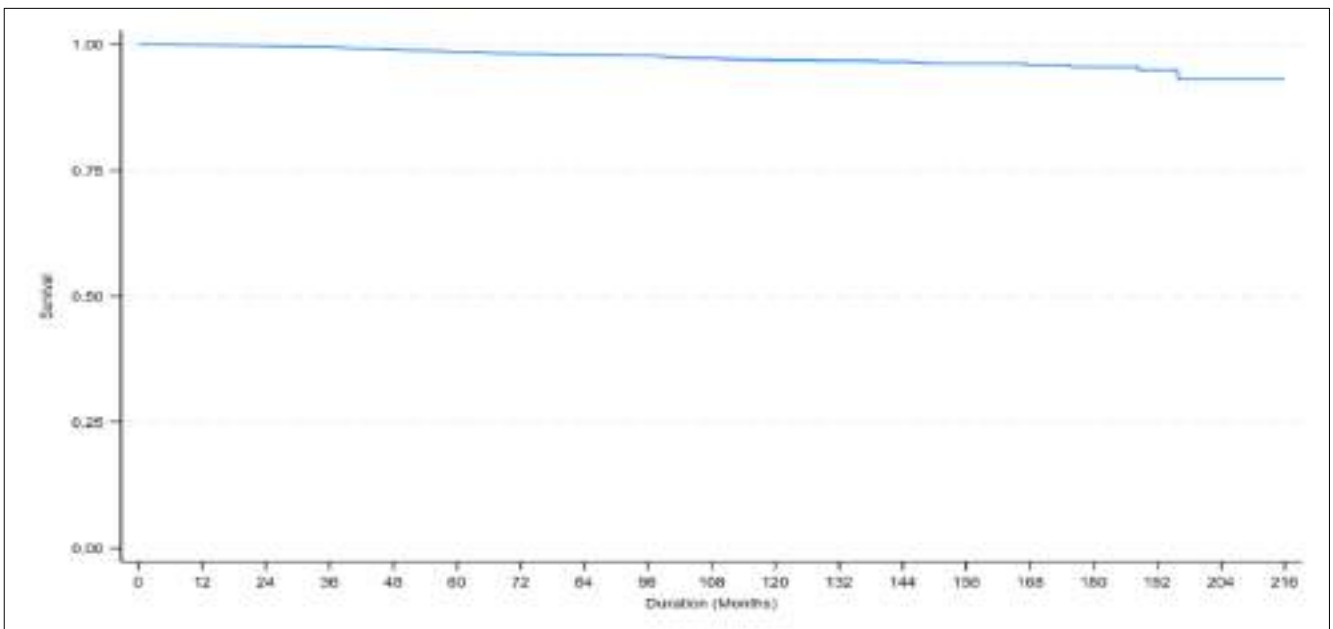


Figure 2.3.6 (a): Renal Survival estimates for MCD, 2005-2022

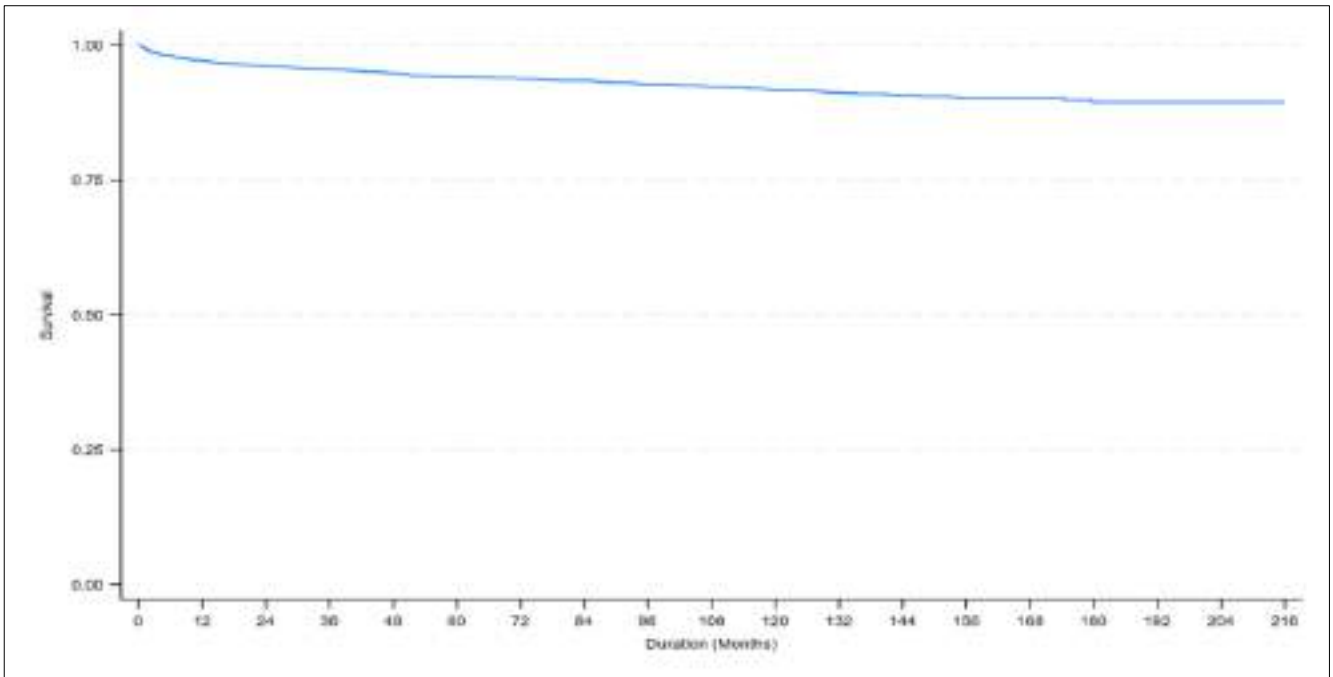


Figure 2.3.6 (b): Patients Survival estimates for death in MCD, 2005-2022

## 2.4 IgA Nephropathy (IgAN)

### 2.4.1 Introduction

- IgAN is defined by the predominant deposition of IgA in the glomerular mesangium although light microscopic appearances and clinical features can vary considerably due to the various patterns of histopathologic injury found in this glomerulonephritis.
- The prevalence of IgAN varies as it depends on screening procedures and biopsy practices.
- There has been a significant increase in the number of patients with IgAN. This is likely due to better awareness in chronic kidney disease, improved screening procedures, earlier referral to nephrologist and lower biopsy threshold.

### 2.4.2 Patient Population and Characteristics

- There were 2281 reported cases of IgAN from 2005 to 2022.
- As previously reported, there was a slight female preponderance in our cohort (60.3% vs 39.7%) (Figure 2.4.2(a)).
- There appeared to be no racial predilection in the incidence of IgA nephropathy (Figure 2.4.2(a)).
- The mean age at biopsy was  $34.2 \pm 12.16$  years and the majority of cases (82.0%) were between the ages 15 to 45 years (Figure 2.4.2(b)).

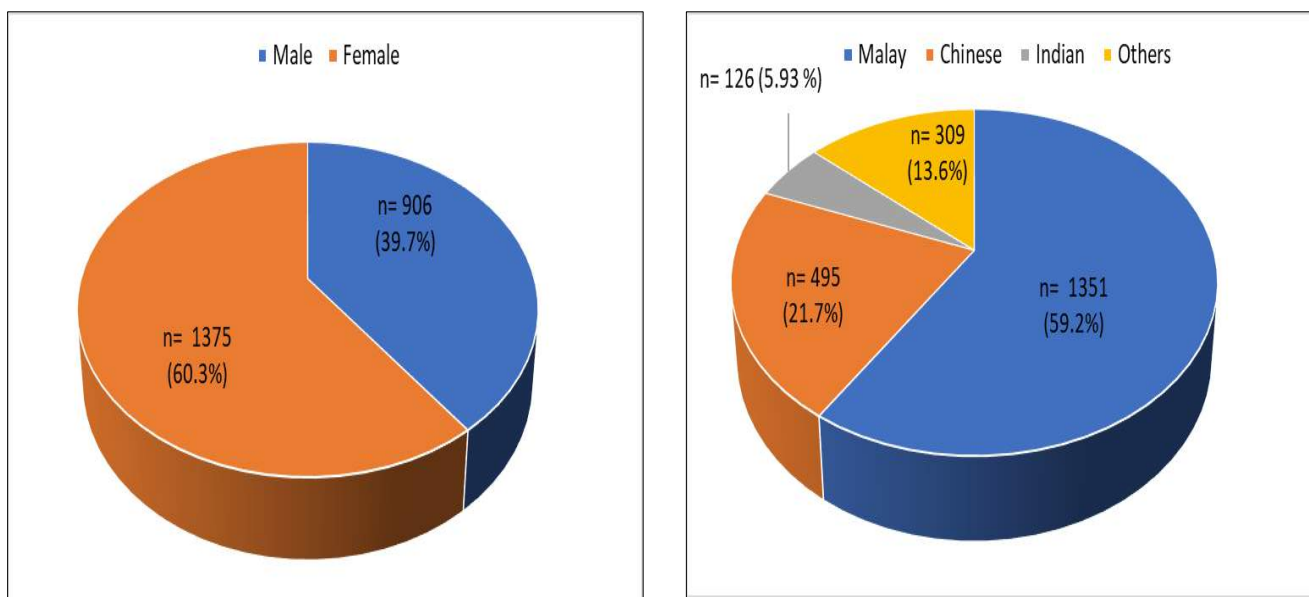


Figure 2.4.2 (a): Demographic characteristics for IgAN, 2005-2022

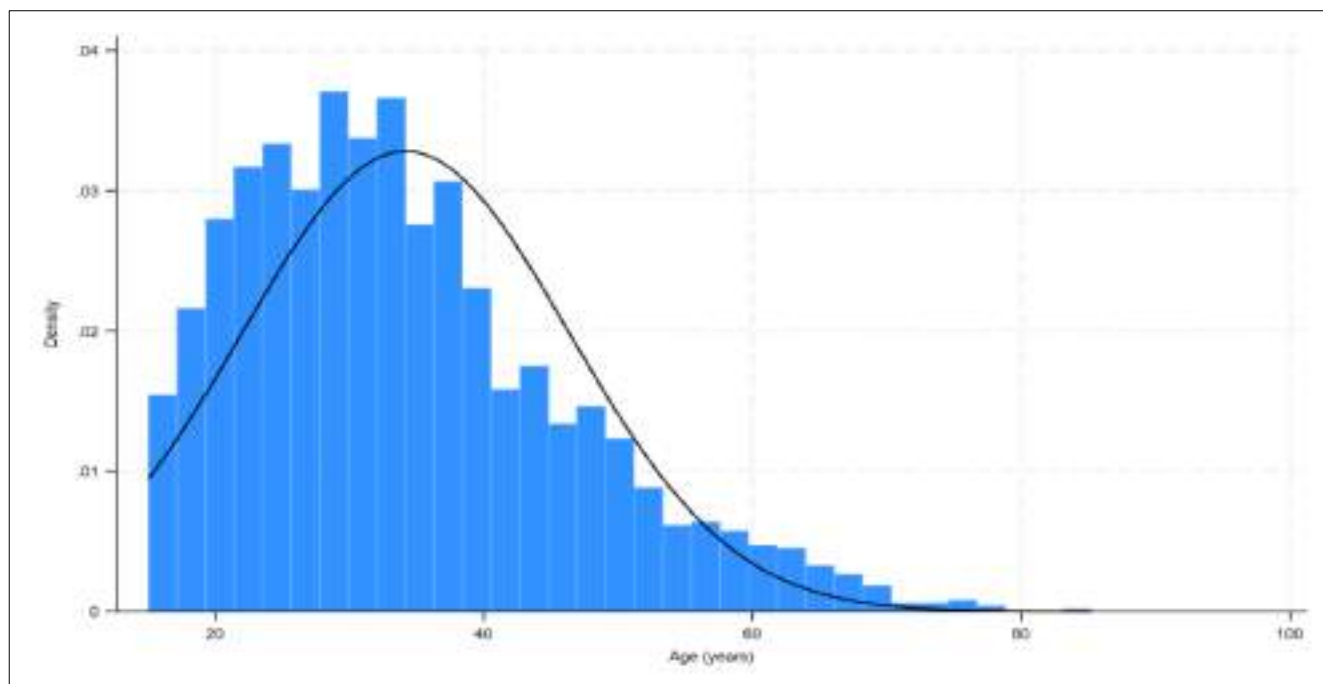


Figure 2.4.2 (b): Age at time of biopsy (year) IgAN, 2005-2022

### 2.4.3 Clinical presentation

- Asymptomatic urine abnormalities was the most common presentation of IgAN (49.3%). Asymptomatic urine abnormalities remained the most common presentation regardless of age group. (Figure 2.4.3(b)).
- Up to 21.2% of those who were biopsied presented with nephrotic syndrome (Table 2.4.3(a)).
- Nearly a quarter of those above the age of 65 years did not have data available. Overall, the number of cases for whom data was missing on clinical presentation had reduced to 8.8% in 2022, implying a better reporting by nephrology units.

Table 2.4.3 (a): Clinical presentation for IgAN, 2005-2022

Clinical Presentation	2005-2009 (n=319)		2010-2014 (n=629)		2015-2019 (n=786)		2020 (n=191)		2021 (n=151)		2022 (n=205)		Total (n=2281)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Nephrotic syndrome	80	25.1	134	21.3	163	20.7	37	19.4	39	25.8	31	15.1	484	21.2
Asymptomatic urine abnormalities	165	51.7	284	45.2	383	48.7	92	48.2	87	57.6	114	55.6	1125	49.3
Nephritic-Nephrotic	22	6.9	60	9.5	78	9.9	22	11.5	13	8.6	27	13.2	222	9.7
Nephritic	22	6.9	47	7.5	44	5.6	18	9.4	4	2.6	15	7.3	150	6.6
Not available	30	9.4	104	16.5	118	15.0	22	11.5	8	5.3	18	8.8	300	13.2

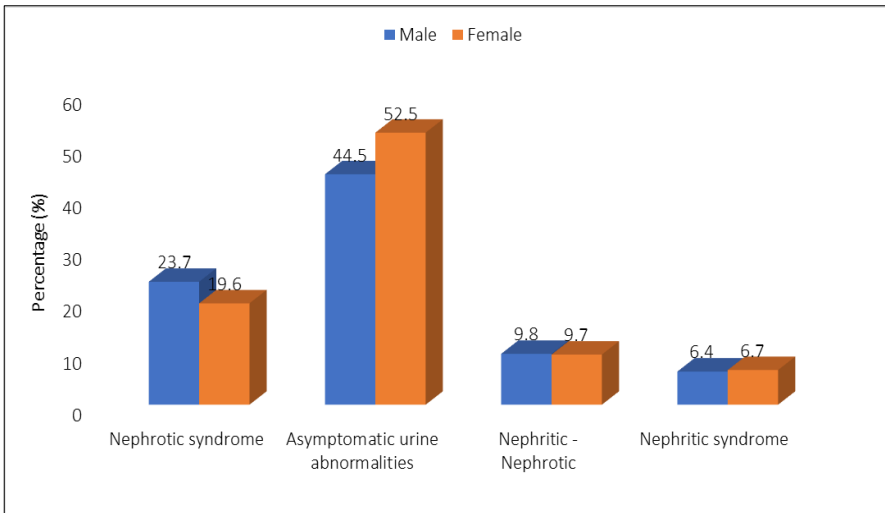


Figure 2.4.3 (a): Clinical presentation by gender for IgAN, 2005-2022

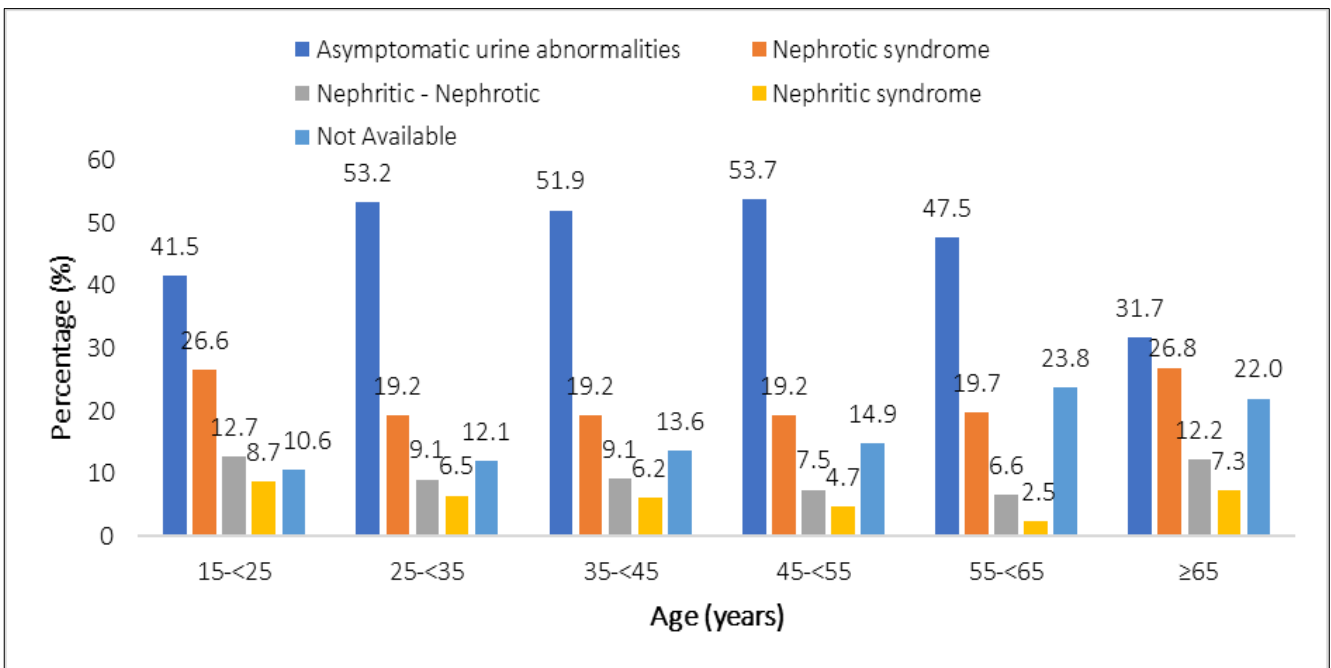


Figure 2.4.3 (b): Clinical presentation by age group for IgAN, 2005-2022

**2.4.4 Hypertension**

- Nearly half (49.3%, n=1102) of patients with IgAN were hypertensive at presentation.
- The prevalence of hypertension in IgAN was 51.3% for males, 46.3% for females (Figure 2.4.4(a)).
- More than 3/4 of patients over the age of 65 years were hypertensive and 55.6% of those above the age of 35 years old were hypertensive (Figure 2.4.4(b)).

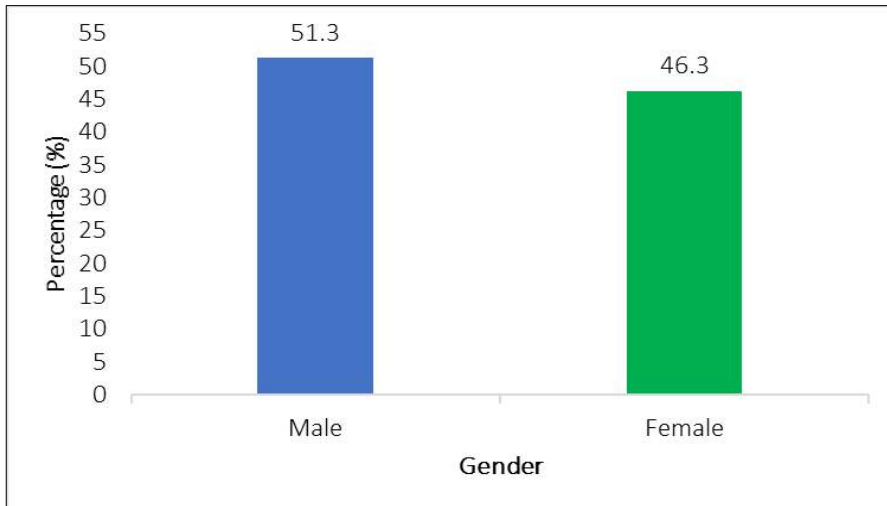


Figure 2.4.4 (a): Hypertension by gender for IgAN, 2005-2022

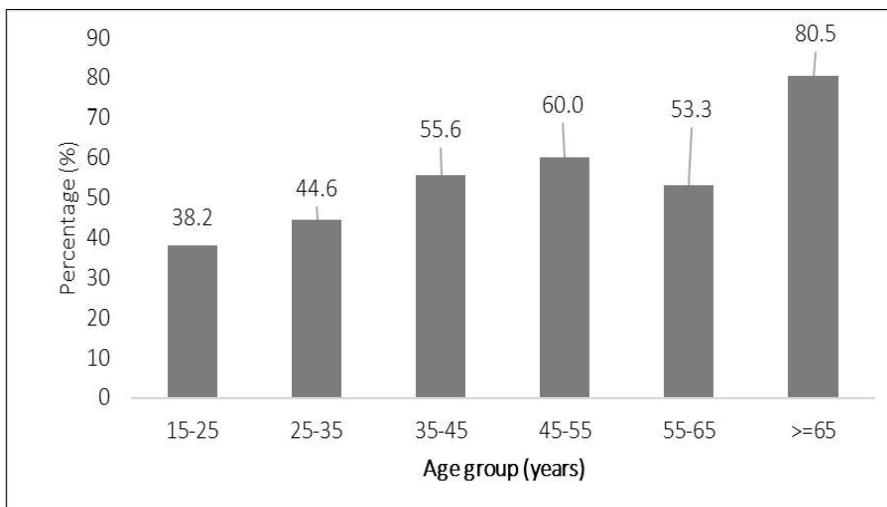


Figure 2.4.4 (b): Hypertension by age group for IgAN, 2005-2022

### 2.4.5 Renal function

- There were no differences in renal function based on gender (Figure 2.4.5(a)).
- Older patients (age ≥ 65 years old) had poorer renal function with 41.5% had eGFR of less than 30mls/min/1.73m<sup>2</sup> (Figure 2.4.5(b)). About half of those aged between 15-35 presented with eGFR >60mls/min/1.73m<sup>2</sup> (Figure 2.4.5(b)).

Table 2.4.5 (a): Renal function in IgAN, 2005-2022

eGFR (mls/min/1.73m <sup>2</sup> )	2005-2009 (n=319)		2010-2014 (n=629)		2015-2019 (n=786)		2020 (n=191)		2021 (n=151)		2022 (n=205)		Total (n=2281)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
< 15	31	9.7	70	11.1	54	6.9	14	7.3	11	7.3	14	6.8	194	8.5
15 to < 30	30	9.4	76	12.1	92	11.7	25	13.1	10	6.6	23	11.2	256	11.2
30 to < 60	85	26.6	140	22.3	193	24.6	38	19.9	44	29.1	46	22.4	546	23.9
60 to < 90	74	23.2	130	20.7	187	23.8	49	25.7	30	19.9	52	25.4	522	22.9
≥ 90	81	25.4	161	25.6	166	21.1	35	18.3	39	25.8	46	22.4	528	23.1
Not available	18	5.6	52	8.3	94	12.0	30	15.7	17	11.3	24	11.7	235	10.3

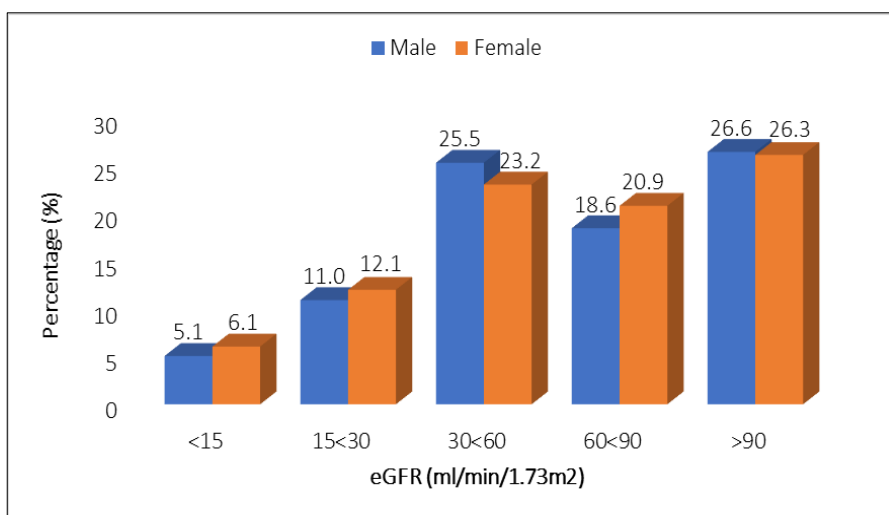


Figure 2.4.5 (a): Renal function by gender for IgAN, 2005-2022

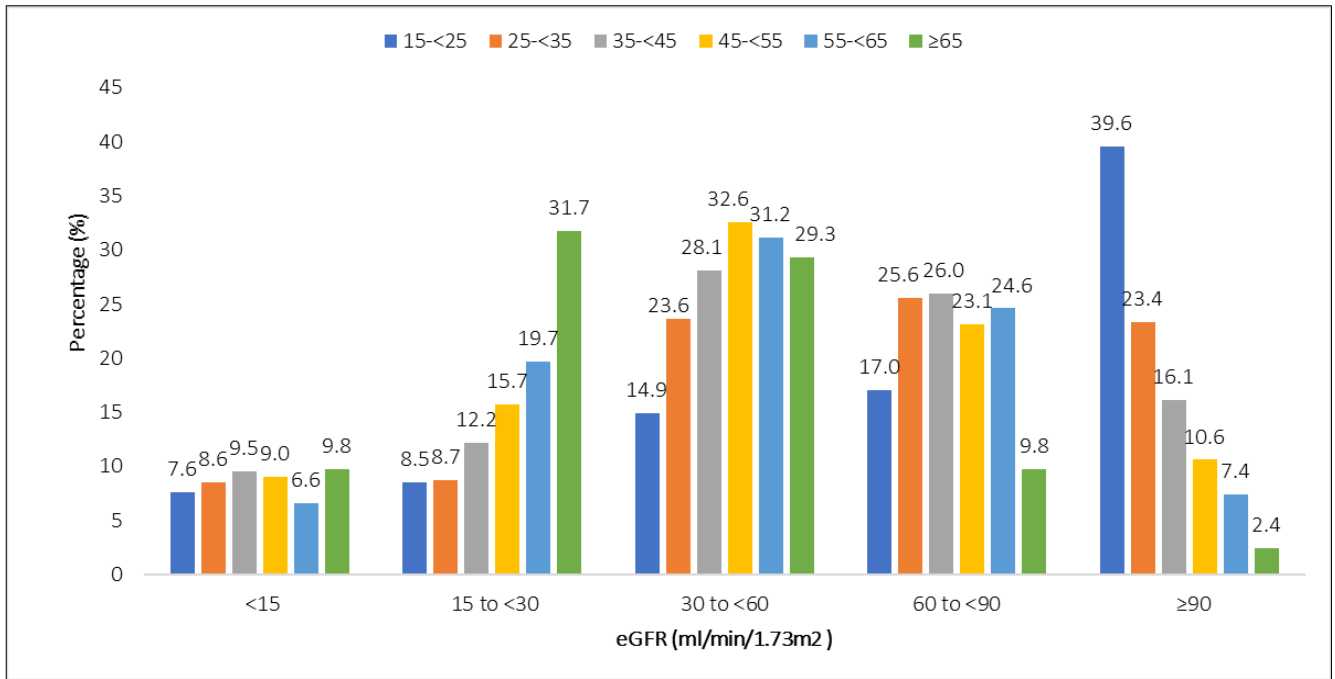


Figure 2.4.5 (b): Renal function at presentation by age group for IgAN, 2005-2022

**2.4.6 Outcome**

- Renal survival for IgAN at 5-years and 10-years were 75.1% and 63.9% respectively (Figure 2.4.6(a)).
- The rate of progression to ESKD within 20 years is reported to be about 30%. However, Malaysian data suggested a higher rate of progression over a shorter period indicating that patients with IgAN in Malaysia may have a different natural history and progression. This data may also be compounded by local practice of not biopsying those with minimal proteinuria. Therefore, those with good prognosis may have not been included in the registry.
- Patient survival at 5-years and 10- years were 95.2% and 93.9% respectively (Figure 2.4.6(b)).

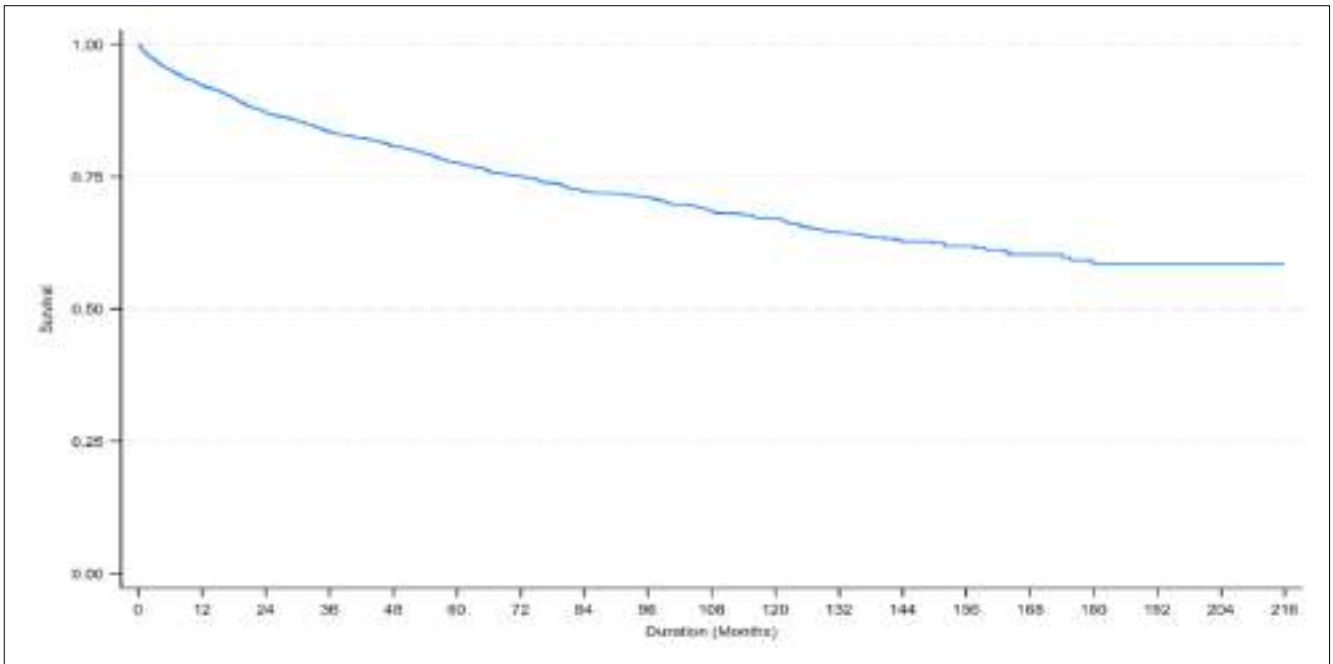


Figure 2.4.6 (a): Renal Survival estimates for IgAN 2005-2022

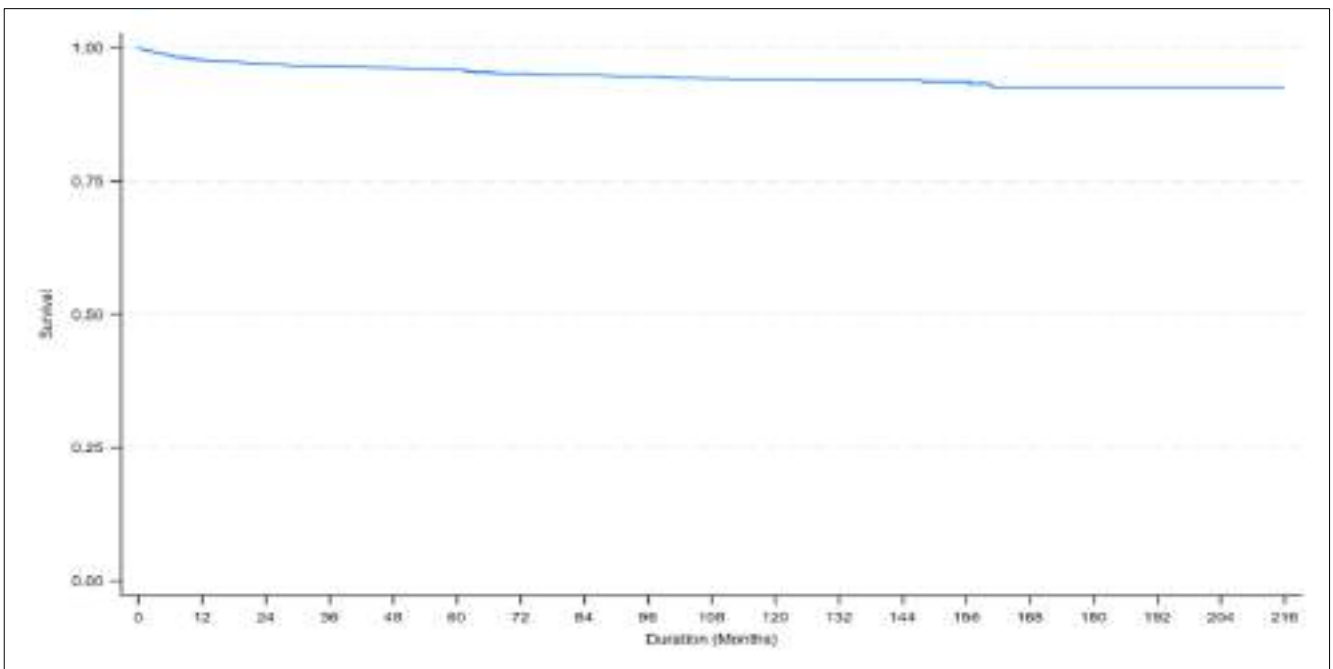


Figure 2.4.6 (b): Patient Survival estimates for death in IgAN, 2005-2022

## 2.5 Membranous Nephropathy (MN)

### 2.5.1 Introduction

- Membranous nephropathy is characterised by subepithelial immune deposits with spikes and thickening of the basement membrane. The absence of associated hypercellularity or glomerular inflammation confirms the diagnosis.
- Idiopathic Membranous Nephropathy was the fourth most commonly reported primary glomerulonephritis in Malaysia, contributing 10.7% of the total primary GN (Table 2.1).

### 2.5.2 Patient Population and Characteristics

- There were 953 reported cases of MN.
- There was a slight male preponderance in our cohort (53.3% vs 46.7%) (Figure 2.5.2(a)).
- There was a tendency towards more proportion of Chinese having membranous nephropathy as compared to the other glomerulonephritis. (Figure 2.5.2(a))
- Patients with MN were older with a mean age of  $47.2 \pm 15.57$  years at biopsy and majority of cases (57.6%) were more than 45 years old (Figure 2.5.2(b)).

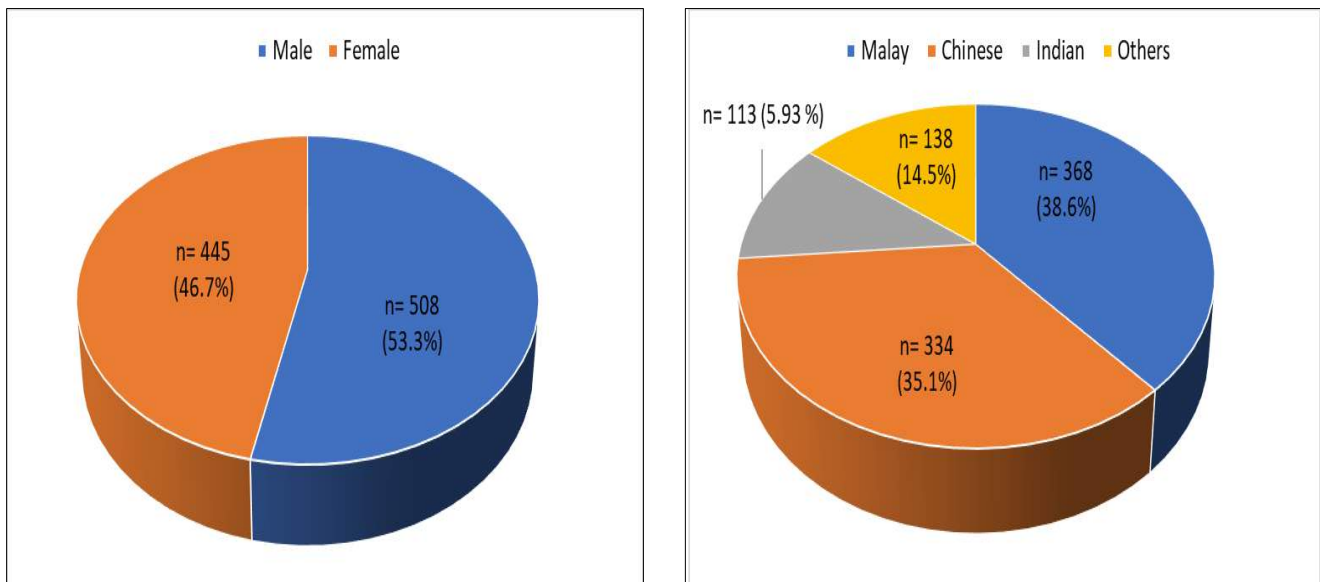


Figure 2.5.2 (a): Demographic characteristics for MN, 2005-2022

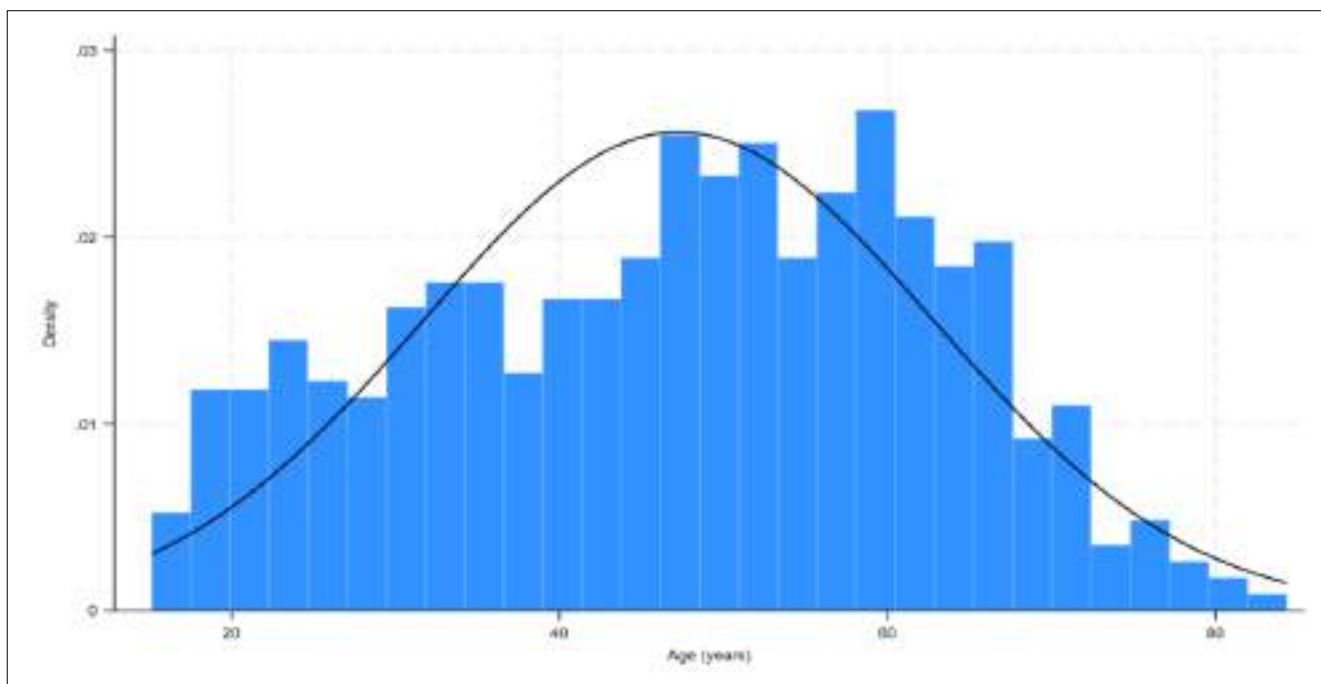


Figure 2.5.2 (b): Age at time of biopsy (year) MN, 2005-2022

### 2.5.3 Clinical presentation

- Nephrotic syndrome was the most common presentation of MN (Table 2.5.3(a)).
- In general, there were no differences in presentation with regards to gender (Figure 2.5.3(a)) and age group (Figure 2.5.3(b)) except that males seemed more likely to present with nephritic syndrome than females.

Table 2.5.3 (a): Clinical presentation for MN, 2005-2022

Clinical Presentation	2005-2009 (n=156)		2010-2014 (n=243)		2015-2019 (n=331)		2020 (n=87)		2021 (n=63)		2022 (n=73)		Total (n=953)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Nephrotic syndrome	101	64.7	147	60.5	169	51.1	41	47.1	39	61.9	40	54.8	537	56.3
Asymptomatic urine abnormalities	41	26.3	53	21.8	82	24.8	17	19.5	12	19.0	15	20.5	220	23.1
Nephritic-Nephrotic	5	3.2	15	6.2	33	10.0	14	16.1	5	7.9	8	11.0	80	8.4
Nephritic	3	1.9	3	1.2	20	6.0	5	5.7	3	4.8	5	6.8	39	4.1
Not available	6	3.8	25	10.3	27	8.2	10	11.5	4	6.3	5	6.8	77	8.1

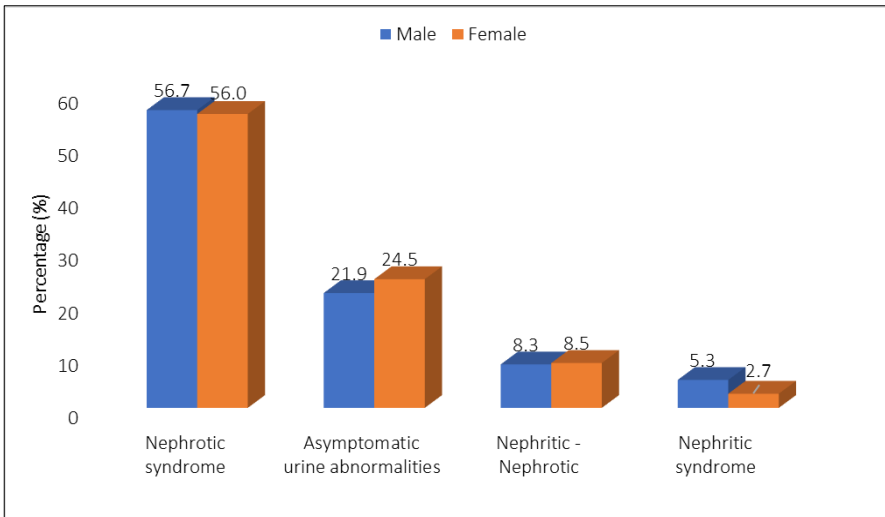


Figure 2.5.3 (a): Clinical presentation by gender for MN, 2005-2022

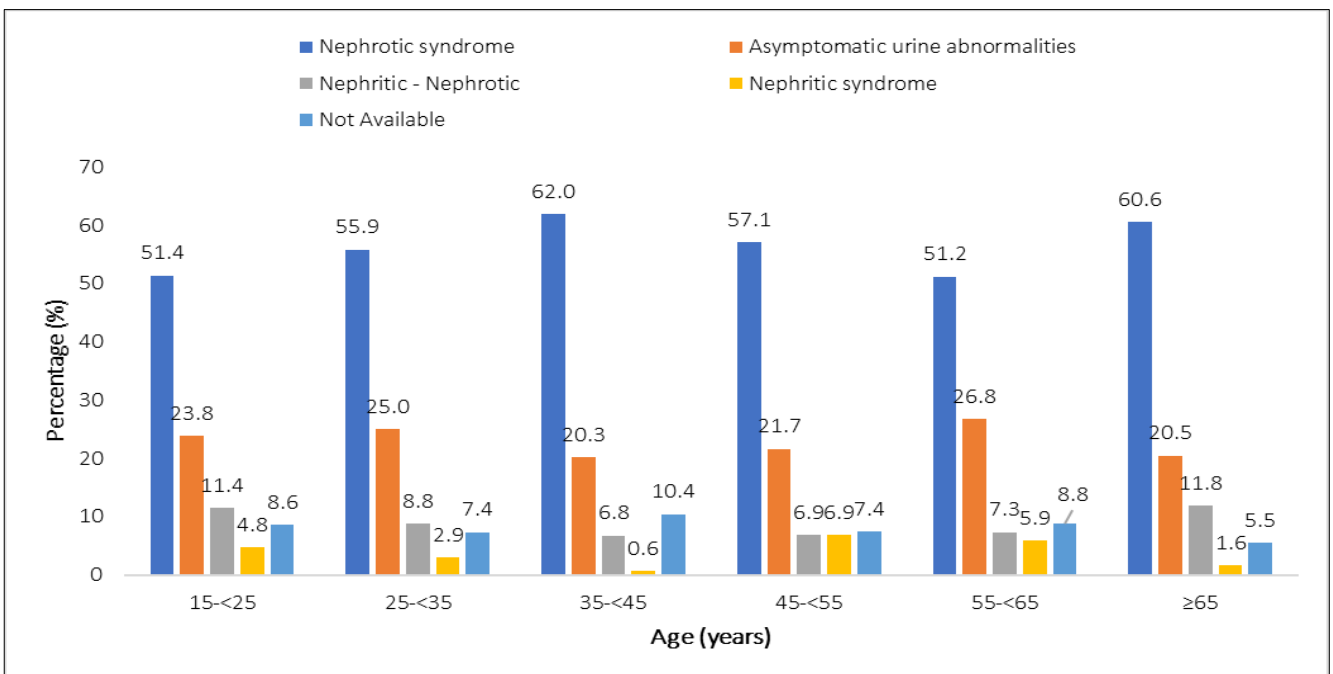


Figure 2.5.3 (b): Clinical presentation by age group for MN, 2005-2022

**2.5.4 Hypertension**

- There appeared to be an increasing trend of hypertension over the last decade with around half of the patients with MN (48.2%) were hypertensive at presentation.
- There was no difference in the prevalence of hypertension between the two genders (Male 50.4%, Female 45.8%) (Figure 2.5.4(a)).
- More than half patients over the age of 45 years had hypertension (Figure 2.4.5(b)).

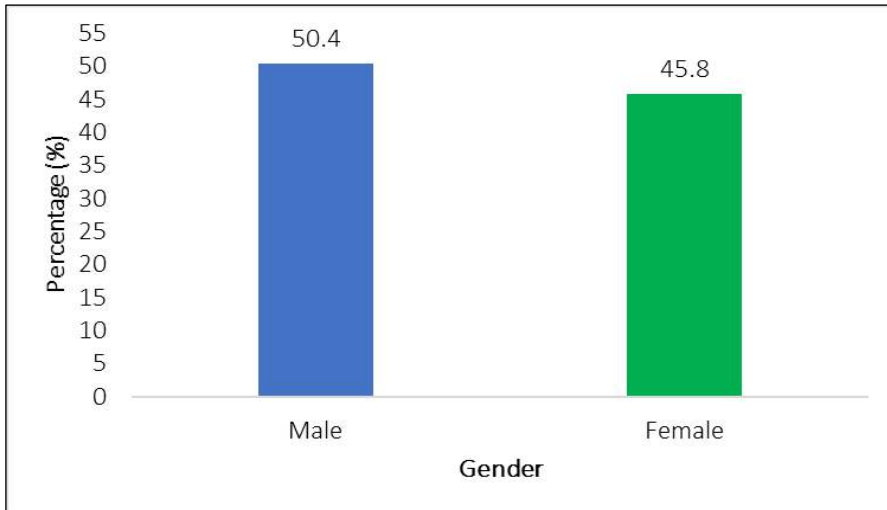


Figure 2.5.4 (a): Hypertension by gender for MN, 2005-2022

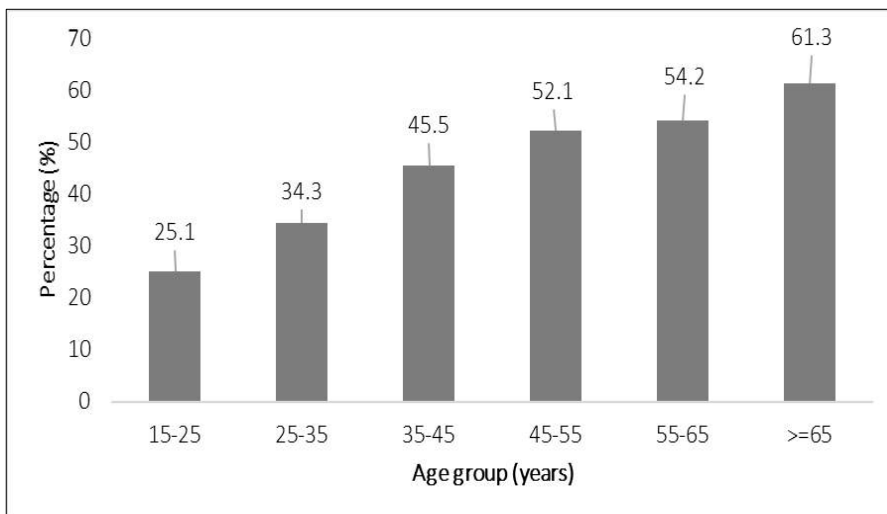


Figure 2.5.4 (b): Hypertension by age group for MN, 2005-2022

### 2.5.5 Renal function

- Majority of the patients with MN had preserved eGFR with 62.3% had eGFR > 60 mls/min/1.73m<sup>2</sup> at presentation (Table 2.5.5(a)).
- There were no differences in renal function by gender (Figure 2.5.5(a)).
- Older patients (age ≥ 65 years old) predominantly had eGFR of < 60 mls/min/1.73m<sup>2</sup>.

Table 2.5.5 (a): Renal function in MN, 2005-2022

eGFR (mls/min/1.73m <sup>2</sup> )	2005-2009 (n=156)		2010-2014 (n=243)		2015-2019 (n=331)		2020 (n=87)		2021 (n=63)		2022 (n=73)		Total (n=953)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
< 15	4	2.6	9	3.7	6	1.8	2	2.3	2	3.2	3	4.1	26	2.7
15 to < 30	10	6.4	15	6.2	30	9.1	5	5.7	7	11.1	1	1.4	68	7.1
30 to < 60	36	23.1	47	19.3	45	13.6	14	16.1	8	12.7	15	20.5	165	17.3
60 to < 90	48	30.8	50	20.6	82	24.8	27	31.0	17	27.0	19	26.0	243	25.5
≥ 90	47	30.1	92	37.9	131	39.6	32	36.8	25	39.7	24	32.9	351	36.8
Not available	11	7.1	30	12.3	37	11.2	7	8.0	4	6.3	11	15.1	100	10.5

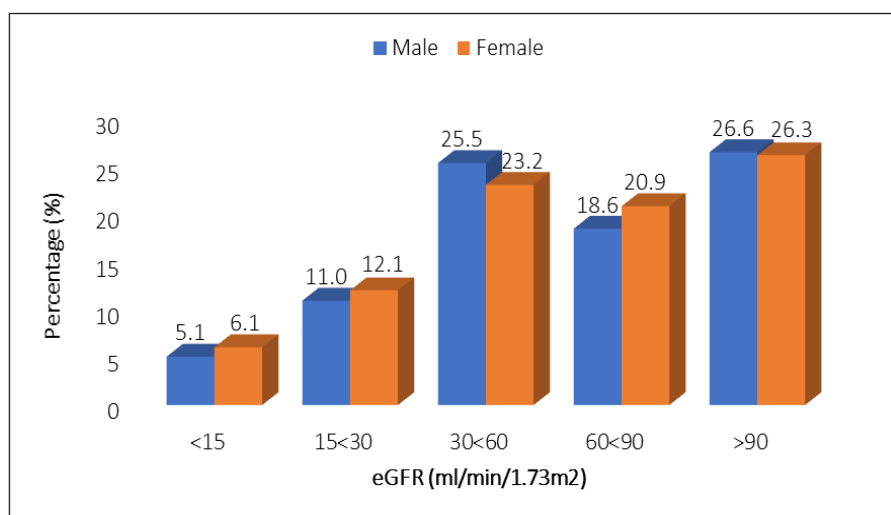


Figure 2.5.5 (a): Renal function by gender for MN, 2005-2022

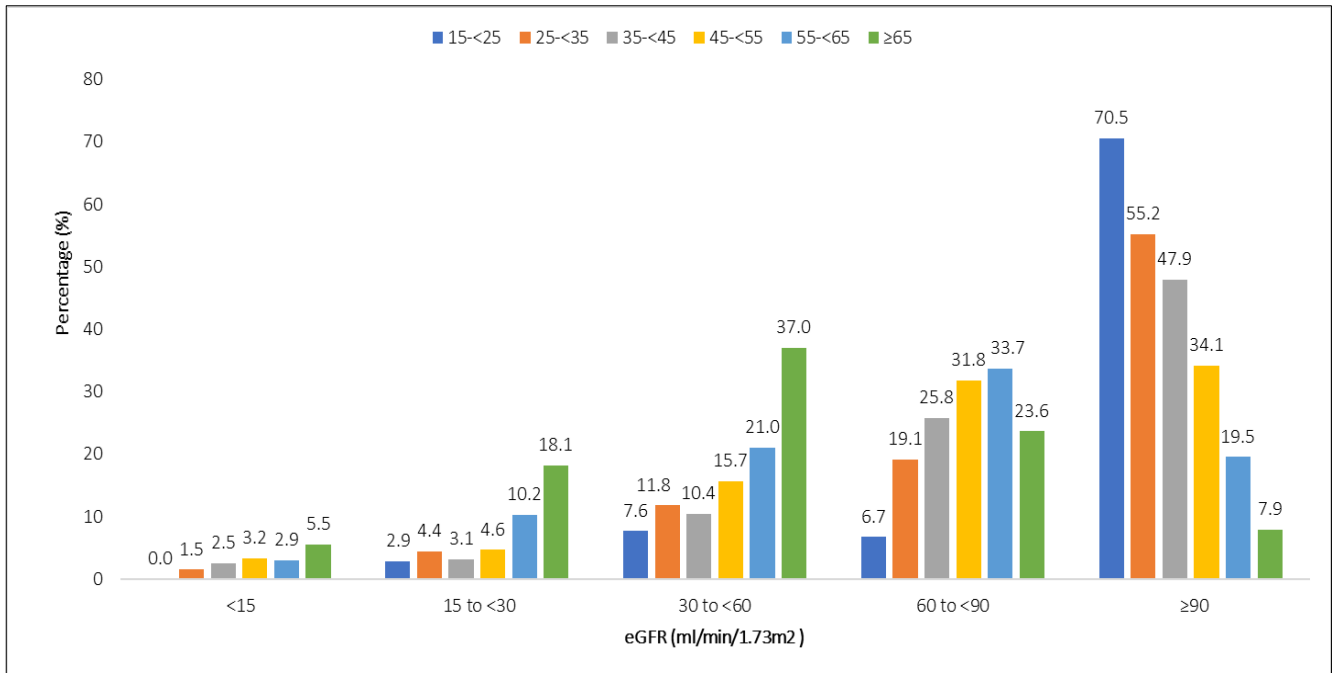


Figure 2.5.5 (b): Renal function at presentation by age group for MN, 2005-2022

**2.5.6 Outcome**

- The 5-year and 10-year renal survival for MN were 89.3% and 88.8% respectively (Figure 2.5.6a).
- Renal survival was good at 5 years in MN compared to FSGS or IgAN.
- However, the 5-year and 10-year patient survival were lower at 86.4% and 77.7% respectively (Figure 2.5.6(b)). This was probably contributed by the older age group of patients, presence of other comorbidities as well as treatment related toxicity.

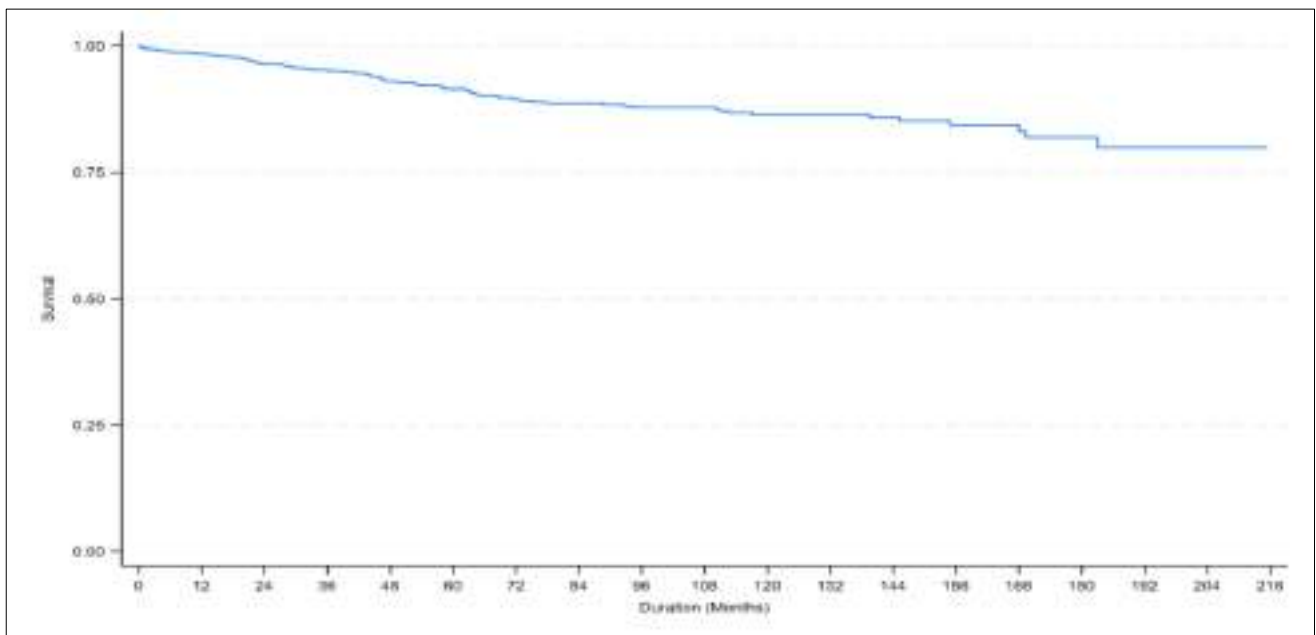


Figure 2.5.6 (a): Renal Survival estimates for MN 2005-2022

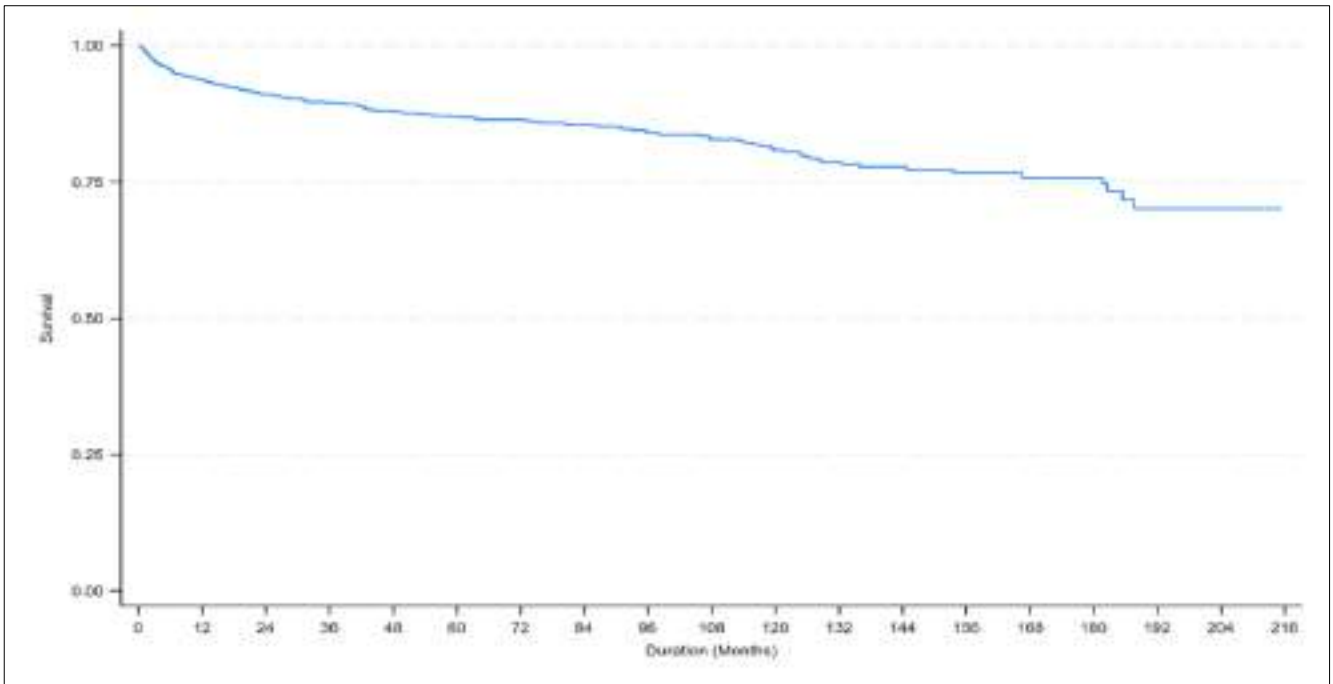


Figure 2.5.6 (b): Patient Survival estimates for death in MN, 2005-2022

# **CHAPTER 3**

# **SECONDARY GLOMERULONEPHRITIS**

**Thong Kah Mean  
Benjamin Tan Wei Wang  
Anim Md Shah**

### 3.1 Introduction

- This chapter reports the main secondary glomerular diseases in adults (defined as individuals above 15 years old) between 2005 and 2022.
- Lupus nephritis (LN) was the most common cause of biopsy proven secondary glomerular disease (78.7%) (Table 3.1). This could be attributed to routine practice of urinary screening followed by renal biopsy in systemic lupus erythematosus (SLE) patients with proteinuria with or without active urine sediments and positive lupus serology markers.
- Diabetic nephropathy was the second most frequent biopsy proven secondary glomerular diseases in Malaysia (15%) despite being the most common cause of end stage kidney disease (ESKD) in Malaysia and globally. This discrepancy could be due to variations in renal biopsy practices amongst patients with diabetic kidney disease. Nevertheless, the data showed an increasing trend in cases being reported, from 10.1% in the initial years of registry to 25.2% in 2022.
- Post infectious GN was the third most common cause (2.7%). The incidence appeared to be decreasing from 3.1 -3.2% in the year of 2010-2019 to 1.4% in 2022. This may reflect improved living conditions in Malaysia.
- Other causes of secondary glomerular disease were generally uncommon, and probably under-diagnosed due to limited availability of electron microscopy and special staining.

Table 3.1: Causes of secondary glomerulonephritis in adult, 2005-2022

Type of secondary GN	2005-2009 (n=1657)		2010-2014 (n=2797)		2015-2019 (n=3164)		2020 (n=686)		2021 (n=488)		2022 (n=644)		Total (n=9436)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Lupus Nephritis	1414	85.3	2221	79.4	2496	78.9	490	71.4	349	71.5	454	70.5	7424	78.7
Diabetic nephropathy	167	10.1	373	13.3	443	14.0	157	22.9	113	23.2	162	25.2	1415	15.0
Post Infectious GN	32	1.9	93	3.3	98	3.1	13	1.9	7	1.4	9	1.4	252	2.7
Amyloidosis	9	0.5	20	0.7	23	0.7	8	1.2	7	1.4	2	0.3	69	0.7
Other infection	8	0.5	19	0.7	16	0.5	4	0.6	0	0.0	3	0.5	50	0.5
Systemic vasculitis	4	0.2	14	0.5	9	0.3	0	0.0	1	0.2	2	0.3	30	0.3
Henoch-Schonlein Purpura	7	0.4	7	0.3	3	0.1	0	0.0	2	0.4	0	0.0	19	0.2
Multiple myeloma	8	0.5	4	0.1	7	0.2	1	0.1	0	0.0	2	0.3	22	0.2
Light / Heavy chain deposit disease	2	0.1	2	0.1	6	0.2	1	0.1	0	0.0	2	0.3	13	0.1
HUS / TTP	0	0.0	3	0.1	5	0.2	2	0.3	0	0.0	0	0.0	10	0.1
Malignancy	3	0.2	4	0.1	2	0.1	0	0.0	0	0.0	0	0.0	9	0.1
Anti GBM disease	0	0.0	3	0.1	8	0.3	3	0.4	2	0.4	1	0.2	17	0.2
Immunotactoid / fibrillary GN	0	0.0	1	0.0	2	0.1	1	0.1	0	0.0	1	0.2	5	0.1
Not Available	3	0.2	33	1.2	46	1.5	6	0.9	7	1.4	6	0.9	101	1.1

### 3.2 Lupus nephritis (LN)

#### 3.2.1 Introduction

- Lupus Nephritis was the commonest form of biopsy-proven secondary GN (78.7%) in adults (Table 3.1).
- From 2015 till 2022, LN was reported to account for 40.4% of all adult native renal biopsies in Malaysia.

#### 3.2.2 Patient population and characteristics

##### 3.2.2.1 Age at time of biopsy

- The mean age of diagnosis of LN patients was 31.4 years old ± 11.32 years with a median of 29.11 years old (Table 3.2.2.1).
- LN predominantly affected young SLE patients with majority (>80%) being 45 years old or younger (Figure 3.2.2.1).
- The most common age groups were 15-25 years old (29-39%) and 25-35 years old (32-35%). The age group distribution remained similar over the last 18-year observational period.

Table 3.2.2.1: Age group at time of biopsy (years), 2005-2022

Age group (years)	2005 (n=240)	2006 (n=275)	2007 (n=286)	2008 (n=312)	2009 (n=290)	2010 (n=311)	2011 (n=434)	2012 (n=437)	2013 (n=451)	2014 (n=478)
Mean	30.48	30.89	29.83	30.53	29.26	30.44	30.78	30.51	30.57	31.14
Standard deviation	10.59	10.32	10.18	11.03	9.71	10.96	10.98	11.46	10.17	10.61
Median	29.00	29.64	27.50	28.37	27.75	27.90	27.96	27.53	28.49	29.69

Age group (years)	2015 (n=459)	2016 (n=409)	2017 (n=463)	2018 (n=543)	2019 (n=495)	2020 (n=487)	2021 (n=349)	2022 (n=451)	Total (n=7170)
Mean	31.58	32.56	31.68	31.65	32.81	31.16	33.00	33.53	31.39
Standard deviation	12.06	12.07	11.36	11.00	12.00	11.76	12.56	12.05	11.32
Median	29.45	30.11	29.70	29.53	31.25	27.83	30.94	30.95	29.11

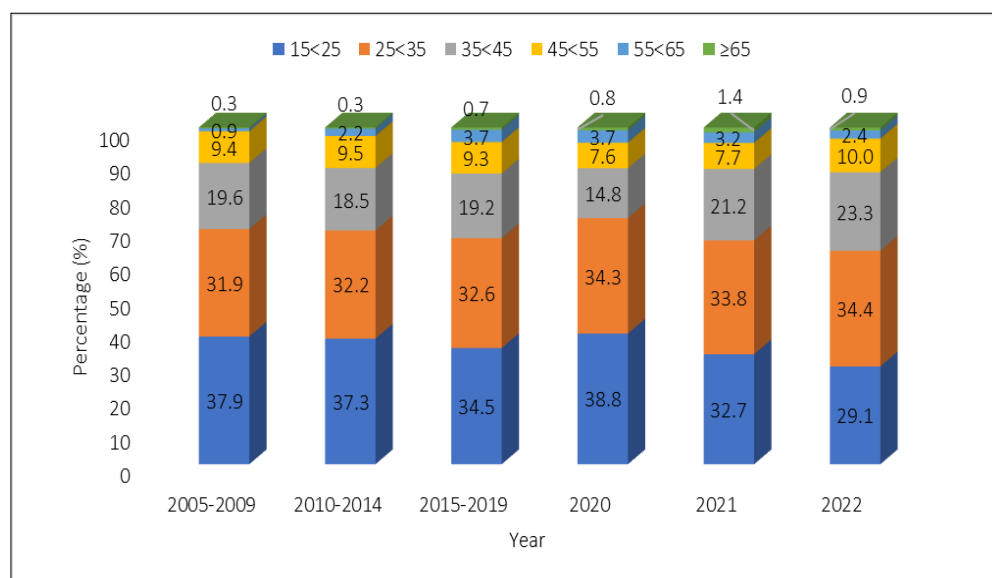


Figure 3.2.2.1: Age group at time of biopsy (years), 2005-2022

**3.2.2.2 Gender distribution**

- The majority of patients were females, accounting for nearly 90% of total patients with LN (Figure 3.2.2.2(a))
- The median age at time of renal biopsy were 27.6 and 29.1 years old in males and females respectively (Figure 3.2.2.2(b) and (c)).

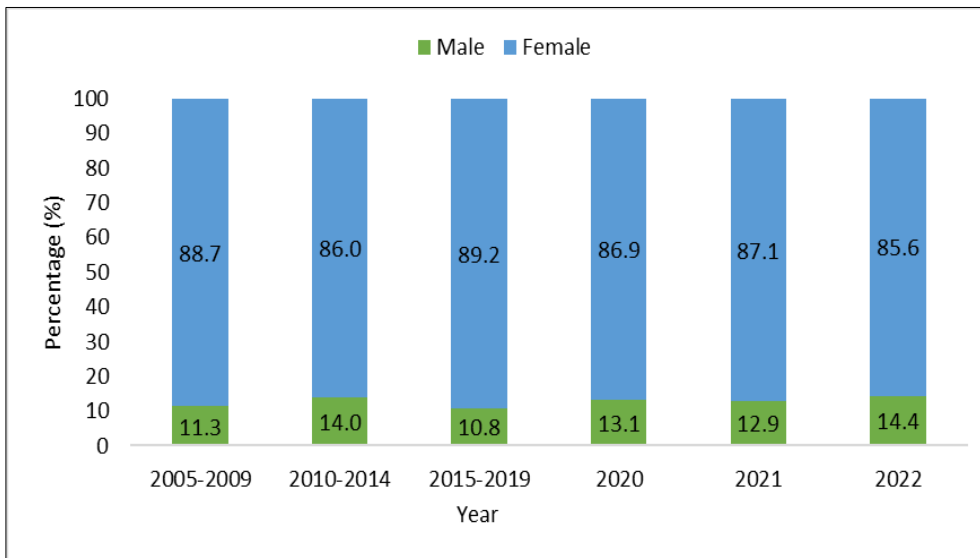


Figure 3.2.2.2 (a): Gender distribution, 2005-2022

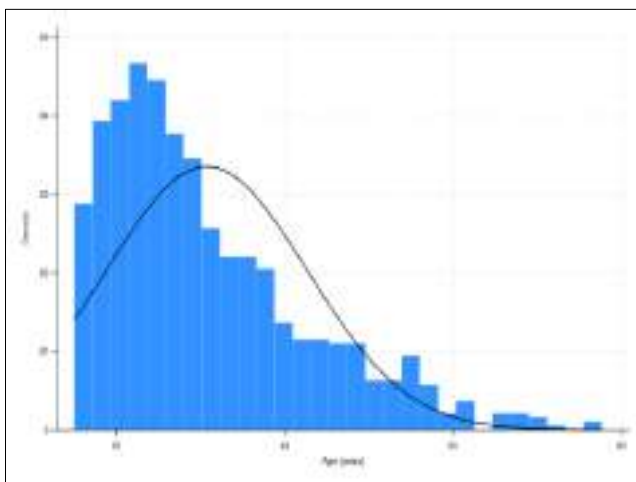


Figure 3.2.2.2 (b): Age distribution (Male), 2005-2022

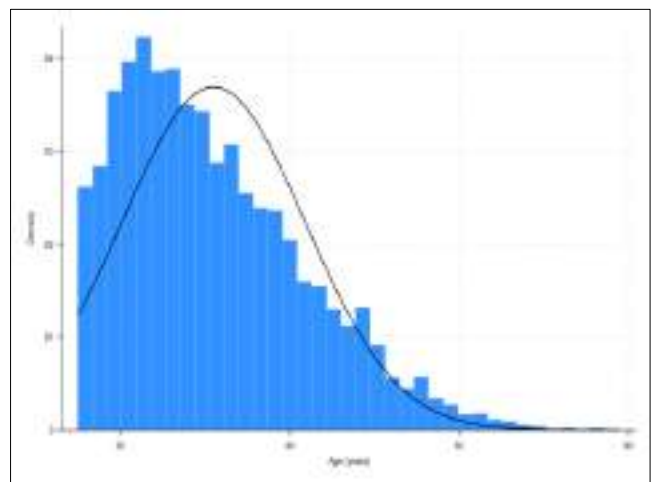


Figure 3.2.2.2 (c): Age distribution (Female), 2005-2022

3.2.2.3 Ethnic prevalence

- Malays formed the biggest proportion (56.8% to 75.4%) of LN patients, followed by Chinese and then other races (Figure 3.2.2.3).
- The proportion of Indians at 3.1 to 4.9%, which was less compared to the overall ethnic distribution in Malaysia, where the proportion of Indians is around 6.5%.
- It appears that there were less proportion of Chinese affected by LN in the more recent years. Whether, this is a true decrease in the incidence among Chinese population is uncertain. Other possible explanation is that Chinese tend to visit private healthcare facilities, whereas this registry predominantly captured data in public hospitals.

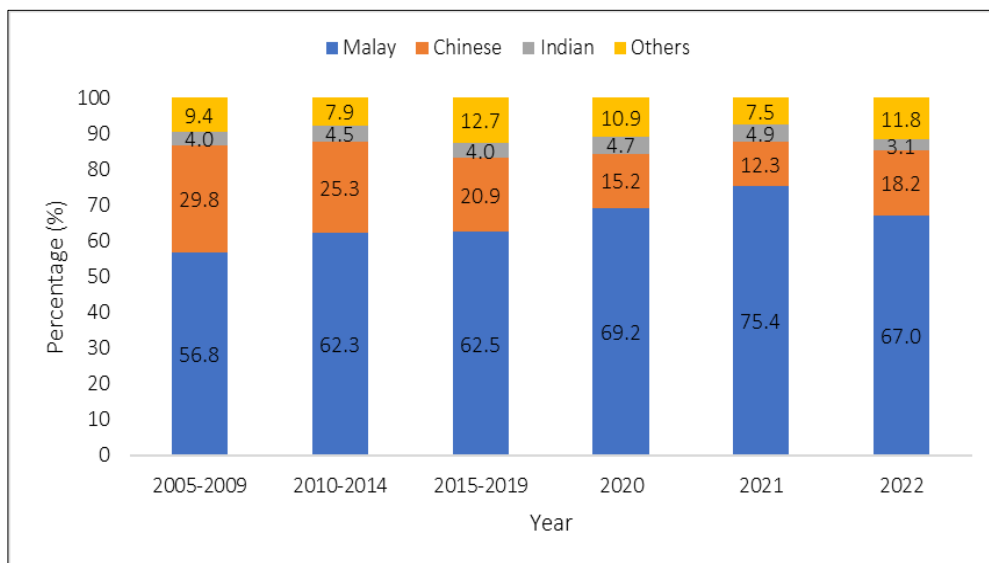


Figure 3.2.2.3: Ethnic distribution, 2005-2022

3.2.3: Clinical presentation

- The most common clinical presentation for LN was asymptomatic urinary abnormalities (where patients with extra-renal manifestations were screened for kidney involvement), followed by nephrotic syndrome and then nephrotic-nephritic syndrome (Figure 3.2.3).
- This trend was similarly observed among LN patients irrespective of age group or gender (Figure 3.2.3(a) and (b)).

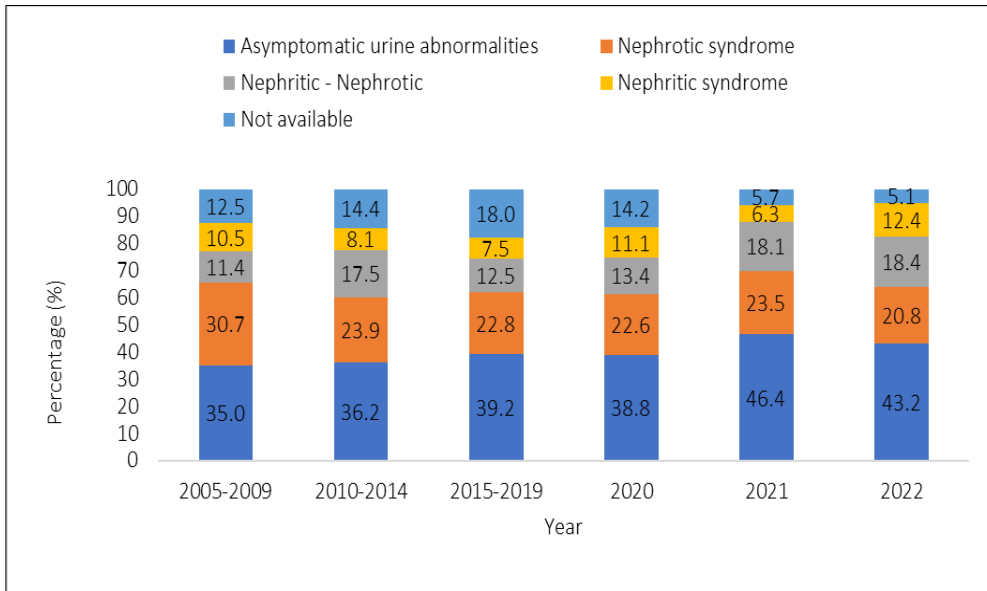


Figure 3.2.3: Clinical presentation by year, 2005-2022

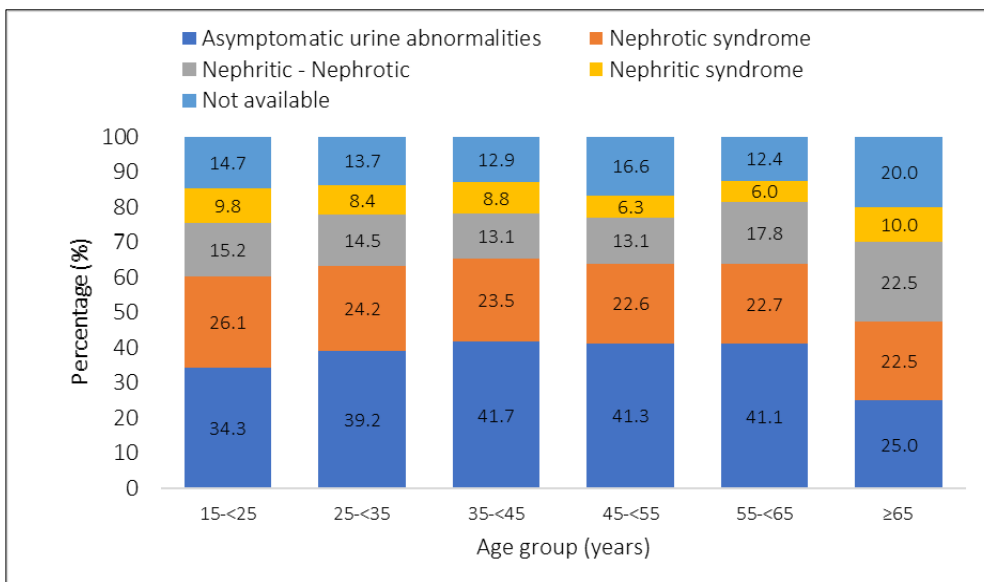


Figure 3.2.3 (1): Clinical presentation by age group, 2005-2022

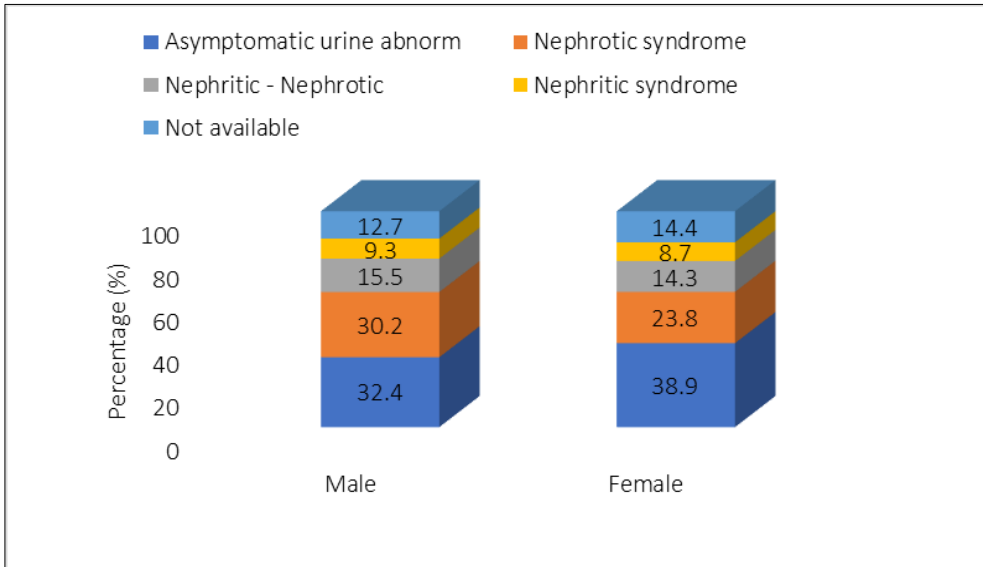


Figure 3.2.3 (2): Clinical presentation by gender, 2005-2022

**3.2.3.1 Hypertension**

- Hypertension was observed between 40-50% of patients with biopsy proven LN between 2010 to 2022 (Figure 3.2.3.1).
- It was more common in males and in those who were above 55 years old (Figure 3.2.3.1(a) and (b)).

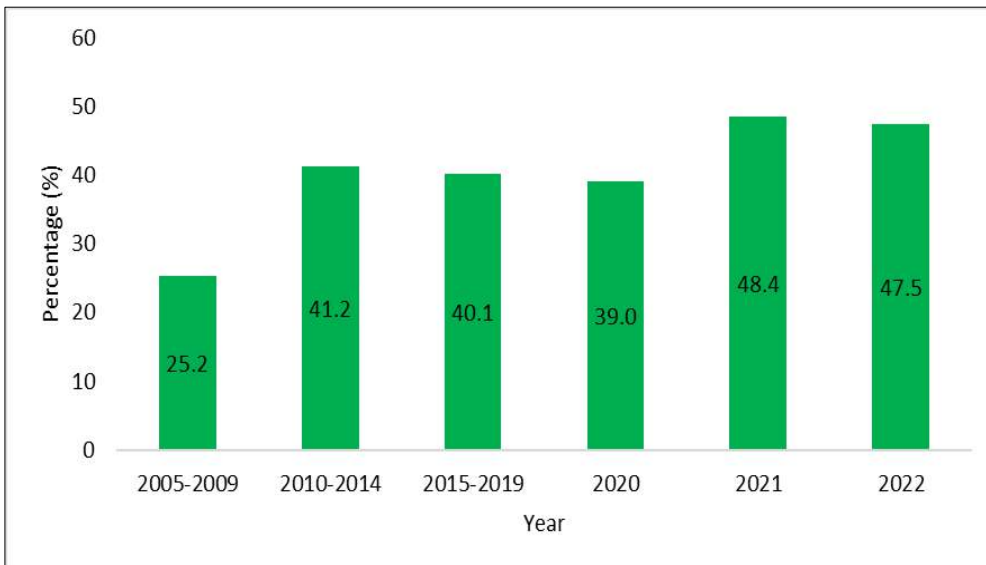


Figure 3.2.3.1: Hypertension by year, 2005-2022

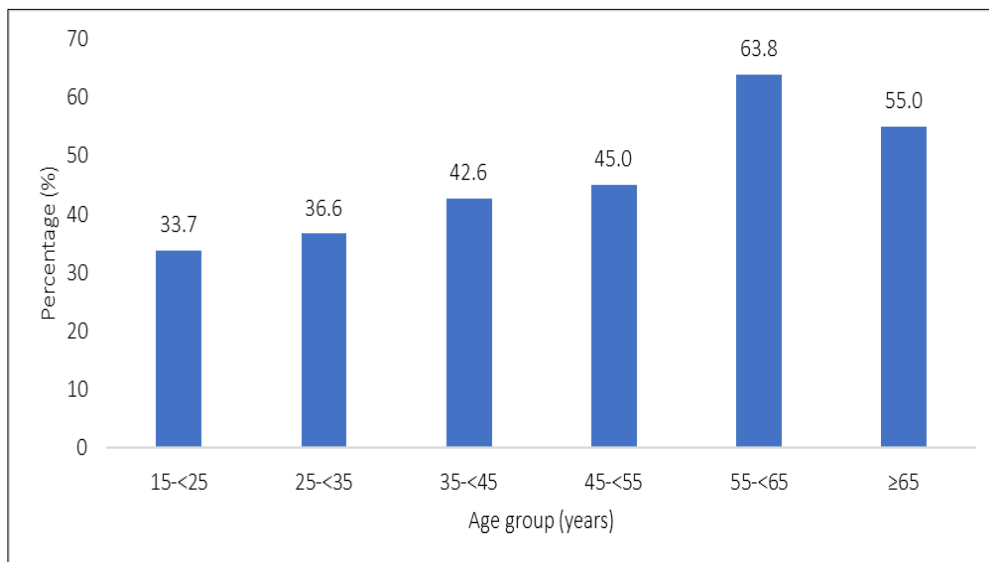


Figure 3.2.3.1 (a): Hypertension by age group, 2005-2022

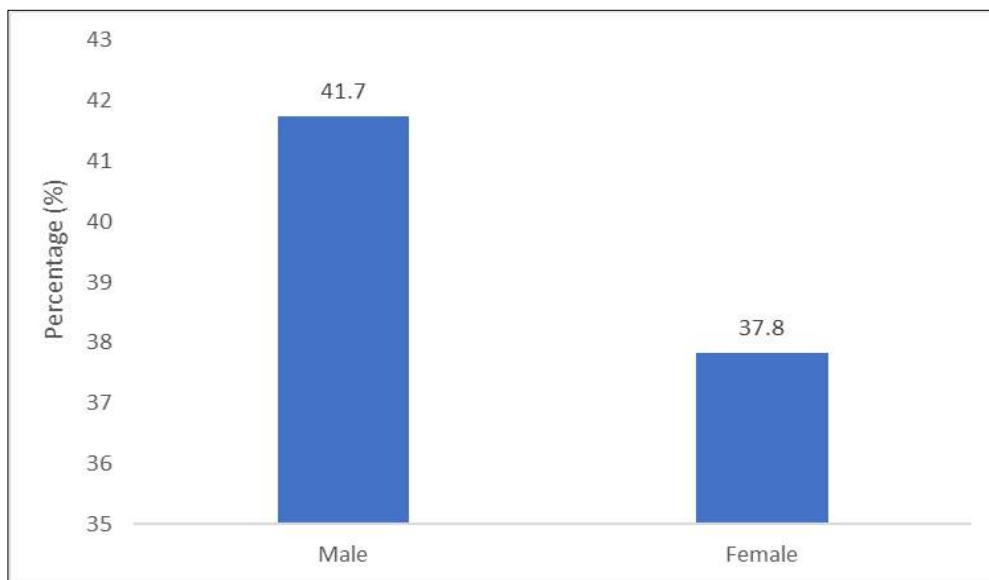


Figure 3.2.3.1 (b): Hypertension by gender, 2005-2022

**3.2.3.2 Renal function**

- A greater proportion of patients (38.5%) had an initial eGFR >90ml/min/1.73m<sup>2</sup> at presentation (Table 3.2.3.2).
- The percentage of lupus nephritis patients with impaired renal function increased with age (Table 3.2.3.2(a)).
- For patients 45-<65 years old, majority had eGFR 30 to 90 ml/min/1.73m<sup>2</sup> upon presentation; whereas for those aged ≥65, 70% of them had initial eGFR <60 ml/min/1.73m<sup>2</sup>.
- Renal function did not differ much between the two genders (Table 3.2.3.2(b)).

Table 3.2.3.2: Renal function by year, 2005-2022

eGFR (ml/min/1.73m <sup>2</sup> )	2005-2009 (n=1403)		2010-2014 (n=2111)		2015-2019 (n=2369)		2020 (n=487)		2021 (n=349)		2022 (n=451)		Total (n=7170)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
<15	78	5.6	98	4.6	92	3.9	13	2.7	16	4.6	34	7.5	331	4.6
15 to <30	119	8.5	149	7.1	161	6.8	37	7.6	20	5.7	31	6.9	517	7.2
30 to <60	281	20.0	345	16.3	353	14.9	80	16.4	67	19.2	70	15.5	1196	16.7
60 to <90	343	24.4	471	22.3	449	19.0	90	18.5	70	20.1	92	20.4	1515	21.1
≥90	474	33.8	779	36.9	986	41.6	197	40.5	131	37.5	190	42.1	2757	38.5
Not available	108	7.7	269	12.7	328	13.8	70	14.4	45	12.9	34	7.5	854	11.9

Table 3.2.3.2 (a): Renal function by age group, 2005-2022

eGFR (ml/min/1.73m <sup>2</sup> )	15-<25 (n=2570)		25-<35 (n=2340)		35-<45 (n=1372)		45-<55 (n=663)		55-<65 (n=185)		≥65 (n=40)		Total (n=7170)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
<15	105	4.1	97	4.1	70	5.1	43	6.5	12	6.5	4	10.0	331	4.6
15-29	135	5.3	167	7.1	126	9.2	61	9.2	16	8.6	12	30.0	517	7.2
30-59	307	11.9	371	15.9	288	21.0	167	25.2	51	27.6	12	30.0	1196	16.7
60-89	438	17.0	500	21.4	348	25.4	174	26.2	48	25.9	7	17.5	1515	21.1
≥90	1,230	47.9	950	40.6	390	28.4	151	22.8	33	17.8	3	7.5	2757	38.5
Not Available	355	13.8	255	10.9	150	10.9	67	10.1	25	13.5	2	5.0	854	11.9

Table 3.2.3.2 (b): Renal function by gender, 2005-2022

eGFR (ml/min/1.73m <sup>2</sup> )	Male (n=884)		Female (n=6286)		Total (n=7170)	
	n	%	n	%	n	%
<15	44	5.0	287	4.6	331	4.6
15-29	80	9.0	437	7.0	517	7.2
30-59	146	16.5	1,050	16.7	1196	16.7
60-89	178	20.1	1,337	21.3	1515	21.1
≥90	337	38.1	2,420	38.5	2757	38.5
Not Available	99	11.2	755	12.0	854	11.9

### 3.2.4 Histopathological diagnosis

- The most common histopathological finding was class III and IV, with or without a membranous component, consisting of almost 80% of all biopsy proven LN (Table 3.2.4).
- Class V, with or without class II, was the second most commonly observed histopathological finding, accounting for 10% of all LN cases.
- This trend was similar irrespective of age groups and gender (Table 3.2.4(a) and (b)).

Table 3.2.4: Histopathological diagnosis in lupus nephritis by year, 2005-2022

Histo-pathological diagnosis	2005-2009 (n=1403)		2010-2014 (n=2111)		2015-2019 (n=2369)		2020 (n=487)		2021 (n=349)		2022 (n=451)		Total (n=7170)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
I	9	0.6	19	0.9	20	0.8	4	0.8	1	0.3	1	0.2	54	0.8
II	121	8.6	127	6.0	117	4.9	27	5.5	15	4.3	26	5.8	433	6.0
III & III+V	290	20.7	538	25.5	749	31.6	150	30.8	107	30.7	145	32.2	1979	27.6
IV & IV+V	802	57.2	1126	53.3	1192	50.3	233	47.8	165	47.3	206	45.7	3724	51.9
V & II+V	144	10.3	230	10.9	229	9.7	59	12.1	43	12.3	60	13.3	765	10.7
VI	9	0.6	28	1.3	6	0.3	3	0.6	3	0.9	2	0.4	51	0.7
Others	9	0.6	2	0.1	3	0.1	0	0.0	0	0.0	0	0.0	14	0.2
Not available	19	1.4	41	1.9	53	2.2	11	2.3	15	4.3	11	2.4	150	2.1

Table 3.2.4 (a): Histopathological diagnosis by age group in lupus nephritis, 2005-2022

Histo-pathological diagnosis	15-<25 (n=2570)		25-<35 (n=2340)		35-<45 (n=1372)		45-<55 (n=663)		55-<65 (n=185)		≥65 (n=40)		Total (n=7170)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
I	27	1.1	12	0.5	8	0.6	4	0.6	2	1.1	1	2.5	54	0.8
II	158	6.1	136	5.8	88	6.4	42	6.3	9	4.9	0	0.0	433	6.0
III & III+V	643	25.0	680	29.1	388	28.3	196	29.6	59	31.9	13	32.5	1,979	27.6
IV & IV+V	1,463	56.9	1,198	51.2	673	49.1	288	43.4	84	45.4	18	45.0	3,724	51.9
V & II+V	209	8.1	253	10.8	173	12.6	106	16.0	19	10.3	5	12.5	765	10.7
VI	18	0.7	17	0.7	9	0.7	6	0.9	1	0.5	0	0.0	51	0.7
Others	5	0.2	3	0.1	2	0.1	3	0.5	1	0.5	0	0.0	14	0.2
Not available	47	1.8	41	1.8	31	2.3	18	2.7	10	5.4	3	7.5	150	2.1

Table 3.2.4 (b): Histopathological diagnosis by gender, 2005-2022

Histo-pathological diagnosis	Male (n=884)		Female (n=6286)		Total (n=7170)	
	n	%	n	%	n	%
I	6	0.7	48	0.8	54	0.8
II	49	5.5	384	6.1	433	6.0
III & III+V	249	28.2	1,730	27.5	1,979	27.6
IV & IV+V	448	50.7	3,276	52.1	3,724	51.9
V & II+V	107	12.1	658	10.5	765	10.7
VI	6	0.7	45	0.7	51	0.7
Others	1	0.1	13	0.2	14	0.2
Not available	18	2.0	132	2.1	150	2.1

**3.2.4.1: Clinical Presentation by histopathology**

- Across all LN classes, the most common clinical presentation was asymptomatic urinary abnormalities, followed by nephritic syndrome and then nephritic-nephrotic syndrome (Figure 3.2.4.1).
- Interestingly, nephrotic syndrome was an uncommon presentation in patients with class V LN, with or without class II, possibly indicating a less severe pathology or diagnosis at an early stage.
- Hypertension was a feature in 35-43% of patients with class III/ IV LN, with or without class V (Figure 3.2.4.1(a)).
- About 53% of patients with class VI LN were hypertensive upon diagnosis (Figure 3.2.4.1(a)).
- The prevalence of impaired renal function also correlated with histopathological findings. Impaired eGFR (<60ml/min/1.73m<sup>2</sup>) occurred most frequently in Class VI LN (55.0%), followed by class IV/ IV+V (39.1%) and Class III/III+V (16.6%) (Figure 3.2.4.1(b)).

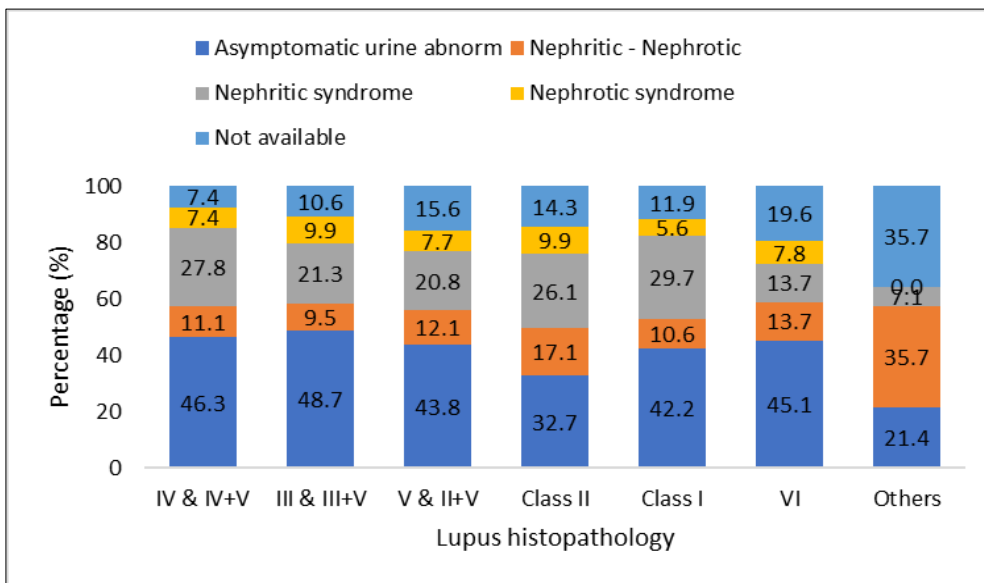


Figure 3.2.4.1: Clinical presentation by histopathology in lupus nephritis, 2005-2022

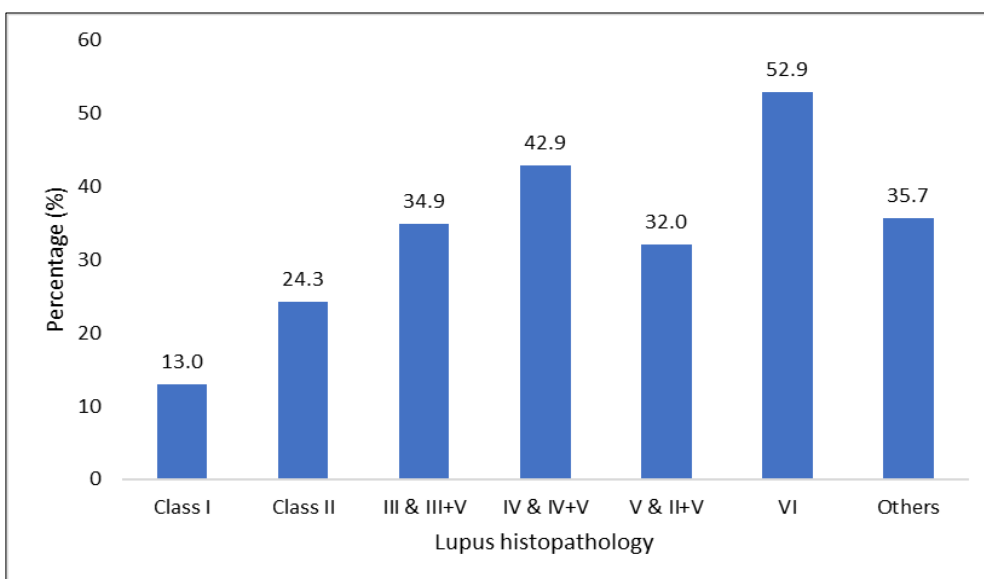


Figure 3.2.4.1 (a): Hypertension by histopathology in lupus nephritis, 2005-2022

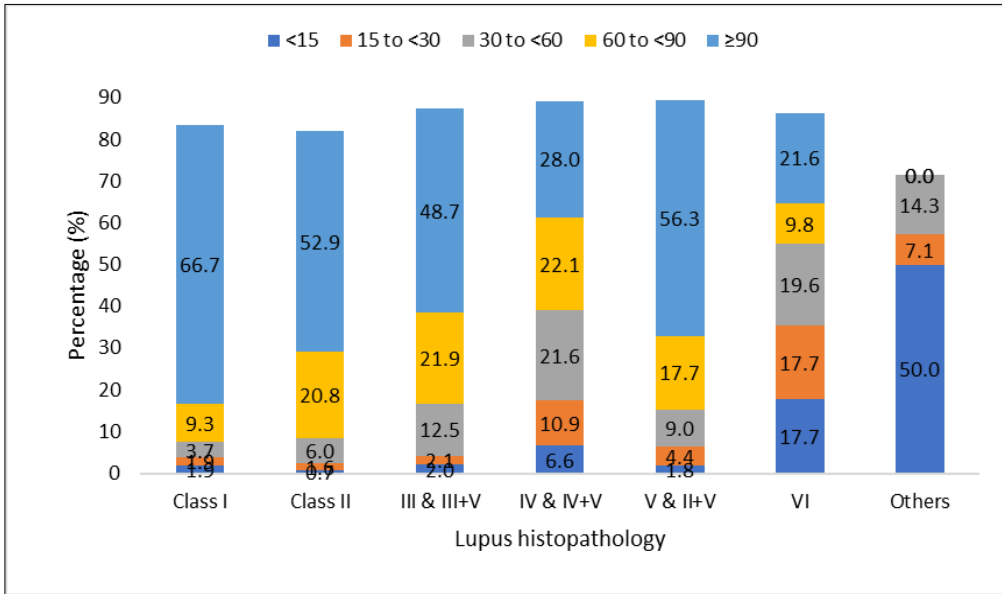


Figure 3.2.4.1 (b): Renal function by histopathology, 2005-2022

### 3.2.5 Survival in lupus nephritis

- Patient survival rates were at 92% at 1 year, 85% at 5 years and 80% at 10 years (Figure 3.2.5(a)).
- Death-censored renal survival rates were 92% at 1 year, 87% at 5 years and 80% at 10 years (Figure 3.2.5(b)).
- Our result was much lower than the reported data from Hong Kong, in which patient survival rates were 98.6% and 98.2%, at 5 and 10 years respectively. And the renal survival rates were 99.5% and 98%, at 5 and 10 years respectively (Reference 1).
- Another cohort at China reported an overall patient survival rates at 88% and 77%, at 5 and 10 years respectively (Reference 2).

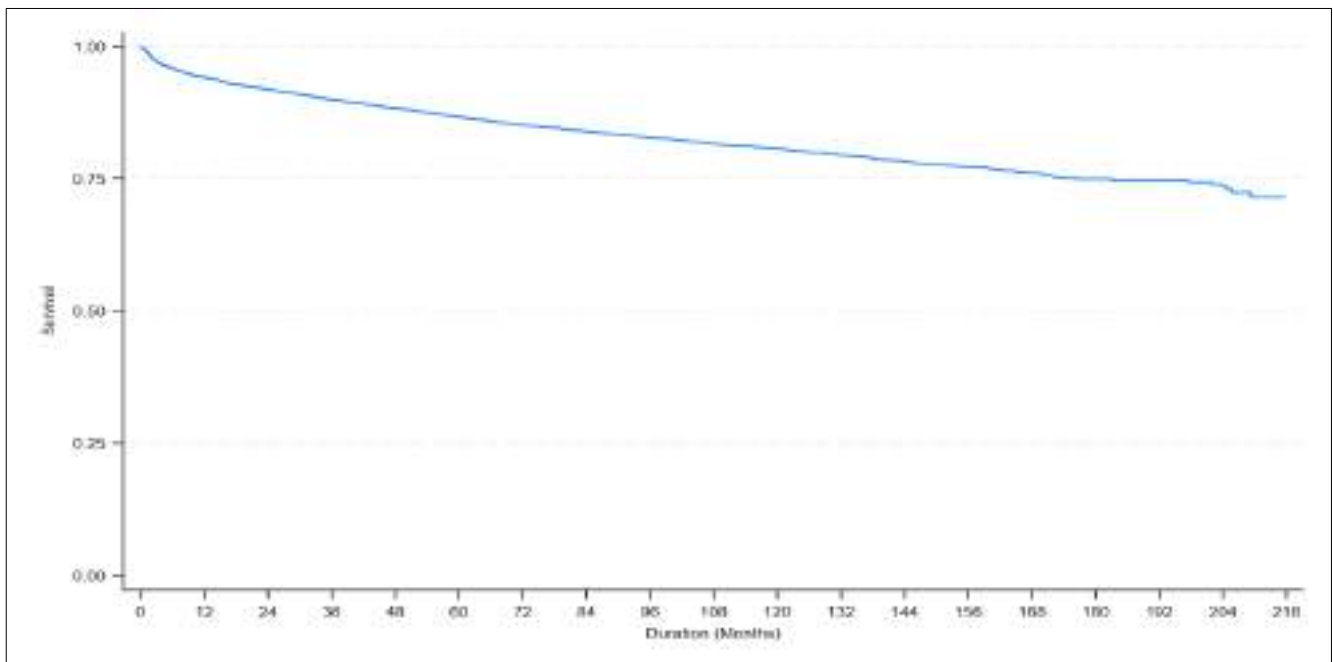


Figure 3.2.5 (a): Patients Survival estimates for death in lupus nephritis, 2005-2022

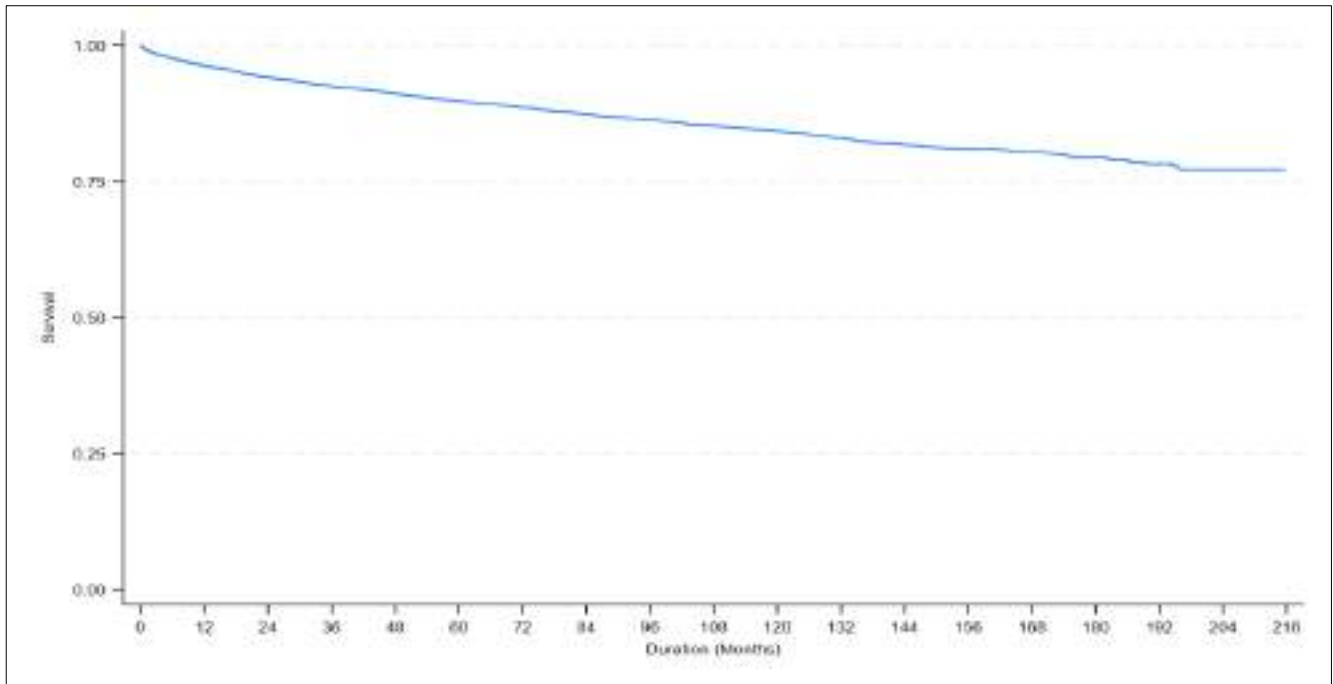


Figure 3.2.5 (b): Death-censored Renal Survival estimates for lupus nephritis, 2005-2022

**Reference:**

1. Yap DYH, Tang CSO, Ma MKM, et al. Survival analysis and causes of mortality in patients with lupus nephritis. *Nephrology Dialysis Transplantation* 2012; 27: 3248–3254.
2. Zheng Z, Zhang L, Liu W, et al. Predictors of survival in Chinese patients with lupus nephritis. *Lupus*. 2012;21(10):1049-1056.



# **CHAPTER 4**

# **PAEDIATRIC RENAL BIOPSIES**

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**Caroline Eng Siew Yin**

### 4.1 Introduction

- Chapter 4 reports on renal biopsies done in children and young people less than 15 years of age over a span of 18 years. Yearly data is available from 2020 to 2022.
- A total of 2491 renal biopsies were performed in 2463 children.
- The majority of renal biopsies were performed in the Ministry of Health hospital (96.6%).
- The average number of renal biopsies yearly was 110-140 (Table and Figure 4.1.1).
- It was the first episode of renal biopsy in 89.9% of patients (Table 4.1.2).
- Eighty-percent of the biopsies yielded 10 or more glomeruli; the minimum number deemed adequate for histopathological diagnosis (Table 4.1.3).

Table 4.1.1: Number of patients from various hospitals, 2005-2022

Hospitals	2005-2009 (n=701)		2010-2014 (n=769)		2015-2019 (n=654)		2020 (n=112)		2021 (n=113)		2022 (n=114)		Total (n=2463)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Hospital Kuala Lumpur	173	24.7	160	20.8	145	22.2	32	28.6	20	17.7	16	14.0	546	22.2
Other MOH Hospitals	511	72.9	567	73.7	492	75.2	77	68.8	91	80.5	94	82.5	1832	74.4
Non MOH* Hospitals	17	2.4	42	5.5	17	2.6	3	2.7	2	1.8	4	3.5	85	3.5

\* University Hospital, Army Hospital, Private Hospital

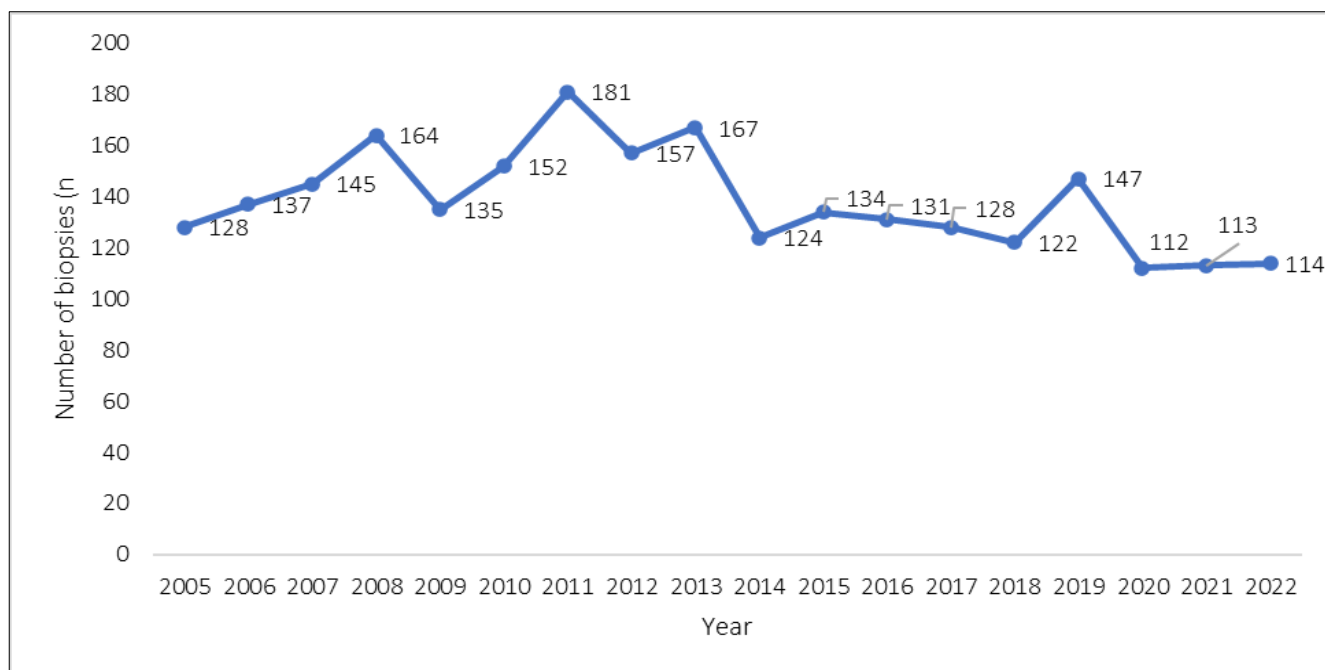


Figure 4.1.1: Number of renal biopsies, 2005-2022

Table 4.1.2: Distribution of native renal biopsy in patients by number of attempts, 2005-2022

Number of biopsy(s)	2005-2009 (n=701)		2010-2014 (n=769)		2015-2019 (n=654)		2020 (n=112)		2021 (n=113)		2022 (n=114)		Total (n=2463)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
1st episode	605	86.3	694	90.2	595	91.3	104	95.4	107	94.7	104	91.2	2214	89.9
2nd episode	74	10.6	64	8.3	53	8.1	5	4.6	6	5.3	9	7.9	211	8.6
3rd episode	20	2.9	9	1.2	1	0.2	0	0.0	0	0	1	0.9	31	1.3
4th episode	2	0.3	2	0.3	3	0.5	0	0	0	0	0	0	7	0.3

Table 4.1.3: Number of glomeruli obtained at each biopsy, 2005-2022

Number of glomeruli	2005-2009 (n=705)		2010-2014 (n=770)		2015-2019 (n=638)		2020 (n=109)		2021 (n=109)		2022 (n=105)		Total (n=2436)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
< 10	146	20.7	168	21.8	119	18.7	9	8.3	16	14.7	22	21.0	480	19.7
≥ 10	559	79.3	602	78.2	519	81.3	100	91.7	93	85.3	83	79.0	1956	80.3

\* 55 cases with missing number of glomeruli

## 4.2 Patient demographics

- There was an equal male to female ratio.
- The ethnic distribution was Malay 66.1%, Chinese 15.9%, Indian 5.5% and others 12.5%. This pattern followed the demographic composition of the country.
- The mean age at biopsy was 9.91 years.

Table 4.2.1: Gender and racial distribution, 2005-2022

	2005-2009 (n=709)		2010-2014 (n=781)		2015-2019 (n=662)		2020 (n=112)		2021 (n=113)		2022 (n=114)		Total (n=2491)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
<b>Gender</b>														
Male	347	48.9	380	48.7	350	52.9	63	56.3	60	53.1	54	47.4	1254	50.3
Female	362	51.1	401	51.3	312	47.1	49	43.8	53	46.9	60	52.6	1237	49.7
<b>Race</b>														
Malay	426	60.1	527	67.5	451	68.1	76	67.9	84	74.3	83	72.8	1647	66.1
Chinese	145	20.5	120	15.4	94	14.2	19	17.0	8	7.1	9	7.9	395	15.9
Indian	58	8.2	34	4.4	25	3.8	6	5.4	10	8.8	4	3.5	137	5.5
Others*	80	11.3	100	12.8	92	13.9	11	9.8	11	9.7	18	15.8	312	12.5

Table 4.2.2: Age distribution, 2005-2022

Year	2005 (n=128)	2006 (n=137)	2007 (n=145)	2008 (n=164)	2009 (n=135)	2010 (n=152)	2011 (n=181)	2012 (=157)	2013 (n=167)	2014 (n=124)
Mean	9.21	10.35	9.83	9.95	9.86	9.71	9.64	9.70	9.91	9.34
SD	4.32	3.57	3.61	3.74	3.99	3.94	4.33	4.26	3.83	4.13
Median	10.49	11.41	10.73	10.53	10.90	10.65	11.03	10.87	10.74	10.27
Minimum	0.59	1.06	2.41	0.25	0.53	0.86	0.23	0.13	0.10	0.37
Maximum	14.89	14.95	14.90	14.94	14.95	14.85	14.98	14.97	14.99	14.95

Year	2015 (n=134)	2016 (n=131)	2017 (n=128)	2018 (n=122)	2019 (=147)	2020 (n=112)	2021 (n=113)	2022 (n=114)	Total (n=2491)
Mean	100	10.16	101	9.76	10.14	10.42	9.94	10.70	9.91
SD	4.04	4.09	3.69	3.94	3.84	3.97	4.13	3.77	3.97
Median	11.09	11.50	11.32	10.58	10.77	11.62	11.47	12.03	10.97
Minimum	1.65	1.36	1.95	0.96	0.68	1.90	1.38	1.78	0.10
Maximum	14.99	14.97	14.89	14.95	14.98	14.98	14.98	14.98	14.99

### 4.3 Clinical presentation

- The most frequent clinical presentation at biopsy was nephrotic syndrome (51.0%), followed by asymptomatic urine abnormalities (18.5%), mixed nephrotic-nephritic syndrome (12.7%) and nephritic syndrome (11.4%) (Table 4.3.1).
- About two-thirds (65.8%) of patients had normal renal function at the time of biopsy and one third (28.5%) had impaired renal function (Table 4.3.2).
- Hypertension was found in 36.6% of patients and the commonly used antihypertensive drugs were calcium channel blocker (56%) and ACEI / ARB (47.3%) (Table 4.3.3 (a) and (b)).

Table 4.3.1: Clinical presentation at biopsy, 2005-2022

Clinical Presentation	2005-2009 (n=709)		2010-2014 (n=781)		2015-2019 (n=662)		2020 (n=112)		2021 (n=113)		2022 (n=114)		Total (n=2491)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Nephrotic syndrome	375	52.9	367	47.0	330	49.8	67	59.8	66	58.4	66	57.9	1271	51.0
Asymptomatic urine abnormalities	120	16.9	156	20	133	20.1	20	17.9	21	18.6	12	10.5	462	18.5
Nephritic - Nephrotic	67	9.4	123	15.7	94	14.2	9	8.0	9	8.0	15	13.2	317	12.7
Nephritic syndrome	90	12.7	91	11.7	63	9.5	11	9.8	12	10.6	16	14.0	283	11.4
Not Available	57	80.4	44	56.3	42	6.3	5	4.5	5	4.4	5	4.4	158	6.3

Table 4.3.2: Renal function at biopsy, 2005-2022

Renal function	2005-2009 (n=709)		2010-2014 (n=781)		2015-2019 (n=662)		2020 (n=112)		2021 (n=113)		2022 (n=114)		Total (n=2491)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Impaired	209	29.5	239	30.6	169	25.5	24	21.4	30	26.5	40	35.1	711	28.5
Normal	453	63.9	497	63.6	455	68.7	85	75.9	79	69.9	70	61.4	1639	65.8
Not Available	47	6.6	45	5.8	38	5.7	3	2.7	4	3.5	4	3.5	141	5.7

Table 4.3.3 (a): Hypertension at biopsy, 2005-2022

Hypertension	2005-2009 (n=709)		2010-2014 (n=781)		2015-2019 (n=662)		2020 (n=112)		2021 (n=113)		2022 (n=114)		Total (n=2491)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Yes	217	30.6	346	44.3	250	37.8	29	25.9	56	43.8	33	28.9	912	36.6
No	467	65.9	388	49.7	356	53.8	70	62.5	63	49.2	75	65.8	1424	57.2
Not Available	25	3.5	47	6.0	56	8.5	13	11.6	9	7.0	6	5.3	155	6.2

Table 4.3.3 (b): Type of antihypertensive drugs, 2005-2022

Type of antihypertensives	2005-2009 (n=217)		2010-2014 (n=346)		2015-2019 (n=250)		2020 (n=29)		2021 (n=56)		2022 (n=33)		Total (n=841)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Calcium Channel Blocker	115	53.0	183	52.9	163	65.2	16	55.2	18	48.6	16	48.5	511	56.0
ACEI	61	28.1	177	51.2	112	44.8	15	51.7	22	59.5	16	48.5	403	44.2
B Blocker	33	15.2	61	17.6	30	12.0	4	13.8	2	5.4	4	12.1	110	12.1
Alpha Blocker	32	14.7	30	8.7	18	7.2	3	10.3	7	18.9	5	15.2	95	10.4
ARB	7	3.2	12	3.5	7	2.8	0	0	0	0	2	6.1	28	3.1
Others	18	8.3	41	11.8	17	6.8	4	13.8	6	16.2	5	15.2	91	10
No drug available	70	32.3	16	4.6	13	5.2	0	0	1	2.7	0	0	100	11.0

\*Patients may have more than one antihypertensives drug

#### 4.4 Diagnosis of paediatric renal biopsies

- Minimal change disease and FSGS together accounted for the largest diagnostic group, comprising 44.9%.
- Lupus nephritis was diagnosed in 25.1%, post-infectious glomerulonephritis in 7.2%, IgA nephropathy in 7.4% and Henoch-Schonlein Purpura in 3.0% (Table 4.4).

Table 4.4: Diagnosis of paediatric renal biopsies, 2005-2022

Diagnosis	2005-2009 (n=682)		2010-2014 (n=742)		2015-2019 (n=631)		2020 (n=110)		2021 (n=108)		2022 (n=106)		Total (n=2379)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Lupus Nephritis	176	25.8	192	25.9	152	24.1	26	23.6	28	25.9	22	20.8	596	25.1
Minimal Change	141	20.7	172	23.2	169	26.8	33	30	35	32.4	39	36.8	589	24.8
FSGS	176	25.8	119	16.0	118	18.7	25	22.7	24	22.2	15	14.2	477	20.1
Post Infectious GN	48	7.0	77	10.4	37	5.9	5	4.5	3	2.8	2	1.9	172	7.2
IgA nephropathy	36	5.3	66	8.9	53	8.4	7	6.4	7	6.5	7	6.6	176	7.4
Henoch- Schonlein Purpura	22	3.2	14	1.9	26	4.1	5	4.5	2	1.9	2	1.9	71	3.0
Mesangial Proliferative GN-non IgA	13	1.9	22	3.0	7	1.1	2	1.8	0	0	1	0.9	45	1.9
Advanced GN	21	3.1	12	1.6	7	1.1	1	0.9	0	0	3	2.8	44	1.8
Membranous nephropathy	9	1.3	14	1.9	11	1.7	0	0	0	0	1	0.9	35	1.5
Acute tubular necrosis	18	2.6	7	0.9	4	0.6	1	0.9	1	0.9	31	29.2	62	2.6
Membrano-proliferative	8	1.2	6	0.8	1	0.2	1	0.9	0	0	1	0.9	17	0.7
Idiopathic Crescentic GN	5	0.7	2	0.3	3	0.5	1	0.9	0	0	0	0	11	0.5
Acute interstitial nephritis	2	0.3	9	1.2	3	0.5	0	0	1	0.9	15	14.2	30	1.3
Systemic vasculitis	4	0.6	1	0.1	3	0.5	0	0	0	0	0	0	8	0.3
Chronic interstitial nephritis	7	1.0	3	0.4	1	0.2	0	0	0	0	11	10.4	22	0.9
HUS / TTP	3	0.4	2	0.3	0	0	1	0.9	0	0	0	0	6	0.3
Crescentic ANCA	1	0.1	1	0.1	1	0.2	0	0	0	0	2	1.9	5	0.2
Thin Basement Membrane disease	1	0.1	2	0.3	1	0.2	0	0	0	0	0	0	4	0.2
Benign / Malignant Hypertension	1	0.1	1	0.1	1	0.2	0	0	0	0	1	0.9	4	0.2
Amyloidosis	0	0	1	0.1	0	0	0	0	0	0	0	0	1	0
Anti GBM disease	0	0	1	0.1	0	0	0	0	0	0	0	0	1	0
Malignancy	1	0.1	0	0	0	0	0	0	0	0	0	0	1	0
Other infection	0	0	0	0	0	0	1	0.9	0	0	0	0	1	0
Alport's syndrome	1	0.1	0	0	0	0	0	0	0	0	0	0	1	0
Other Hereditary	0	0	1	0.1	0	0	0	0	0	0	0	0	1	0
Others	3	0.4	16	2.2	14	2.2	3	2.7	2	1.9	3	2.8	41	1.7
Not Available	2	0.3	9	1.2	10	1.6	2	1.8	0	0	0	0	23	1.0

\*Patients may have more than 1 diagnosis classification (total=2491 but report conclusive n=2379)

## 4.5 Nephrotic syndrome

- A total of 1109 renal biopsies were performed in children with nephrotic syndrome.
- The common diagnoses were MCD (41.9%), FSGS (33.5%) and lupus nephritis (12.4%) (Table 4.5.1).
- MCD was the commonest histological finding (43.6%) for steroid-resistant nephrotic syndrome, followed by FSGS (32.5%) (Table 4.5.2).

Table 4.5.1: Renal histopathology diagnosis of children presenting with nephrotic syndrome, 2005-2022

Diagnosis	2005-2009 (n=366)		2010-2014 (n=348)		2015-2019 (n=322)		2020 (n=65)		2021 (n=63)		2022 (n=64)		Total (n=1109)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Minimal Change	116	31.7	152	43.7	148	46.0	30	46.2	31	49.2	37	57.8	514	41.9
FSGS	152	41.5	108	31.0	96	29.8	19	29.2	22	34.9	14	21.9	411	33.5
Lupus nephritis	58	15.8	43	12.4	34	10.6	7	10.8	6	9.5	4	6.3	152	12.4
IgA nephropathy	9	2.5	9	2.6	12	3.7	2	3.1	1	1.6	1	1.6	34	2.8
Mesangial proliferative GN non-IgA	5	1.4	10	2.9	1	0.3	2	3.1	0	0	1	1.6	19	1.5
Post-infectious GN	4	1.1	5	1.4	3	0.9	1	1.5	1	1.6	0	0	14	1.1
Others**	30	8.2	22	6.3	28	8.7	5	7.7	1	1.6	7	10.9	93	7.6

\*Patients may have more than 1 diagnosis classification (nephrotic n=1271 but report conclusive for nephrotic n=1228)

\*\* Others – Henoch-Schonlein Purpura, HUS/TTP, Systemic vasculitis, Malignancy, Membranous nephropathy, Membranoproliferative, Idiopathic crescentic GN, Acute interstitial nephritis, Acute tubular necrosis, Chronic interstitial nephritis, Heredity (others), Advance GN, Others, Not available

Table 4.5.2: The histopathological profile in different steroid response categories (nephrotic syndrome), 2005-2022

Diagnosis	Steroid resistant (n=1009)		Steroid sensitive (n=43)		Not available (n=219)		Total (n=1271)	
	n	%	n	%	n	%	n	%
FSGS	328	32.5	5	11.6	78	35.6	411	32.3
Minimal Change	440	43.6	10	23.3	64	29.2	514	40.4
Lupus Nephritis	101	10	8	18.6	43	19.6	152	12.0
Membranous nephropathy	19	1.9	2	4.7	1	0.5	22	1.7
IgA nephropathy	21	2.1	3	7.0	10	4.6	34	2.7
Mesangial Proliferative GN-non-IgA	14	1.4	2	4.7	3	1.4	19	1.5
Others**	62	6.1	13	30.2	13	5.9	88	6.9

\*Patients may have more than 1 diagnosis classification

\*\* Others – Henoch-Schonlein Purpura, Membranoproliferative, Idiopathic crescentic GN, Acute interstitial nephritis, Acute tubular necrosis, Chronic interstitial nephritis, Post Infectious GN, Heredity (others), Advance GN, Others, Not available

## 4.6 Nephritic syndrome

- In children presenting with nephritic syndrome; the common diagnoses were lupus nephritis (28.6%) and post-infectious GN (26.4%).
- IgA nephropathy was diagnosed in 11.2% and Henoch-Schonlein Purpura in 4.5%.

Table 4.6: Renal histopathology diagnosis of children presenting with nephritic syndrome, 2005-2022

Diagnosis	2005-2009 (n=88)		2010-2014 (n=87)		2015-2019 (n=58)		2020 (n=11)		2021 (n=12)		2022 (n=13)		Total (n=269)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Post-infectious GN	21	23.9	30	34.5	14	24.1	3	27.3	1	8.3	2	15.4	71	26.4
Lupus nephritis	24	27.3	21	24.1	15	25.9	5	45.5	6	50	6	46.2	77	28.6
IgA nephropathy	7	8.0	9	10.3	9	15.5	1	9.1	2	16.7	2	15.4	30	11.2
Henoch-Schonlein Purpura	5	5.7	1	1.1	4	6.9	1	9.1	0	0	1	7.7	12	4.5
FSGS	8	9.1	4	4.6	5	8.6	1	9.1	1	8.3	0	0	19	7.1
MCD	7	8.0	0	0	5	8.6	0	0	2	16.7	1	7.7	15	5.6
Mesangial proliferative GN-non IgA	3	3.4	3	3.4	1	1.7	0	0	0	0	0	0	7	2.6
Acute tubular necrosis	9	10.2	2	2.3	0	0	0	0	0	0	0	0	11	4.1
Others**	15	17.0	19	21.8	8	13.8	1	9.1	0	0	4	30.8	47	17.5

\*Patients may have more than 1 diagnosis classification

\*\* Others – Systemic vasculitis, Anti GBM disease, Alport's syndrome, Thin Basement Membrane disease, Advanced GN, Membrano-proliferative, Crescentic ANCA, Idiopathic crescentic GN, Chronic interstitial nephritis, not available

^nephritic n=283 but report conclusive for nephrotic n=269

#### 4.7 Causes of severe renal failure (needed dialysis therapy)

- At the time of the biopsy, 165 children (6.7%) needed dialysis therapy.
- Common histological findings in patients presenting with severe kidney injury (requiring dialysis) were lupus nephritis (25.5%), post-infectious GN (23.6%) and advanced glomerulosclerosis (12.7%).

Table 4.7: Histology finding of children who had severe renal failure (needed dialysis therapy) who underwent renal biopsy, 2005-2022

Diagnosis	2005-2009 (n=38)		2010-2014 (n=73)		2015-2019 (n=39)		2020 (n=4)		2021 (n=6)		2022 (n=5)		Total (n=165)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Post-infectious GN	5	13.2	22	30.1	10	25.6	1	25.0	1	16.7	0	0	39	23.6
Lupus nephritis	9	23.7	16	21.9	9	23.1	2	50	4	66.7	2	40	42	25.5
FSGS	3	7.9	3	4.1	2	5.1	0	0	1	16.7	1	20	10	6.1
Advanced glomerulosclerosis (advanced GN)	9	23.7	7	9.6	4	10.3	0	0	0	0	1	20	21	12.7
HUS/TTP	0	0	2	2.7	0	0	1	25.0	0	0	0	0	3	1.8
Acute tubular necrosis	5	13.2	4	5.5	3	7.7	0	0	0	0	0	0	12	7.3
MCD	0	0	0	0	1	2.6	0	0	0	0	1	20	2	1.2
Acute interstitial nephritis	0	0	5	6.8	1	2.6	0	0	0	0	0	0	6	3.6
IgA nephropathy	1	2.6	5	6.8	0	0	0	0	0	0	0	0	6	3.6
Others	8	21.1	12	16.4	9	23.1	0	0	0	0	2	40	31	18.8

\*Patients may have more than 1 diagnosis classification

\*\* Other – Anti GBM disease, Systemic vasculitis, Membrano-proliferative, Idiopathic crescentic GN, Henoch-Schonlein Purpura, Crescentic ANCA, Chronic interstitial nephritis, Mesangial Proliferative GN-non IgA, Other infection, Heredity, Malignancy, Others, Not available

^needed dialysis therapy n=183 but report conclusive, n=165

#### 4.8 Paediatric focal segmental glomerulosclerosis and minimal change disease

- Children with FSGS had hypertension and lower eGFR compared to MCD (Table 4.8.1).
- Both FSGS and MCD exhibited similar patient survival rates (Table 4.8.2 and Figure 4.8.1).
- Children with FSGS showed much poorer renal survival compared to MCD; 77.9% versus 91.0% and 72.3% versus 87.9% at 3 and 5 years respectively (Table 4.8.3 and Figure 4.8.2).

Table 4.8.1: Clinical characteristics of children with MCD and FSGS, 2005-2022

Clinical characteristics	FSGS		MCD		p-value
	n	%	n	%	
<b>Number</b>	328	42.7	440	57.3	
<b>Age/year (mean (SD))</b>	8.6	3.98	8.0	4.29	0.83 <sup>a</sup>
<b>Age/year (median (IQR))</b>	8.5	6.80	8.1	8.1	
<b>Race</b>					
Malay	226	68.9	322	73.2	0.121 <sup>b</sup>
Chinese	37	11.3	45	10.2	
Indian	22	6.7	37	8.4	
Others	43	13.1	36	8.2	
<b>Gender</b>					
Male	215	65.5	312	70.9	0.113 <sup>b</sup>
Female	113	34.5	128	29.1	
<b>Gross haematuria</b>					
Present	7	2.1	5	1.1	0.270 <sup>e</sup>
Absent	321	97.9	435	98.9	
<b>Hypertension</b>					
Present	136	41.5	112	25.5	<001 <sup>b</sup>
Absent	192	58.5	328	74.5	
<b>Family history</b>					
Yes	11	3.4	10	2.3	0.364 <sup>b</sup>
No	317	96.6	430	97.7	
<b>eGFR ml/min/1.73m<sup>2</sup></b>					
<15	4	1.2	0	0	<001 <sup>b</sup>
15-30	10	3.0	2	0.5	
30-60	30	9.1	6	1.4	
60-90	34	10.4	38	8.6	
≥90	195	59.5	286	65.0	
Not available	55	16.8	108	24.5	
<b>Dialysis required</b>					
Yes	8	2.4	2	0.5	0.22 <sup>c</sup>
No	320	97.6	438	99.5	

a two sample t test

b Chi-square test

c Fisher's exact test

Table 4.8.2: Patient survival by focal segmental glomerulosclerosis and minimal change disease, 2005-2022 (overall)

Time (Months)	Focal segmental glomerulosclerosis		Minimal change disease	
	Survival (%)	SE	Survival (%)	SE
12	95.8	0.0094	98.0	0.0061
36	94.8	0.0106	97.1	0.0075
60	94.2	0.0114	95.2	0.0102
84	93.2	0.0127	94.5	0.0111
108	93.2	0.0127	94.5	0.0111
120	92.7	0.0134	93.6	0.0128

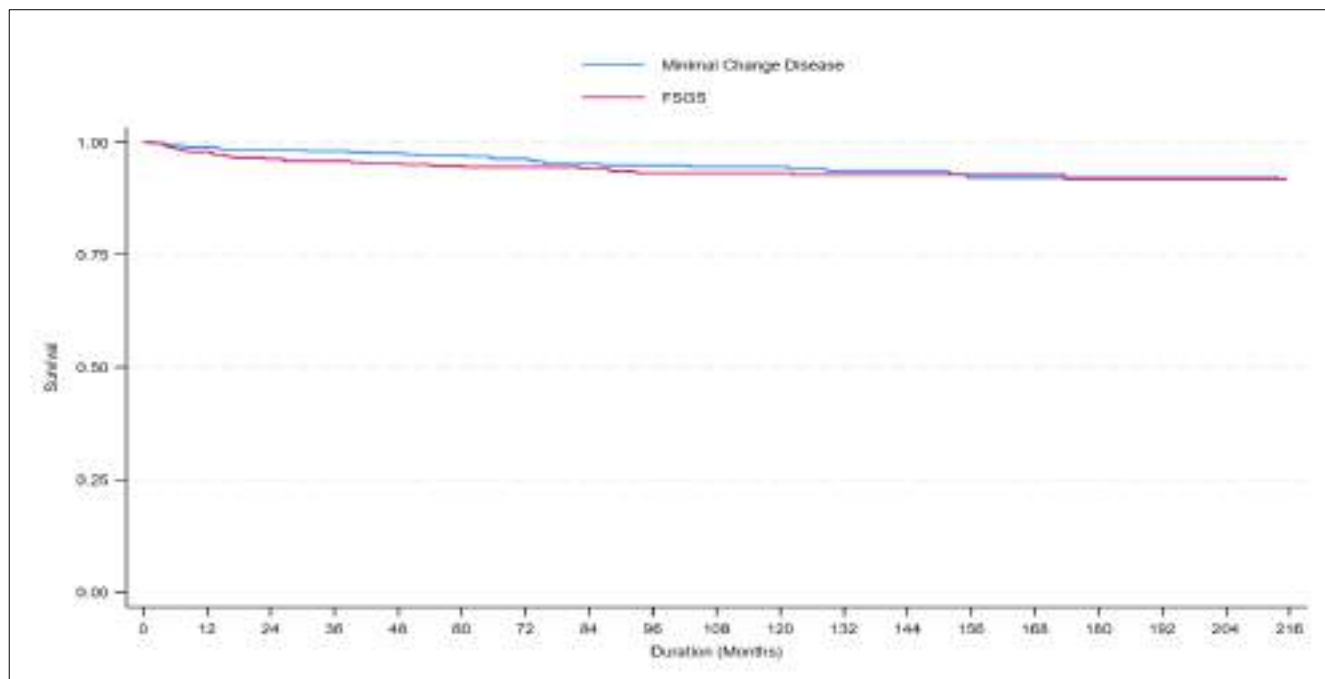


Figure 4.8.1: Patient survival by focal segmental glomerulosclerosis and minimal change disease, 2005-2022 (overall)

Table 4.8.3: Renal survival by focal segmental glomerulosclerosis and minimal change disease, 2005- 2022 (overall)

Time (Months)	Focal segmental glomerulosclerosis		Minimal change disease	
	Survival (%)	SE	Survival (%)	SE
12	85.9	0.0169	93.9	0.0109
36	77.9	0.0209	91.0	0.0133
60	72.3	0.0233	87.9	0.0158
84	70.1	0.0243	84.7	0.0184
108	69.2	0.0248	83.9	0.0193
120	68.7	0.0251	81.8	0.0214

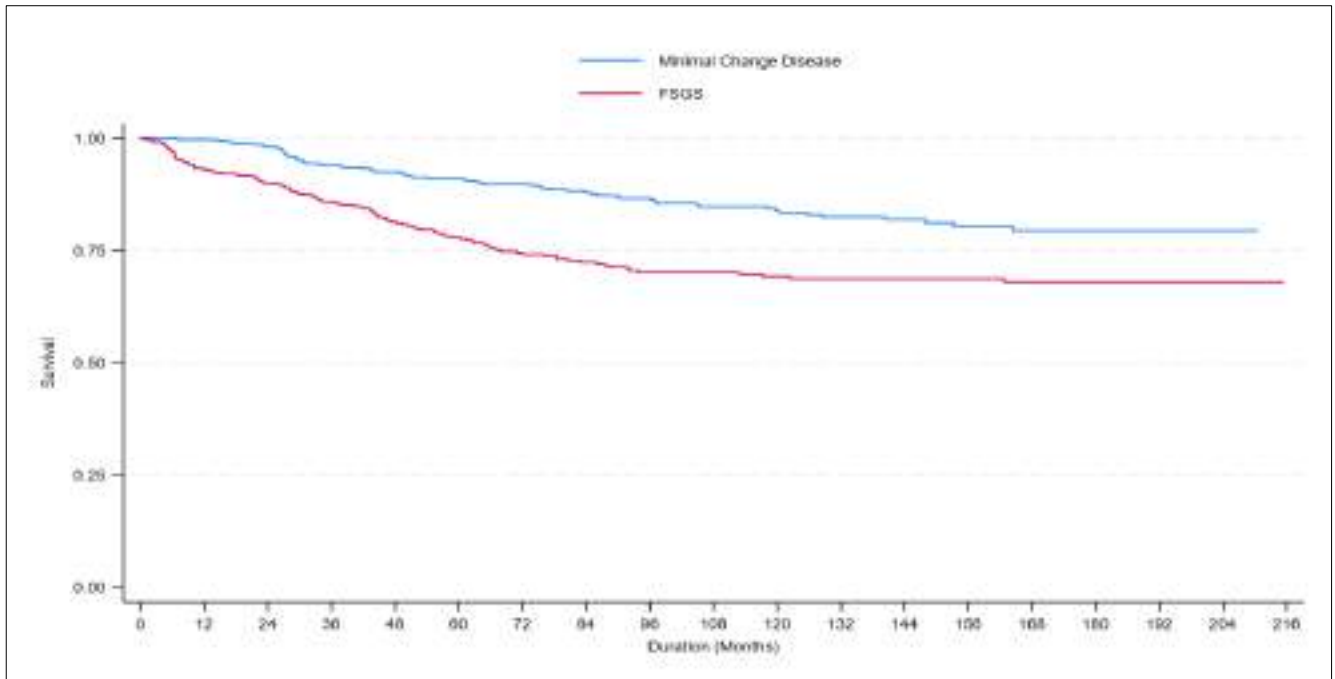


Figure 4.8.2: Renal survival by focal segmental glomerulosclerosis and minimal change disease, 2005- 2022 (overall)

### 4.9 Paediatric Lupus Nephritis

- There were a total of 558 renal biopsies performed for children with lupus nephritis (Figure 4.9.1).
- Most children (86.4%) with lupus received only one renal biopsy. Seventy-six (13.6%) had repeat biopsies (Table 4.9.2).
- The female: male ratio was 5.3:1 (Table 4.9.3).
- The racial distribution was Malay (67.1%), Chinese (20.1%), and Indian (2.8%). This observation may suggest a disproportionately lower prevalence of lupus nephritis among the Indian population (Table 4.9.3).
- The mean age at the time of the biopsy was 11.9 years (Table 4.9.4).
- About 39 (6.9%) of patients had severe kidney failure and needed dialysis support. The histologic class was proliferative GN (74.3%) and advanced sclerosing lupus nephritis (5.1%) (Table 4.9.5 and Table 4.9.9).
- The most frequent clinical presentation at biopsy was urinary abnormalities (34.2%) followed by nephrotic syndrome (Table 4.9.7)
- The common extra kidney manifestations were cutaneous features (malar rash 42.9%, photosensitivity (20.6%), discoid rash (8.9%), haematological involvement (59.1%), arthritis (26.5%), and oral ulcer (25.6%) (Table 4.9.8).
- ANF was positive in 85.1% of patients.
- For patients who did not require dialysis therapy, the histological class was proliferative GN (Class III/III+V and IV//IV+V) in 83.8% of biopsies (Table 4.9.9).
- The patient survival was 90.1% at 3 years and 87.1% at 5 years from the time of diagnosis of lupus nephritis (Table 4.9.10 and Figure 4.9.2).
- The renal survival for lupus nephritis was 90.6% at 3 years and 87.5% at 5 years (Table 4.9.11 and Figure 4.9.3).

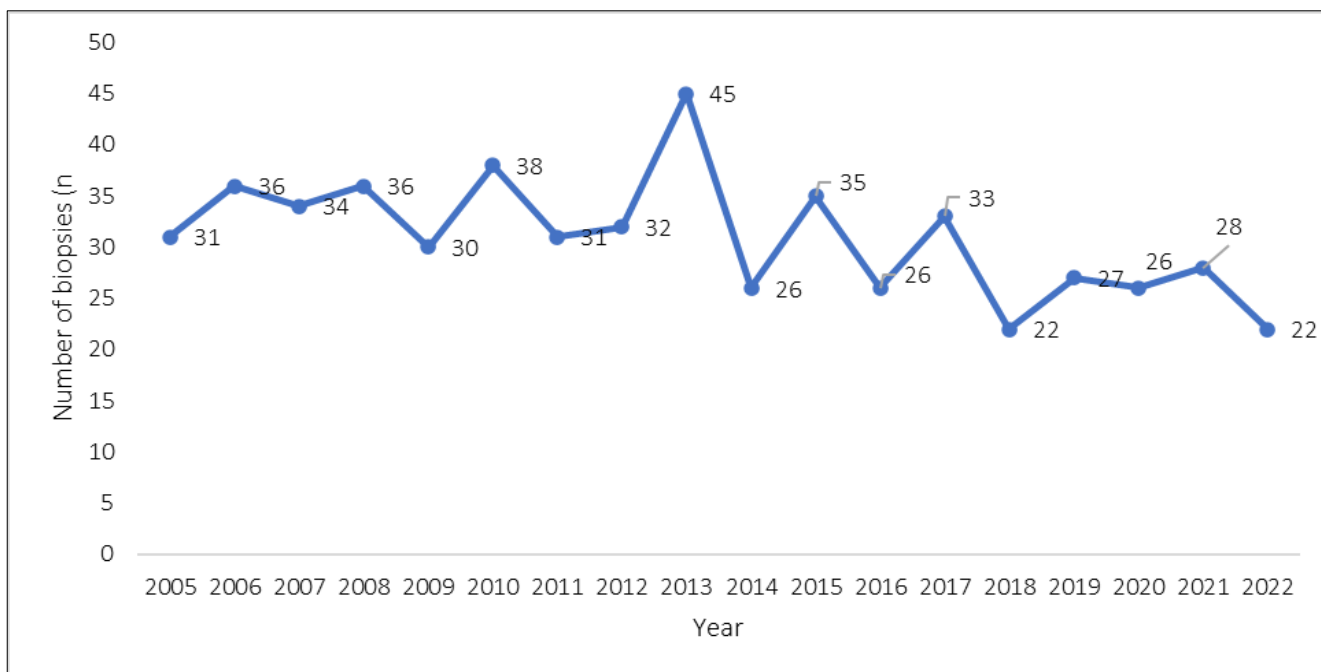


Figure 4.9.1: Total number of biopsies (SLE), 2005-2022

Table 4.9.2: Distribution of renal biopsy in patients with lupus by number of episodes, 2005-2022

Year	2005-2009 (n=167)		2010-2014 (n=172)		2015-2019 (n=143)		2020 (n=26)		2021 (n=28)		2022 (n=22)		Total (n=558)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
1st episode	145	86.8	143	83.1	124	86.7	25	96.2	27	96.4	18	81.8	482	86.4
2nd episode	19	11.4	24	14.0	18	12.6	1	3.8	1	3.6	4	18.2	67	12.0
3rd episode	3	1.8	5	2.9	0	0	0	0	0	0	0	0	8	1.4
4th episode	0	0	0	0	1	0.7	0	0	0	0	0	0	1	0.2

Table 4.9.3: Gender and racial distribution of paediatric lupus nephritis, 2005-2022

	2005-2009 (n=167)		2010-2014 (n=174)		2015-2019 (n=145)		2020 (n=26)		2021 (n=28)		2022 (n=22)		Total (n=562)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
<b>Gender</b>														
Male	24	14.4	25	14.4	30	20.7	5	19.2	3	10.7	2	9.1	89	15.8
Female	143	85.6	149	85.6	115	79.3	21	80.8	25	89.3	20	90.9	473	84.2
<b>Race</b>														
Malay	102	61.1	117	67.2	105	72.4	19	73.1	19	67.9	15	68.2	377	67.1
Chinese	43	25.7	34	19.5	27	18.6	3	11.5	4	14.3	2	9.1	113	20.1
Indian	7	4.2	3	1.7	2	1.4	2	7.7	1	3.6	1	4.5	16	2.8
Others*	15	9.0	20	11.5	11	7.6	2	7.7	4	14.3	4	18.2	56	10

Table 4.9.4: Age distribution of paediatric lupus nephritis, 2005-2022

Year	2005 (n=31)	2006 (n=36)	2007 (n=34)	2008 (n=36)	2009 (n=30)	2010 (n=39)	2011 (n=31)	2012 (=33)	2013 (n=45)	2014 (n=26)
Mean	12.46	12.08	12.24	11.16	11.34	11.76	12.08	11.53	11.34	11.40
SD	2.20	2.44	2.03	3.27	3.77	2.51	3.67	3.88	3.35	2.74
Median	13.16	12.93	12.65	11.70	11.89	12.19	13.22	12.80	12.36	12.62
Minimum	4.89	6.63	7.30	0.25	0.53	1.46	0.23	0.27	0.10	4.08
Maximum	14.80	14.76	14.89	14.94	14.95	14.82	14.98	14.97	14.97	14.78

Year	2015 (n=35)	2016 (n=26)	2017 (n=34)	2018 (n=23)	2019 (=27)	2020 (n=26)	2021 (n=28)	2022 (n=22)	Total (n=562)
Mean	12.31	12.34	12.00	12.00	11.78	13.28	12.35	12.17	11.94
SD	2.15	2.71	2.18	2.43	3.19	2.14	1.85	2.34	2.81
Median	12.54	13.46	12.32	12.84	12.61	13.99	12.73	12.49	12.81
Minimum	6.15	3.14	6.22	7.15	2.23	6.48	7.04	5.83	0.10
Maximum	14.95	14.90	14.89	14.95	14.98	14.92	14.80	14.98	14.98

Table 4.9.5: Dialysis therapy for paediatric lupus nephritis at the time of biopsy, 2005-2022

Needed dialysis therapy	2005-2009 (n=167)		2010-2014 (n=174)		2015-2019 (n=145)		2020 (n=26)		2021 (n=28)		2022 (n=22)		Total (n=562)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Yes	8	4.8	14	8.0	9	6.2	2	7.7	4	14.3	2	9.1	39	6.9
No	132	79.0	158	90.8	136	93.8	24	92.3	24	85.7	20	90.9	494	87.9
Not available	27	16.2	2	1.1	0	0	0	0	0	0	0	0	29	5.2

Table 4.9.6: Presence of hypertension of paediatric lupus nephritis, 2005-2022

Hypertension	2005-2009 (n=167)		2010-2014 (n=174)		2015-2019 (n=145)		2020 (n=26)		2021 (n=28)		2022 (n=22)		Total (n=562)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Present	64	38.3	79	45.4	69	47.6	8	30.8	13	46.4	9	40.9	242	43.1
Absent	103	61.7	95	54.6	76	52.4	18	69.2	15	53.6	13	59.1	320	56.9

Table 4.9.7: Clinical presentation at biopsy of paediatric lupus nephritis, 2005-2022

Clinical Presentation	2005-2009 (n=167)		2010-2014 (n=174)		2015-2019 (n=145)		2020 (n=26)		2021 (n=28)		2022 (n=22)		Total (n=562)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Asymptomatic urine abnormalities	47	28.1	67	38.5	56	38.6	8	30.8	8	28.6	6	27.3	192	34.2
Nephrotic syndrome	57	34.1	41	23.6	33	22.8	7	26.9	6	21.4	4	18.2	148	26.3
Nephritic - Nephrotic	22	13.2	37	21.3	30	20.7	4	15.4	8	28.6	4	18.2	105	18.7
Nephritic syndrome	23	13.8	19	10.9	15	10.3	5	19.2	6	21.4	6	27.3	74	13.2
Not Available	18	10.8	10	5.7	11	7.6	2	7.7	0	0	2	9.1	43	7.7

Table 4.9.8: Extra-kidney manifestation at presentation, 2005-2022

ARA criteria	2005-2009 (n=167)		2010-2014 (n=174)		2015-2019 (n=145)		2020 (n=25)		2021 (n=25)		2022 (n=25)		Total (n=511)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Malar rash	80	47.9	71	40.8	63	43.4	8	30.8	12	42.9	7	31.8	241	42.9
Photo-sensitivity	41	24.6	40	23.0	27	18.6	5	19.2	1	3.6	2	9.1	116	20.6
Arthritis	50	29.9	56	32.2	32	22.1	0	0	5	17.9	6	27.3	149	26.5
Cerebral	15	9.0	23	13.2	14	9.7	1	3.8	3	10.7	3	13.6	59	10.5
Renal	139	83.2	149	85.6	113	77.9	21	80.8	25	89.3	20	90.9	467	83.1
Hematological	99	59.3	105	60.3	78	53.8	16	61.5	21	75.0	13	59.1	332	59.1
Discoid rash	9	5.4	19	10.9	17	11.7	1	3.8	3	10.7	1	4.5	50	8.9
Serositis	22	13.2	24	13.8	24	16.6	4	15.4	9	32.1	8	36.4	91	16.2
Oral ulcers	45	26.9	50	28.7	30	20.7	6	23.1	6	21.4	7	31.8	144	25.6
ANF* Positive	157	94.0	140	80.5	111	76.6	19	73.1	24	85.7	27	122.7	478	85.1
At least one positive in other labs*	112	67.1	115	66.1	116	80	21	80.8	20	71.4	19	86.4	403	71.7

\*Anti-Nuclear Factor

\*\*dsDNA, ssDNA, Anti-cardiolipin antibody, Anti-phospholipid antibody, Histone, Nucleo, Ro, La or Sm

Table 4.9.9: Classification of paediatric lupus nephritis, 2005-2022

Needed dialysis														
WHO/ISN /RPS Class	2005-2009 (n=8)		2010-2014 (n=14)		2015-2019 (n=9)		2020 (n=2)		2021 (n=4)		2022 (n=2)		Total (n=39)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Class II	1	12.5	1	7.1	0	0	0	0	0	0	0	0	2	5.1
Class III or III + V	0	0	3	21.4	2	22.2	0	0	0	0	0	0	5	12.8
Class IV or IV + V	4	50	9	64.3	6	66.7	1	50	4	100	0	0	24	61.5
Class V or II + V	1	12.5	0	0	1	11.1	0	0	0	0	2	100	4	10.3
Class VI	2	25	0	0	0	0	0	0	0	0	0	0	2	5.1
Not Available	0	0	1	7.1	0	0	1	50	0	0	0	0	2	5.1
Not needed dialysis														
WHO/ISN /RPS Class	2005-2009 (n=159)		2010-2014 (n=160)		2015-2019 (n=136)		2020 (n=24)		2021 (n=24)		2022 (n=20)		Total (n=523)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Class I	0	0	4	2.5	2	1.5	0	0	0	0	0	0	6	1.1
Class II	12	7.5	15	9.4	10	7.4	1	4.2	1	4.2	1	5.0	40	7.6
Class III or III + V	27	17.0	44	27.5	50	36.8	9	37.5	6	25.0	6	30	142	27.2
Class IV or IV + V	111	69.8	83	51.9	63	46.3	13	54.2	14	58.3	12	60	296	56.6
Class V or II + V	9	5.7	11	6.9	6	4.4	0	0	2	8.3	1	5.0	29	5.5
Not Available	0	0	3	1.9	5	3.7	1	4.2	1	4.2	0	0	10	1.9

Table 4.9.10: Patient survival in lupus nephritis, 2005-2022

Time (Months)	Lupus nephritis	
	Survival (%)	Survival (%)
12	91.4	0.0123
36	90.1	0.0133
60	87.1	0.0154
84	85.8	0.0164
108	85.2	0.0170
120	84.2	0.0180

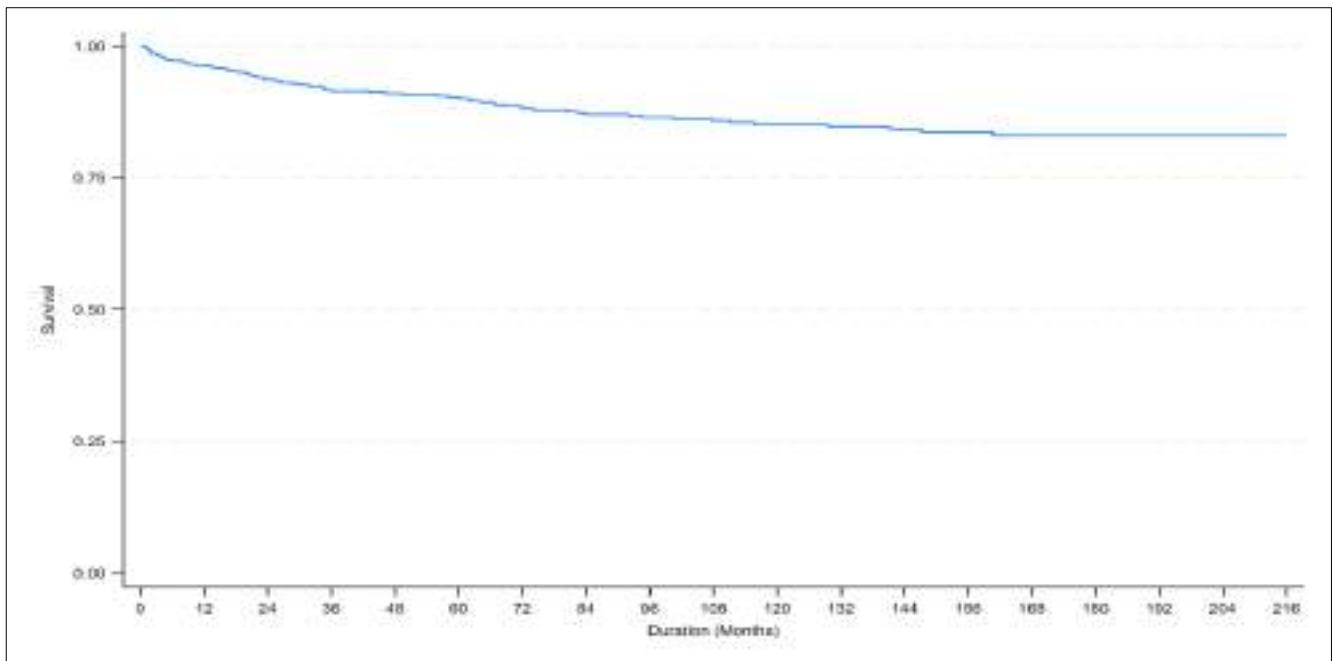


Figure 4.9.2: Patient survival in lupus nephritis, 2005-2022

Table 4.9. 11: Death-censored renal survival in lupus nephritis, 2005-2022

Time (Months)	Lupus nephritis	
	Survival (%)	Survival (%)
12	93.3	0.0113
36	90.6	0.0135
60	87.5	0.0161
84	85.4	0.0177
108	85.4	0.0177
120	83.8	0.0197

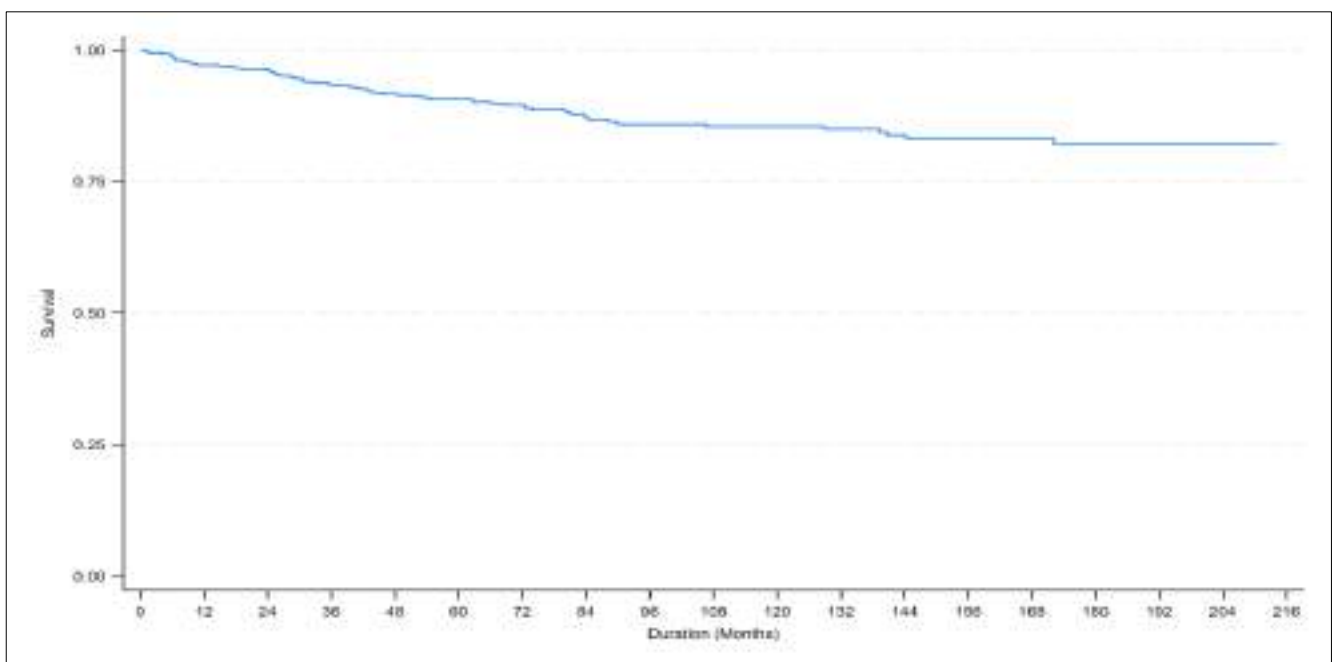


Figure 4.9.3: Death-censored renal survival in lupus nephritis, 2005-2022

#### 4.10 Overall Kidney outcome

- Of the 2463 children biopsied, 420 (17%) of these children were reported to the Malaysian Dialysis and Transplant Registry with End Stage Kidney Disease (ESKD) (Table 4.10.1).
- FSGS was the most cause of ESKD accounting for 28.6%.
- Other causes of ESKD in children were lupus nephritis (16.6%), MCD (16.9%), Advanced GN (10.5%), IgA nephropathy 6.4% and Henoch-Schonlein Purpura 1.2%.

Table 4.10.1: Causes of end-stage kidney disease in children who underwent renal biopsy, 2005-2022

Causes	n=420	%
FSGS	120	28.6
Lupus Nephritis	74	17.6
Minimal Change	71	16.9
Advance GN	44	10.5
IgA nephropathy	27	6.4
Post Infectious GN	11	2.6
Mesangial Proliferative GN-non IgA	8	1.9
Chronic interstitial nephritis	8	1.9
Membranous nephropathy	6	1.4
Idiopathic Crescentic GN	6	1.4
Henoch-Schonlein Purpura	5	1.2
HUS / TTP	4	1.0
Systemic vasculitis	4	1.0
Membrano-proliferative	3	0.7
Acute interstitial nephritis	3	0.7
Acute tubular necrosis	3	0.7
Crescentic ANCA	2	0.5
Benign / Malignant Hypertension	2	0.5
Others	1	0.2
Alport's syndrome	1	0.2
Others	10	2.4
Not available	4	1.0
Not Conclusive	31	7.4

\*Patients may have more than one cause of end-stage renal disease

#### 4.11 Biopsy failure and complication

- The complication rate for the biopsy procedure was reported to be 3.2% (Table 4.11.1).
- The overall risk of bleeding was 2.7% mainly gross hematuria. The risk of perinephric collection was 0.5%.
- The risk of complications post renal biopsy was higher in those less than 2 years of age, with low GFR <60ml/min/1.73m<sup>2</sup> and needing dialysis therapy at the time of biopsy.
- The use of a small diameter biopsy decreased the risk for complication (odds ratio 0.10, p=0.03) (Table 4.11.2).

Table 4.11.1: Frequency of complication, 2005-2022

Causes	n	%
<b>Total number of biopsies</b>	2491	
<b>Total number of complications</b>	80	3.2
Bleeding	68	2.73
Perirenal collection	13	0.52
Arteriovenous malformation	1	0.04
Hypotension	3	0.12

Table 4.11.2: Risk factors for complication, 2005-2022

Factors	n	Number of complications	Odds ratio	95% CI	p-value
<b>Age (years)</b>					
<2	70	5	2.69	1.03,7.03	0.044
>2-≤5	330	13	1.43	0.76,2.71	0.269
>5-≤10	654	22	1.22	0.72,2.06	0.469
>10 (ref*)	1,437	40	1.00	-	-
<b>Calculated GFR ml/min/1.73m<sup>2</sup></b>					
<15	92	9	3.94	1.82,8.52	0.001
15-<30	120	9	2.94	1.37,8.52	0.006
30-<60	220	13	2.28	1.18,4.42	0.015
60- <90	290	14	1.84	0.97,3.50	0.062
> 90 (ref*)	1,194	32	1.00	-	-
Unknown	575	3	-	-	-
<b>Renal failure</b>					
Needed dialysis	183	16	3.37	1.90,5.98	<0.001
Not needed dialysis (ref*)	2208	61	1.00	-	-
Unknown	100	3	-	-	-
<b>Needle size</b>					
14G	190	13	1.14	0.62,2.11	0.615
16G (ref*)	1058	64	1.00	-	-
18G	454	3	0.10	0.3,0.33	0.0322
Unknown	789	0	-	-	-

(ref\*) Reference category

CI-confidence interval

Unknown = No information



# **CHAPTER 5**

## **RENAL ALLOGRAFT BIOPSY**

**Yee Seow Yeing**  
**Maisarah Binti Jalalonmuhali**

## 5.1 Introduction

- Renal allograft biopsy remained an important diagnostic tool for allograft dysfunction.
- A total of 34 centres performed renal allograft biopsies.
- There were 4 major transplant centres in the country namely University Malaya Medical Centre (UMMC), Hospital Kuala Lumpur (HKL), Prince Court Medical Centre and Selayang Hospital.

## 5.2 Allograft renal biopsy

- UMMC contributed to more than a quarter (26.9%) of all allograft biopsies between 2005 to 2022, followed by HKL (Adult) 21.4%, Prince Court Medical Centre 17.8% and Selayang Hospital (Adult) 13.4% (Table 5.2.1).
- The majority of patients had one allograft biopsy and 24.3% underwent 2 biopsies (Table 5.2.2).
- There were more male (65.2%) had allograft biopsies (Table 5.2.3). This is consistent with the proportion of male who had a kidney transplant in the country.
- Most of the patients who underwent renal allograft biopsies were Chinese, 34.8% were Malay, 9.3% were Indian and others (5.1%) (Table 5.2.4).
- Almost all of the centres obtained >10 glomeruli in biopsies (which is considered as adequate specimen), except for a few centres that performed very few biopsies over the years (Table 5.2.5).
- Majority of patients were young as most patients who had a kidney transplant were in these age groups (Table 5.2.6 and Figure 5.2.1).

Table 5.2.1: Distribution of reported graft renal biopsies by centre, 2005-2022

Centre	2005-2009 (n=576)		2010-2014 (n=1183)		2015-2019 (n=1441)		2020 (n=293)		2021 (n=173)		2022 (n=253)		Total (n=3919)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
UMMC	64	11.1	280	23.7	502	34.8	106	36.2	38	22.0	63	24.9	1053	26.9
Kuala Lumpur (Adult)	203	35.2	186	15.7	339	23.5	63	21.5	24	13.9	23	9.1	838	21.4
Prince Court Medical Centre	7	1.2	277	23.4	287	19.9	45	15.4	34	19.7	48	19.0	698	17.8
Selayang Hospital (Adult)	115	20	182	15.4	119	8.3	28	9.6	26	15.0	55	21.7	525	13.4
Pulau Pinang (Adult)	31	5.4	40	3.4	40	2.8	12	4.1	6	3.5	3	1.2	132	3.4
Kuala Lumpur (Paed)	52	9.0	35	3.0	13	0.9	0	0	0	0	0	0	100	2.6
Tengku Ampuan Rahimah	47	8.2	27	2.3	6	0.4	3	1.0	0	0	0	0	83	2.1
PPUKM	0	0	33	2.8	18	1.2	0	0	2	1.2	3	1.2	56	1.4
Sultanah Bahiyah	6	1.0	26	2.2	13	0.9	0	0	2	1.2	3	1.2	50	1.3
Sarawak General	14	2.4	15	1.3	13	0.9	4	1.4	4	2.3	3	1.2	53	1.4
Melaka Hospital	4	0.7	13	1.1	9	0.6	1	0.3	4	2.3	7	2.8	38	1.0
Queen Elizabeth	9	1.6	3	0.3	13	0.9	5	1.7	7	4.0	8	3.2	45	1.1
Serdang Hospital	3	0.5	11	0.9	5	0.3	2	0.7	4	2.3	2	0.8	27	0.7
Sultan Ismail (Paed)	3	0.5	12	1.0	2	0.1	0	0	0	0	0	0	17	0.4
Tengku Ampuan Afzan	0	0	4	0.3	12	0.8	3	1.0	1	0.6	2	0.8	22	0.6
Tuanku Ja'afar (Adult)	5	0.9	5	0.4	8	0.6	4	1.4	1	0.6	3	1.2	26	0.7
Sultanah Aminah	4	0.7	9	0.8	5	0.3	5	1.7	5	2.9	9	3.6	37	0.9
Raja Permaisuri Bainun	5	0.9	4	0.3	2	0.1	1	0.3	6	3.5	3	1.2	21	0.5
Selayang (Paed)	1	0.2	2	0.2	5	0.3	0	0	0	0	0	0	8	0.2
Pakar Sultanah Fatimah (Muar)	0	0	5	0.4	3	0.2	5	1.7	3	1.7	4	1.6	20	0.5
KPJ Ampang Puteri	1	0.2	3	0.3	2	0.1	0	0	0	0	0	0	6	0.2
Pulau Pinang (Paed)	1	0.2	2	0.2	1	0.1	0	0	1	0.6	1	0.4	6	0.2
Sultanah Nur Zahirah	0	0	1	0.1	2	0.1	0	0	0	0	0	0	3	0.1
Miri Hospital	0	0	1	0.1	2	0.1	1	0.3	0	0	0	0	4	0.1
Sultanah Nora Ismail	0	0	0	0	2	0.1	0	0	1	0.6	2	0.8	5	0.1
Normah Medical Specialist	0	0	2	0.2	0	0	0	0	0	0	0	0	2	0.1
Fan Medical Renal Clinic	0	0	2	0.2	2	0.1	0	0	0	0	0	0	4	0.1
Loh Guan Lye Specialist	0	0	2	0.2	0	0	0	0	0	0	0	0	2	0.1
Tuanku Ja'afar (Paed)	0	0	1	0.1	0	0	0	0	0	0	0	0	1	0
Raja Perempuan Zainab II	1	0.2	0	0	2	0.1	1	0.3	0	0	0	0	4	0.1
Hospital Tunku Azizah (Paed)	0	0	0	0	9	0.6	4	1.4	4	2.3	9	3.6	26	0.7
Hospital Wanita Dan Kanak-kanak Sabah	0	0	0	0	3	0.2	0	0	0	0	0	0	3	0.1
Kulim Hospital	0	0	0	0	2	0.1	0	0	0	0	0	0	2	0.1
Pusat Perubatan Sunway Velocity	0	0	0	0	0	0	0	0	0	0	2	0.8	2	0.1

Table 5.2.2: Distribution of graft renal biopsy in patients by number of episodes, 2005-2022

Year	2005-2009 (n=470)		2010-2014 (n=800)		2015-2019 (n=992)		2020 (n=215)		2021 (n=132)		2022 (n=187)		Total (n=2796)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
1 <sup>st</sup> episode	284	60.4	362	45.3	315	31.8	75	34.9	51	38.6	86	46.0	1173	42.0
2 <sup>nd</sup> episode	121	25.7	214	26.8	224	22.6	51	23.7	31	23.5	38	20.3	679	24.3
3 <sup>rd</sup> episode	39	8.3	102	12.8	156	15.7	40	18.6	22	16.7	26	13.9	385	13.8
4 <sup>th</sup> episode	26	5.5	122	15.3	297	29.9	49	22.8	28	21.2	37	19.8	559	20

Table 5.2.3: Gender distribution of renal allograft biopsy, 2005-2022

Gender	2005-2009 (n=576)		2010-2014 (n=1183)		2015-2019 (n=1441)		2020 (n=293)		2021 (n=173)		2022 (n=253)		Total (n=3919)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Male	373	64.8	785	66.4	950	65.9	183	62.5	111	64.2	155	61.3	2557	65.2
Female	203	35.2	398	33.6	491	34.1	110	37.5	62	35.8	98	38.7	1362	34.8

Table 5.2.4: Racial distribution of renal allograft biopsy, 2005-2022

Race	2005-2009 (n=576)		2010-2014 (n=1183)		2015-2019 (n=1441)		2020 (n=293)		2021 (n=173)		2022 (n=253)		Total (n=3919)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Malay	199	34.5	333	28.1	510	35.4	121	41.3	87	50.3	113	44.7	1363	34.8
Chinese	294	51.0	648	54.8	755	52.4	125	42.7	62	35.8	109	43.1	1993	50.9
Indian	56	9.7	113	9.6	122	8.5	32	10.9	17	9.8	25	9.9	365	9.3
Others	27	4.7	89	7.5	54	3.7	15	5.1	7	4.0	6	2.4	198	5.1

Table 5.2.5: Number of glomeruli obtained at each renal allograft biopsy by centres, 2005-2022

Total number of glomeruli Centre	<10 (n=1101)		≥10 (n=2680)		Missing (n=138)		Total (n=3919)	
	n	%	n	%	n	%	n	%
UMMC	364	34.6	653	62.0	36	3.4	1,053	100
Kuala Lumpur (Adult)	186	22.2	641	76.5	11	1.3	838	100
Prince Court Medical Centre	106	15.2	574	82.2	18	2.6	698	100
Selayang Hospital (Adult)	163	31.0	339	64.6	23	4.4	525	100
Pulau Pinang (Adult)	56	42.4	75	56.8	1	0.8	132	100
Kuala Lumpur (Paed)	23	23.0	77	77.0	0	0	100	100
Tengku Ampuan Rahimah	29	34.9	54	65.1	0	0	83	100
PPUKM	30	53.6	23	41.1	3	5.4	56	100
Sultanah Bahiyah	21	42.0	29	58.0	0	0	50	100
Sarawak General	20	37.7	33	62.3	0	0	53	100
Melaka Hospital	13	34.2	24	63.2	1	2.6	38	100
Queen Elizabeth	6	13.3	16	35.6	23	51.1	45	100
Serdang Hospital	3	11.1	24	88.9	0	0	27	100
Sultan Ismail (Paed)	11	64.7	6	35.3	0	0	17	100
Tengku Ampuan Afzan	3	13.6	13	59.1	6	27.3	22	100
Tuanku Ja'afar (Adult)	8	30.8	14	53.8	4	15.4	26	100
Sultanah Aminah	22	59.5	15	40.5	0	0	37	100
Raja Permaisuri Bainun	3	14.3	10	47.6	8	38.1	21	100
Selayang Hospital (Paed)	7	87.5	1	12.5	0	0	8	100
Hospital Pakar Sultanah Fatimah (Muar)	11	55.0	9	45.0	0	0	20	100
KPJ Ampang Puteri	2	33.3	4	66.7	0	0	6	100
Pulau Pinang (Paed)	2	33.3	4	66.7	0	0	6	100
Sultanah Nur Zahirah	1	33.3	2	66.7	0	0	3	100
Miri Hospital	2	50	1	25.0	1	25.0	4	100
Sultanah Nora Ismail	2	40	3	60	0	0	5	100
Normah Medical Specialist	0	0	2	100	0	0	2	100
Fan Medical Renal Clinic	2	50	2	50	0	0	4	100
Loh Guan Lye Specialist	0	0	2	100	0	0	2	100
Tuanku Ja'afar (Paed)	0	0	1	100	0	0	1	100
Raja Perempuan Zainab II	2	50	1	25.0	1	25.0	4	100
Hospital Tunku Azizah (Paed)	2	7.7	24	92.3	0	0	26	100
Hospital Wanita Dan Kanak-kanak Sabah	1	33.3	2	66.7	0	0	3	100
Kulim Hospital	0	0	2	100	0	0	2	100

Table 5.2.6: Renal allograft biopsy by year and age group, rate per million populations, 2005-2022

Age	2005 (n=71)			2006 (n=118)			2007 (n=124)			2008 (n=124)			2009 (n=139)			2010 (n=180)		
	n	%	rate	n	%	rate	n	%	rate	n	%	rate	n	%	rate	n	%	rate
<15	0	0	0	5	4.2	0.2	7	5.6	0.3	9	7.3	0.3	8	4.4	0.3	8	4.4	0.3
15-<25	15	21.1	0.6	26	22.0	1.0	19	15.3	0.7	22	17.7	0.8	21	11.7	0.5	21	11.7	0.7
25-<35	11	15.5	0.4	25	21.2	1.0	15	12.1	0.6	20	16.1	0.7	29	16.1	1.1	29	16.1	1.0
35-<45	23	32.4	0.9	26	22.0	0.9	49	39.5	1.9	25	20.2	0.9	66	36.7	0.9	66	36.7	2.3
45-<55	12	16.9	0.5	24	20.3	0.9	24	19.4	0.9	35	28.2	1.3	40	22.2	1.3	40	22.2	1.4
55-<65	8	11.3	0.3	8	6.8	0.3	10	8.1	0.4	9	7.3	0.3	12	6.7	0.6	12	6.7	0.4
≥65	2	2.8	0.1	4	3.4	0.2	0	0	0	4	3.2	0.1	4	2.2	0	4	2.2	0.1

Age	2011 (n=239)			2012 (n=290)			2013 (n=244)			2014 (n=230)			2015 (n=291)			2016 (n=251)		
	n	%	rate	n	%	rate	n	%	rate	n	%	rate	n	%	rate	n	%	rate
<15	9	3.8	0.3	8	2.8	0.3	6	2.5	0.2	5	2.2	0.2	1	0.3	0	2	0.8	0.1
15-<25	34	14.2	1.2	21	7.2	0.7	22	9.0	0.7	27	11.7	0.9	25	8.6	0.8	15	6.0	0.5
25-<35	36	15.1	1.2	78	26.9	2.6	45	18.4	1.5	54	23.5	1.8	45	15.5	1.4	57	22.7	1.8
35-<45	86	36.0	3.0	76	26.2	2.6	73	29.9	2.4	62	27.0	2.0	86	29.6	2.8	62	24.7	2.0
45-<55	44	18.4	1.5	69	23.8	2.3	75	30.7	2.5	48	20.9	1.6	89	30.6	2.9	58	23.1	1.8
55-<65	29	12.1	1.0	33	11.4	1.1	19	7.8	0.6	30	13.0	1.0	39	13.4	1.3	44	17.5	1.4
≥65	1	0.4	0	5	1.7	0.2	4	1.6	0.1	4	1.7	0.1	6	2.1	0.2	13	5.2	0.4

Age	2017 (n=281)			2018 (n=260)			2019 (n=358)			2020 (n=293)			2021 (n=173)			2022 (n=253)		
	n	%	rate	n	%	rate	n	%	rate	n	%	rate	n	%	rate	n	%	rate
<15	0	0	0	4	1.5	0.1	9	2.5	0.3	2	0.7	0	3	1.7	0	6	2.4	0.1
15-<25	26	9.3	0.8	19	7.3	0.6	28	7.8	0.8	16	5.5	0.3	27	15.6	0.5	20	7.9	0.3
25-<35	70	24.9	2.2	58	22.3	1.5	81	22.6	2.1	75	25.6	1.3	40	23.1	0.7	77	30.4	1.4
35-<45	68	24.2	2.1	75	28.8	1.8	84	23.5	1.8	92	31.4	1.9	48	27.7	1.0	62	24.5	1.2
45-<55	70	24.9	2.2	57	21.9	1.0	78	21.8	1.5	51	17.4	1.5	27	15.6	0.8	50	19.8	1.4
55-<65	43	15.3	1.3	37	14.2	0.3	60	16.8	0.5	46	15.7	1.8	21	12.1	0.8	23	9.1	0.8
≥65	4	1.4	0.1	10	3.8	0.1	18	5.0	0.3	11	3.8	0.5	7	4.0	0.3	15	5.9	0.6

\*Rate based on the total population of the year of biopsy

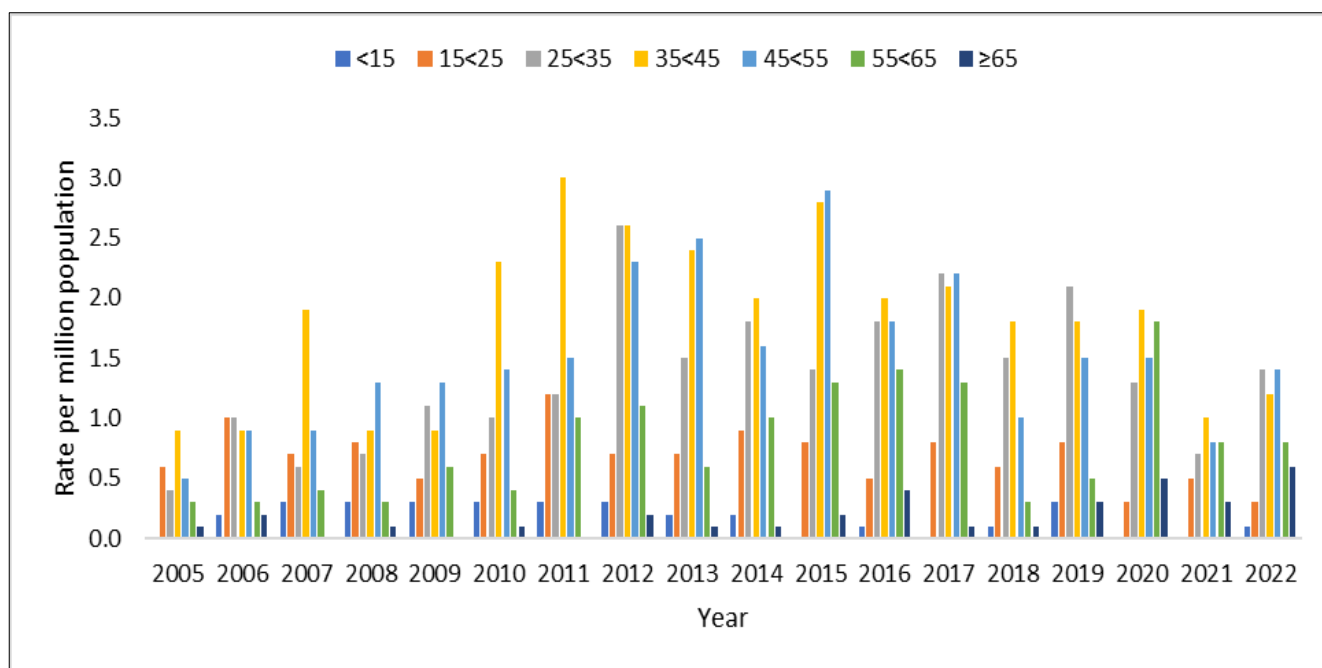


Figure 5.2.1: Allograft biopsy by year and age group, rate per million populations, 2005-2022

### 5.3 Clinical presentation at biopsy

- Almost two-third (65.4%) of all allograft biopsies were performed for abnormal allograft function, of which 46% were “Creeping creatinine” and 19.4% were “Acute deterioration” (Table 5.3.1).
- There was a doubling of allograft biopsies done for asymptomatic proteinuria, from 3.1% in 2005-2009 to 7.5% in 2022.
- Roughly 4% of the biopsies were performed to delineate the cause of poor or delayed graft function.
- About 20 – 30% of cases did not report clinical presentation of graft function.

Table 5.3.1: Indications for renal allograft biopsy, 2005-2022

Current clinical presentation	2005-2009 (n=576)		2010-2014 (n=1183)		2015-2019 (n=1441)		2020 (n=293)		2021 (n=173)		2022 (n=253)		Total (n=3919)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
<b>Urine abnormality</b>	<b>42</b>	<b>-</b>	<b>81</b>	<b>-</b>	<b>115</b>	<b>-</b>	<b>22</b>	<b>-</b>	<b>19</b>	<b>-</b>	<b>23</b>	<b>-</b>	<b>302</b>	<b>-</b>
Asymptomatic hematuria	2	0.3	6	0.5	10	0.7	1	0.3	1	0.6	0	0	20	0.5
Asymptomatic hematuria and proteinuria	8	1.4	22	1.9	31	2.2	4	1.4	1	0.6	0	0	66	1.7
Asymptomatic proteinuria	18	3.1	39	3.3	47	3.3	9	3.1	11	6.4	19	7.5	143	3.6
Gross Hematuria	3	0.5	1	0.1	2	0.1	0	0	0	0	0	0	6	0.2
Nephrotic range proteinuria	8	1.4	6	0.5	14	1.0	8	2.7	6	3.5	4	1.6	46	1.2
Not Available**	11	1.9	6	0.5	11	0.8	0	0	0	0	0	0	21	0.5
<b>Graft function</b>	<b>530</b>	<b>-</b>	<b>907</b>	<b>-</b>	<b>925</b>	<b>-</b>	<b>190</b>	<b>-</b>	<b>122</b>	<b>-</b>	<b>182</b>	<b>-</b>	<b>2856</b>	<b>-</b>
Acute deterioration	231	40.1	188	15.9	208	14.4	57	19.5	29	16.8	46	18.2	759	19.4
Creeping creatinine	228	39.6	640	54.1	609	42.3	117	39.9	85	49.1	124	49.0	1803	46.0
Poor delayed graft function	69	12.0	73	6.2	92	6.4	14	4.8	7	4.0	11	4.3	266	6.8
Not available**	2	0.3	6	0.5	16	1.1	2	0.7	1	0.6	1	0.4	28	0.7
No information***	28	4.9	258	21.8	450	31.2	99	33.8	47	27.2	59	23.3	973	24.8

\* Patients may have one or more clinical presentation

\*\*Not available-missing type of clinical presentation

\*\*\*No information of clinical presentation

### 5.4 Timing of renal allograft biopsy

- Over the last 18 years, there had not been much change in the timing of renal allograft biopsies.
- Allograft biopsies performed within 1-month post-transplantation in 2020, 2021 and 2022 were 17%, 13% and 16% respectively.
- Allograft biopsies performed after 1-year post-transplantation were 42%, 55% and 44% respectively, for 2020, 2021 and 2022.

Table 5.4: Timing of renal allograft biopsy, 2005-2022 (dates: date of biopsy & date of transplant)

Timing of renal transplant biopsy	Within 1 week		>1 week to 1 month		> 1 month to 3 months		> 3 months to 6 months		> 6months to 1 year		>1-year post-transplant		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
2005-2009	21	3.7	65	11.3	75	13.0	42	7.3	50	8.7	322	56.0	575	100
2010-2014	41	3.5	184	15.6	189	16.0	136	11.5	128	10.8	505	42.7	1183	100
2015-2019	45	3.1	165	11.5	206	14.3	169	11.7	176	12.2	680	47.2	1441	100
2020	15	5.1	35	11.9	36	12.3	46	15.7	38	13.0	123	42.0	293	100
2021	7	4.3	14	8.6	20	12.3	14	8.6	19	11.7	89	54.6	163	100
2022	7	2.8	32	12.9	35	14.1	41	16.5	25	10.0	109	43.8	249	100

\*15 notifications with the missing date of transplant

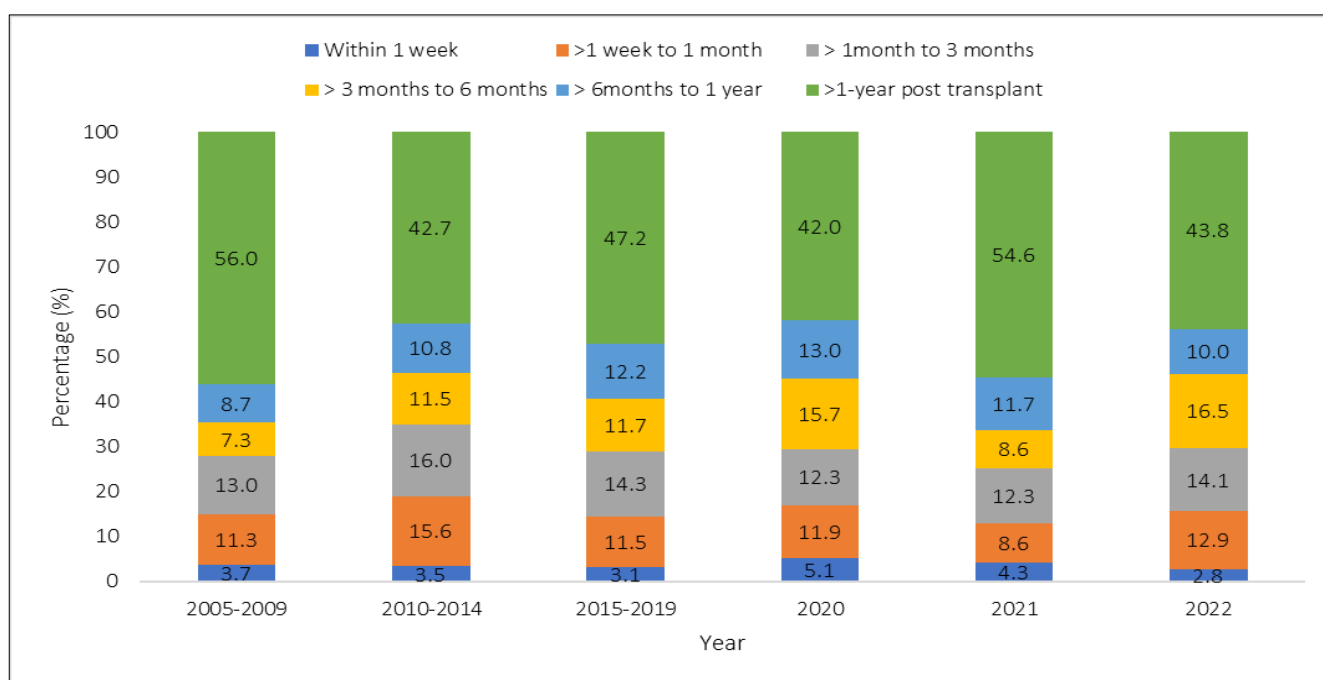


Figure 5.4: Timing of renal allograft biopsy, 2005-2022

## 5.5 Renal allograft biopsy procedure

### 5.5.1 Renal allograft biopsy method

- All the renal allograft biopsies were performed under ultrasonographic guidance primarily for the last 3 years.
- The number of allograft biopsies performed without real-time ultrasonographic guidance continued to decline, with only 0%, 2.9% and 0.4% in the recent 3 years.
- However, up to 30% of the biopsies methods were not reported (Table 5.5.1).

Table 5.5.1: Biopsy method, 2005-2022

Method	2005-2009 (n=576)		2010-2014 (n=1183)		2015-2019 (n=1441)		2020 (n=293)		2021 (n=173)		2022 (n=253)		Total (n=3919)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Blind (not US-guided)	2	0.3	2	0.2	1	0.1	0	0	0	0	0	0	5	0.1
US-guided: real-time	339	58.9	657	55.5	806	55.9	155	52.9	111	64.2	165	65.2	2233	57.0
US-guided: not real-time	81	14.1	116	9.8	5	0.3	0	0	5	2.9	1	0.4	208	5.3
Not available	154	26.7	408	34.5	629	43.7	138	47.1	57	32.9	87	34.4	1473	37.6

### 5.5.2 Number of passes

- The number of passes made during renal allograft biopsy showed a similar trend since 2005, with the majority being either one or 2 passes.
- In the last 3 years (2020, 2021, 2022), 1 or 2 passes comprised 49%, 57% and 59% respectively. In comparison, the percentage of 3 or more attempts made was 6.8%, 10.4% and 7.5%, respectively, over these 3 years.
- The remaining data on the number of passes were not reported (Table 5.5.2 & Figure 5.5.2).

Table 5.5.2: Number of passes, 2005-2022

Number of passes	2005-2009 (n=576)		2010-2014 (n=1183)		2015-2019 (n=1441)		2020 (n=293)		2021 (n=173)		2022 (n=253)		Total (n=3919)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
1	133	23.1	251	21.2	337	23.4	72	24.6	51	29.5	81	32.0	925	23.6
2	227	39.4	416	35.2	371	25.7	73	24.9	48	27.7	68	26.9	1203	30.7
3	53	9.2	94	7.9	90	6.2	18	6.1	16	9.2	14	5.5	285	7.3
4	4	0.7	19	1.6	27	1.9	2	0.7	1	0.6	4	1.6	57	1.5
5	0	0	5	0.4	3	0.2	0	0	1	0.6	1	0.4	10	0.3
6	0	0	2	0.2	0	0	0	0	0	0	0	0	2	0.1
Not available	159	27.6	396	33.5	613	42.5	128	43.7	56	32.4	85	33.6	1437	36.7

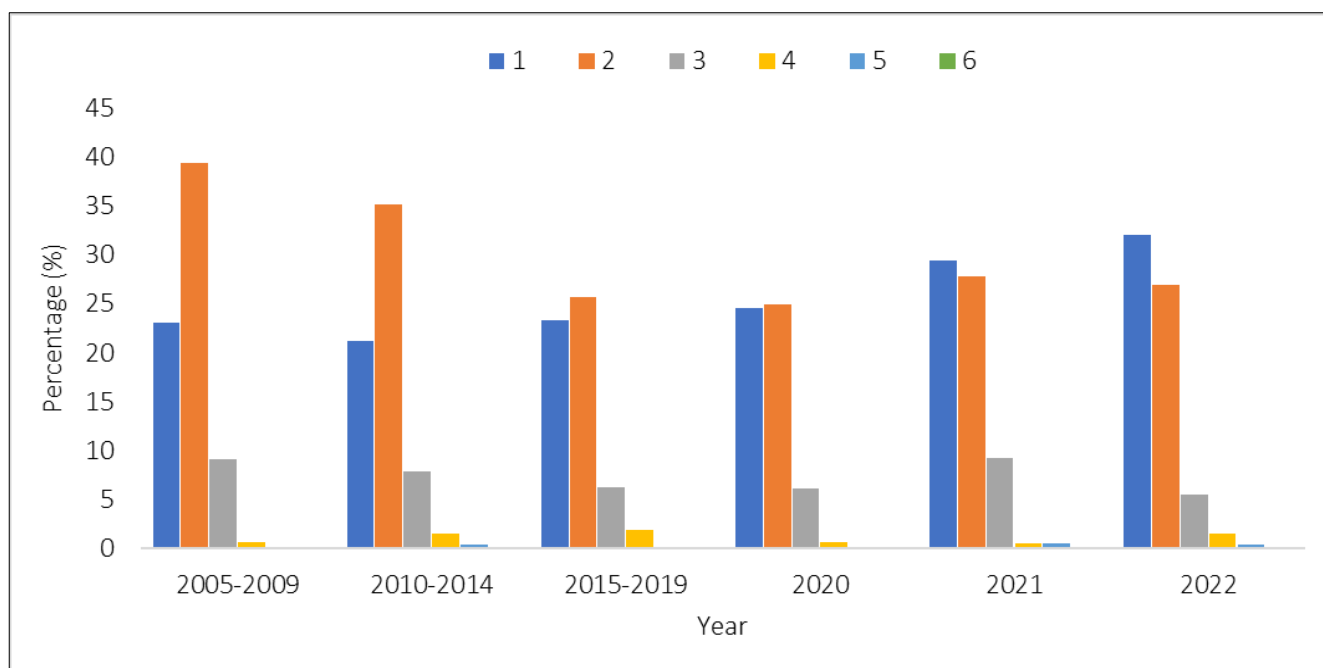


Figure 5.5.2: Number of passes, 2005-2022

### 5.5.3 Number of glomeruli obtained on biopsy

- A successful allograft biopsy is defined as having at least 10 glomeruli in the specimen.
- Despite increasing utility of using ultrasonographic guidance real-time allograft biopsies, there were 22.5%, 17.3% and 19% biopsy reported to have nine or fewer glomeruli, over the last three years.

Table 5.5.3: Number of glomeruli obtained on biopsy, 2005-2022

Number of glomeruli obtained	2005-2009 (n=576)		2010-2014 (n=1183)		2015-2019 (n=1441)		2020 (n=293)		2021 (n=173)		2022 (n=253)		Total (n=3919)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
0	26	4.5	54	4.6	49	3.4	8	2.7	3	1.7	4	1.6	144	3.7
1-9	147	25.5	341	28.8	340	23.6	58	19.8	27	15.6	44	17.4	957	24.4
10-19	249	43.2	489	41.3	615	42.7	124	42.3	69	39.9	92	36.4	1638	41.8
≥20	145	25.2	259	21.9	409	28.4	88	30	54	31.2	87	34.4	1042	26.6
Unknown	9	1.6	40	3.4	28	1.9	15	5.1	20	11.6	26	10.3	138	3.5

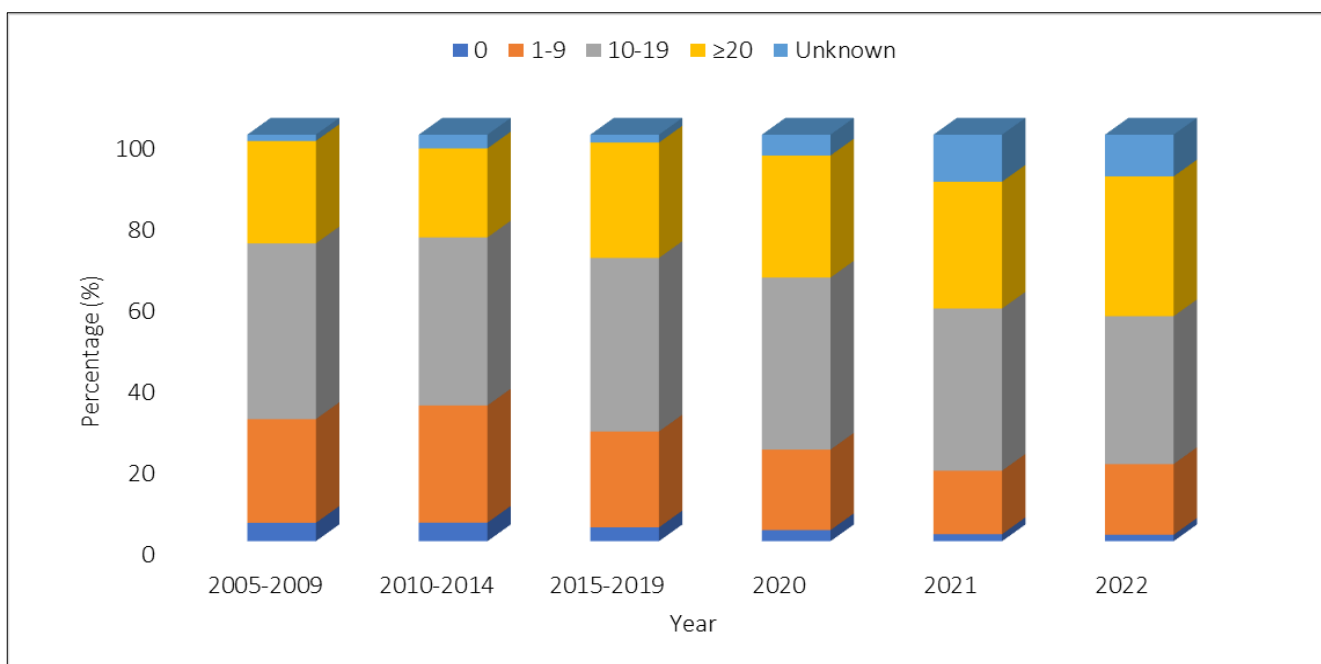


Figure 5.5.3: Number of glomeruli obtained on biopsy, 2005-2022

### 5.5.4 Type of complications

- Complications associated with allograft biopsy that required intervention were extremely low, with 0 cases reported over the last three years (Table 5.5.4).

Table 5.5.4: Type of complications, 2005-2022

Type of complications	2005-2009 (n=576)		2010-2014 (n=1183)		2015-2019 (n=1441)		2020 (n=293)		2021 (n=173)		2022 (n=253)		Total (n=3919)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Mild complication <sup>a</sup>	10	1.7	14	1.2	11	0.8	1	0.3	3	1.7	2	0.8	41	1.0
Severe complication <sup>b</sup>	4	0.7	3	0.3	1	0.1	0	0	0	0	0	0	8	0.2
No complication	562	97.6	1166	98.6	1429	99.2	292	99.7	170	98.3	251	99.2	3870	98.7

<sup>a</sup>Mild complication is defined as the presence of gross hematuria, perirenal collection, hematoma, or AVM that do not require intervention.

<sup>b</sup>Severe complication is defined as the presence of hypotension or complications requiring intervention.

## 5.6 Histological diagnosis

- Allograft rejection remained the most common histological diagnosis over the years. This can be either acute or borderline rejection.
- Borderline rejections were identified in the setting of protocol biopsy (without biochemical abnormalities).
- Moreover, for the last three years, the reported histological diagnosis of borderline rejection superseded acute rejection histology, with reported cases of 20.8%, 9.8% and 17% in 2020, 2021 and 2022, respectively. This could be due to the lower threshold of performing allograft biopsy and hence detecting borderline rejection early.
- In comparison, reported cases of acute rejection over these three years were 10.9%, 7.5% and 12.3% respectively (Table 5.6 & Figure 5.6). This was consistent with around 19% of the allograft biopsies were performed because of acute deterioration of allograft function (Table 5.3.1).
- Interestingly, the histological diagnosis of acute tubular necrosis demonstrated an increasing pattern over the last three years, contributing 20.1%, 23.7% and 24.5% from the yearly histological diagnosis (Figure 5.6). This was in contrast to the earlier years. The likely reason was probably the increasing trend of deceased donor transplantation.
- The histological diagnosis of calcineurin inhibitor toxicity, chronic allograft nephropathy and recurrent GN had demonstrated a declining trend over the years. The percentage of calcineurin inhibitor toxicity was reported to be about 5.9 % in the year 2022. The low number of this incidence was likely due to lower therapeutic targets over the years post-transplantation as well as improved histopathological interpretation.
- Other histological diagnoses of diabetic nephropathy, de novo disease and PTLD remained uncommon findings.

Table 5.6: Histological diagnosis, 2005-2022

Benign/malignant hypertension	2005-2009 (n=576)		2010-2014 (n=1183)		2015-2019 (n=1441)		2020 (n=293)		2021 (n=173)		2022 (n=253)		Total (n=3919)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Acute rejection	116	20.1	183	15.5	220	15.3	32	10.9	13	7.5	31	12.3	592	15.1
Borderline rejection	54	9.4	236	19.9	366	25.4	61	20.8	17	9.8	43	17.0	777	19.8
Calcineurin inhibitor toxicity	110	19.1	128	10.8	75	5.2	14	4.8	15	8.7	15	5.9	354	9.0
Chronic allograft nephropathy	108	18.8	61	5.2	73	5.1	8	2.7	2	1.2	15	5.9	267	6.8
Acute tubular necrosis	90	15.6	154	13.0	283	19.6	59	20.1	41	23.7	62	24.5	689	17.6
'Acute interstitial nephritis	5	0.9	6	0.5	19	1.3	4	1.4	1	0.6	5	2.0	40	1.0
Chronic interstitial nephritis	9	1.6	32	2.7	16	1.1	2	0.7	0	0	6	2.4	65	1.7
PTLD**	7	1.2	1	0.1	12	0.8	1	0.3	1	0.6	1	0.4	23	0.6
De novo	0	0	4	0.3	3	0.2	3	1.0	1	0.6	2	0.8	13	0.3
Recurrent GN	22	3.8	23	1.9	2	0.1	0	0	1	0.6		0	48	1.2
Diabetic nephropathy	11	1.9	10	0.8	16	1.1	5	1.7	3	1.7	3	1.2	48	1.2
Benign/malignant hypertension	3	0.5	32	2.7	43	3.0	3	1.0	6	3.5	8	3.2	95	2.4
Others	17	3.0	117	9.9	105	7.3	17	5.8	5	2.9	16	6.3	277	7.1

\*\* \*Post Transplant Lymphoproliferative disease

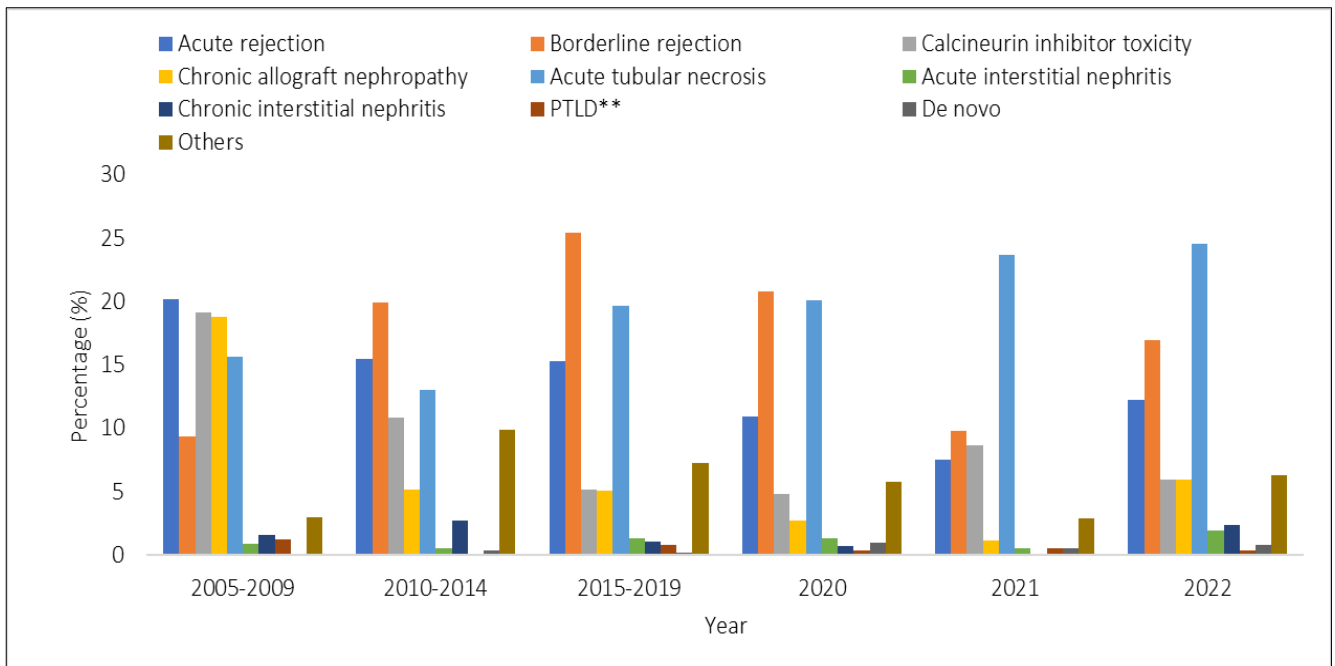


Figure 5.6: Histological diagnosis, 2005-2022



# **APPENDIX I**

## **ANALYSIS CRITERIA AND STATISTICAL METHODOLOGY**

# Appendix I

## ANALYSIS CRITERIA AND STATISTICAL METHODOLOGY

### ANALYSIS SETS

This pertains to the data sets of cases incorporated in the analysis for this report. The period covered by the current report spans from 1<sup>st</sup> January 2005 to 31<sup>st</sup> December 2022.

#### 1. All native renal biopsy

The analysis set in Chapter 1 includes patients who underwent native renal biopsy.

#### 2. Primary glomerulonephritis patients

Chapter 2 discusses patients over 15 years old who had primary glomerulonephritis at the time of their renal biopsy.

#### 3. Lupus nephritis patients

Chapter 3 describes patients over 15 years old at the time of biopsy, diagnosed with lupus nephritis, and marked YES for SLE.

#### 4. Paediatric native renal biopsy

Chapter 4 describes patients who were under 15 years old at the time of the biopsy.

#### 5. Renal Allograft biopsy

The analysis includes only graft biopsies.

### STATISTICAL METHOD

#### Number of episodes of renal biopsy

The analysis set is based on the biopsy number, defined as the number of renal biopsy episodes in patients. Only the highest episode per patient was considered. This analysis set was used in Chapters 1, 3, 4, and 5.

#### Patient's characteristics

These sections include the patient's age at biopsy, gender, and ethnic group in every chapter of this report. Ethnic groups other than Malay, Chinese, or Indian are classified as "Others". Patients' age was also presented as a density histogram, where the height of the bars is scaled so that their total area equals 1. The density scale is calculated by determining the probability of patients within a given interval and dividing it by the interval width. This figure was included in Chapters 2 and 3.

#### Clinical presentation

These sections described clinical presentation at the time of biopsy. Apart from clinical presentation, chapter 2 and chapter 3 also report on prevalence of hypertension and degree of renal function.

**Biopsy data**

The biopsy data and outcome on complications are reported in Chapter 1, Chapter 2, Chapter 4 and Chapter 5.

**Laboratory data**

Given the significant amount of missing data, only GFR data was analyzed and reported in all applicable chapters.

**Histopathological diagnosis**

A detailed analysis of histopathological diagnosis is presented in Chapter 1 for renal biopsy and Chapter 5 for renal allograft biopsy. Chapters 2, 3, and 4 focus on primary glomerulonephritis, secondary glomerulonephritis, and histopathological diagnosis in the pediatric population, respectively.

**Survival analysis**

The unadjusted survival probabilities were calculated using the Kaplan-Meier method. Survival analysis models time-to-event data, where death and end-stage renal failure are considered events for patient survival and renal survival, respectively. Patients were censored if they were lost to follow-up or died in the context of renal survival. This analysis was conducted in Chapters 2, 3, and 4.

**Renal allograft biopsy rates**

The renal transplant biopsy rate is calculated as the ratio of the number of patients each year (categorised by age group) to Malaysia's population for that year, expressed per million population. This analysis was conducted in Chapter 5.

**Univariate analysis**

In Chapter 4, univariate analyses were conducted, including simple logistic regression, to examine the clinical characteristics of children with steroid-resistant nephrotic syndrome and identify risk factors for biopsy complications.



# **APPENDIX II**

## **DATA MANAGEMENT**

**Lim Jie Ying**  
**Choo Cheh Loo**  
**Wan Najdah Binti Wan Mohamad Ali**  
**Amy R Porle**  
**Sebastian Thoo**

## Appendix II

The Malaysian Registry of Renal Biopsy (MRRB) was established on the 1<sup>st</sup> January 2005. It started off as a pilot project involving centers with Nephrology services within the Ministry of Health Malaysia. In its infancy, this registry was called Glomerulonephritis (GN) Registry but subsequently changed to MRRB as it was deemed to be more appropriate.

The MRRB has gone through several enhancements in the data collection format in order to make it user friendly.

The operations of the MRRB are supported by an extensive ICT infrastructure to ensure operational efficiency and effectiveness. The MRRB data is stored in SQL Server and has a web-based application.

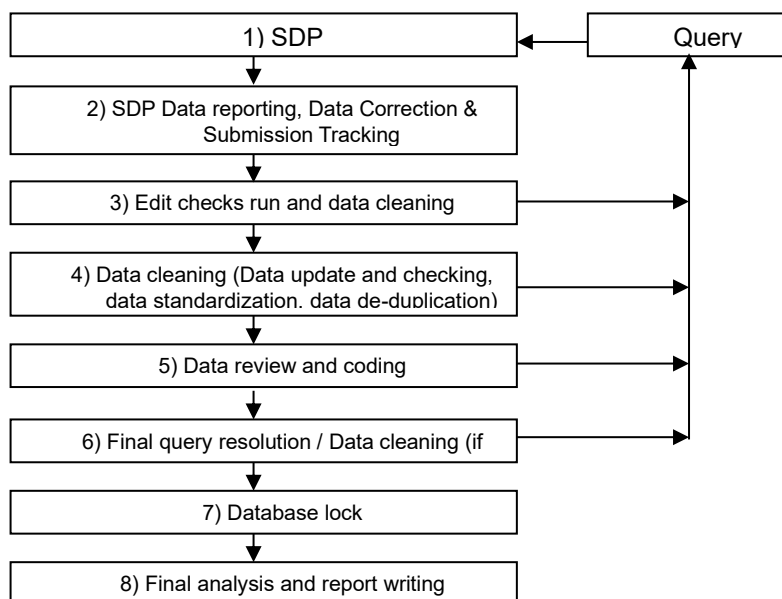
### DATA SOURCES

Before the setting up of the MRRB, there were two separated databases in MOH related to renal biopsy. They were the paediatric (Institute Paediatric, HKL) renal biopsy database (1993 – 2004) and adult Department of Nephrology HKL renal biopsy database (2004-2005). The data from these databases had been mapped and incorporated into MRRB in 2005. In the period between 2005 and 2022, the number of sites had increased and as of 2022, there were 58 sites submitting data to MRRB.

MRRB intends to be a national population-based registry and the participation is opened to all hospitals with nephrology services for renal biopsy throughout Malaysia.

### DATA FLOW PROCESS

This section describes the data management flow process of the Malaysian Registry of Renal Biopsy.



**SDP**

Nephrologist or renal physician who provides renal biopsy services in Malaysia.

**SDP Data reporting, Data Correction and Submission tracking**

Primary source data is reported by SDP via web applications e-Case Report Forms:

- MRRB Patient Notification form (Native Kidney Biopsy)
- MRRB Patient Notification form (Graft Kidney Biopsy)
- MRRB Biopsy Procedure form
- MRRB Outcome Notification form

The secondary data source is to determine both renal and mortality outcomes. Verification of both renal and mortality outcomes can be done through the Malaysian Dialysis and Transplant Registry and National Vital Registration System respectively.

**Edit checks run and Data cleaning**

Edit checks identify missing compulsory data, out of range values, inconsistent data, invalid values and error with de-duplication. Data cleaning is then performed based on the results of edit checks.

**Data review and coding**

Expert panels and registry manager performed data coding of free text description to its predetermined coding table or dictionary. The expert panel comprises of members with expertise and knowledge in the relevant area. They also perform Quality Control function on the assessment of coding. They ensure that complex medical data are reviewed and assessed to detect clinical nuances.

**Final query resolution / data cleaning / database lock**

A final edit check was performed to ensure that data is clean. All queries were resolved before database is locked to ensure data quality and integrity. Final dataset is subsequently locked and exported to statistician for analysis.

**Data release and publication policy**

The MRRB is part of the National Renal Registry (NRR), which is owned by the Malaysian Society of Nephrology (MSN). One of the primary objectives of the Registry is to make data available to the renal community.

The registry's published report is available on the websites (<http://www.msn.org.my/nrr> or <https://www.macr.org.my/emrrb>). The report is copyrighted. However, it may be freely reproduced without the permission of the National Renal Registry, Malaysia. Acknowledgement would be appreciated. Suggested citation is: Thong KM (Eds), 8th Report of the Malaysian Registry of Renal Biopsy 2022, Kuala Lumpur 2025.

The Registry encourages original research and publication using MRRB data in part or full. Any request for raw data or aggregated data must be made in writing (by e-mail, fax, or registered mail). The researcher is required to submit a completed Data Release Application Form and signed Data Release Agreement Form, accompanied with a study proposal / mock table. Such request will require approval from NRR Advisory Board.

**NRR POSITION AS FOLLOWS:**

- The NRR does not envisage independent individual publication based entirely on NRR published results, without further analyses or additional data collection.
- NRR however agrees that investigator shall have the right to publish any information or material arising in part out of NRR work. In other words, there must be additional original contribution by the investigator in the work intended for publication.
- NRR encourages the use of its data for research purpose. Any proposed publication or presentation (e.g. manuscript, abstract or poster) for submission to journal or scientific meeting that is based in part or entirely on NRR data should be sent to the NRR prior to submission. NRR will undertake to comment on such documents within 4 weeks. Acknowledgement of the source of the data would also be appreciated.
- Any formal publication of a research based in part or entirely on NRR data in which the input of NRR exceeded that of conventional data management and provision will be considered as a joint publication by investigator and the appropriate NRR personnel.

The Malaysian Society of Nephrology has made a grant towards the cost of running the registry and the report printing to allow distribution to all members of the association and the source data producers. The report will also be distributed to relevant Health Authorities and international registries.

# **APPENDIX III**

# **ABBREVIATIONS**

## Appendix III

### ABBREVIATIONS

ANCA	Antineutrophilic Cytoplasmic Antibody
AVM	Arterio-venous malformation
eGFR	Calculated Creatinine Clearance based on Schwartz Formula
ESRD	End Stage Renal Disease
FSGS	Focal Segmental Glomerulosclerosis
GN	Glomerulonephritis
Hb	Hemoglobin
HPE	Histopathology Examination
HSP	Henoch-Schonlein Purpura
HUS/TTP	Haemolytic Uremic Syndrome / Thrombotic Thrombocytopenic Purpura
IgAN	IgA Nephropathy
IMN	Idiopathic Membranous Nephropathy
ISN/RPS	International Society Nephrology/ Renal Pathology Society
LN	Lupus Nephritis
MCD	Minimal Change Disease
MOH	Ministry of Health, Malaysia
MyKAS	Malaysian Kidney Allocation System
MRRB	Malaysian Registry of Renal Biopsy
MSN	Malaysian Society of Nephrology
NRR	National Renal Registry
Ref*	References
RRT	Renal Replacement Therapy
SDP	Source Data Producer
SLE	Systemic Lupus Erythromatosus
WHO	World Health Organization

# APPENDIX IV

## FORMULA

## Appendix IV

### e-GFR formula

This formula is used in Chapter 4 Paediatric Renal Biopsy

### Calculated Creatinine Clearance base on Schwartz Formula:

$$\text{Schwartz Formula} = \frac{*K \times \text{Height (cm)}}{\text{Serum Creatinine (umol/L)}}$$

*\*K for infant less than 1 year is 35,*

*\*K for child >1year is 40*

### MDRD for Adult

Male :  $175 \times (\text{creatinine(umol/l)} / 88.4)^{-1.154} \times (\text{age})^{-0.203} \times 1.0$

Female :  $175 \times (\text{creatinine (umol/l)} / 88.4)^{-1.154} \times (\text{age})^{-0.203} \times 0.742$