Singapore Renal Registry
Annual Report 2021

National Registry of Diseases Office

Acknowledgement

This report was produced with joint effort from the following staff of Health Promotion Board.

National Registry of Diseases Office

Registry Coordinators	Ms Lynn Khor Ms Ang Ghim Sin Ms Grace Cai Ms Maureen Ng Dr Win Nyunt Ms Wong Seow Foong
Data Manager	Mr Augustine Ng
Biostatistician	Ms Zheng Huili
Deputy Director	Dr Foo Ling Li
Group Director	Dr Annie Ling

Contents

1. GLOSSARY

ASIR	Age-standardised incidence rate
ASPR	Age-standardised prevalence rate
Ca	Calcium
CKD5	Chronic kidney disease stage 5
CIR	Crude incidence rate
CPR	Crude prevalence rate
CVD	Cerebrovascular disease
DN	Diabetic nephropathy
eGFR	Estimated glomerular filtration rate
ESA	Erythropoietin stimulating agent
IHD	Ischemic heart disease
Kt/V	Fractional clearance of urea
GN	Glomerulonephritis
HD	Haemodialysis
hb	Haemoglobin
iPTH	Intact parathyroid hormone
PD	Peritoneal dialysis
pmp	Per million population
PO_4	Phosphate
PVD	Peripheral vascular disease
SRR	Singapore Renal Registry
URR	Urea reduction ratio
VWO	Voluntary Welfare Organisation

2. EXECUTIVE SUMMARY

The crude incidence rate (CIR) of chronic kidney disease stage 5 (CKD5) increased significantly from 418.8 per million population (pmp) in 2011 to 556.1 pmp in 2020. While the age-standardised incidence rate (ASIR) of CKD5 remained stable and ranged between 266.7 pmp and 295.6 pmp in 2011 to 2020, the ASIR of definitive dialysis increased significantly from 169.6 pmp in 2011 to 195.9 pmp in 2021. The age-standardised prevalence rate (ASPR) of definitive dialysis also increased significantly from 919.2 pmp in 2011 to 1182.3 pmp in 2021.

Males outnumbered females in both the incidence and prevalence rates of dialysis. In 2021, the ASIR was 244.0 pmp for males and 151.4 pmp for females, while the ASPR was 1391.2 pmp for males and 989.7 pmp for females. The incidence and prevalence rates of dialysis were higher among Malays than Chinese and Indians. In 2021, the ASIR was 154.5 pmp for Chinese, 482.7 pmp for Malays and 187.4 pmp for Indians, while the ASPR was 924.0 pmp for Chinese, 2986.1 pmp for Malays and 1196.6 pmp for Indians. Most dialysis patients were on haemodialysis (HD). 80.9% of the new patients and 86.9% of the prevalent patients were on HD in 2021. Diabetic nephropathy (DN) was the main cause of CKD5 among patients on dialysis. 66.9% of the new dialysis patients and 56.3% of the prevalent dialysis patients had DN in 2021.

Cardiac event and infection were the two most common causes of death among prevalent patients on dialysis. 40.7% of the deaths in 2021 were due to cardiac event, while 29.8% were due to infection. After adjusting for demographics, etiology and co-morbidities, the risk of death was 1.5 times higher for patients on peritoneal dialysis (PD) compared to those on HD. This is mainly because patients who were older and/or with medical conditions (besides the co-morbidities captured by the Singapore Renal Registry) were preferentially placed on PD, a gentler therapy than HD. However, the disparity in survival between HD and PD narrowed over the years as the survival of HD patients remained stable while the survival of PD patients significantly improved.

The management of prevalent patients on dialysis was assessed using several criteria: frequency of dialysis, management of urea, management of anaemia, and management of mineral and bone disease. 97.0% of the HD patients had thrice weekly dialysis in 2021. Urea was well managed in 97.6% of the HD patients and 36.5% of the PD patients based on their urea reduction ratio or fractional clearance of urea in 2021. Anaemia was well managed in 75.5% of the HD patients and 60.2% of the PD patients based on their haemoglobin level in 2021. Bone metabolism was well managed in 73.7%, 56.2% and 27.8% of the HD patients and 59.9%, 54.6% and 27.1% of the PD patients based on their calcium level, phosphate level and intact parathyroid hormone level respectively in 2021.

The ASIR of kidney transplant fluctuated over the years between 2011 and 2021 due to the small number of transplants done each year. However, the ASPR of kidney transplant remained stable during the same period as survival among the transplant patients was high. The ASIR was 14.2 pmp, while the ASPR was 260.0 pmp in 2021.

Males outnumbered females in both the incidence and prevalence rates of kidney transplant. In 2021, the ASIR was 16.2 pmp for males and 12.4 pmp for females, while the ASPR was 283.6 pmp for males and 238.3 pmp for females. There was no consistent ethnic difference in the incidence rate of transplant, but Chinese had the highest prevalence rate of transplant. In 2021, the ASIR was 14.1 pmp for Chinese, 17.4 pmp for Malays and 11.4 pmp for Indians, while the ASPR was 261.1 pmp for Chinese, 241.7 pmp for Malays and 227.0 pmp for Indians. Most transplants were performed locally. 95.9% of the transplants in 2021 were performed in Singapore. Glomerulonephritis (GN) was the main cause of CKD5 among patients with transplant. 52.7% of the new transplant patients and 65.8% of the prevalent transplant patients had GN in 2021.

Patients with kidney transplants from living donors had better survival (5-year graft survival 93.9%, 5-year patient survival 96.3%) than those with kidney transplants from deceased donors (5-year graft survival 85.9%, 5-year patient survival 91.6%). After adjusting for demographics, etiology and co-morbidities, the risk of death was lower for patients with transplant, be it from living or deceased donor, than those who were on dialysis.

3. INTRODUCTION

Chronic kidney disease (CKD) is a worldwide epidemic[1], with diabetes as its leading cause. Based on the National Population Health Survey 2020, about 1 in 10 Singapore residents have diabetes[2]. Our ageing population further compounds the situation in Singapore as decline in kidney function tends to rise with age[3].

Estimated glomerular filtration rate (eGFR; glomerular filtration rate corrected to body surface area of 1.73m^2) is one of the markers of kidney damage. Internationally, CKD is defined as eGFR <60 mL/min/1.73m^2. There are five stages of CKD. This report focuses on CKD5, the most severe stage of kidney failure, whereby the eGFR is <15 ml/min/1.73m^2 on at least two occasions >90 days apart. CKD5 patients may undergo dialysis, kidney transplant or conservative management after discussion with their doctor. This report focuses on CKD5 patients who were on renal replacement therapy (i.e. dialysis or kidney transplant). There are two main modalities of dialysis: haemodialysis (HD) and peritoneal dialysis (PD). Older patients and/or those with medical conditions were preferentially placed on PD, a gentler therapy compared to HD.

[1] Mallamaci F. Highlights of the 2015 ERA-EDTA congress: chronic kidney disease, hypertension. Nephrology Dialysis Transplant. 2016; 31(7): 1044-1046.
[2] National Population Health Survey 2020 (Household Interview and Health Examination). Ministry of Health, Singapore. www.moh.gov.sg/resources-statistics/reports//national-survey-2019-20 Accessed on 1 Feb 2022.
[3] Ayodele OE and Alebiosu CO. Burden of chronic kidney disease: an international perspective. Advanced Chronic Kidney Disease. 2010; 17(3): 215-224.

4. METHODOLOGY

The National Registry of Diseases Office (NRDO) collects and analyses epidemiological data to support policy planning and review as well as programme evaluation.

In most renal registries, only patients who initiated dialysis are captured[4]. There are also others, such as the United States Renal Data System[5], which capture only patients who survived >90 days after initiation of dialysis. However, these registries may underestimate the burden of kidney failure in the country and the workload of healthcare professionals. Hence, the Singapore Renal Registry (SRR) captures patients with CKD5, regardless whether they have initiated dialysis or survived >90 days after initiation of dialysis.

In 2007, the Singapore General Hospital started providing their list of patients with eGFR <15 ml/min/1.73m^2 to the SRR. This practice was followed by the National University Hospital in 2009 and the remaining healthcare institutions in 2010, after legislation mandating notification of CKD5 from all healthcare institutions was put in place by the Ministry of Health.

Data sources

The SRR receives CKD5 case notifications from the public hospitals, dialysis centres, private nephrology clinics, kidney transplant centres and the National Organ Transplant Unit.

From 1999 to 2009, case finding for CKD5 was guided by serum creatinine ≥10 mg/dl or ≥880 µmol/L, or initiation of renal replacement therapy. Since 2010, to ensure that case coverage is as comprehensive as possible, the guiding principle was subsequently changed to serum creatinine ≥500 µmol/L, eGFR <15 ml/min/1.73m^2, or initiation of renal replacement therapy. Once a potential CKD5 case is identified, the SRR monitors the patient's eGFR readings that are at least six months apart before accepting the case as CKD5. The monitoring period is to let the eGFR readings stabilise over a period of time for accurate case ascertainment and to rule out the possibility of acute kidney impairment. This is in accordance with the Kidney Disease Outcomes Quality Initiative guidelines[6].

The registry coordinators confirm the diagnosis of CKD5 by viewing the patients' medical records, before extracting relevant detailed clinical information from there.

For this report, the death status of all patients registered in the SRR were updated till 30 April 2022 by matching the patients' unique National Registration Identity Card number with information from the Death Registry.

[4] Liu FX, Rutherford P, Smoyer-Tomic K, Prichard S, Laplante S. A global overview of renal registries: a systematic review. BMC Nephrology. 2015; 16: 31.
[5] United States Renal Data System (USRDS). www.usrds.org Accessed on 1 Mar 2021.
[6] Chronic Kidney Disease: Evaluation, Classification, and Stratification 2002. National Kidney Foundation, New York.

The Singapore population estimates used to calculate the incidence rates and prevalence rates in this report were obtained from the Singapore Department of Statistics, which releases mid-year population estimates of Singapore residents (i.e. Singapore citizens and permanent residents) annually[7]. The Segi World population estimates used for age standardisation are available on the World Health Organisation website[8].

This report focuses on Singapore residents with CKD5 and underwent dialysis or kidney transplant in 2011 to 2021, as they stood on 20 July 2022. Statistics on prevalence and survival included patients since the start of the SRR in 1999. Detailed definition of each indicator is elaborated at the start of each section of this report.

[7] SingStat Table Builder, Population and Population Structure, Annual Population, Singapore Residents by age group, ethnic group and sex. Department of Statistics, Singapore. www.tablebuilder.singstat.gov.sg Accessed on 9 May 2022.
[8] Omar BA et al. Age standardization of rates: a new WHO standard. GPE discussion paper series: no. 31. EIP.GPE/EBD World Health Organization 2001.

5. FINDINGS

5.1 Overview of dialysis and transplant

Table 5.1.1 shows the stock and flow of patients in the past five years from 2017 to 2021. The number of new dialysis patients, deaths among dialysis patients, and prevalent dialysis patients generally increased over the years. The number of new kidney transplant patients generally dropped during the same period, though there was a slight rise in 2021. Deaths among transplant patients and number of prevalent transplant patients remained stable over the years.

Table 5.1.1: Stock and flow in 2017 – 2021

	2017	2018	2019	2020	2021
Incidence					
Definitive dialysis	1173	1255	1207	1334	1409
Transplant	115	114	105	50	74
Death					
Definitive dialysis	879	915	907	957	1029
Transplant	20	39	33	30	34
Prevalence					
Definitive dialysis	7007	7407	7765	8219	8668
Transplant	1568	1602	1619	1609	1609

All dialysis and transplant patients are tracked by the SRR at the end of every year as part of the year-end follow-up monitoring. Patients can be followed up for dialysis or consultation with nephrologist, and the prevalence numbers in Table 5.1.2 were based on the last follow-up visit for each patient.

Not only are HD patients followed up by their nephrologists in the public hospital[9], they also have routine follow-up at the dialysis centre, where they go for their regular dialysis. In 2021, most of the prevalent HD patients were last followed up at dialysis centres run by the Voluntary Welfare Organisations (VWO, 62.6%), followed by the private clinics and dialysis centres (35.3%), then the public hospitals and affiliated dialysis centres (2.2%).

On the other hand, as PD is done at home, follow-up among PD patients is typically for consultation with their nephrologists, where PD was initiated. Almost all the prevalent PD patients (99.2%) were last followed up at the public hospitals and affiliated dialysis centres in 2021.

Similarly, follow-up among transplant patients is typically for consultation with their nephrologists, where transplant was done. Almost all the prevalent transplant patients (90.7%) were followed up at the public hospitals and affiliated dialysis centres in 2021.

Detailed breakdown of the prevalent patients by service providers is shown in the Annex.

[9] Patients on HD routinely follow up with a primary nephrologist at the Specialist Outpatient Clinics (SOC) in the RH once every 4-6 months.

Table 5.1.2: Prevalent patients as at 31 December 2021

	HD		PD		Transplant	
	Number	%	Number	%	Number	%
Public hospitals and affiliated dialysis centres	162	2.2	1125	99.2	1460	90.7
Dialysis centres under Voluntary Welfare Organisations	4713	62.6	0	0.0	0	0.0
Private clinics and dialysis centres	2659	35.3	9	0.8	148	9.2
Overseas	0	0.0	0	0.0	1	0.1
Total	7534	100.0	1134	100.0	1609	100.0

5.2 Incidence of CKD5

The incidence rate of CKD5 in each year was calculated by taking the number of new CKD5 patients in a year, divided by the number of Singapore residents in the same year. The count was based on the diagnosis date of CKD5. Patients were categorised into 10-year age groups and age standardisation was done using the direct method with the Segi World population as the reference population.

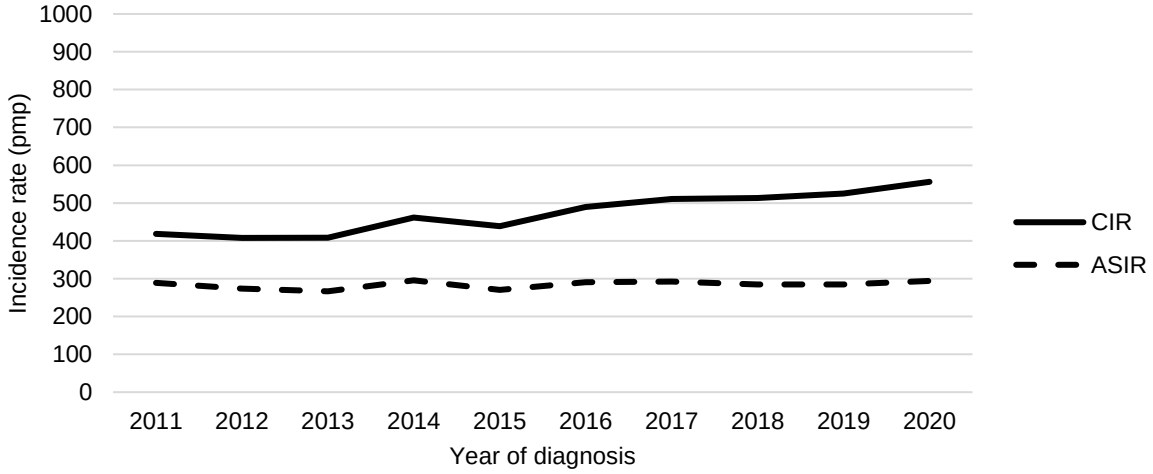
As the registry monitors the patient's eGFR readings for at least six months before accepting a case as CKD5 to allow for accurate case ascertainment, all statistics related to new CKD5 patients for 2021 are not shown in this section.

The number of new patients diagnosed with CKD5 increased from 1,587 in 2011 to 2,249 in 2020 (Table 5.2.1 and Figure 5.2.1). Correspondingly, the CIR increased significantly from 418.8 pmp in 2011 to 556.1 pmp in 2020 ($p<0.001$). However, the ASIR remained stable and ranged between 266.7 pmp and 295.6 pmp during the same period. The stable ASIR trend in relation to the significant rise in CIR suggests that the rise in CIR was driven mainly by Singapore's ageing population.

Table 5.2.1: Incidence number and rate (pmp) of CKD5

Year of diagnosis	Number	CIR	ASIR
2011	1587	418.8	288.9
2012	1557	407.8	274.0
2013	1570	408.4	266.7
2014	1788	461.9	295.6
2015	1711	438.4	270.3
2016	1926	489.6	291.1
2017	2025	510.6	292.8
2018	2050	513.2	285.0
2019	2116	525.6	284.6
2020	2249	556.1	293.9
P for trend	-	<0.001	0.258

Figure 5.2.1: Incidence rate (pmp) of CKD5



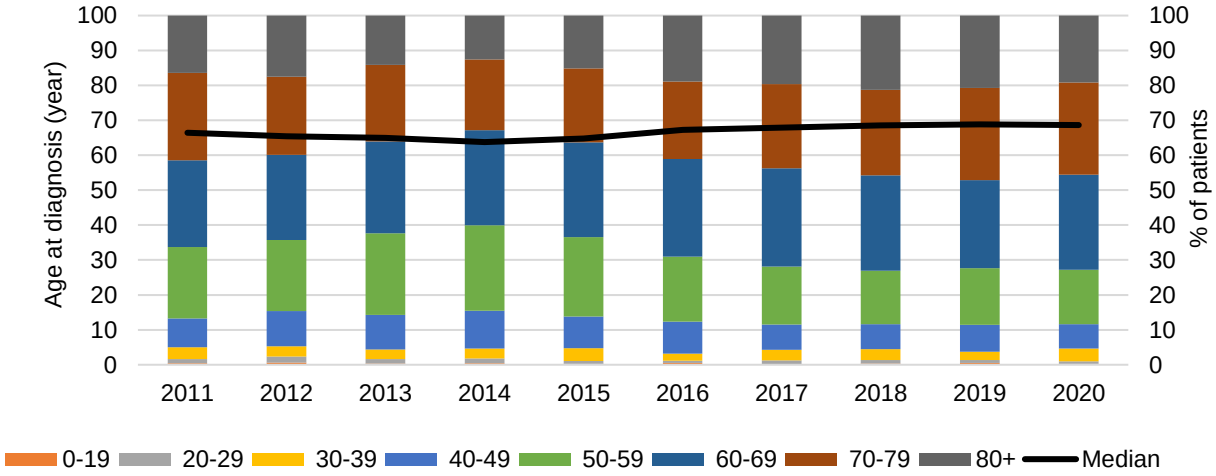
The age-specific incidence rates of CKD5 did not show any distinct trend over the years (Table 5.2.2).

Table 5.2.2: Age distribution (%) and age-specific incidence rate (pmp) of CKD5

Year of diagnosis	Age 0-19			Age 20-29			Age 30-39			Age 40-49		
	Number	%	CIR	Number	%	CIR	Number	%	CIR	Number	%	CIR
2011	7	0.4	7.8	19	1.2	36.7	54	3.4	88.0	131	8.3	207.7
2012	10	0.6	11.3	26	1.7	50.1	46	3.0	75.5	157	10.1	249.3
2013	5	0.3	5.7	21	1.3	40.2	43	2.7	71.4	155	9.9	246.5
2014	8	0.4	9.4	24	1.3	45.3	51	2.9	85.8	194	10.9	310.6
2015	5	0.3	5.9	14	0.8	26.2	62	3.6	104.8	156	9.1	251.5
2016	10	0.5	12.0	12	0.6	22.2	40	2.1	68.1	176	9.1	286.4
2017	4	0.2	4.8	22	1.1	40.1	61	3.0	105.1	147	7.3	239.0
2018	7	0.3	8.6	21	1.0	38.4	64	3.1	109.4	146	7.1	238.8
2019	11	0.5	13.5	18	0.9	33.5	50	2.4	84.1	162	7.7	264.5
2020	5	0.2	6.2	18	0.8	33.9	81	3.6	135.6	158	7.0	258.6
P for trend	-	-	0.992	-	-	0.362	-	-	0.073	-	-	0.458
Year of diagnosis	Age 50-59			Age 60-69			Age 70-79			Age 80+		
	Number	%	CIR	Number	%	CIR	Number	%	CIR	Number	%	CIR
2011	324	20.4	569.8	394	24.8	1229.3	398	25.1	2384.7	260	16.4	3551.9
2012	317	20.4	544.5	380	24.4	1108.5	348	22.4	2023.3	273	17.5	3518.0
2013	367	23.4	617.9	413	26.3	1122.0	344	21.9	1953.4	222	14.1	2704.0
2014	437	24.4	723.6	487	27.2	1240.1	363	20.3	1982.4	224	12.5	2566.0
2015	388	22.7	635.9	464	27.1	1097.1	363	21.2	1974.5	259	15.1	2771.6
2016	359	18.6	583.6	537	27.9	1193.7	428	22.2	2232.1	364	18.9	3721.9
2017	335	16.5	545.2	571	28.2	1223.7	488	24.1	2307.9	397	19.6	3920.0
2018	314	15.3	511.9	560	27.3	1157.5	501	24.4	2189.0	437	21.3	4088.7
2019	344	16.3	565.4	533	25.2	1065.7	559	26.4	2284.2	439	20.7	3795.7
2020	349	15.5	579.8	614	27.3	1194.5	593	26.4	2272.0	431	19.2	3476.5
P for trend	-	-	0.442	-	-	0.753	-	-	0.277	-	-	0.207

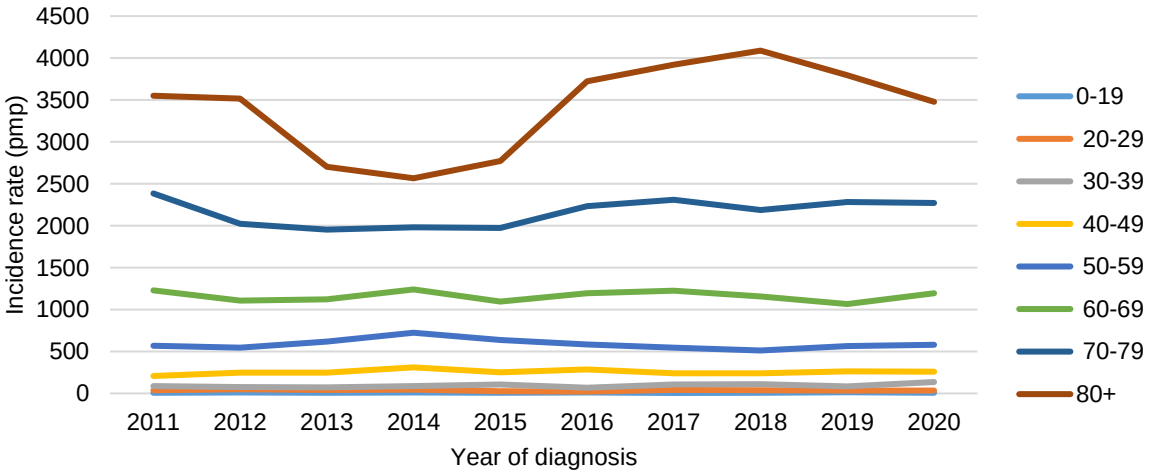
The median age at diagnosis of CKD5 increased slightly from 66.5 years in 2011 to 68.6 years in 2020 (Figure 5.2.2a).

Figure 5.2.2a: Median age (year) and age distribution (%) of CKD5 patients



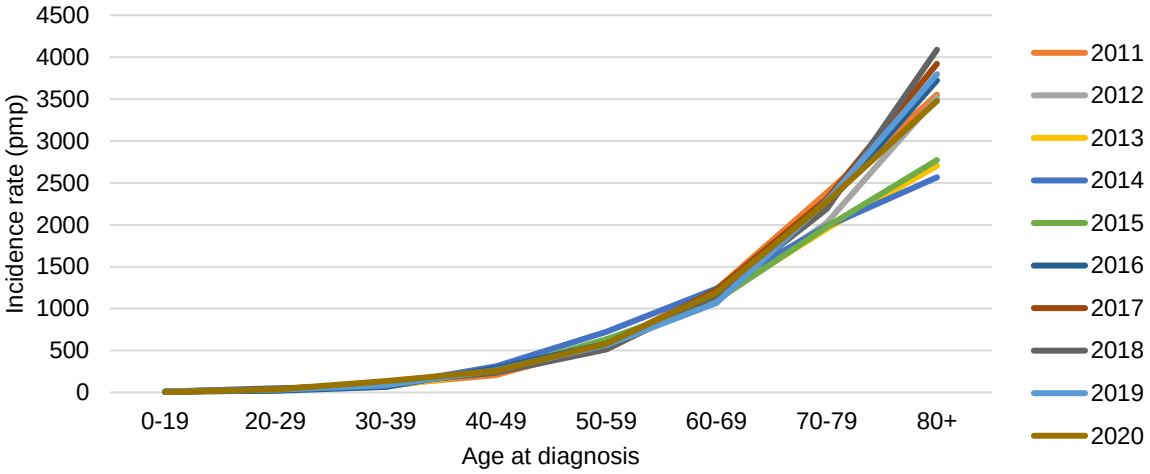
The age-specific incidence rate of CKD5 was highest for those aged 80 years or older (Figure 5.2.2b).

Figure 5.2.2b: Age-specific incidence rate (pmp) of CKD5 across years



The age-specific incidence rates of CKD5 increased exponentially with age for all the years (Figure 5.2.3).

Figure 5.2.3: Age-specific incidence rate (pmp) of CKD5 across age groups

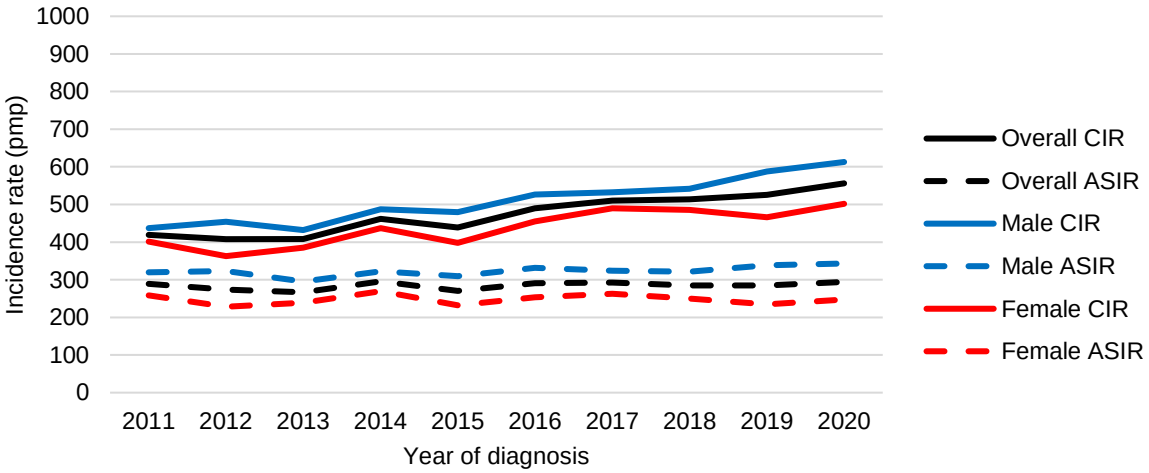


The ASIRs of CKD5 were consistently higher among males than females across the years (Table 5.2.3 and Figure 5.2.4). In 2020, the ASIR was 343.1 pmp and 247.2 pmp for males and females respectively. The ASIRs for both genders remained stable over the years.

Table 5.2.3: Incidence number and rate (pmp) of CKD5 by gender

Male				
Year of diagnosis	**Number**	**%**	**CIR**	**ASIR**
2011	816	51.4	436.8	319.4
2012	854	54.8	454.3	323.5
2013	817	52.0	432.0	295.3
2014	927	51.8	487.3	321.9
2015	920	53.8	480.0	309.8
2016	1015	52.7	526.0	331.5
2017	1034	51.1	532.0	323.8
2018	1060	51.7	542.0	321.0
2019	1158	54.7	588.0	338.7
2020	1212	53.9	612.9	343.1
P for trend	-	-	<0.001	0.051
Female				
Year of diagnosis	**Number**	**%**	**CIR**	**ASIR**
2011	771	48.6	401.4	258.4
2012	703	45.2	362.8	228.3
2013	753	48.0	385.5	239.2
2014	861	48.2	437.4	269.5
2015	791	46.2	398.3	232.4
2016	911	47.3	454.6	253.1
2017	991	48.9	490.0	262.6
2018	990	48.3	485.7	250.1
2019	958	45.3	465.8	234.4
2020	1037	46.1	501.8	247.2
P for trend	-	-	0.001	0.988

Figure 5.2.4: Incidence rate (pmp) of CKD5 by gender



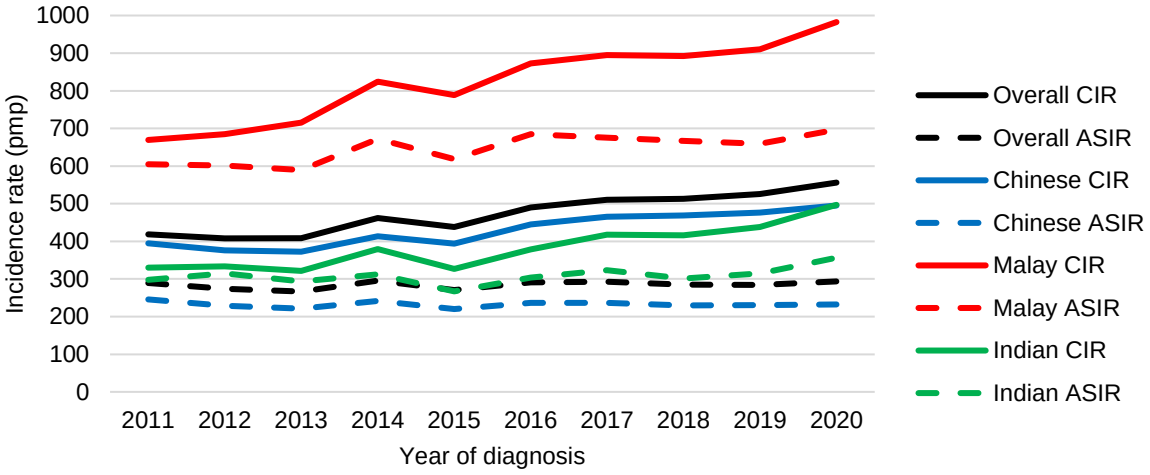
The ASIRs of CKD5 were consistently higher among Malays than Chinese and Indians across the years (Table 5.2.4 and Figure 5.2.5). In 2020, the ASIR among Malays was 696.8 pmp, which was about 3-fold compared to Chinese (232.4 pmp) and 2-fold compared to Indians (356.5 pmp). While the ASIR for Malays increased significantly over the years (p=0.006), the ASIRs for Chinese and Indians remained stable.

Table 5.2.4: Incidence number and rate (pmp) of CKD5 by ethnicity

Chinese				
Year of diagnosis	**Number**	**%**	**CIR**	**ASIR**
2011	1109	69.9	394.9	245.7
2012	1065	68.4	376.1	228.8
2013	1063	67.7	372.5	221.6
2014	1189	66.5	413.7	241.5
2015	1142	66.7	393.8	220.1
2016	1300	67.5	444.7	236.9
2017	1373	67.8	465.7	236.9
2018	1391	67.9	468.5	229.8
2019	1426	67.4	476.3	230.6
2020	1489	66.2	495.2	232.4
P for trend	-	-	<0.001	0.719
Malay				
Year of diagnosis	**Number**	**%**	**CIR**	**ASIR**
2011	339	21.4	669.4	604.8
2012	349	22.4	685.1	601.0
2013	367	23.4	715.8	589.5
2014	426	23.8	824.5	671.7
2015	411	24.0	789.0	618.2
2016	459	23.8	872.8	685.1
2017	475	23.5	895.0	675.9
2018	478	23.3	892.1	667.2
2019	492	23.3	909.8	659.2
2020	536	23.8	982.6	696.8
P for trend	-	-	<0.001	0.006

Indian				
Year of diagnosis	**Number**	**%**	**CIR**	**ASIR**
2011	115	7.2	329.7	298.0
2012	117	7.5	333.3	314.5
2013	113	7.2	321.5	293.2
2014	134	7.5	379.6	311.9
2015	116	6.8	326.8	267.1
2016	135	7.0	378.3	303.6
2017	150	7.4	418.0	322.9
2018	150	7.3	416.1	301.2
2019	159	7.5	438.5	314.6
2020	180	8.0	496.9	356.5
P for trend	-	-	<0.001	0.149

Figure 5.2.5: Incidence rate (pmp) of CKD5 by ethnicity



5.3 Incidence of ever-started dialysis

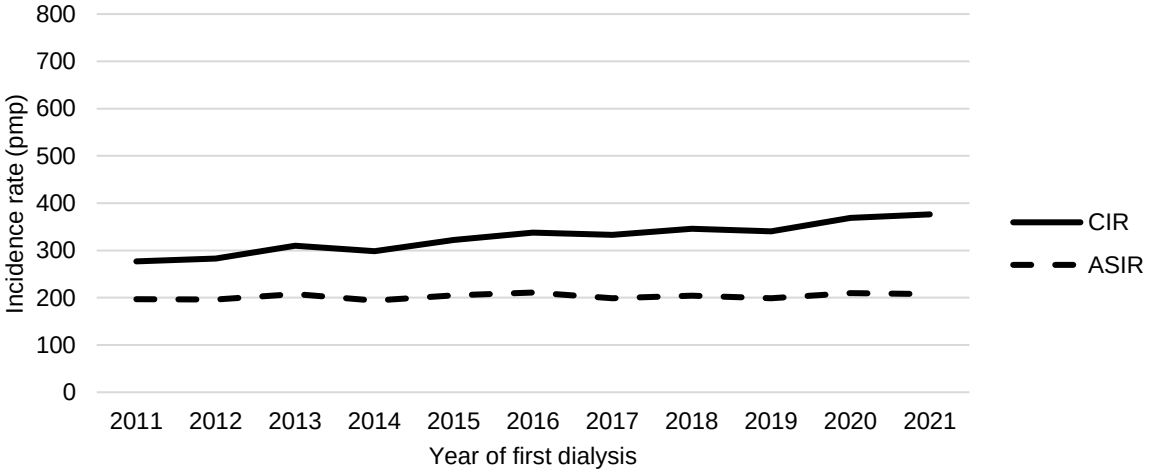
The incidence rate of ever-started dialysis in each year was calculated by taking the number of new patients who ever-started on dialysis in a year, divided by the number of Singapore residents in the same year. The modality was based on the first dialysis. Patients were categorised into 10-year age groups and age standardisation was done using the direct method with the Segi World population as the reference population.

The number of new patients who initiated dialysis increased from 1,049 in 2011 to 1,500 in 2021 (Table 5.3.1 and Figure 5.3.1). Correspondingly, the CIR increased significantly from 276.8 pmp in 2011 to 376.2 pmp in 2021 ($p<0.001$). However, the ASIR remained stable and ranged between 194.0 pmp and 210.9 pmp during the same period.

Table 5.3.1: Incidence number and rate (pmp) of ever-started dialysis

Year of first dialysis	Number	CIR	ASIR
2011	1049	276.8	197.1
2012	1080	282.9	195.9
2013	1192	310.1	207.5
2014	1154	298.1	194.0
2015	1258	322.3	205.2
2016	1328	337.6	210.9
2017	1320	332.8	198.8
2018	1381	345.7	204.5
2019	1371	340.5	198.7
2020	1492	368.9	209.7
2021	1500	376.2	207.7
P for trend	-	<0.001	0.128

Figure 5.3.1: Incidence rate (pmp) of ever-started dialysis



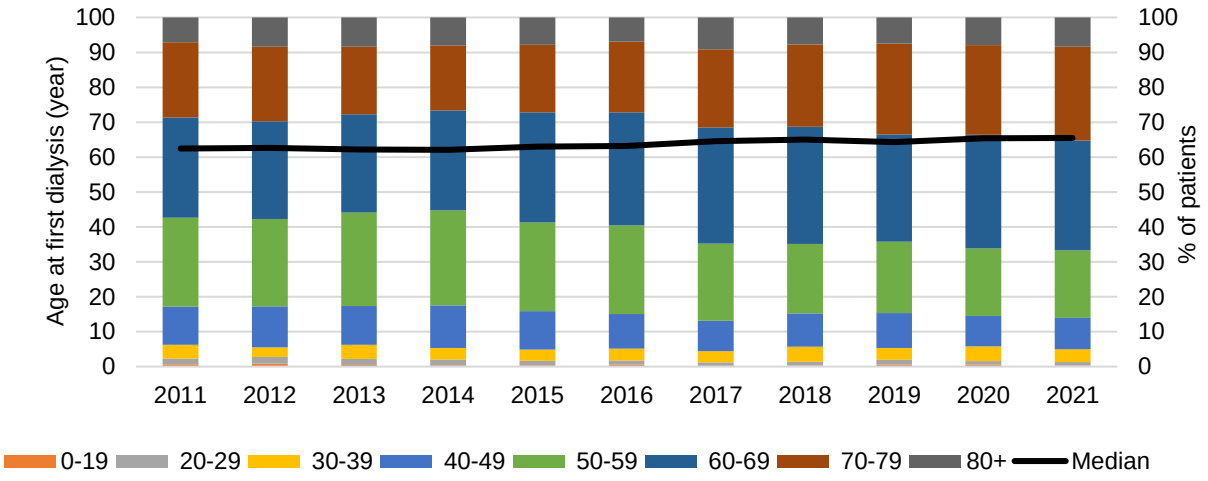
The age-specific incidence rate of ever-started dialysis increased for those aged 30 to 39 years (p=0.016) and 70 to 79 years (p=0.016), but it dropped for those aged 80 years and above (p=0.044) (Table 5.3.2).

Table 5.3.2: Age distribution (%) and age-specific incidence rate (pmp) of ever-started dialysis

Year of first dialysis	Age 0-19			Age 20-29			Age 30-39			Age 40-49		
	Number	%	CIR	Number	%	CIR	Number	%	CIR	Number	%	CIR
2011	7	0.7	7.8	17	1.6	32.8	42	4.0	68.4	114	10.9	180.8
2012	9	0.8	10.2	21	1.9	40.4	30	2.8	49.3	126	11.7	200.1
2013	6	0.5	6.9	21	1.8	40.2	48	4.0	79.7	132	11.1	209.9
2014	4	0.3	4.7	20	1.7	37.8	38	3.3	63.9	140	12.1	224.2
2015	5	0.4	5.9	16	1.3	29.9	41	3.3	69.3	138	11.0	222.5
2016	8	0.6	9.6	15	1.1	27.7	46	3.5	78.3	131	9.9	213.1
2017	3	0.2	3.6	13	1.0	23.7	42	3.2	72.4	115	8.7	187.0
2018	4	0.3	4.9	15	1.1	27.4	60	4.3	102.5	131	9.5	214.2
2019	8	0.6	9.8	19	1.4	35.4	46	3.4	77.4	137	10.0	223.7
2020	8	0.5	10.0	15	1.0	28.2	64	4.3	107.1	130	8.7	212.8
2021	4	0.3	5.1	15	1.0	29.1	56	3.7	94.9	134	8.9	226.0
P for trend	-	-	0.706	-	-	0.070	-	-	0.006	-	-	0.102
Year of first dialysis	Age 50-59			Age 60-69			Age 70-79			Age 80+		
	Number	%	CIR	Number	%	CIR	Number	%	CIR	Number	%	CIR
2011	267	25.5	469.6	301	28.7	939.2	226	21.5	1354.1	75	7.1	1024.6
2012	271	25.1	465.5	302	28.0	881.0	230	21.3	1337.2	91	8.4	1172.7
2013	319	26.8	537.1	335	28.1	910.1	231	19.4	1311.8	100	8.4	1218.0
2014	315	27.3	521.6	330	28.6	840.3	214	18.5	1168.7	93	8.1	1065.4
2015	319	25.4	522.8	397	31.6	938.7	243	19.3	1321.8	99	7.9	1059.4
2016	337	25.4	547.8	430	32.4	955.8	269	20.3	1402.9	92	6.9	940.7
2017	292	22.1	475.2	439	33.3	940.8	296	22.4	1399.9	120	9.1	1184.9
2018	275	19.9	448.4	464	33.6	959.1	325	23.5	1420.0	107	7.7	1001.1
2019	281	20.5	461.8	420	30.6	839.8	357	26.0	1458.8	103	7.5	890.6
2020	288	19.3	478.5	486	32.6	945.5	383	25.7	1467.4	118	7.9	951.8
2021	290	19.3	496.4	472	31.5	911.2	403	26.9	1480.0	126	8.4	959.5
P for trend	-	-	0.545	-	-	0.775	-	-	0.016	-	-	0.044

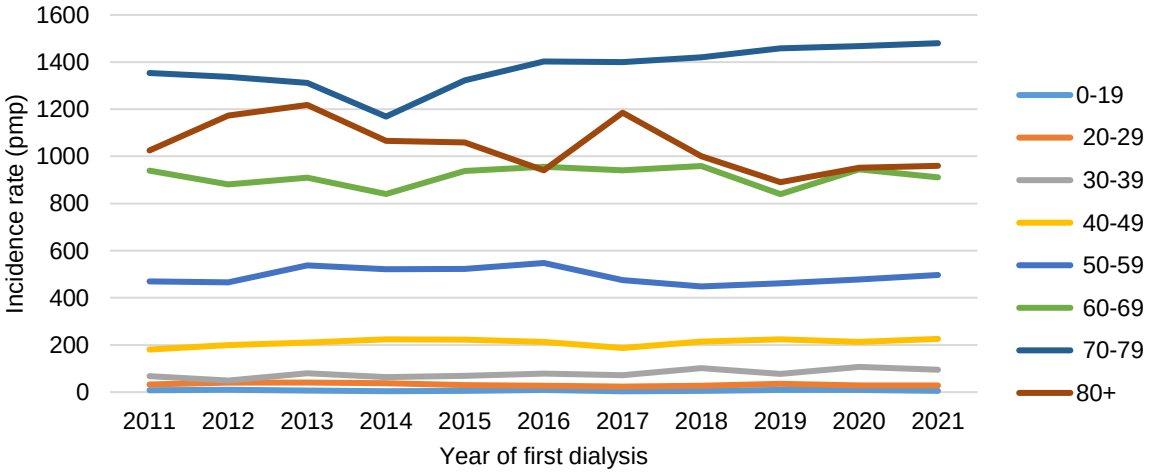
The median age at first dialysis increased slightly from 62.5 years in 2011 to 65.5 years in 2021 (Figure 5.3.2a).

Figure 5.3.2a: Median age (year) and age distribution (%) of ever-started dialysis patients



The age-specific incidence rate of ever-started dialysis was highest for those aged 70 to 79 years (Figure 5.3.2b).

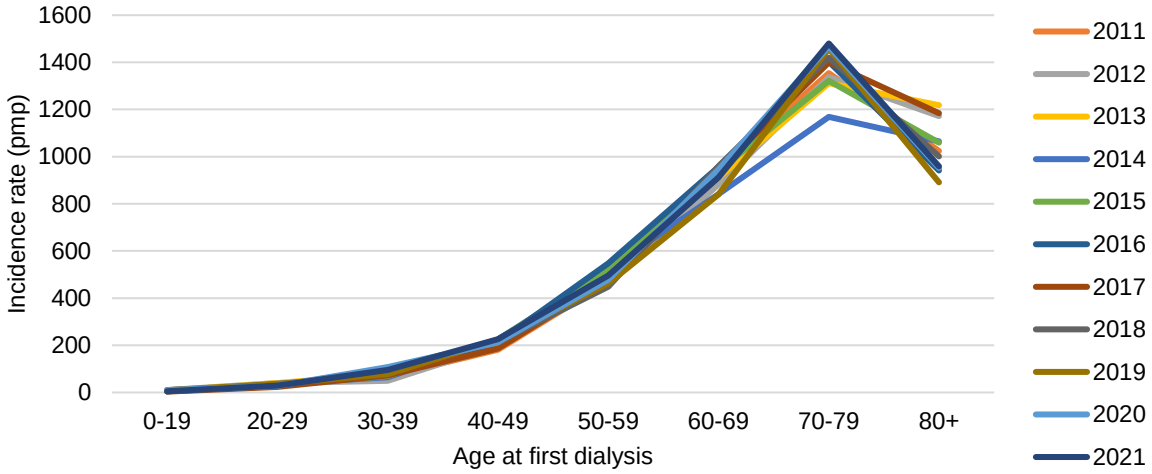
Figure 5.3.2b: Age-specific incidence rate (pmp) of ever-started dialysis across years



Although the age-specific incidence rates of ever-started dialysis increased with age, a decline was observed among those aged 80 years or older for all the years (Figure 5.3.3). Possible reasons for this decline could be elderly patients passing away before their first planned dialysis or refusing dialysis as studies have shown that dialysis offers little advantage in improving survival, especially among those with pre-existing co-morbidities[10].

[10] Sarbjit V and Watson D. Dialysis in late life: benefit or burden. Clinical Journal of American Society of Nephrology. 2009; 4: 2008-2012.

Figure 5.3.3: Age-specific incidence rate (pmp) of ever-started dialysis across age groups



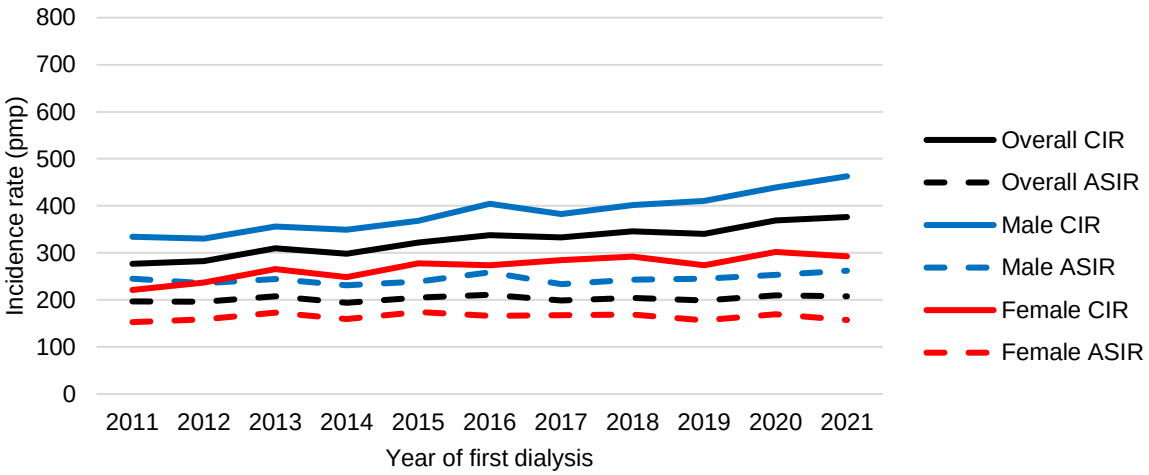
The ASIRs of ever-started dialysis were consistently higher among males than females across the years (Table 5.3.3 and Figure 5.3.4). In 2021, the ASIR was 262.1 pmp and 157.1 pmp for males and females respectively. The ASIRs for both genders remained stable over the years.

Table 5.3.3: Incidence number and rate (pmp) of ever-started dialysis by gender

Male				
Year of first dialysis	**Number**	**%**	**CIR**	**ASIR**
2011	624	59.5	334.0	245.2
2012	621	57.5	330.4	235.4
2013	673	56.5	355.8	244.6
2014	665	57.6	349.6	231.2
2015	706	56.1	368.4	239.1
2016	780	58.7	404.2	258.7
2017	744	56.4	382.8	233.8
2018	785	56.8	401.4	243.1
2019	808	58.9	410.3	245.0
2020	868	58.2	438.9	253.3
2021	904	60.3	462.9	262.1
P for trend	-	-	<0.001	0.095

Female				
Year of first dialysis	**Number**	**%**	**CIR**	**ASIR**
2011	425	40.5	221.2	152.8
2012	459	42.5	236.9	158.9
2013	519	43.5	265.7	172.8
2014	489	42.4	248.4	159.6
2015	552	43.9	277.9	174.3
2016	548	41.3	273.4	166.2
2017	576	43.6	284.8	167.5
2018	596	43.2	292.4	168.7
2019	563	41.1	273.7	156.4
2020	624	41.8	301.9	169.8
2021	596	39.7	293.1	157.1
P for trend	-	-	<0.001	0.727

Figure 5.3.4: Incidence rate (pmp) of ever-started dialysis by gender

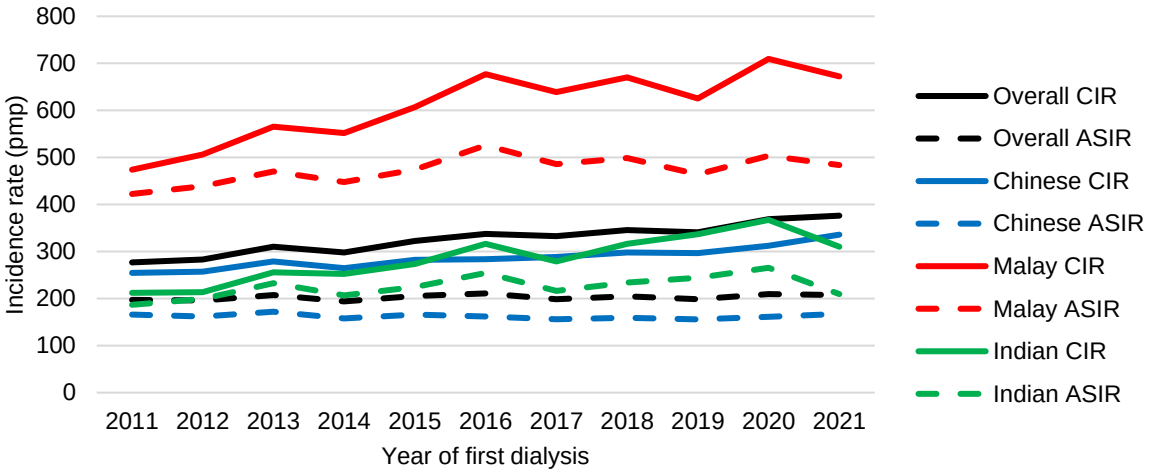


The ASIRs of ever-started dialysis were consistently higher among Malays than Chinese and Indians across the years (Table 5.3.4 and Figure 5.3.5). In 2021, the ASIR was 167.4 pmp, 483.8 pmp and 209.5 pmp for Chinese, Malays and Indians respectively. While the ASIRs for Malays increased significantly over the years (p=0.023), the ASIRs for Chinese and Indians remained stable.

Table 5.3.4: Incidence number and rate (pmp) of ever-started dialysis by ethnicity

Chinese				
Year of first dialysis	**Number**	**%**	**CIR**	**ASIR**
2011	715	68.2	254.6	165.6
2012	729	67.5	257.5	162.0
2013	795	66.7	278.6	172.0
2014	760	65.9	264.4	157.6
2015	819	65.1	282.4	166.1
2016	829	62.4	283.6	161.8
2017	851	64.5	288.6	156.0
2018	885	64.1	298.1	158.9
2019	888	64.8	296.6	156.1
2020	939	62.9	312.3	161.4
2021	994	66.3	335.8	167.4
P for trend	-	-	<0.001	0.390
Malay				
Year of first dialysis	**Number**	**%**	**CIR**	**ASIR**
2011	240	22.9	473.9	422.4
2012	258	23.9	506.5	438.7
2013	290	24.3	565.6	470.3
2014	285	24.7	551.6	447.7
2015	316	25.1	606.6	473.9
2016	356	26.8	677.0	525.7
2017	339	25.7	638.8	485.4
2018	359	26.0	670.0	498.8
2019	338	24.7	625.0	464.1
2020	387	25.9	709.4	503.5
2021	366	24.4	672.2	483.8
P for trend	-	-	<0.001	0.023
Indian				
Year of first dialysis	**Number**	**%**	**CIR**	**ASIR**
2011	74	7.1	212.2	186.8
2012	75	6.9	213.7	199.2
2013	90	7.6	256.0	233.0
2014	89	7.7	252.1	206.6
2015	97	7.7	273.3	224.1
2016	113	8.5	316.6	254.1
2017	100	7.6	278.7	216.0
2018	114	8.3	316.2	233.9
2019	122	8.9	336.4	244.4
2020	133	8.9	367.1	265.4
2021	110	7.3	310.0	209.5
P for trend	-	-	<0.001	0.059

Figure 5.3.5: Incidence rate (pmp) of ever-started dialysis by ethnicity



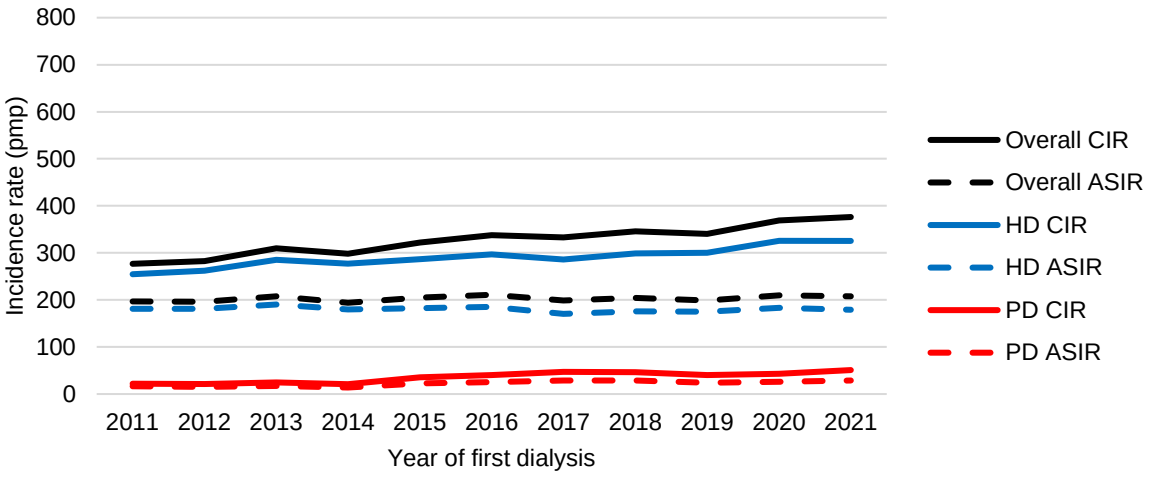
The ASIRs of ever-started dialysis were consistently higher among HD than PD across the years (Table 5.3.5 and Figure 5.3.6). In 2021, the ASIR was 179.0 pmp and 28.7 pmp for HD and PD respectively. While the ASIR for PD increased significantly over the years (p=0.001), the ASIR for HD remained stable. The Ministry of Health has been working with the public healthcare institutions and dialysis service providers to promote the uptake of PD among local dialysis patients.

Table 5.3.5: Incidence number and rate (pmp) of ever-started dialysis by modality

HD				
Year of first dialysis	**Number**	**%**	**CIR**	**ASIR**
2011	965	92.0	254.7	181.0
2012	1000	92.6	261.9	181.0
2013	1096	91.9	285.1	190.3
2014	1073	93.0	277.2	180.1
2015	1120	89.0	287.0	182.3
2016	1169	88.0	297.2	185.6
2017	1133	85.8	285.7	170.4
2018	1195	86.5	299.2	176.1
2019	1209	88.2	300.3	174.7
2020	1317	88.3	325.7	183.5
2021	1297	86.5	325.3	179.0
P for trend	-	-	<0.001	0.261

PD				
Year of first dialysis	**Number**	**%**	**CIR**	**ASIR**
2011	84	8.0	22.2	16.2
2012	80	7.4	21.0	14.8
2013	96	8.1	25.0	17.2
2014	81	7.0	20.9	13.8
2015	138	11.0	35.4	22.9
2016	159	12.0	40.4	25.4
2017	187	14.2	47.2	28.4
2018	186	13.5	46.6	28.4
2019	162	11.8	40.2	24.0
2020	175	11.7	43.3	26.2
2021	203	13.5	50.9	28.7
P for trend	-	-	<0.001	0.001

Figure 5.3.6: Incidence rate (pmp) of ever-started dialysis by modality



5.4 Incidence of definitive dialysis

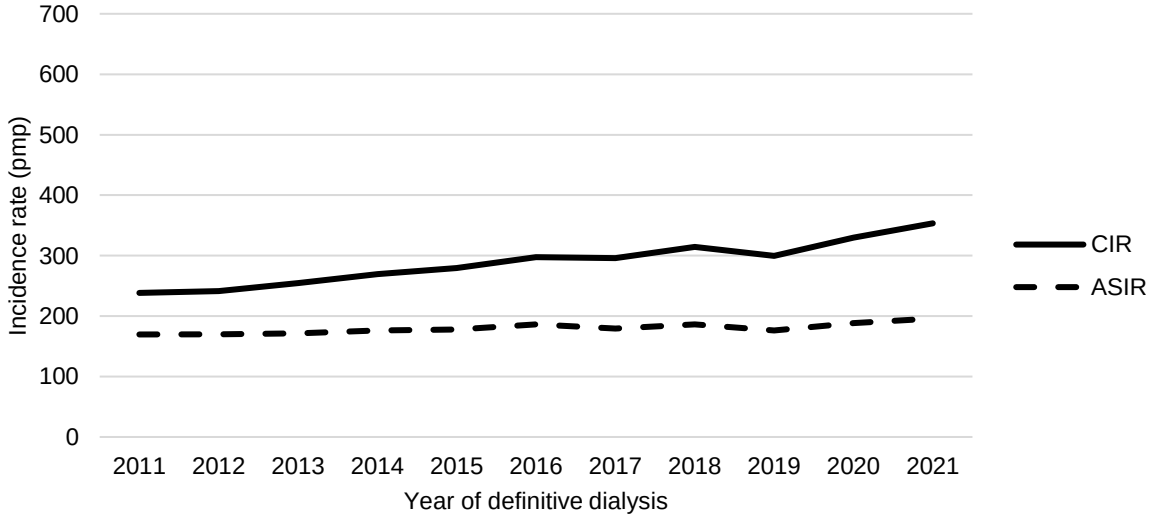
The incidence rate of definitive dialysis in each year was calculated by taking the number of new patients who survived >90 days after initiation of dialysis in a year, divided by the number of Singapore residents in the same year. The modality was based on the dialysis closest to the 91st day from initiation of dialysis. As some patients did not survive beyond three months from the first dialysis, those on definitive dialysis is a more stable subset of the CKD5 and ever-started dialysis cohorts. Patients were categorised into 10-year age groups and age standardisation was done using the direct method with the Segi World population as the reference population.

The number of new patients on definitive dialysis increased from 903 in 2011 to 1,409 in 2021 (Table 5.4.1 and Figure 5.4.1). Correspondingly, the CIR increased significantly from 238.3 pmp in 2011 to 353.4 pmp in 2021 (p<0.001). The rise in ASIR from 169.6 pmp in 2011 to 195.9 pmp in 2021 was also significant (p=0.001), albeit of a smaller magnitude than the rise in CIR.

Table 5.4.1: Incidence number and rate (pmp) of definitive dialysis

Year of definitive dialysis	Number	CIR	ASIR
2011	903	238.3	169.6
2012	921	241.2	169.6
2013	978	254.4	171.2
2014	1042	269.2	176.1
2015	1090	279.3	177.7
2016	1171	297.7	186.4
2017	1173	295.8	179.4
2018	1255	314.2	186.5
2019	1207	299.8	176.3
2020	1334	329.9	188.3
2021	1409	353.4	195.9
P for trend	-	<0.001	0.001

Figure 5.4.1: Incidence rate (pmp) of definitive dialysis



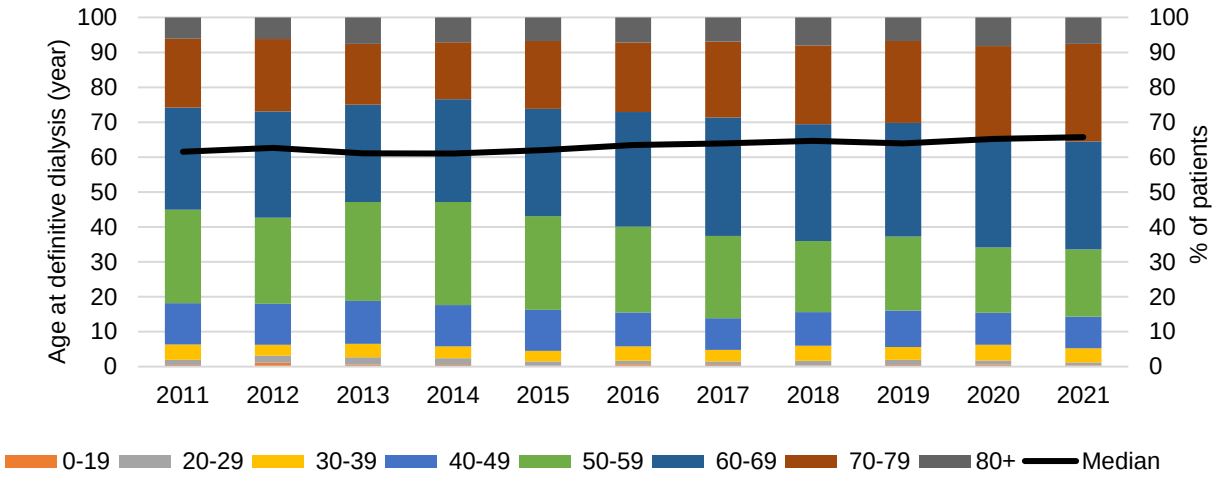
The age-specific incidence rate of definitive dialysis increased for those aged 30 to 39 years (p=0.002), 40 to 49 years (p=0.017) and 70 to 79 years (p=0.003) (Table 5.4.2).

Table 5.4.2: Age distribution (%) and age-specific incidence rate (pmp) of definitive dialysis

Year of definitive dialysis	Age 0-19			Age 20-29			Age 30-39			Age 40-49		
	Number	%	CIR	Number	%	CIR	Number	%	CIR	Number	%	CIR
2011	4	0.4	4.5	14	1.6	27.0	39	4.3	63.5	107	11.8	169.7
2012	10	1.1	11.3	19	2.1	36.6	29	3.1	47.6	108	11.7	171.5
2013	6	0.6	6.9	20	2.0	38.3	38	3.9	63.1	120	12.3	190.8
2014	5	0.5	5.8	20	1.9	37.8	35	3.4	58.9	124	11.9	198.5
2015	2	0.2	2.4	14	1.3	26.2	33	3.0	55.8	128	11.7	206.4
2016	8	0.7	9.6	12	1.0	22.2	48	4.1	81.7	114	9.7	185.5
2017	6	0.5	7.3	12	1.0	21.8	38	3.2	65.5	107	9.1	174.0
2018	4	0.3	4.9	17	1.4	31.1	54	4.3	92.3	121	9.6	197.9
2019	6	0.5	7.4	17	1.4	31.6	45	3.7	75.7	126	10.4	205.7
2020	8	0.6	10.0	16	1.2	30.1	59	4.4	98.8	123	9.2	201.3
2021	5	0.4	6.4	12	0.9	23.3	57	4.0	96.6	128	9.1	215.9
P for trend	-	-	0.646	-	-	0.239	-	-	0.002	-	-	0.017
Year of definitive dialysis	Age 50-59			Age 60-69			Age 70-79			Age 80+		
	Number	%	CIR	Number	%	CIR	Number	%	CIR	Number	%	CIR
2011	242	26.8	425.6	264	29.2	823.7	178	19.7	1066.5	55	6.1	751.4
2012	227	24.6	389.9	280	30.4	816.8	191	20.7	1110.5	57	6.2	734.5
2013	277	28.3	466.4	273	27.9	741.6	170	17.4	965.4	74	7.6	901.3
2014	307	29.5	508.4	307	29.5	781.8	170	16.3	928.4	74	7.1	847.7
2015	293	26.9	480.2	335	30.7	792.1	212	19.4	1153.2	73	6.7	781.2
2016	287	24.5	466.5	385	32.9	855.8	233	19.9	1215.1	84	7.2	858.9
2017	276	23.5	449.2	398	33.9	852.9	255	21.7	1206.0	81	6.9	799.8
2018	255	20.3	415.7	420	33.5	868.1	283	22.5	1236.5	101	8.0	945.0
2019	255	21.1	419.1	393	32.6	785.8	284	23.5	1160.5	81	6.7	700.3
2020	249	18.7	413.7	420	31.5	817.1	350	26.2	1341.0	109	8.2	879.2
2021	271	19.2	463.9	435	30.9	839.8	394	28.0	1446.9	107	7.6	814.8
P for trend	-	-	0.892	-	-	0.284	-	-	0.003	-	-	0.557

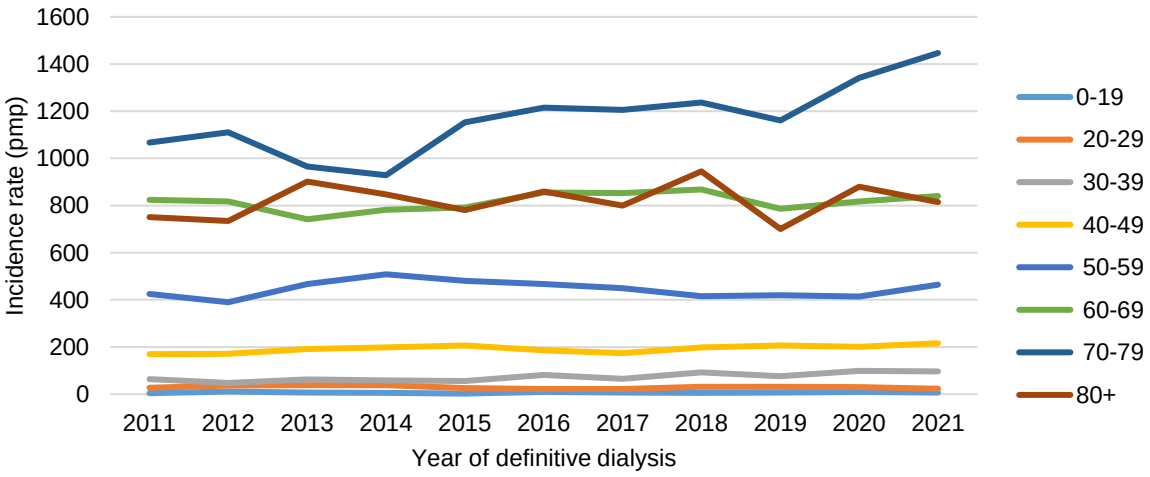
The median age at definitive dialysis increased slightly from 61.5 years in 2011 to 65.7 years in 2021 (Figure 5.4.2a).

Figure 5.4.2a: Median age (year) and age distribution (%) of new definitive dialysis patients



The age-specific incidence rate of definitive dialysis was highest for those aged 70 to 79 years (Figure 5.4.2b).

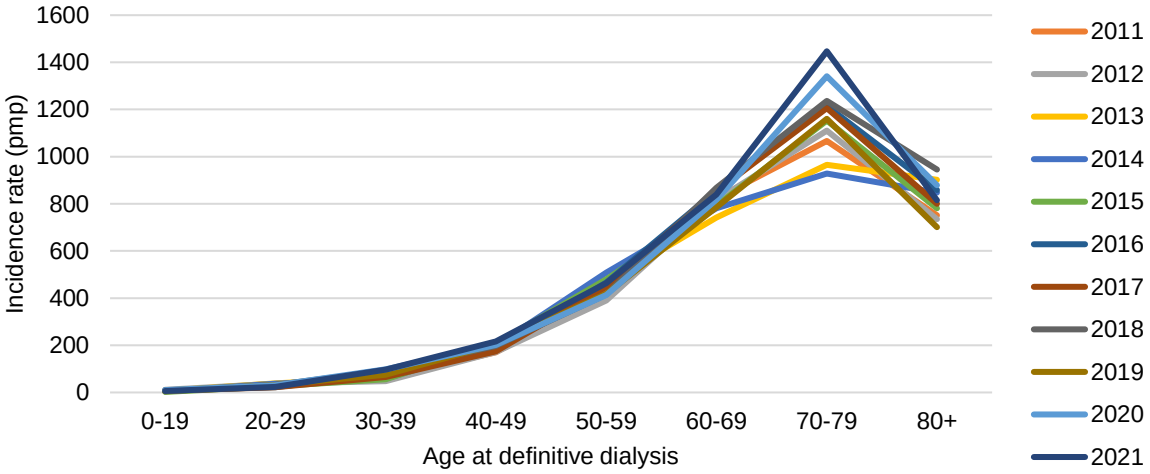
Figure 5.4.2b: Age-specific incidence rate (pmp) of definitive dialysis across years



The age-specific incidence rates of definitive dialysis increased with age, but a decline was observed from those aged 80 years or older for all the years (Figure 5.4.3). Possible reasons for this decline could be elderly patients passing away before reaching definitive dialysis or refusing dialysis as studies have shown that dialysis offers little advantage in improving survival, especially among those with pre-existing co-morbidities[11].

[11] Sarbjit V and Watson D. Dialysis in late life: benefit or burden. Clinical Journal of American Society of Nephrology. 2009; 4: 2008-2012.

Figure 5.4.3: Age-specific incidence rate (pmp) of definitive dialysis across age groups



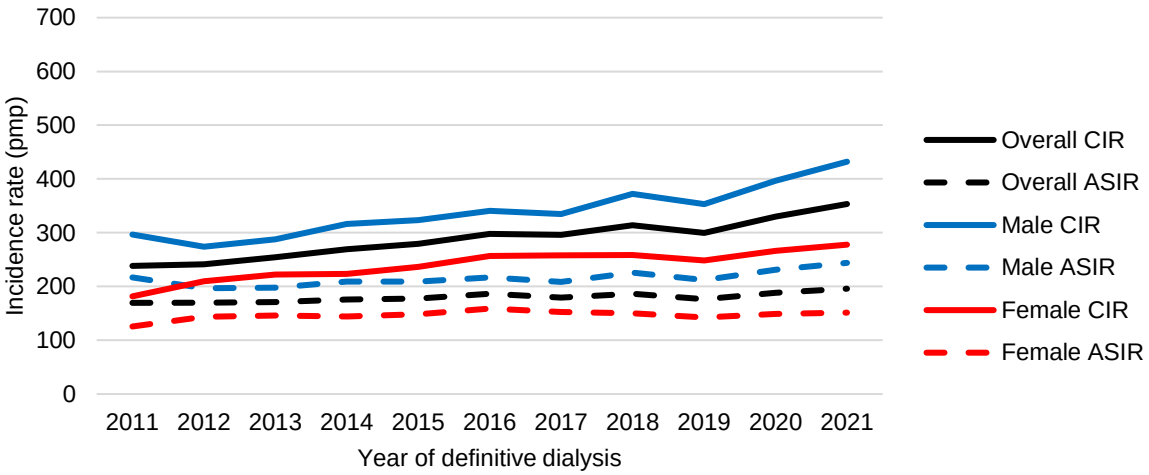
The ASIRs of definitive dialysis were consistently higher among males than females across the years (Table 5.4.3 and Figure 5.4.4). In 2021, the ASIR was 244.0 pmp and 151.4 pmp for males and females respectively. The ASIR increased significantly over the years for males (p=0.008), but not for females.

Table 5.4.3: Incidence number and rate (pmp) of definitive dialysis by gender

Male				
Year of definitive dialysis	**Number**	**%**	**CIR**	**ASIR**
2011	554	61.4	296.5	217.1
2012	515	55.9	274.0	196.8
2013	544	55.6	287.6	198.1
2014	602	57.8	316.4	209.2
2015	620	56.9	323.5	209.2
2016	657	56.1	340.5	216.6
2017	651	55.5	335.0	208.4
2018	728	58.0	372.2	225.6
2019	696	57.7	353.4	212.4
2020	784	58.8	396.4	231.4
2021	844	59.9	432.1	244.0
P for trend	-	-	<0.001	0.008

Female				
Year of definitive dialysis	**Number**	**%**	**CIR**	**ASIR**
2011	349	38.6	181.7	125.6
2012	406	44.1	209.5	143.7
2013	434	44.4	222.2	146.2
2014	440	42.2	223.5	144.4
2015	470	43.1	236.6	148.6
2016	514	43.9	256.5	158.9
2017	522	44.5	258.1	152.3
2018	527	42.0	258.5	150.3
2019	511	42.3	248.4	142.7
2020	550	41.2	266.1	148.7
2021	565	40.1	277.8	151.4
P for trend	-	-	<0.001	0.073

Figure 5.4.4: Incidence rate (pmp) of definitive dialysis by gender

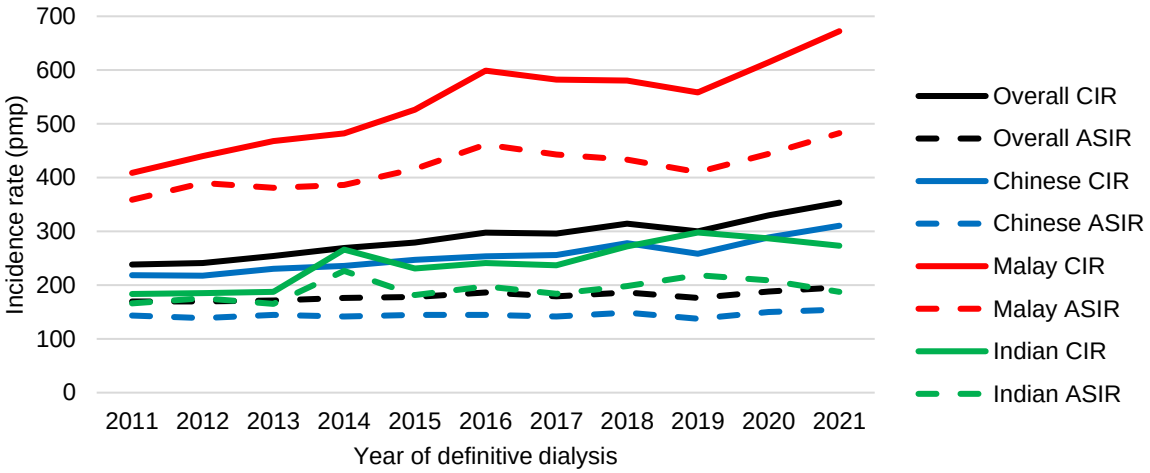


The ASIRs of definitive dialysis were consistently higher among Malays than Chinese and Indians across the years (Table 5.4.4 and Figure 5.4.5). In 2021, the ASIR was 154.5 pmp, 482.7 pmp and 187.4 pmp for Chinese, Malays and Indians respectively. While the ASIRs for Malays increased significantly over the years (p=0.001), the ASIRs for Chinese and Indians remained stable.

Table 5.4.4: Incidence number and rate (pmp) of definitive dialysis by ethnicity

Chinese				
Year of definitive dialysis	**Number**	**%**	**CIR**	**ASIR**
2011	614	68.0	218.6	143.2
2012	616	66.9	217.5	138.7
2013	658	67.3	230.6	144.6
2014	677	65.0	235.5	141.9
2015	717	65.8	247.2	144.4
2016	742	63.4	253.8	144.6
2017	754	64.3	255.7	141.6
2018	825	65.7	277.8	148.6
2019	773	64.0	258.2	137.4
2020	868	65.1	288.7	149.8
2021	919	65.2	310.5	154.5
P for trend	-	-	<0.001	0.088
Malay				
Year of definitive dialysis	**Number**	**%**	**CIR**	**ASIR**
2011	207	22.9	408.8	358.8
2012	224	24.3	439.7	389.9
2013	240	24.5	468.1	380.7
2014	249	23.9	481.9	386.6
2015	274	25.1	526.0	415.8
2016	315	26.9	599.0	461.1
2017	309	26.3	582.2	442.7
2018	311	24.8	580.4	433.3
2019	302	25.0	558.4	410.2
2020	335	25.1	614.1	443.9
2021	366	26.0	672.2	482.7
P for trend	-	-	<0.001	0.001
Indian				
Year of definitive dialysis	**Number**	**%**	**CIR**	**ASIR**
2011	64	7.1	183.5	166.0
2012	65	7.1	185.2	175.7
2013	66	6.7	187.8	165.1
2014	94	9.0	266.3	226.4
2015	82	7.5	231.0	181.4
2016	86	7.3	241.0	197.5
2017	85	7.2	236.9	184.2
2018	98	7.8	271.8	198.4
2019	108	8.9	297.8	218.6
2020	104	7.8	287.1	209.2
2021	97	6.9	273.3	187.4
P for trend	-	-	<0.001	0.083

Figure 5.4.5: Incidence rate (pmp) of definitive dialysis by ethnicity



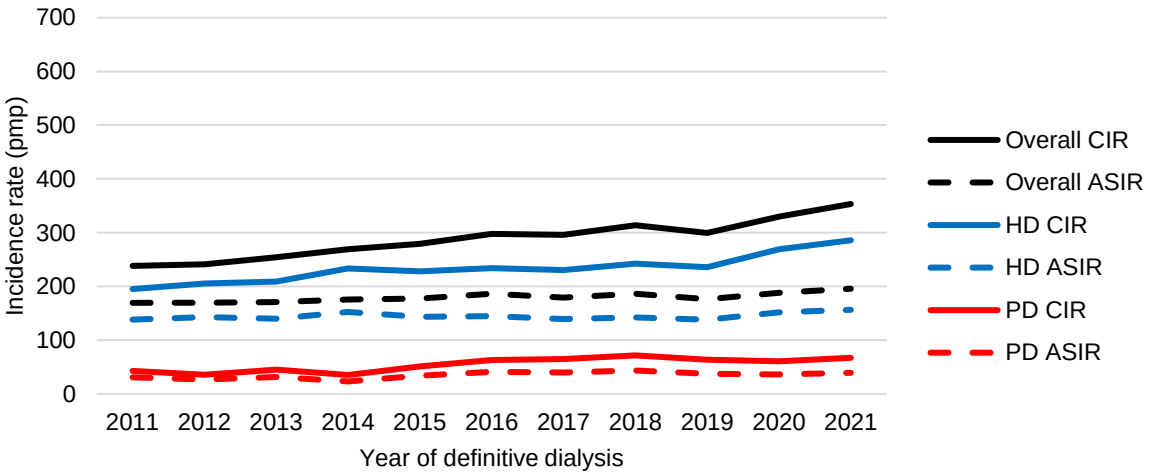
The ASIRs of definitive dialysis were consistently higher among HD than PD across the years (Table 5.4.5 and Figure 5.4.6). In 2021, the ASIR was 156.7 pmp and 39.2 pmp for HD and PD respectively. While the ASIR for PD increased significantly over the years (p=0.021), the ASIR for HD remained stable.

Table 5.4.5: Incidence number and rate (pmp) of definitive dialysis by modality

HD				
Year of definitive dialysis	**Number**	**%**	**CIR**	**ASIR**
2011	740	81.9	195.3	138.4
2012	784	85.1	205.4	142.8
2013	803	82.1	208.9	139.8
2014	905	86.9	233.8	152.7
2015	890	81.7	228.0	143.8
2016	922	78.7	234.4	144.9
2017	915	78.0	230.7	139.3
2018	968	77.1	242.3	142.7
2019	951	78.8	236.2	138.5
2020	1089	81.6	269.3	151.9
2021	1140	80.9	285.9	156.7
P for trend	-	-	<0.001	0.143

PD				
Year of definitive dialysis	Number	%	CIR	ASIR
2011	163	18.1	43.0	31.1
2012	137	14.9	35.9	26.7
2013	175	17.9	45.5	31.4
2014	137	13.1	35.4	23.4
2015	200	18.3	51.2	33.9
2016	249	21.3	63.3	41.5
2017	258	22.0	65.1	40.1
2018	287	22.9	71.9	43.7
2019	256	21.2	63.6	37.9
2020	245	18.4	60.6	36.4
2021	269	19.1	67.5	39.2
P for trend	-	-	0.002	0.021

Figure 5.4.6: Incidence rate (pmp) of definitive dialysis by modality



Among new patients on definitive dialysis, DN was the biggest cause of CKD5, followed by GN (Table 5.4.6). In 2021, 66.9% of the new definitive dialysis patients had DN, while 12.7% had GN.

Table 5.4.6: Incidence number of definitive dialysis by etiology

Year of definitive dialysis	DN		GN		Others	
	Number	%	Number	%	Number	%
2011	553	61.2	159	17.6	191	21.2
2012	609	66.1	144	15.6	168	18.2
2013	637	65.1	156	16.0	185	18.9
2014	673	64.6	166	15.9	203	19.5
2015	727	66.7	176	16.1	187	17.2
2016	780	66.6	169	14.4	222	19.0
2017	789	67.3	173	14.7	211	18.0
2018	830	66.1	176	14.0	249	19.8
2019	824	68.3	139	11.5	244	20.2
2020	905	67.8	163	12.2	266	19.9
2021	943	66.9	179	12.7	287	20.4

5.5 Prevalence of definitive dialysis

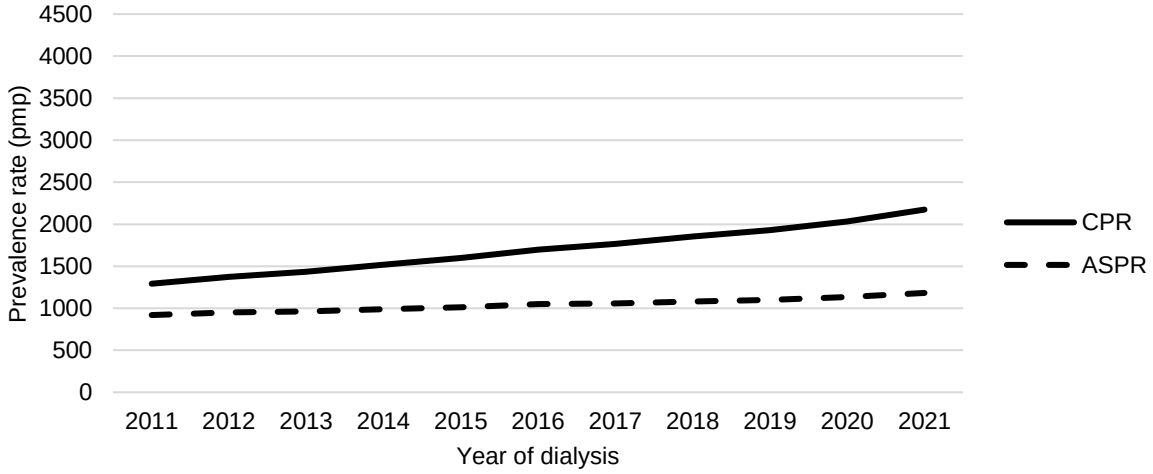
The prevalence rate of definitive dialysis in each year was calculated by taking the cumulative number of surviving (existing and new) definitive dialysis patients in a year, divided by the number of Singapore residents in the same year. Only patients surviving >90 days after initiation of dialysis were included. The modality was based on the last dialysis in each year. Patients were categorised into 10-year age groups and age standardisation was done using the direct method with the Segi World population as the reference population.

Like the incidence trends of definitive dialysis (Table 5.4.1 and Figure 5.4.1), the number of prevalent patients on definitive dialysis increased consistently since 2011 (Table 5.5.1 and Figure 5.5.1). Correspondingly, both the crude prevalence rate (CPR, $p<0.001$) and ASPR ($p<0.001$) increased significantly over the years. At the end of 2021, there were a total of 8,668 surviving dialysis patients, with CPR of 2,174.2 pmp and ASPR of 1,182.3 pmp. The rise in ASPR suggests that the rise in new patients undergoing definitive dialysis was faster than the drop from those who died, even after adjusting for Singapore's ageing population.

Table 5.5.1: Prevalence number and rate (pmp) of definitive dialysis

Year of dialysis	Number	CPR	ASPR
2011	4895	1291.8	919.2
2012	5244	1373.6	949.0
2013	5521	1436.1	961.8
2014	5880	1519.1	987.1
2015	6231	1596.6	1012.2
2016	6673	1696.4	1048.4
2017	7007	1766.9	1058.8
2018	7407	1854.4	1081.8
2019	7765	1928.6	1101.1
2020	8219	2032.3	1133.4
2021	8668	2174.2	1182.3
P for trend	-	<0.001	<0.001

Figure 5.5.1: Prevalence rate (pmp) of definitive dialysis



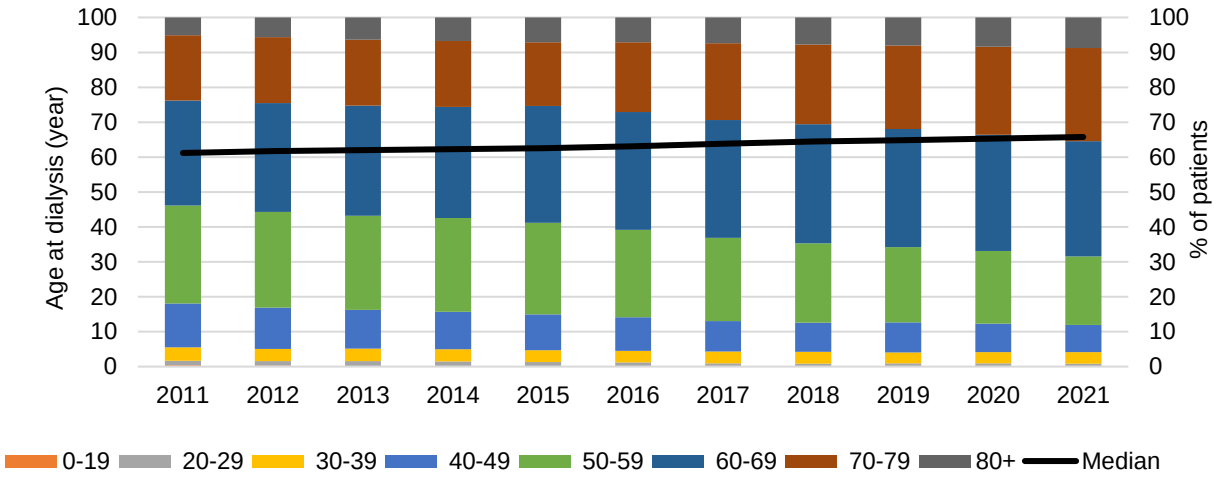
The age-specific prevalence rate of definitive dialysis increased for those aged 30 years and above (p<0.001), but it dropped for those aged 20 to 29 years (p=0.004) (Table 5.5.2).

Table 5.5.2: Age distribution (%) and age-specific prevalence rate (pmp) of definitive dialysis

Year of dialysis	Age 0-19			Age 20-29			Age 30-39			Age 40-49		
	Number	%	CPR	Number	%	CPR	Number	%	CPR	Number	%	CPR
2011	17	0.3	18.9	67	1.4	129.3	185	3.8	301.4	616	12.6	976.8
2012	16	0.3	18.1	68	1.3	131.0	182	3.5	298.8	620	11.8	984.6
2013	13	0.2	14.9	73	1.3	139.7	198	3.6	328.7	611	11.1	971.7
2014	12	0.2	14.0	75	1.3	141.6	207	3.5	348.3	629	10.7	1007.1
2015	12	0.2	14.2	70	1.1	130.8	210	3.4	354.9	639	10.3	1030.4
2016	13	0.2	15.6	67	1.0	123.9	224	3.4	381.2	637	9.5	1036.4
2017	12	0.2	14.5	55	0.8	100.1	234	3.3	403.2	611	8.7	993.6
2018	13	0.2	15.9	51	0.7	93.2	249	3.4	425.6	621	8.4	1015.6
2019	14	0.2	17.2	59	0.8	109.8	241	3.1	405.5	668	8.6	1090.7
2020	19	0.2	23.6	55	0.7	103.5	265	3.2	443.7	674	8.2	1103.1
2021	18	0.2	23.0	54	0.6	104.7	289	3.3	489.6	677	7.8	1141.9
P for trend	-	-	0.165	-	-	0.004	-	-	<0.001	-	-	<0.001
Year of dialysis	Age 50-59			Age 60-69			Age 70-79			Age 80+		
	Number	%	CPR	Number	%	CPR	Number	%	CPR	Number	%	CPR
2011	1372	28.0	2412.9	1472	30.1	4592.8	917	18.7	5494.3	249	5.1	3401.6
2012	1439	27.4	2471.7	1633	31.1	4763.7	991	18.9	5761.6	295	5.6	3801.5
2013	1490	27.0	2508.8	1739	31.5	4724.3	1046	18.9	5939.8	351	6.4	4275.3
2014	1578	26.8	2613.0	1871	31.8	4764.5	1110	18.9	6062.0	398	6.8	4559.3
2015	1634	26.2	2678.0	2086	33.5	4932.4	1140	18.3	6201.0	440	7.1	4708.5
2016	1672	25.1	2717.9	2251	33.7	5003.6	1335	20.0	6962.2	474	7.1	4846.7
2017	1673	23.9	2722.6	2364	33.7	5066.2	1541	22.0	7287.9	517	7.4	5104.9
2018	1685	22.7	2747.2	2520	34.0	5208.9	1693	22.9	7397.1	575	7.8	5379.9
2019	1677	21.6	2756.2	2624	33.8	5246.7	1859	23.9	7596.2	623	8.0	5386.6
2020	1707	20.8	2836.0	2734	33.3	5318.8	2076	25.3	7954.1	689	8.4	5557.6
2021	1698	19.6	2906.6	2857	33.0	5515.4	2313	26.7	8494.2	762	8.8	5802.9
P for trend	-	-	<0.001	-	-	<0.001	-	-	<0.001	-	-	<0.001

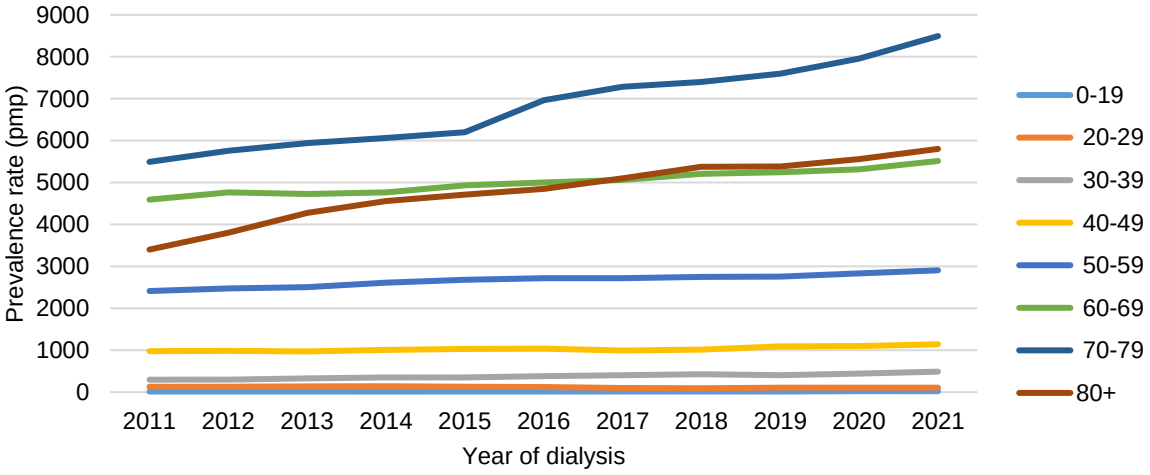
The median age among prevalent definitive dialysis patients increased slightly from 61.2 years in 2011 to 65.8 years in 2021 (Figure 5.5.2a).

Figure 5.5.2a: Median age (year) and age distribution (%) of prevalent definitive dialysis patients



The age-specific prevalence rate of definitive dialysis was the highest for those aged 70 to 79 years (Figure 5.5.2b).

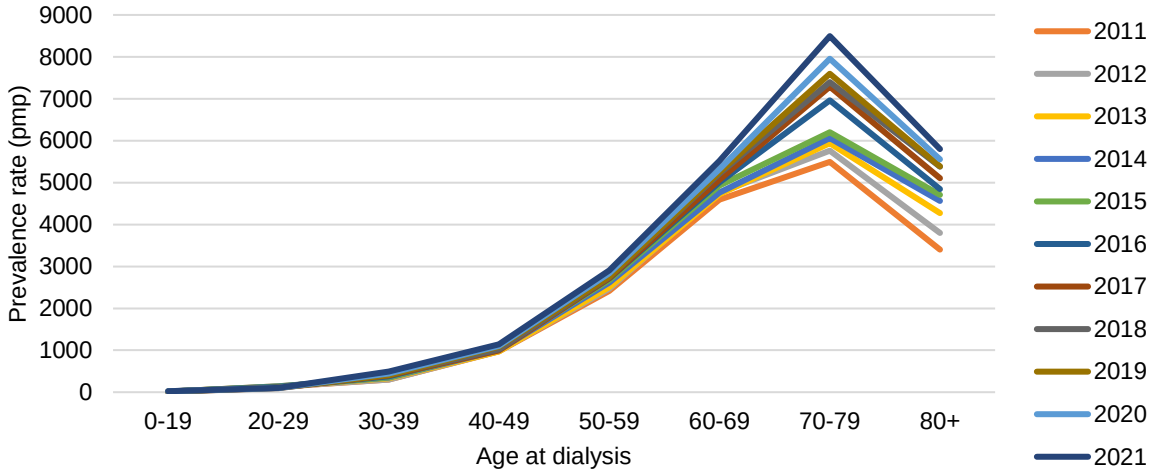
Figure 5.5.2b: Age-specific prevalence rate (pmp) of definitive dialysis across years



The age-specific prevalence rates of definitive dialysis increased with age, but a decline was observed from those aged 80 years and above for all the years (Figure 5.5.3). Possible reasons for this decline could be elderly patients passing away before reaching definitive dialysis or refusing dialysis as studies have shown that dialysis offers little advantage in improving survival, especially among those with pre-existing co-morbidities[12].

[12] Sarbjit V and Watson D. Dialysis in late life: benefit or burden. Clinical Journal of American Society of Nephrology. 2009; 4: 2008-2012.

Figure 5.5.3: Age-specific prevalence rate (pmp) of definitive dialysis across age groups



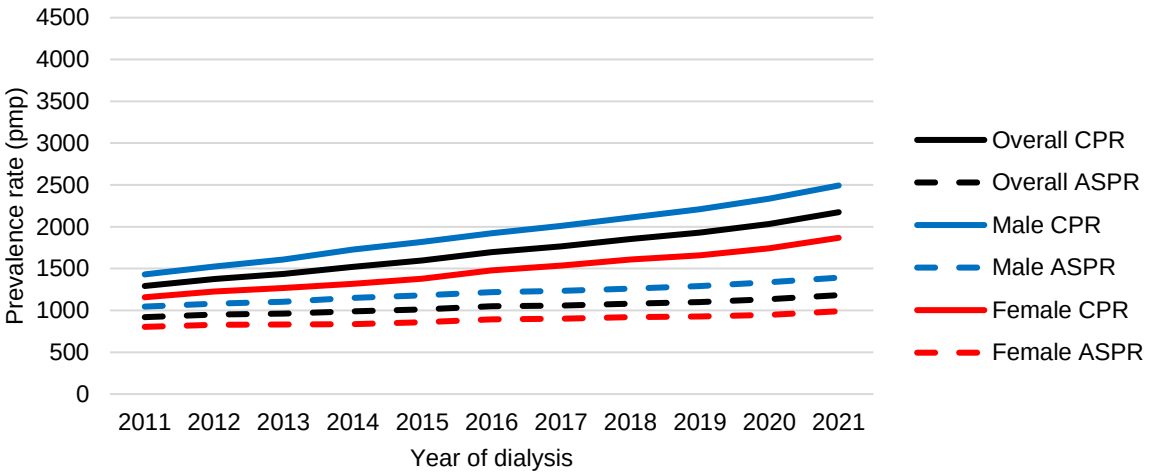
The ASPRs of definitive dialysis were consistently higher among males than females across the years (Table 5.5.3 and Figure 5.5.4). In 2021, the ASPR was 1,391.2 pmp and 989.7 pmp for males and females respectively. The ASPRs for both genders increased significantly over the years (p<0.001), with a larger rise for males.

Table 5.5.3: Prevalence number and rate (pmp) of definitive dialysis by gender

Male				
Year of dialysis	**Number**	**%**	**CPR**	**ASPR**
2011	2672	54.6	1430.3	1045.6
2012	2867	54.7	1525.2	1082.1
2013	3042	55.1	1608.4	1104.7
2014	3283	55.8	1725.7	1149.8
2015	3489	56.0	1820.4	1180.0
2016	3713	55.6	1924.3	1217.4
2017	3905	55.7	2009.2	1234.1
2018	4126	55.7	2109.6	1260.8
2019	4353	56.1	2210.3	1290.1
2020	4620	56.2	2336.2	1335.2
2021	4869	56.2	2492.9	1391.2
P for trend	-	-	<0.001	<0.001

Female				
Year of dialysis	**Number**	**%**	**CPR**	**ASPR**
2011	2223	45.4	1157.2	803.2
2012	2377	45.3	1226.6	826.6
2013	2479	44.9	1269.3	831.0
2014	2597	44.2	1319.4	837.1
2015	2742	44.0	1380.6	857.4
2016	2960	44.4	1477.0	893.6
2017	3102	44.3	1533.9	898.9
2018	3281	44.3	1609.6	918.3
2019	3412	43.9	1658.9	928.9
2020	3599	43.8	1741.5	948.0
2021	3799	43.8	1868.0	989.7
P for trend	-	-	<0.001	<0.001

Figure 5.5.4: Prevalence rate (pmp) of definitive dialysis by gender

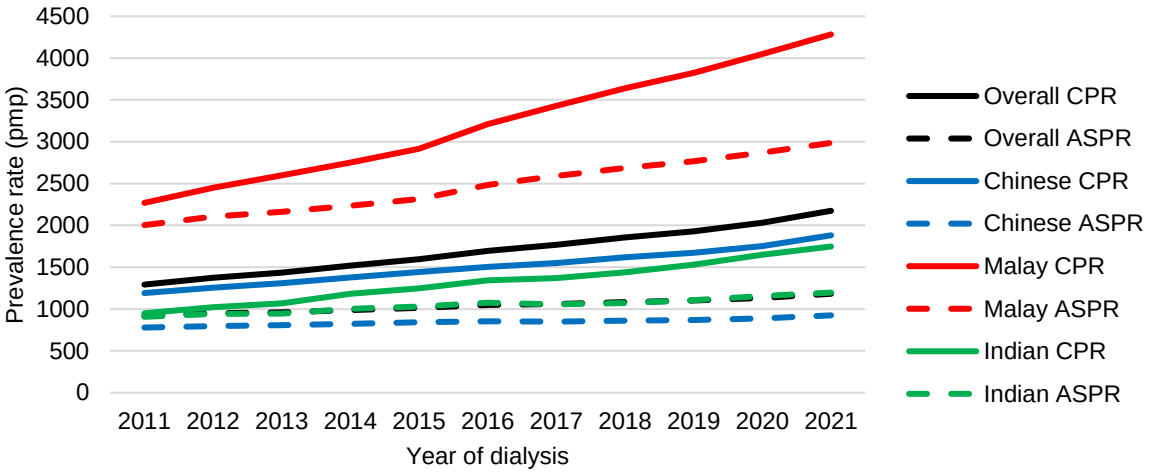


The ASPRs of definitive dialysis were consistently higher among Malays than Chinese and Indians across the years (Table 5.5.4 and Figure 5.5.5). In 2021, the ASPR was 924.0 pmp, 2,986.1 pmp and 1,196.6 pmp for Chinese, Malays and Indians respectively. While the ASPRs for all the three ethnic groups increased significantly over the years ($p<0.001$), the increment for Malays was higher than those for Chinese and Indians.

Table 5.5.4: Prevalence number and rate (pmp) of definitive dialysis by ethnicity

Chinese				
Year of dialysis	**Number**	**%**	**CPR**	**ASPR**
2011	3344	68.3	1190.7	778.4
2012	3558	67.8	1256.5	796.5
2013	3739	67.7	1310.2	806.1
2014	3954	67.2	1375.6	821.1
2015	4178	67.1	1440.7	840.0
2016	4397	65.9	1504.2	853.3
2017	4572	65.2	1550.7	849.2
2018	4805	64.9	1618.2	860.2
2019	5004	64.4	1671.5	868.3
2020	5266	64.1	1751.4	888.2
2021	5568	64.2	1881.0	924.0
P for trend	-	-	<0.001	<0.001
Malay				
Year of dialysis	**Number**	**%**	**CPR**	**ASPR**
2011	1149	23.5	2269.0	2003.4
2012	1247	23.8	2448.0	2104.0
2013	1332	24.1	2598.0	2161.3
2014	1421	24.2	2750.4	2235.4
2015	1519	24.4	2916.0	2313.5
2016	1689	25.3	3211.7	2485.2
2017	1820	26.0	3429.4	2591.9
2018	1950	26.3	3639.3	2687.1
2019	2068	26.6	3824.1	2767.7
2020	2209	26.9	4049.5	2871.2
2021	2332	26.9	4283.2	2986.1
P for trend	-	-	<0.001	<0.001
Indian				
Year of dialysis	**Number**	**%**	**CPR**	**ASPR**
2011	331	6.8	949.0	906.7
2012	358	6.8	1019.9	940.5
2013	375	6.8	1066.9	945.9
2014	418	7.1	1184.1	1003.0
2015	443	7.1	1248.1	1027.4
2016	479	7.2	1342.2	1076.1
2017	492	7.0	1371.2	1057.3
2018	519	7.0	1439.6	1069.4
2019	555	7.1	1530.5	1105.7
2020	598	7.3	1650.7	1156.5
2021	620	7.2	1747.0	1196.6
P for trend	-	-	<0.001	<0.001

Figure 5.5.5: Prevalence rate (pmp) of definitive dialysis by ethnicity



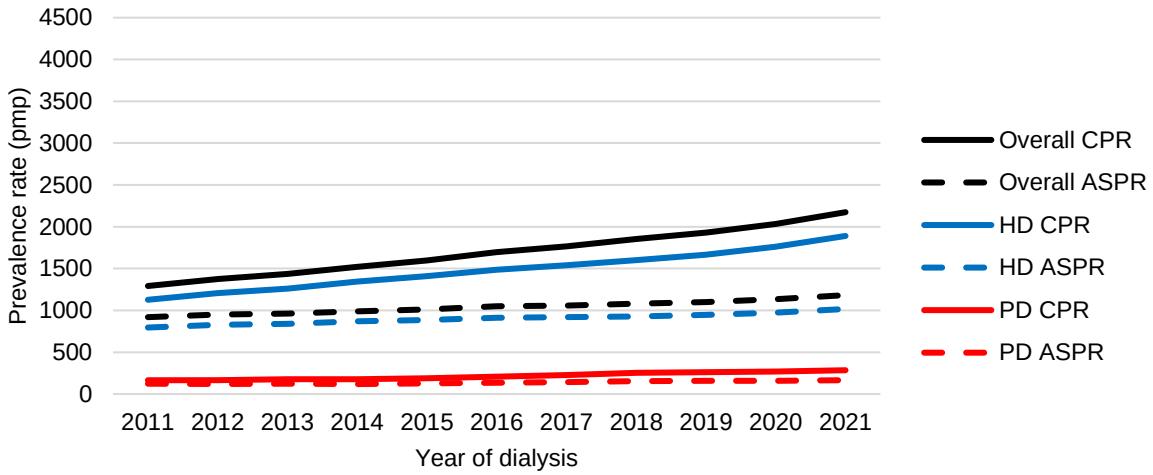
The ASPRs of definitive dialysis were consistently higher among HD than PD across the years (Table 5.5.5 and Figure 5.5.6). In 2021, the ASPR was 1,016.7 pmp and 165.6 pmp for HD and PD respectively. The ASPRs for both HD and PD increased significantly over the years (p<0.001).

Table 5.5.5: Prevalence number and rate (pmp) of definitive dialysis by modality

HD				
Year of dialysis	**Number**	**%**	**CPR**	**ASPR**
2011	4270	87.2	1126.9	795.2
2012	4612	87.9	1208.1	828.6
2013	4841	87.7	1259.2	837.8
2014	5199	88.4	1343.2	868.3
2015	5498	88.2	1408.8	886.9
2016	5850	87.7	1487.2	913.0
2017	6110	87.2	1540.7	917.7
2018	6389	86.3	1599.5	926.8
2019	6709	86.4	1666.3	944.7
2020	7127	86.7	1762.3	974.2
2021	7534	86.9	1889.7	1016.7
P for trend	-	-	<0.001	<0.001

PD				
Year of dialysis	**Number**	**%**	**CPR**	**ASPR**
2011	625	12.8	164.9	124.0
2012	632	12.1	165.5	120.4
2013	680	12.3	176.9	124.0
2014	681	11.6	175.9	118.8
2015	733	11.8	187.8	125.3
2016	823	12.3	209.2	135.3
2017	897	12.8	226.2	141.1
2018	1018	13.7	254.9	155.0
2019	1056	13.6	262.3	156.3
2020	1092	13.3	270.0	159.2
2021	1134	13.1	284.4	165.6
P for trend	-	-	<0.001	<0.001

Figure 5.5.6: Prevalence rate (pmp) of definitive dialysis by modality



The proportion of prevalent definitive dialysis patients with DN increased from 46.8% in 2011 to 56.3% in 2021 (Table 5.5.6). On the other hand, the proportion of prevalent definitive dialysis patients with GN dropped from 31.2% in 2011 to 22.0% in 2020.

Table 5.5.6: Prevalence number of definitive dialysis by etiology

Year of dialysis	DN		GN		Others	
	Number	%	Number	%	Number	%
2011	2290	46.8	1525	31.2	1080	22.1
2012	2543	48.5	1558	29.7	1143	21.8
2013	2760	50.0	1570	28.4	1191	21.6
2014	2998	51.0	1613	27.4	1269	21.6
2015	3272	52.5	1681	27.0	1278	20.5
2016	3569	53.5	1725	25.9	1379	20.7
2017	3802	54.3	1746	24.9	1459	20.8
2018	4063	54.9	1776	24.0	1568	21.2
2019	4288	55.2	1808	23.3	1669	21.5
2020	4606	56.0	1847	22.5	1766	21.5
2021	4881	56.3	1910	22.0	1877	21.7

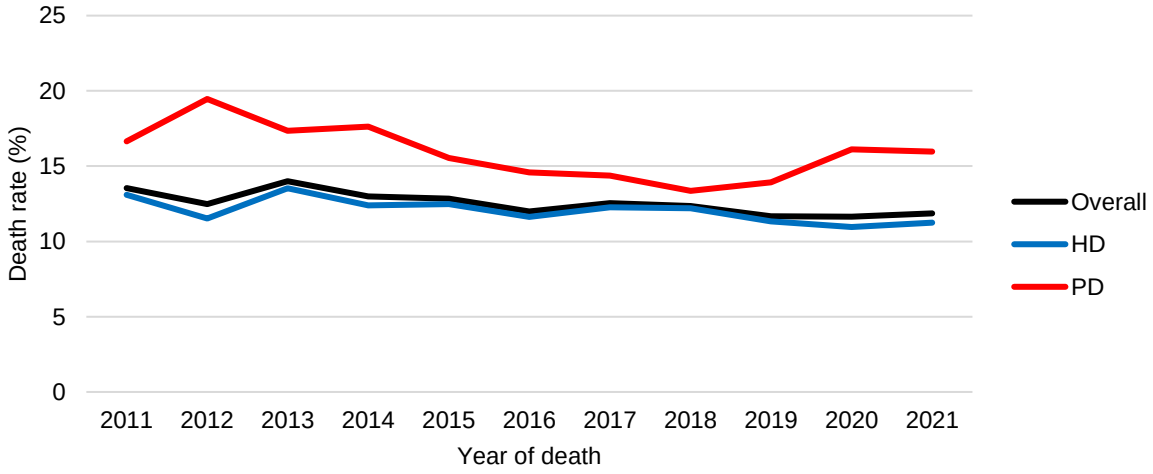
5.6 Mortality of definitive dialysis

11% to 14% of the patients on definitive dialysis died every year in the past decade (Table 5.6.1 and Figure 5.6.1). Consistently, there were proportionally more deaths among PD patients than HD patients over the years, whereby the modality was based on the last modality that the dialysis patient received before death. The disparity in mortality between the two modalities narrowed over the years prior to 2018, but it started to widen since 2018. The mortality rate for PD dropped from 19.5% in 2012 to 13.4% in 2018 before rising to 16.0% in 2021, while it remained stable and ranged between 11.0% and 13.5% for HD in the past decade. The disparity in mortality between HD and PD will be further examined in the next section.

Table 5.6.1: All-cause mortality by modality

Year of death	Overall		HD		PD	
	Number	%	Number	%	Number	%
2011	663	13.5	559	13.1	104	16.6
2012	654	12.5	531	11.5	123	19.5
2013	773	14.0	655	13.5	118	17.4
2014	764	13.0	644	12.4	120	17.6
2015	800	12.8	686	12.5	114	15.6
2016	800	12.0	680	11.6	120	14.6
2017	879	12.5	750	12.3	129	14.4
2018	915	12.4	779	12.2	136	13.4
2019	907	11.7	760	11.3	147	13.9
2020	957	11.6	781	11.0	176	16.1
2021	1029	11.9	848	11.3	181	16.0

Figure 5.6.1: All-cause mortality by modality



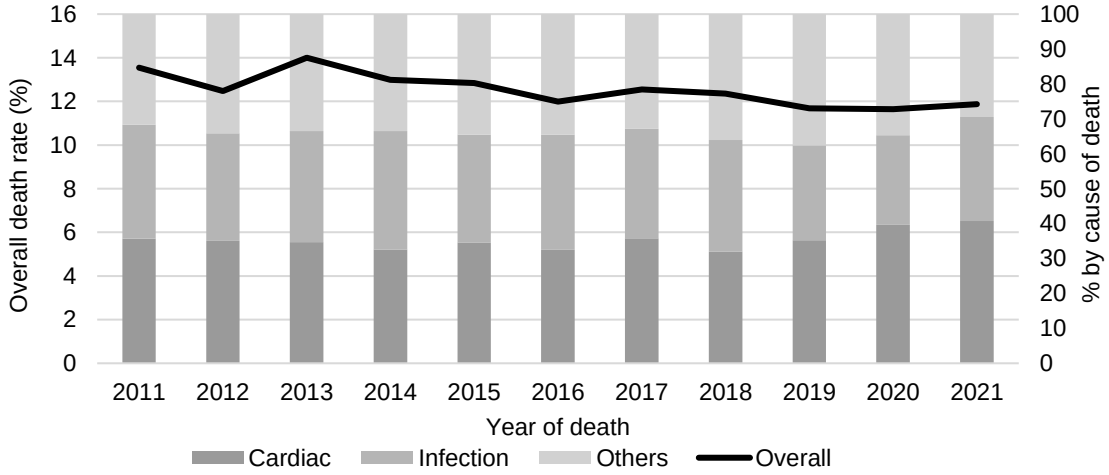
Deaths related to cardiac event and infection were the two most common causes of death and each of them accounted for about a third of all deaths across the years (Table 5.6.2 and Figure 5.6.2).

Table 5.6.2: Mortality by cause of death

Year of death	Overall		Cardiac event		Infection		Others	
	Number	%*	Number	%^	Number	%^	Number	%^
2011	663	13.5	237	35.7	216	32.6	210	31.7
2012	654	12.5	229	35.0	202	30.9	223	34.1
2013	773	14.0	268	34.7	246	31.8	259	33.5
2014	764	13.0	249	32.6	259	33.9	256	33.5
2015	800	12.8	277	34.6	247	30.9	276	34.5
2016	800	12.0	260	32.5	264	33.0	276	34.5
2017	879	12.5	315	35.8	275	31.3	289	32.9
2018	915	12.4	292	31.9	293	32.0	330	36.1
2019	907	11.7	320	35.3	246	27.1	341	37.6
2020	957	11.6	379	39.6	246	25.7	332	34.7
2021	1029	11.9	419	40.7	307	29.8	303	29.4

*Mortality among prevalent dialysis patients
^Mortality among prevalent dialysis patients who died

Figure 5.6.2: Mortality by cause of death



5.7 Survival of definitive dialysis

The unadjusted survival rate and median survival duration of new patients on definitive dialysis were estimated using the Kaplan-Meier method in Tables 5.7.2 to 5.7.11. Event was defined as all-cause death. Patients were censored if they stopped definitive dialysis (i.e. received kidney transplant), or reached the end of the follow-up period (i.e. neither received kidney transplant nor died by 30 April 2022, the date until which the death status of all patients were updated for this report). Median survival duration is indicated as “not reached (NR)” if more than half of the patients were alive as of 30 April 2022. Multivariable Cox regression was used to estimate the adjusted risk of death, accounting for the effects of potential confounders in Table 5.7.12.

All analyses in this section were stratified by or adjusted for modality as the baseline characteristics (Table 5.7.1) and survival (Table 5.7.2) differed between HD and PD patients. The modality, age, gender, ethnicity, etiology and co-morbidities in this section were based on data captured by the registry at the start of definitive dialysis.

Compared to PD patients, the proportion of males was higher ($p<0.001$), but the proportion of Chinese was lower ($p<0.001$) among HD patients (Table 5.7.1). The proportions of those aged 60 years and above ($p=0.026$) and those with cerebrovascular disease ($p=0.001$) were lower among HD patients. However, HD patients had higher proportions of peripheral vascular disease ($p=0.001$) and cancer ($p<0.001$).

Table 5.7.1: Baseline characteristics by modality

	HD	PD	Overall
Age group (%)			
≥60 years	55.2	57.0	55.6
Gender (%)			
Male	57.3	50.3	55.8
Ethnicity (%)			
Chinese	65.8	71.9	67.1
Malay	24.8	20.1	23.8
Indian	7.8	6.2	7.4
Etiology (%)			
DN	62.5	62.7	62.5
Co-morbidities (%)			
Ischemic heart disease	46.2	45.6	46.1
Cerebrovascular disease	23.1	25.5	23.6
Peripheral vascular disease	15.1	13.1	14.7
Cancer	9.0	4.6	8.0

HD patients had significantly better survival than PD patients as indicated by their higher survival rates and longer median survival duration (p<0.001) (Table 5.7.2).

Table 5.7.2: Survival of definitive dialysis by modality

	HD	PD	Overall
1-year survival (%)	90.8	89.9	90.6
5-year survival (%)	60.6	41.9	56.5
10-year survival (%)	32.3	19.5	29.5
Median survival (years)	6.6	4.2	6.0

Although 5- and 10-year survival were consistently better among HD than PD patients, their gap narrowed over the years as the survival of HD patients were similar throughout the years, while the survival of PD patients improved over the years (p<0.001) (Table 5.7.3).

Table 5.7.3: Survival of definitive dialysis by year and modality

	1999-2005			2006-2011		
	HD	**PD**	**Overall**	**HD**	**PD**	**Overall**
1-year survival (%)	90.6	85.8	89.1	89.3	88.4	89.1
5-year survival (%)	58.6	34.0	50.6	59.0	39.6	55.5
10-year survival (%)	32.6	15.5	27.1	31.0	19.3	28.9
Median survival (years)	6.5	3.4	5.1	6.3	3.8	5.8
	2012-2016			**2017-2021**		
	HD	**PD**	**Overall**	**HD**	**PD**	**Overall**
1-year survival (%)	90.9	92.3	91.1	91.9	93.9	92.3
5-year survival (%)	61.7	50.8	59.8	NA	NA	NA
10-year survival (%)	NA	NA	NA	NA	NA	NA
Median survival (years)	6.7	5.1	6.4	NR	NR	NR

Younger patients aged below 60 years had significantly better survival than older patients aged 60 years and above regardless of modality (p<0.001) (Table 5.7.4).

Table 5.7.4: Survival of definitive dialysis by age group and modality

	Age <60 years			Age ≥60 years		
	HD	**PD**	**Overall**	**HD**	**PD**	**Overall**
1-year survival (%)	93.7	93.4	93.6	88.5	87.4	88.2
5-year survival (%)	71.9	58.5	69.1	51.2	29.5	46.2
10-year survival (%)	46.6	34.7	44.1	19.6	7.9	16.9
Median survival (years)	9.2	6.3	8.7	5.2	3.3	4.5

Female HD patients had significantly better survival than male HD patients (p=0.006). However, survival among PD patients was fairly similar between the two genders (Table 5.7.5).

Table 5.7.5: Survival of definitive dialysis by gender and modality

	Male			Female		
	HD	PD	Overall	HD	PD	Overall
1-year survival (%)	90.5	90.0	90.4	91.2	89.8	90.8
5-year survival (%)	59.8	43.0	56.5	61.7	40.9	56.6
10-year survival (%)	31.7	18.2	29.1	33.2	20.6	30.1
Median survival (years)	6.5	4.3	6.0	6.7	4.1	5.9

Malay HD patients had significantly better survival than Chinese and Indian HD patients (p<0.001) (Table 5.7.6). However, survival among PD patients was fairly similar across the three ethnic groups.

Table 5.7.6: Survival of definitive dialysis by ethnicity and modality

	Chinese			Malay			Indian		
	HD	PD	Overall	HD	PD	Overall	HD	PD	Overall
1-year survival (%)	90.9	90.1	90.7	91.0	89.5	90.8	89.9	89.2	89.8
5-year survival (%)	59.7	42.0	55.6	63.6	40.3	59.2	59.0	43.2	56.1
10-year survival (%)	31.1	19.1	28.4	36.4	20.5	33.4	29.1	18.3	27.2
Median survival (years)	6.4	4.2	5.8	7.2	3.9	6.4	6.0	3.9	5.8

Patients without DN had significantly better survival than those with DN regardless of modality (p<0.001) (Table 5.7.7).

Table 5.7.7: Survival of definitive dialysis by etiology and modality

	Non-DN			DN		
	HD	PD	Overall	HD	PD	Overall
1-year survival (%)	92.4	93.7	92.7	89.8	87.7	89.4
5-year survival (%)	71.5	63.6	69.9	54.1	29.5	48.6
10-year survival (%)	49.1	38.3	46.9	21.8	8.7	18.9
Median survival (years)	9.8	7.4	9.2	5.5	3.4	4.8

Patients without ischemic heart disease (IHD) had significantly better survival than those with IHD regardless of modality (p<0.001) (Table 5.7.8).

Table 5.7.8: Survival of definitive dialysis by presence of IHD and modality

	No IHD			IHD		
	HD	PD	Overall	HD	PD	Overall
1-year survival (%)	93.0	93.1	93.0	88.5	86.5	88.1
5-year survival (%)	69.9	54.6	66.6	50.7	28.6	45.8
10-year survival (%)	43.4	30.1	40.6	20.0	9.0	17.5
Median survival (years)	8.6	5.6	8.0	5.1	3.2	4.5

Patients without cerebrovascular disease (CVD) had significantly better survival than those with CVD regardless of modality (p<0.001) (Table 5.7.9).

Table 5.7.9: Survival of definitive dialysis by presence of CVD and modality

	No CVD			CVD		
	HD	PD	Overall	HD	PD	Overall
1-year survival (%)	92.0	91.6	91.9	87.2	85.6	86.9
5-year survival (%)	64.6	47.8	61.1	48.5	27.0	43.3
10-year survival (%)	36.3	23.5	33.6	19.2	9.5	16.8
Median survival (years)	7.2	4.8	6.7	4.8	3.0	4.2

Patients without peripheral vascular disease (PVD) had significantly better survival than those with PVD regardless of modality (p<0.001) (Table 5.7.10).

Table 5.7.10: Survival of definitive dialysis by presence of PVD and modality

	No PVD			PVD		
	HD	PD	Overall	HD	PD	Overall
1-year survival (%)	91.9	91.4	91.8	85.5	81.8	84.8
5-year survival (%)	64.0	45.8	60.0	44.6	22.0	40.2
10-year survival (%)	35.7	22.1	32.8	14.6	4.5	12.6
Median survival (years)	7.1	4.5	6.5	4.3	2.7	3.9

Patients without cancer had significantly better survival than those with cancer regardless of modality (p<0.001) (Table 5.7.11).

Table 5.7.11: Survival of definitive dialysis by presence of cancer and modality

	No cancer			Cancer		
	HD	PD	Overall	HD	PD	Overall
1-year survival (%)	92.0	91.6	91.9	83.4	88.9	84.0
5-year survival (%)	63.1	45.3	59.2	45.7	34.0	44.3
10-year survival (%)	34.1	21.4	31.3	19.8	10.3	18.7
Median survival (years)	6.9	4.5	6.3	4.5	3.3	4.3

PD, old age, DN, IHD, CVD, PVD and cancer remained as significant risk factors of death in the multivariable analysis (Table 5.7.12).

Compared to HD patients, the poorer survival among PD patients could be due to several factors, aside from the co-morbidities captured by the registry. For instance, as PD is done at home and self-managed by the patient him/herself or his/her caregiver at own convenience, the efficiency and quality of dialysis may be affected if it is not done properly and regularly at the recommended frequency. As PD patients also visit their healthcare providers less frequently, infections and other complications may be less recognised, thereby affecting the timeliness of intervention[13].

[13] Yang F et al. Hemodialysis versus peritoneal dialysis: A comparison of survival outcomes in South-East Asian patients with end-stage renal disease. PLoS ONE. 2015; 10(10): e0140195.

Table 5.7.12: Adjusted risk of death by factors associated with survival of definitive dialysis

	Hazard ratio	95% confidence interval	P-value
Modality			
HD	1.00	Reference	<0.001
PD	1.53	1.46-1.60	
Age group			
<60 years	1.00	Reference	<0.001
≥60 years	1.90	1.82-1.98	
Gender			
Male	1.00	Reference	0.262
Female	0.98	0.94-1.02	
Ethnicity			
Chinese	1.00	Reference	
Malay	0.92	0.88-0.97	0.001
Indian	0.97	0.91-1.05	0.493
Etiology			
Non-DN	1.00	Reference	<0.001
DN	1.72	1.64-1.80	
IHD			
No	1.00	Reference	<0.001
Yes	1.46	1.40-1.52	
CVD			
No	1.00	Reference	<0.001
Yes	1.33	1.28-1.39	
PVD			
No	1.00	Reference	<0.001
Yes	1.49	1.41-1.57	
Cancer			
No	1.00	Reference	<0.001
Yes	1.48	1.39-1.59	

5.8 Management of definitive dialysis

The management of prevalent patients on dialysis was assessed based on several criteria: frequency of dialysis, management of urea, management of anaemia, and management of mineral and bone disease. The criteria of each of these aspects are shown in the table below and they follow as closely to international guidelines[14,15,16,17] as possible.

Criteria	Modality	Indication of adequacy
Frequency of dialysis and management of urea	HD	Thrice weekly dialysis
		Urea reduction ratio (URR) >=65% or fractional clearance of urea (Kt/V) >=1.2%
	PD	Kt/V >=2.0%
Management of anaemia	HD and PD	Haemoglobin (hb) >=10 g/dL with or without erythropoietin stimulating agent (ESA)
Management of mineral and bone disease	HD and PD	Corrected serum calcium (Ca) <2.37 mmol/L
		Serum phosphate (PO_4) >1.13 mmol/L and <1.78 mmol/L
		Serum intact parathyroid hormone (iPTH) >16.3 pmol/L and <33.0 pmol/L

All analyses in this section were stratified by service provider (public sector / VWOs / private sector) and modality (HD / PD) to look out for groups of patients in need of better dialysis management. The most recent reading of each biomarker for each patient in each year were taken and patients without measurement of biomarkers were excluded[18].

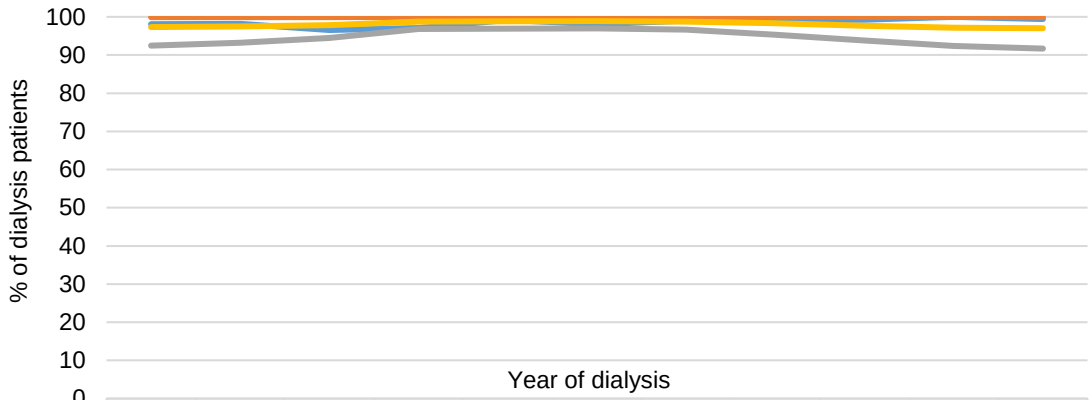
Most prevalent HD patients were dialysed in centres run by the VWOs, followed by the private sector, then the public sector. In 2021, the proportions of HD patients under the care of the VWOs, private sector and public sector were 62.6%, 35.3% and 2.2% respectively (Table 5.1.2). Compared to the VWO and private sector in the past decade, the number of HD patients from the public sector was smaller, resulting in less stable trends.

[14] National Kidney Foundation: K/DOQI clinical practice guidelines for hemodialysis adequacy, 2000. American Journal of Kidney Disease. 2001; 37 (suppl 1): S7-S64.
[15] NKF KDOQI Guidelines. National Kidney Foundation, New York. http://kidneyfoundation.cachefly.net/professionals/KDOQI/guideline_upHD_PD_VA/pd_guide2.htm Accessed on 1 Mar 2021.
[16] Mimura I, Tanaka T, Nangaku M. How the target hemoglobin of renal anemia should be? Nephron. 2015; 131: 202-209.
[17] NKF KDOQI Guidelines. National Kidney Foundation, New York. http://kidneyfoundation.cachefly.net/professionals/KDOQI/guidelines_bone/guidestate.htm Accessed on 1 Mar 2021.
[18] The registry captures the absolute value but not the reference range (which differ from each healthcare institution) of each biomarker for each patient.

On the other hand, almost all the prevalent PD patients were cared for by the public sector. In 2021, 99.2% of the PD patients fell under the care of the public sector, with no patient under the care of the VWOs (Table 5.1.2). As there were only a few PD patients from the private sector in the past decade and no PD patient from the VWOs since 2017, their trends were either unstable or not applicable. Hence, statistics related to PD patients from the private sector in the past decade and from the VWOs since 2017 were not shown in the figures though they were included in the overall statistics.

The proportion of prevalent HD patients with thrice weekly dialysis was consistently higher for the public sector and VWOs than the private sector across the years (Figure 5.8.1a). In 2021, 99.4%, 100% and 91.7% of the patients from the public, VWOs and private sector underwent thrice weekly dialysis respectively.

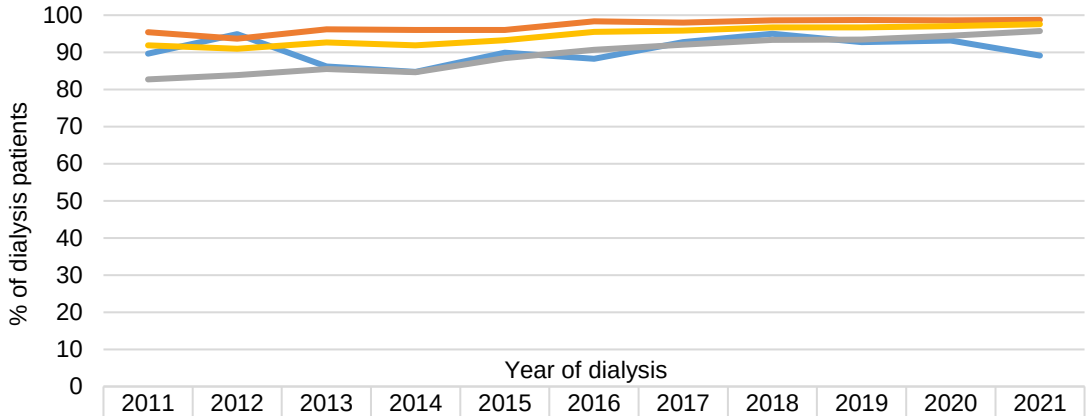
Figure 5.8.1a: Proportion of HD patients with thrice weekly dialysis



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Public	98.0	98.1	96.6	97.1	99.1	98.1	99.0	99.0	99.2	100.0	99.4
VWO	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Private	92.5	93.2	94.5	96.8	96.9	97.0	96.7	95.3	93.8	92.4	91.7
Overall	97.4	97.5	97.9	98.7	98.8	98.9	98.8	98.3	97.7	97.2	97.0

The proportion of prevalent HD patients who met the adequate management of urea criteria of URR >=65% or Kt/V >=1.2% was generally higher for the VWOs than the public and private sectors (Figure 5.8.1b). However, the private sector was catching up, with proportion rising from 82.7% in 2011 to 95.7% in 2021. In 2021, 89.2% and 98.7% of the patients from the public sector and VWOs met the criteria respectively.

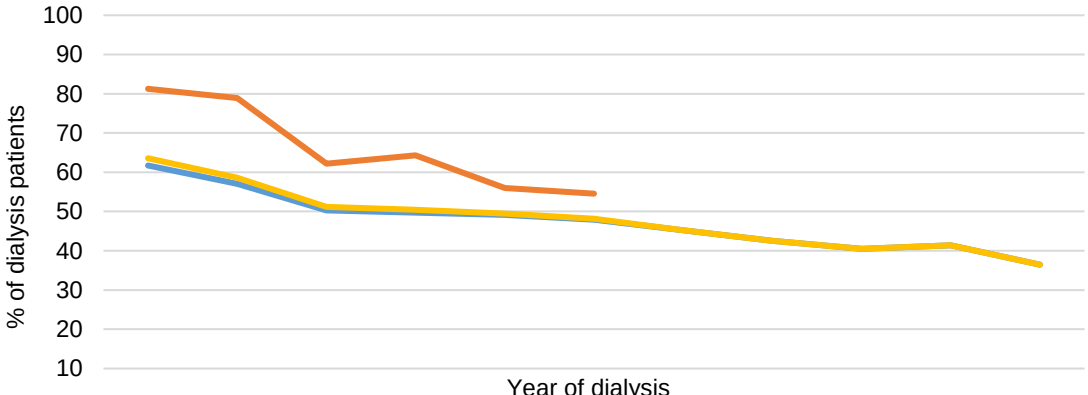
Figure 5.8.1b: Proportion of HD patients with adequate management of urea (URR >=65% or Kt/V >=1.2%)



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Public	89.7	94.9	86.2	84.7	89.9	88.2	92.8	95.0	92.8	93.2	89.2
VWO	95.4	93.7	96.2	96.0	96.0	98.3	98.0	98.6	98.7	98.6	98.7
Private	82.7	83.9	85.5	84.7	88.4	90.6	92.1	93.3	93.4	94.4	95.7
Overall	91.9	91.0	92.6	91.9	93.3	95.5	95.9	96.7	96.7	97.1	97.6

The proportion of prevalent PD patients who met the adequate management of urea criteria of Kt/V >=2.0% dropped from 63.6% in 2011 to 36.5% in 2021 (Figure 5.8.2). Aside from Kt/V, the International Society for Peritoneal Dialysis recommends using other measures to concurrently assess the quality of dialysis, such as anaemia management and bone and mineral management[19].

Figure 5.8.2: Proportion of PD patients with adequate management of urea (Kt/V >=2%)



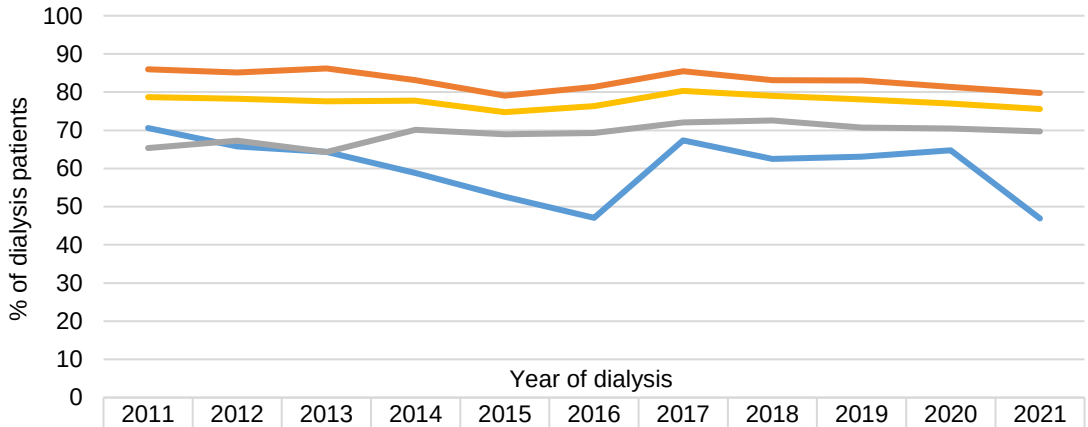
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Public	61.7	57.1	50.3	49.7	49.1	47.9	45.2	42.6	40.5	41.4	36.5
VWO	81.3	78.9	62.2	64.3	56.0	54.5					
Overall	63.6	58.6	51.1	50.5	49.4	48.2	45.2	42.6	40.5	41.4	36.5

[19] Brown EA, Blake PG, Boudville N, et al. International Society for Peritoneal Dialysis practice recommendations: prescribing high-quality goal-directed peritoneal dialysis. Journal of the International Society for Peritoneal Dialysis. 2020; 40: 244-253.

The proportion of prevalent HD patients who fulfilled the adequate management of anaemia criteria of hb >=10 g/dL was consistently higher for the VWOs than the public and private sectors across the years (Figure 5.8.3a). In 2021, 46.9%, 79.8% and 69.7% of the patients from the public, VWOs and private sector fulfilled the criteria respectively.

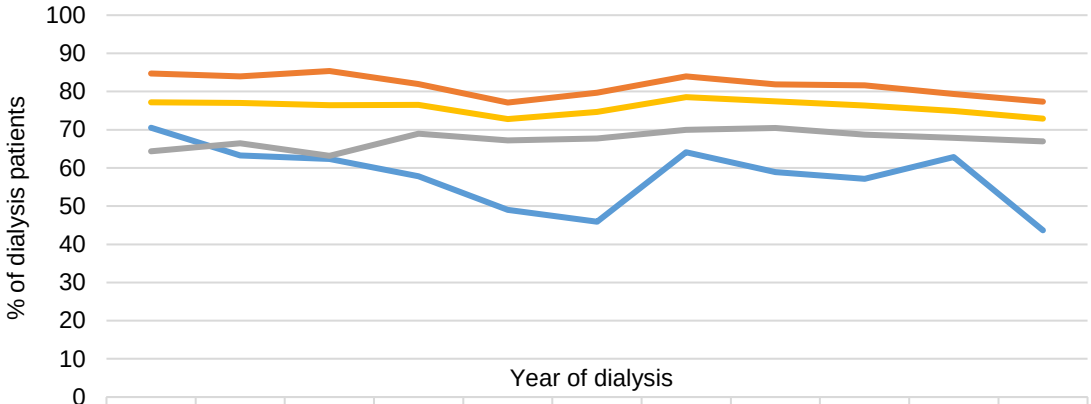
Similar trends were observed after stratification by ESA, a drug that stimulates the production of erythropoietin, a hormone produced primarily by the kidneys and plays a key role in the production of red blood cells (Figures 5.8.3b and 5.8.3c). In addition, the proportion of prevalent HD patients who fulfilled the adequate management of anaemia criteria was consistently higher among those who were not taking ESA than those on ESA (Figure 5.8.3b and Figure 5.8.3c). This could be due to patients who were prone to anaemia being on ESA.

Figure 5.8.3a: Proportion of HD patients with adequate management of anaemia (hb >=10 g/dL)



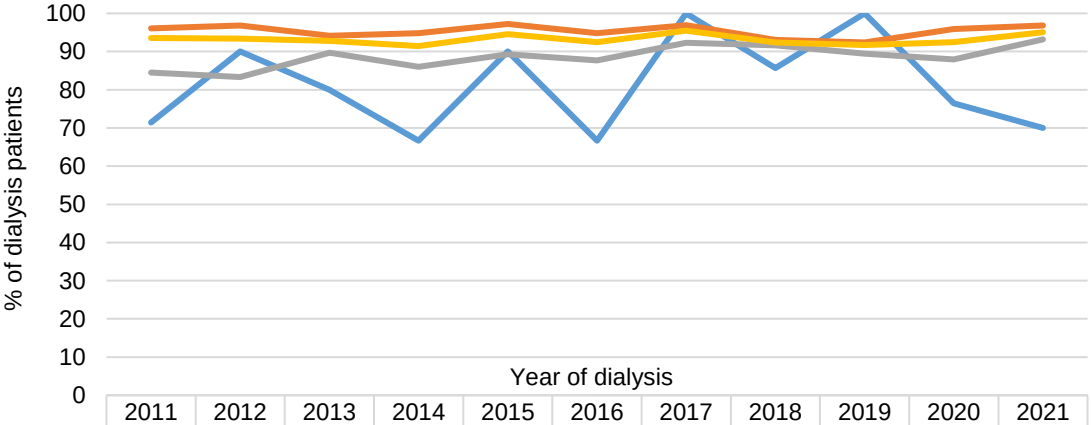
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Public	70.6	65.7	64.4	58.8	52.6	47.1	67.3	62.5	63.1	64.8	46.9
VWO	86.0	85.1	86.2	83.1	79.1	81.3	85.4	83.1	83.0	81.3	79.8
Private	65.4	67.3	64.3	70.1	68.9	69.3	72.1	72.6	70.7	70.5	69.7
Overall	78.7	78.2	77.6	77.7	74.7	76.4	80.3	79.0	78.1	77.0	75.5

Figure 5.8.3b: Proportion of HD patients on ESA with adequate management of anaemia (hb >=10 g/dL)



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Public	70.5	63.3	62.3	57.8	49.0	45.9	64.1	58.9	57.1	62.9	43.7
VWO	84.7	83.9	85.4	81.9	77.1	79.7	84.0	81.9	81.7	79.4	77.4
Private	64.4	66.4	63.2	69.0	67.2	67.7	69.9	70.5	68.8	67.9	67.0
Overall	77.2	77.0	76.4	76.5	72.8	74.7	78.5	77.4	76.3	74.9	72.9

Figure 5.8.3c: Proportion of HD patients not on ESA with adequate management of anaemia (hb >=10 g/dL)

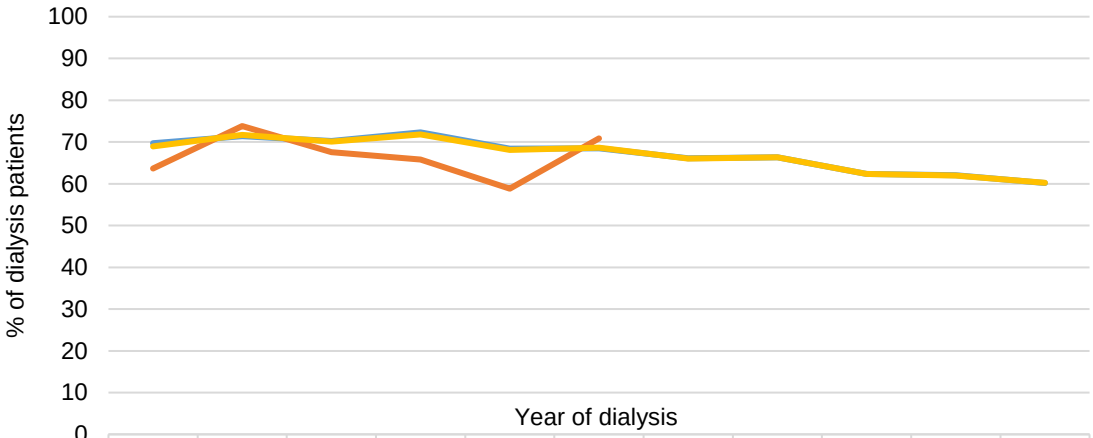


	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Public	71.4	90.0	80.0	66.7	90.0	66.7	100.0	85.7	100.0	76.5	70.0
VWO	96.1	96.9	94.2	94.8	97.2	94.8	96.9	93.0	92.4	95.9	96.8
Private	84.5	83.3	89.7	86.0	89.3	87.7	92.3	91.6	89.5	87.9	93.2
Overall	93.5	93.4	92.8	91.4	94.5	92.4	95.5	92.4	91.7	92.4	95.1

The proportion of prevalent PD patients who fulfilled the adequate management of anaemia criteria of hb >=10 g/dL dropped from 69.0% in 2011 to 60.2% in 2021 (Figure 5.8.4a).

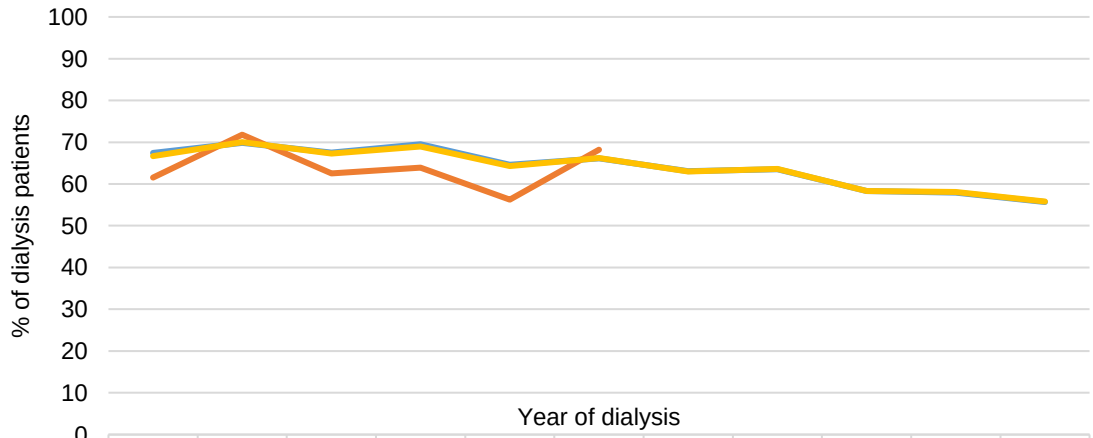
Similar decreasing trend was observed among PD patients taking ESA (Figure 5.8.4b), but the trend since 2017 was stable among those not on ESA (Figure 5.8.4c). Like HD patients, the proportion of PD patients fulfilling the criteria was consistently higher among those who were not taking ESA than those on ESA.

Figure 5.8.4a: Proportion of PD patients with adequate management of anaemia (hb >=10 g/dL)



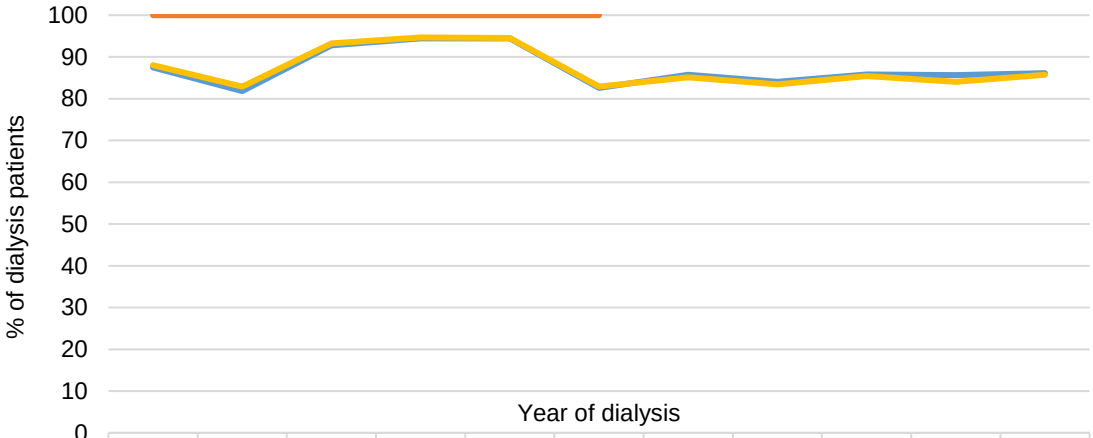
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Public	69.7	71.4	70.2	72.3	68.4	68.5	66.1	66.3	62.4	62.0	60.2
VWO	63.6	73.8	67.6	65.8	58.8	70.8					
Overall	69.0	71.7	70.1	71.8	68.1	68.6	66.0	66.3	62.4	62.0	60.2

Figure 5.8.4b: Proportion of PD patients on ESA with adequate management of anaemia (hb >=10 g/dL)



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Public	67.4	69.8	67.5	69.5	64.6	66.1	63.0	63.5	58.3	57.9	55.7
VWO	61.5	71.8	62.5	63.9	56.3	68.2					
Overall	66.7	70.0	67.3	69.0	64.3	66.2	63.0	63.6	58.3	58.1	55.8

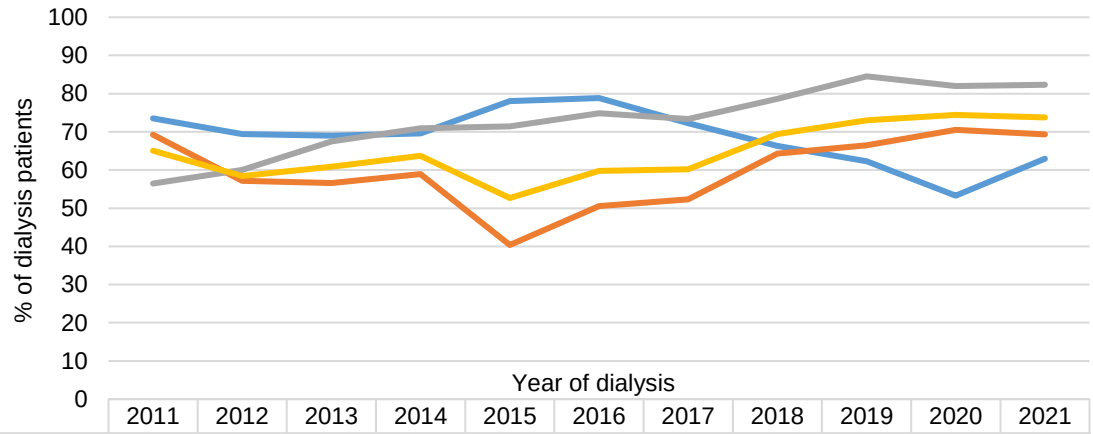
Figure 5.8.4c: Proportion of PD patients not on ESA with adequate management of anaemia (hb >=10 g/dL)



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Public	87.5	81.8	92.8	94.4	94.4	82.6	85.7	84.1	85.8	85.6	86.1
VWO	100.0	100.0	100.0	100.0	100.0	100.0					
Overall	88.1	82.9	93.2	94.7	94.6	82.9	85.1	83.5	85.4	84.0	85.7

The proportion of prevalent HD patients who passed the adequate management of mineral and bone disease criteria of corrected serum Ca <2.37 mmol/L was generally an inverted U-shape trend for the public sector, a U-shape trend for the VWOs, and an upward trend for the private sector (Figure 5.8.5). In 2021, 63.0%, 69.4% and 82.3% of the patients from the public sector, VWOs and private sector passed the criteria respectively.

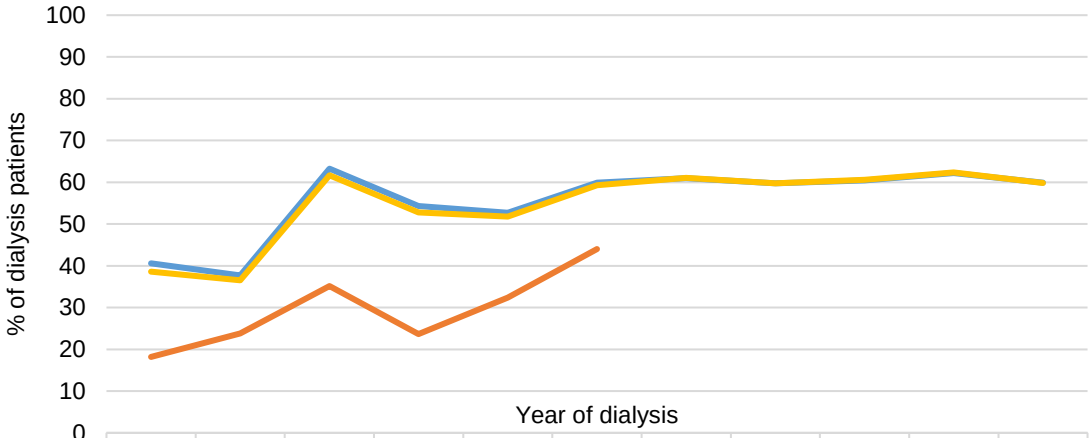
Figure 5.8.5: Proportion of HD patients with adequate management of mineral and bone disease (corrected serum Ca <2.37 mmol/L)



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Public	73.5	69.4	69.0	69.6	78.1	78.8	72.3	66.3	62.3	53.3	63.0
VWO	69.3	57.2	56.6	59.0	40.4	50.6	52.3	64.3	66.4	70.5	69.4
Private	56.5	60.0	67.4	71.0	71.4	74.8	73.3	78.6	84.5	82.0	82.3
Overall	65.1	58.5	60.9	63.7	52.7	59.8	60.2	69.4	73.0	74.4	73.7

The proportion of prevalent PD patients who passed the adequate management of mineral and bone disease criteria of corrected serum Ca <2.37 mmol/L increased from 38.6% in 2011 to 59.9% in 2021 (Figure 5.8.6).

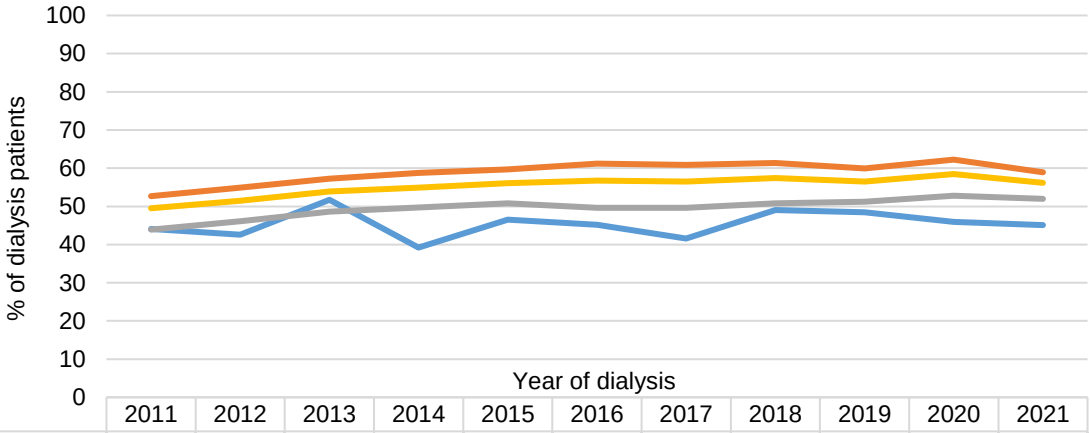
Figure 5.8.6: Proportion of PD patients with adequate management of mineral and bone disease (corrected serum Ca <2.37 mmol/L)



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Public	40.6	37.7	63.2	54.3	52.7	59.9	61.0	59.8	60.4	62.2	59.9
VWO	18.2	23.8	35.1	23.7	32.4	44.0					
Overall	38.6	36.5	61.7	52.8	51.8	59.3	61.0	59.8	60.6	62.4	59.9

The proportion of prevalent HD patients who passed the adequate management of mineral and bone disease criteria of serum PO_4 >1.13 mmol/L and <1.78 mmol/L was consistently higher for the VWOs than the public and private sectors across the years (Figure 5.8.7). In 2021, 45.1%, 58.9% and 52.0% of the patients from the public sector, VWOs and private sector passed the criteria respectively.

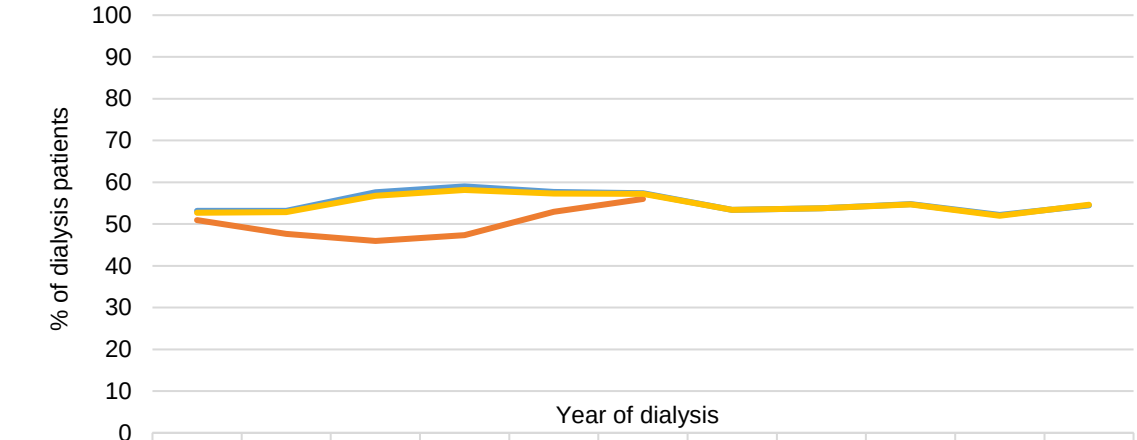
Figure 5.8.7: Proportion of HD patients with adequate management of mineral and bone disease (serum PO_4 >1.13 mmol/L and <1.78 mmol/L)



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Public	44.1	42.6	51.7	39.2	46.5	45.2	41.6	49.0	48.5	45.9	45.1
VWO	52.7	54.9	57.3	58.7	59.7	61.2	60.9	61.4	59.9	62.2	58.9
Private	43.9	46.1	48.6	49.7	50.8	49.7	49.6	50.8	51.3	52.8	52.0
Overall	49.5	51.4	53.9	54.9	56.1	56.8	56.5	57.4	56.5	58.5	56.2

The proportion of prevalent PD patients who passed the adequate management of mineral and bone disease criteria of serum PO_4 >1.13 mmol/L and <1.78 mmol/L remained stable and ranged between 52% and 59% in 2011 to 2021 (Figure 5.8.8).

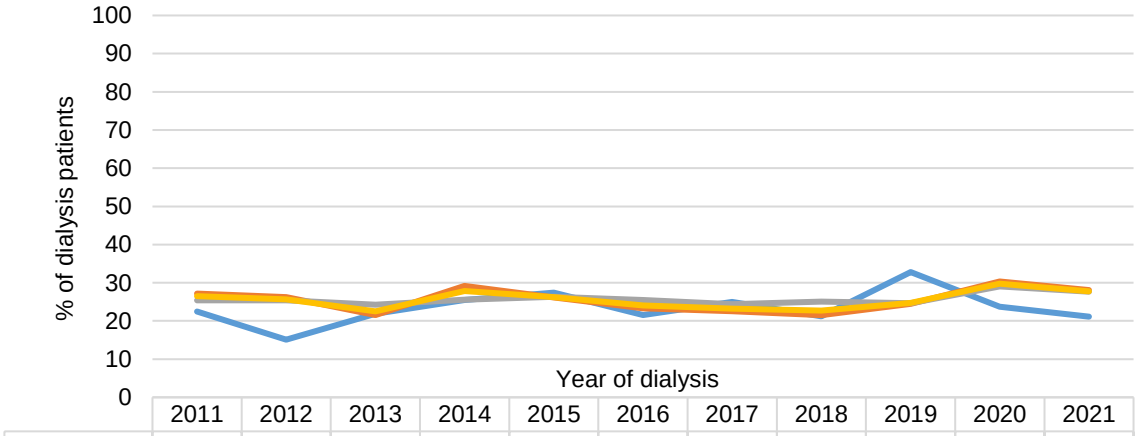
Figure 5.8.8: Proportion of PD patients with adequate management of mineral and bone disease (serum PO_4 >1.13 mmol/L and <1.78 mmol/L)



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Public	53.2	53.2	57.6	59.0	57.7	57.4	53.4	53.8	54.8	52.2	54.5
VWO	50.9	47.6	45.9	47.4	52.9	56.0					
Overall	52.7	52.9	56.8	58.1	57.3	57.2	53.3	53.7	54.7	52.0	54.6

The proportion of prevalent HD patients who passed the adequate management of mineral and bone disease criteria of serum iPTH >16.3 pmol/L and <33.0 pmol/L was fairly similar across the three broad service providers for most years (Figure 5.8.9). In 2021, 21.1%, 28.1% and 27.6% of the patients from the public sector, VWOs and private sector passed the criteria respectively.

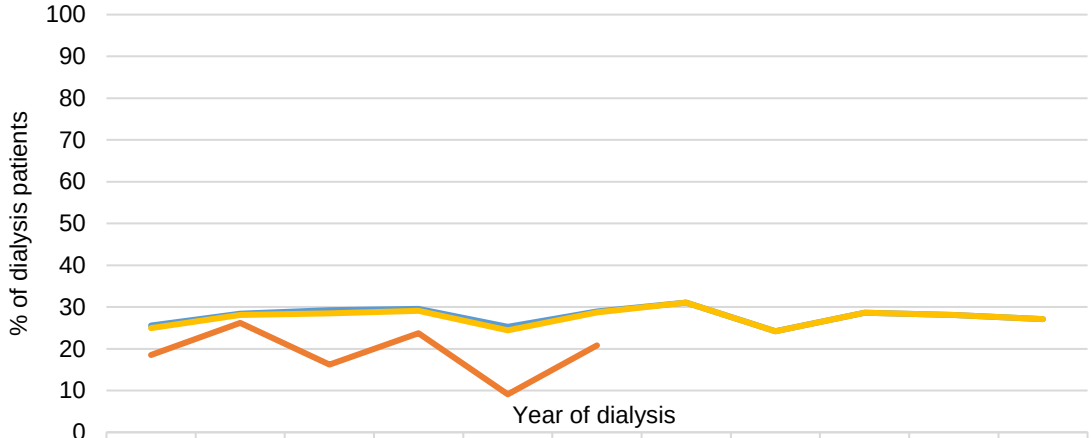
Figure 5.8.9: Proportion of HD patients with adequate management of mineral and bone disease (serum iPTH >16.3 pmol/L and <33.0 pmol/L)



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Public	22.4	15.1	21.8	25.5	27.4	21.6	25.0	21.2	32.8	23.7	21.1
VWO	27.2	26.2	21.5	29.2	26.1	23.3	22.6	21.5	24.5	30.3	28.1
Private	25.4	25.4	24.3	25.6	26.3	25.5	24.4	25.1	24.7	29.0	27.6
Overall	26.5	25.7	22.5	27.8	26.2	24.0	23.3	22.8	24.7	29.8	27.8

The proportion of prevalent PD patients who passed the adequate management of mineral and bone disease criteria of serum iPTH >16.3 pmol/L and <33.0 pmol/L remained stable and ranged between 24% and 32% in 2011 to 2021 (Figure 5.8.10).

Figure 5.8.10: Proportion of PD patients with adequate management of mineral and bone disease (serum iPTH >16.3 pmol/L and <33.0 pmol/L)



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Public	25.6	28.4	29.2	29.5	25.3	29.0	31.1	24.2	28.6	28.1	27.1
VWO	18.5	26.2	16.2	23.7	9.1	20.8					
Overall	25.0	28.1	28.5	29.1	24.4	28.7	31.1	24.2	28.7	28.1	27.1

5.9 Incidence of kidney transplant

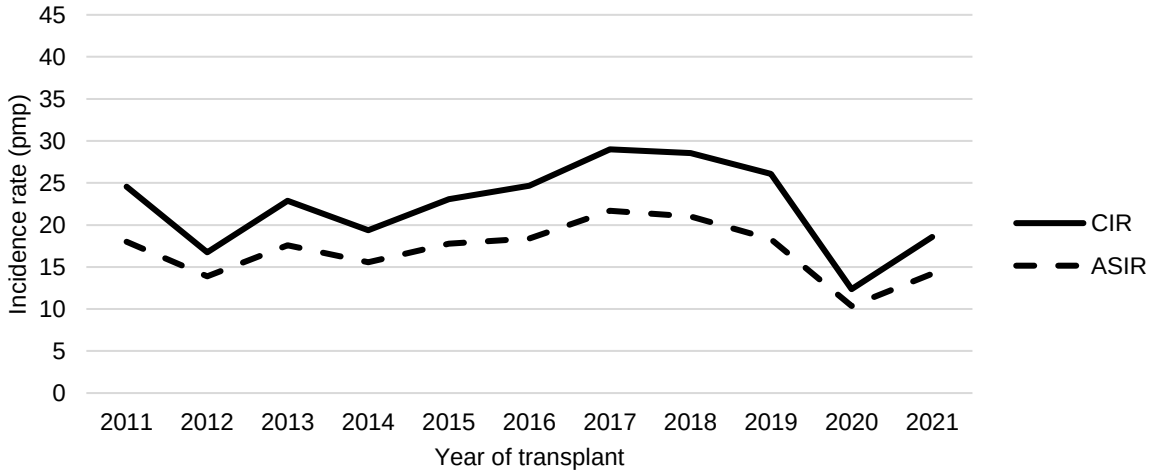
The incidence rate of kidney transplant in each year was calculated by taking the number of new patients with kidney transplant in a year, divided by the number of Singapore residents in the same year. Patients were categorised into 10-year age groups and age standardisation was done using the direct method with the Segi World population as the reference population.

Due to the small number of kidney transplants done each year, the CIR and ASIR of transplant fluctuated year-on-year (Table 5.9.1 and Figure 5.9.1). In 2020, the number of kidney transplants hit the lowest point in the past decade, likely due to COVID-19. But it went up in 2021, as hospitals resumed transplant services and Singapore moved on to living with COVID-19. In 2021, 74 patients received kidney transplant; the CIR was 18.6 pmp and ASIR was 14.2 pmp.

Table 5.9.1: Incidence number and rate (pmp) of kidney transplant

Year of transplant	Number	CIR	ASIR
2011	93	24.5	18.0
2012	64	16.8	13.9
2013	88	22.9	17.6
2014	75	19.4	15.6
2015	90	23.1	17.8
2016	97	24.7	18.4
2017	115	29.0	21.7
2018	114	28.5	21.0
2019	105	26.1	18.3
2020	50	12.4	10.4
2021	74	18.6	14.2
P for trend	-	0.675	0.543

Figure 5.9.1: Incidence rate (pmp) of kidney transplant



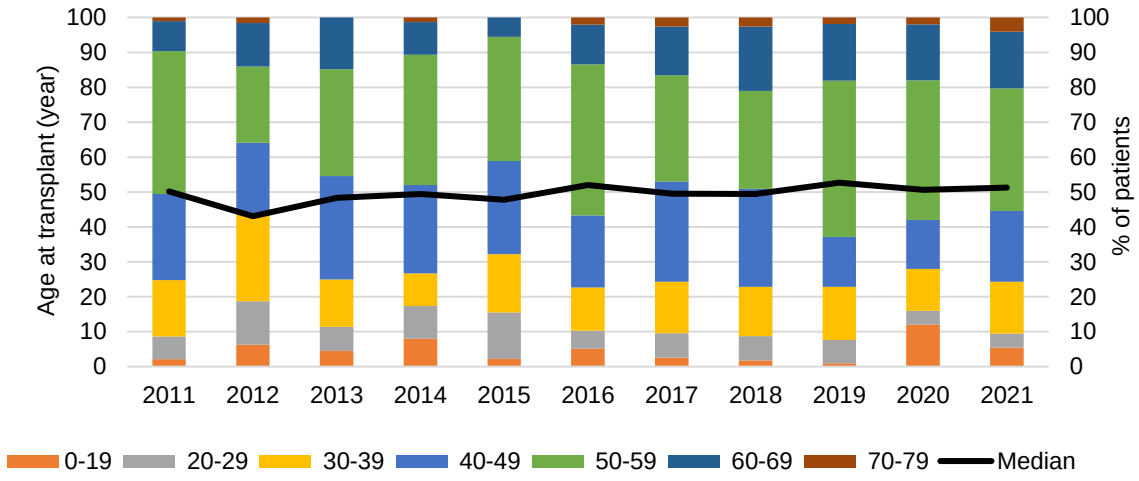
The age-specific incidence rate of kidney transplant fluctuated for all age groups due to the small number of transplants done each year (Table 5.9.2).

Table 5.9.2: Age distribution (%) and age-specific incidence rate (pmp) of kidney transplant

Year of transplant	Age 0-19			Age 20-29			Age 30-39			Age 40-49		
	Number	%	CIR	Number	%	CIR	Number	%	CIR	Number	%	CIR
2011	2	2.2	2.2	6	6.5	11.6	15	16.1	24.4	23	24.7	36.5
2012	4	6.3	4.5	8	12.5	15.4	16	25.0	26.3	13	20.3	20.6
2013	4	4.5	4.6	6	6.8	11.5	12	13.6	19.9	26	29.5	41.3
2014	6	8.0	7.0	7	9.3	13.2	7	9.3	11.8	19	25.3	30.4
2015	2	2.2	2.4	12	13.3	22.4	15	16.7	25.4	24	26.7	38.7
2016	5	5.2	6.0	5	5.2	9.2	12	12.4	20.4	20	20.6	32.5
2017	3	2.6	3.6	8	7.0	14.6	17	14.8	29.3	33	28.7	53.7
2018	2	1.8	2.4	8	7.0	14.6	16	14.0	27.3	32	28.1	52.3
2019	1	1.0	1.2	7	6.7	13.0	16	15.2	26.9	15	14.3	24.5
2020	6	12.0	7.5	2	4.0	3.8	6	12.0	10.0	7	14.0	11.5
2021	4	5.4	5.1	3	4.1	5.8	11	14.9	18.6	15	20.3	25.3
P for trend	-	-	0.941	-	-	0.081	-	-	0.529	-	-	0.383
Year of transplant	Age 50-59			Age 60-69			Age 70-79			Age 80+		
	Number	%	CIR	Number	%	CIR	Number	%	CIR	Number	%	CIR
2011	38	40.9	66.8	8	8.6	25.0	1	1.1	6.0	0	0.0	0.0
2012	14	21.9	24.0	8	12.5	23.3	1	1.6	5.8	0	0.0	0.0
2013	27	30.7	45.5	13	14.8	35.3	0	0.0	0.0	0	0.0	0.0
2014	28	37.3	46.4	7	9.3	17.8	1	1.3	5.5	0	0.0	0.0
2015	32	35.6	52.4	5	5.6	11.8	0	0.0	0.0	0	0.0	0.0
2016	42	43.3	68.3	11	11.3	24.5	2	2.1	10.4	0	0.0	0.0
2017	35	30.4	57.0	16	13.9	34.3	3	2.6	14.2	0	0.0	0.0
2018	32	28.1	52.2	21	18.4	43.4	3	2.6	13.1	0	0.0	0.0
2019	47	44.8	77.2	17	16.2	34.0	2	1.9	8.2	0	0.0	0.0
2020	20	40.0	33.2	8	16.0	15.6	1	2.0	3.8	0	0.0	0.0
2021	26	35.1	44.5	12	16.2	23.2	3	4.1	11.0	0	0.0	0.0
P for trend	-	-	0.757	-	-	0.864	-	-	0.438	-	-	-

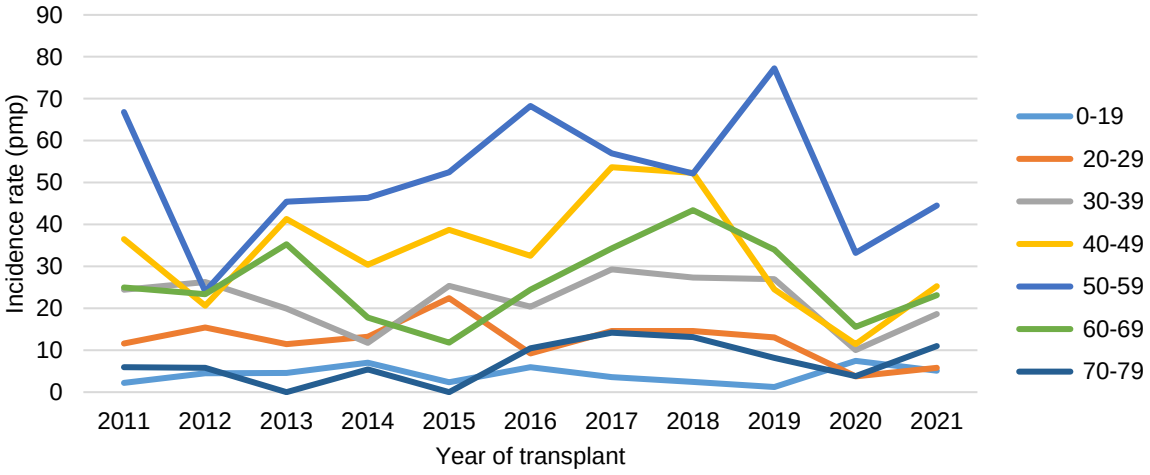
The median age at kidney transplant ranged between 43.1 and 52.7 years in the past decade (Figure 5.9.2a).

Figure 5.9.2a: Median age (year) and age distribution (%) of new kidney transplant patients



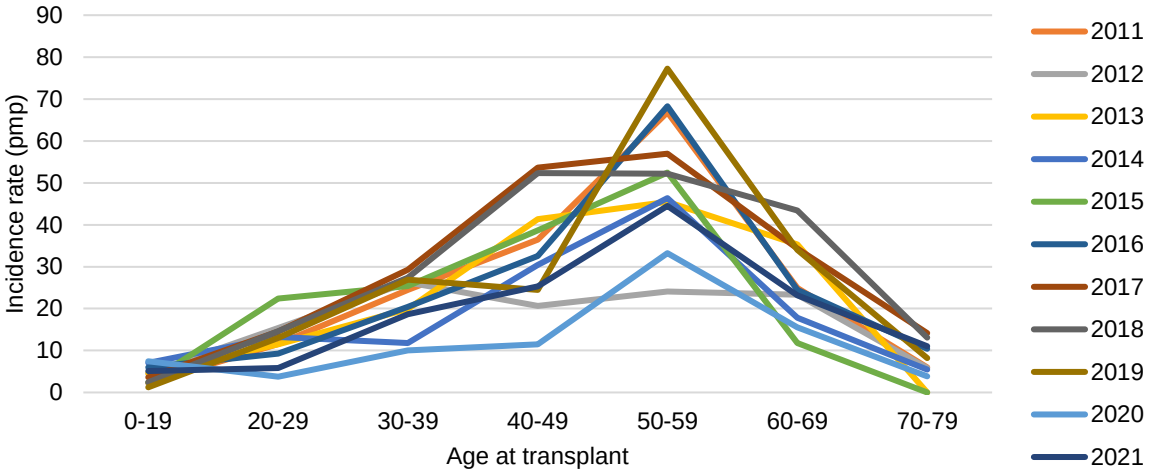
The age-specific incidence rate of kidney transplants was highest for those aged 50 to 59 years (Figure 5.9.2b).

Figure 5.9.2b: Age-specific incidence rate (pmp) of kidney transplant across years



The age-specific incidence rate of kidney transplant peaked at age 50-59 years for all the years, except 2012 (Figure 5.9.3).

Figure 5.9.3: Age-specific incidence rate (pmp) of kidney transplant across age groups



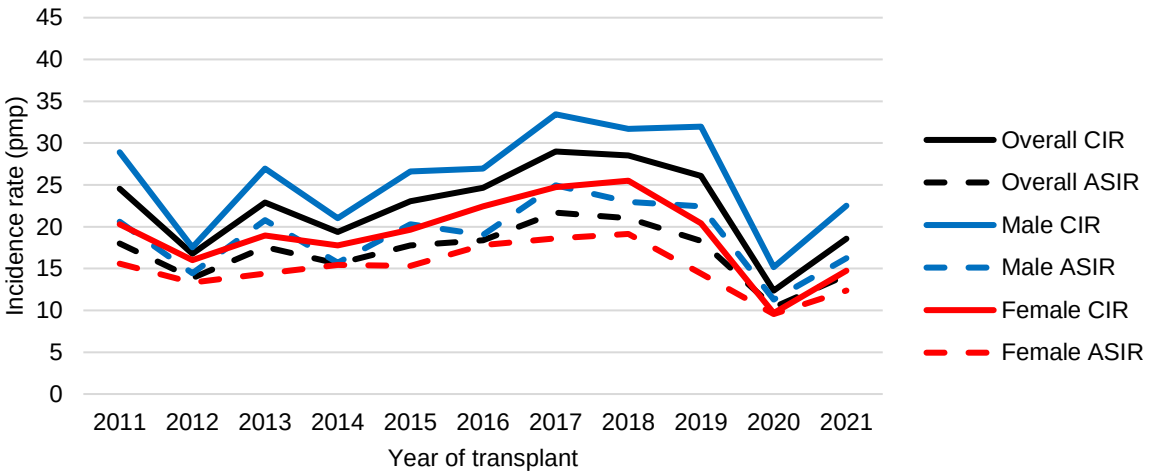
The ASIRs of kidney transplant were generally higher among males than females across the years (Table 5.9.3 and Figure 5.9.4). In 2021, the ASIR was 16.2 pmp and 12.4 pmp for males and females respectively. The ASIRs for both genders fluctuated over the years due to the small number of transplants done each year.

Table 5.9.3: Incidence number and rate (pmp) of kidney transplant by gender

Male				
Year of transplant	**Number**	**%**	**CIR**	**ASIR**
2011	54	58.1	28.9	20.6
2012	33	51.6	17.6	14.5
2013	51	58.0	27.0	20.8
2014	40	53.3	21.0	15.7
2015	51	56.7	26.6	20.3
2016	52	53.6	26.9	19.0
2017	65	56.5	33.4	25.0
2018	62	54.4	31.7	23.0
2019	63	60.0	32.0	22.4
2020	30	60.0	15.2	11.3
2021	44	59.5	22.5	16.2
P for trend	-	-	0.924	0.707

Female				
Year of transplant	**Number**	**%**	**CIR**	**ASIR**
2011	39	41.9	20.3	15.6
2012	31	48.4	16.0	13.3
2013	37	42.0	18.9	14.4
2014	35	46.7	17.8	15.4
2015	39	43.3	19.6	15.3
2016	45	46.4	22.5	17.8
2017	50	43.5	24.7	18.6
2018	52	45.6	25.5	19.1
2019	42	40.0	20.4	14.4
2020	20	40.0	9.7	9.6
2021	30	40.5	14.8	12.4
P for trend	-	-	0.427	0.405

Figure 5.9.4: Incidence rate (pmp) of kidney transplant by gender

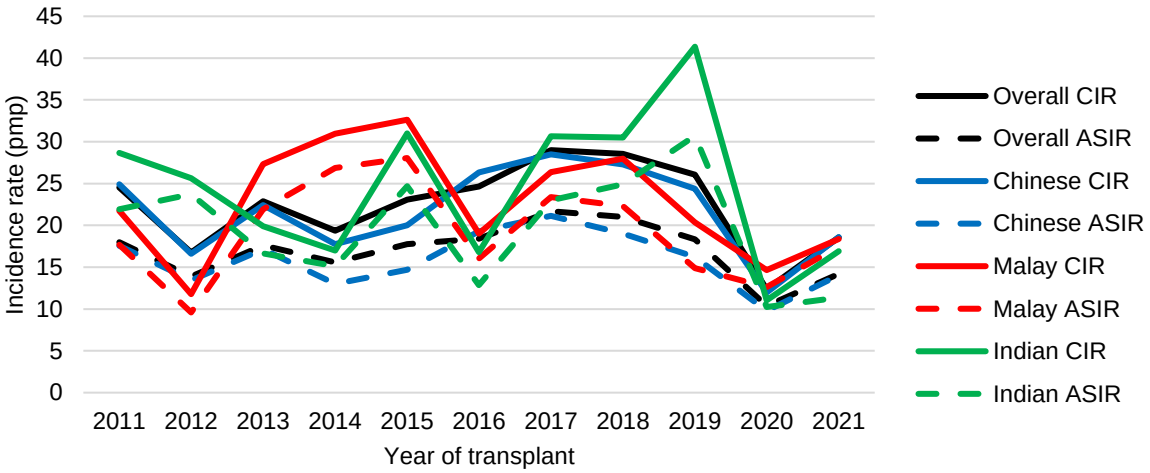


There was no ethnic group with consistently higher or lower incidence rates of kidney transplant across the years (Table 5.9.4 and Figure 5.9.5). In 2021, the ASIR was 14.1 pmp, 17.4 pmp and 11.4 pmp for Chinese, Malays and Indians respectively. The ASIRs for all the three ethnic groups fluctuated over the years due to the small number of transplants done each year.

Table 5.9.4: Incidence number and rate (pmp) of kidney transplant by ethnicity

Chinese				
Year of transplant	**Number**	**%**	**CIR**	**ASIR**
2011	70	75.3	24.9	17.6
2012	47	73.4	16.6	13.4
2013	64	72.7	22.4	17.2
2014	51	68.0	17.7	13.0
2015	58	64.4	20.0	14.7
2016	77	79.4	26.3	19.3
2017	84	73.0	28.5	21.1
2018	81	71.1	27.3	19.0
2019	73	69.5	24.4	16.2
2020	36	72.0	12.0	9.8
2021	55	74.3	18.6	14.1
P for trend	-	-	0.665	0.568
Malay				
Year of transplant	**Number**	**%**	**CIR**	**ASIR**
2011	11	11.8	21.7	17.7
2012	6	9.4	11.8	9.6
2013	14	15.9	27.3	21.9
2014	16	21.3	31.0	26.9
2015	17	18.9	32.6	28.1
2016	10	10.3	19.0	16.0
2017	14	12.2	26.4	23.4
2018	15	13.2	28.0	22.3
2019	11	10.5	20.3	14.9
2020	8	16.0	14.7	12.6
2021	10	13.5	18.4	17.4
P for trend	-	-	0.730	0.849
Indian				
Year of transplant	**Number**	**%**	**CIR**	**ASIR**
2011	10	10.8	28.7	21.9
2012	9	14.1	25.6	23.7
2013	7	8.0	19.9	16.7
2014	6	8.0	17.0	15.1
2015	11	12.2	31.0	24.7
2016	6	6.2	16.8	12.9
2017	11	9.6	30.7	23.0
2018	11	9.6	30.5	24.9
2019	15	14.3	41.4	30.7
2020	4	8.0	11.0	10.2
2021	6	8.1	16.9	11.4
P for trend	-	-	0.541	0.337

Figure 5.9.5: Incidence rate (pmp) of kidney transplant by ethnicity



Most of the new kidney transplants were done locally, with 95.9% being local transplants in 2021 (Table 5.9.5). The ratio of living donors with reference to deceased donors among local transplants increased since 2016. Transplants done overseas were not further stratified into living or deceased donor as the registry does not have the data.

Table 5.9.5: Incidence number of kidney transplant by type of donor

Year of transplant	Local transplant				Overseas transplant	
	Living donor		Deceased donor			
	Number	%	Number	%	Number	%
2011	31	33.3	36	38.7	26	28.0
2012	28	43.8	23	35.9	13	20.3
2013	35	39.8	34	38.6	19	21.6
2014	40	53.3	17	22.7	18	24.0
2015	40	44.4	32	35.6	18	20.0
2016	32	33.0	40	41.2	25	25.8
2017	41	35.7	53	46.1	21	18.3
2018	42	36.8	38	33.3	34	29.8
2019	56	53.3	33	31.4	16	15.2
2020	31	62.0	15	30.0	4	8.0
2021	47	63.5	24	32.4	3	4.1

GN was the main cause of CKD5 among new kidney transplant patients (Table 5.9.6). The proportion of new transplant patients with GN was 52.7% in 2021, while the proportion with DN was 17.6%. There were more patients with GN undergoing transplant than those with DN as patients with DN tend to have more co-morbidities and higher risk of post-transplant complications[20,21].

Table 5.9.6: Incidence number of kidney transplant by etiology

Year of transplant	DN		GN		Others	
	Number	%	Number	%	Number	%
2011	9	9.7	59	63.4	25	26.9
2012	9	14.1	46	71.9	9	14.1
2013	8	9.1	55	62.5	25	28.4
2014	11	14.7	42	56.0	22	29.3
2015	18	20.0	49	54.4	23	25.6
2016	17	17.5	53	54.6	27	27.8
2017	19	16.5	70	60.9	26	22.6
2018	17	14.9	69	60.5	28	24.6
2019	24	22.9	50	47.6	31	29.5
2020	9	18.0	23	46.0	18	36.0
2021	13	17.6	39	52.7	22	29.7

[20] Chantrel F et al. Abysmal prognosis of patients with type 2 diabetes entering dialysis. Nephrology Dialysis Transplant 1999; 14: 129-136.
[21] Hashmi S et al. Overview of renal transplantation. Minerva Med 2007. 98(6): 713-729.

5.10 Prevalence of kidney transplant

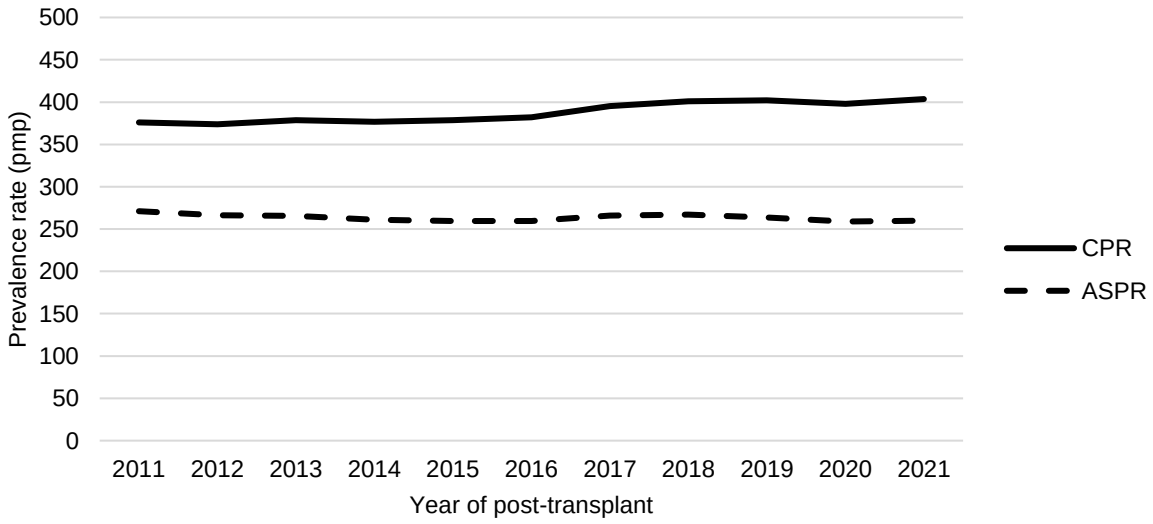
The prevalence rate of kidney transplant in each year was calculated by taking the cumulative number of surviving (existing and new) patients with kidney transplant in a year, divided by the number of Singapore residents in the same year. Patients were categorised into 10-year age groups and age standardisation was done using the direct method with the Segi World population as the reference population.

Unlike the incidence trend of kidney transplant which rose and drop between 2011 and 2021 (Table 5.9.1 and Figure 5.9.1), the number of prevalent patients with kidney transplant generally increased since 2011 (Table 5.10.1 and Figure 5.10.1). There was a significant rise in CPR from 376.1 pmp in 2011 to 403.6 pmp in 2021 (p<0.001), while the ASPR remained stable and ranged between 258.9 pmp and 271.1 pmp during the same period. The stable ASPR trend suggests that the rise in new patients undergoing kidney transplant was fairly similar to the drop from those who died, after adjusting for Singapore's ageing population.

Table 5.10.1: Prevalence number and rate (pmp) of kidney transplant

Year of post-transplant	Number	CPR	ASPR
2011	1425	376.1	271.1
2012	1427	373.8	266.2
2013	1456	378.7	265.5
2014	1458	376.7	261.2
2015	1478	378.7	259.4
2016	1503	382.1	259.4
2017	1568	395.4	266.1
2018	1602	401.1	267.2
2019	1619	402.1	263.7
2020	1609	397.9	258.9
2021	1609	403.6	260.0
P for trend	-	<0.001	0.091

Figure 5.10.1: Prevalence rate (pmp) of kidney transplant



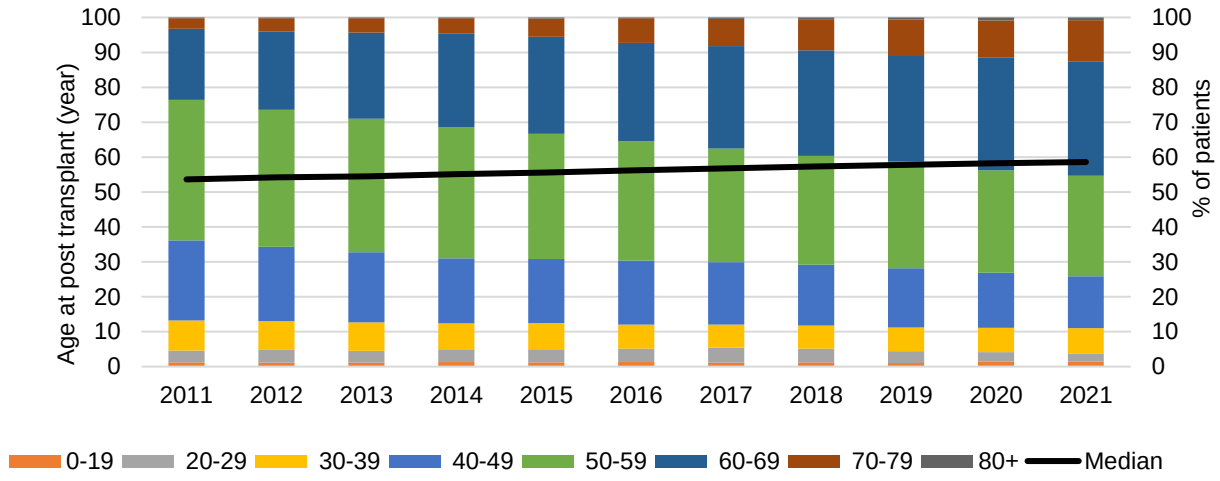
The CPR of kidney transplant increased for those aged 0-19 years (p=0.003), 60-69 years (p=0.004), 70-79 years (p<0.001) and 80 years and above (p<0.001), but it dropped for those aged 40-49 years (p=0.002) and 50-59 years (p<0.001) (Table 5.10.2).

Table 5.10.2: Age distribution (%) and age-specific prevalence rate (pmp) of kidney transplant

Year of post-transplant	Age 0-19			Age 20-29			Age 30-39			Age 40-49		
	Number	%	CPR	Number	%	CPR	Number	%	CPR	Number	%	CPR
2011	17	1.2	18.9	49	3.4	94.6	123	8.6	200.4	326	22.9	517.0
2012	16	1.1	18.1	52	3.6	100.2	118	8.3	193.7	304	21.3	482.8
2013	17	1.2	19.5	49	3.4	93.8	119	8.2	197.5	292	20.1	464.4
2014	19	1.3	22.2	53	3.6	100.1	109	7.5	183.4	271	18.6	433.9
2015	18	1.2	21.3	56	3.8	104.6	110	7.4	185.9	272	18.4	438.6
2016	20	1.3	23.9	57	3.8	105.4	104	6.9	177.0	276	18.4	449.1
2017	18	1.1	21.8	67	4.3	122.0	104	6.6	179.2	280	17.9	455.3
2018	19	1.2	23.2	63	3.9	115.1	107	6.7	182.9	279	17.4	456.3
2019	16	1.0	19.7	55	3.4	102.4	111	6.9	186.8	274	16.9	447.4
2020	22	1.4	27.4	45	2.8	84.7	112	7.0	187.5	253	15.7	414.1
2021	23	1.4	29.4	38	2.4	73.7	117	7.3	198.2	238	14.8	401.4
P for trend	-	-	0.003	-	-	0.427	-	-	0.399	-	-	0.002
Year of post-transplant	**Age 50-59**			**Age 60-69**			**Age 70-79**			**Age 80+**		
	Number	%	CPR	Number	%	CPR	Number	%	CPR	Number	%	CPR
2011	574	40.3	1009.5	289	20.3	901.7	44	3.1	263.6	3	0.2	41.0
2012	560	39.2	961.9	320	22.4	933.5	54	3.8	314.0	3	0.2	38.7
2013	557	38.3	937.9	359	24.7	975.3	60	4.1	340.7	3	0.2	36.5
2014	548	37.6	907.4	392	26.9	998.2	63	4.3	344.1	3	0.2	34.4
2015	529	35.8	867.0	411	27.8	971.8	77	5.2	418.8	5	0.3	53.5
2016	514	34.2	835.5	423	28.1	940.3	105	7.0	547.6	4	0.3	40.9
2017	510	32.5	830.0	460	29.3	985.8	123	7.8	581.7	6	0.4	59.2
2018	499	31.1	813.6	484	30.2	1000.4	143	8.9	624.8	8	0.5	74.9
2019	495	30.6	813.6	493	30.5	985.8	165	10.2	674.2	10	0.6	86.5
2020	473	29.4	785.8	521	32.4	1013.6	169	10.5	647.5	14	0.9	112.9
2021	463	28.8	792.6	526	32.7	1015.4	191	11.9	701.4	13	0.8	99.0
P for trend	-	-	<0.001	-	-	0.004	-	-	<0.001	-	-	<0.001

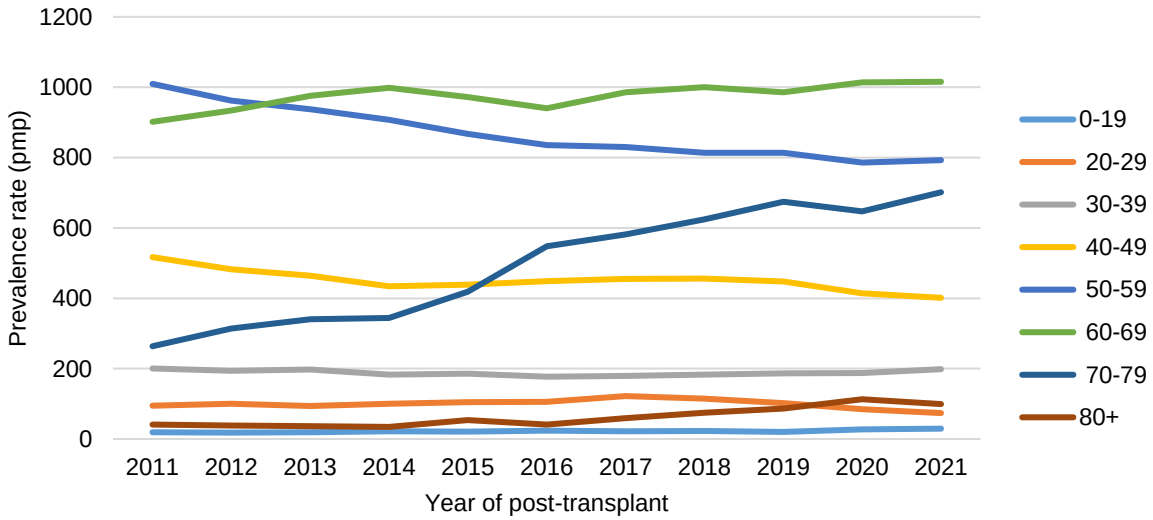
The median age among prevalent kidney transplant patients increased slightly from 53.6 years in 2011 to 58.6 years in 2021 (Figure 5.10.2a).

Figure 5.10.2a: Median age (year) and age distribution (%) of prevalent kidney transplant patients



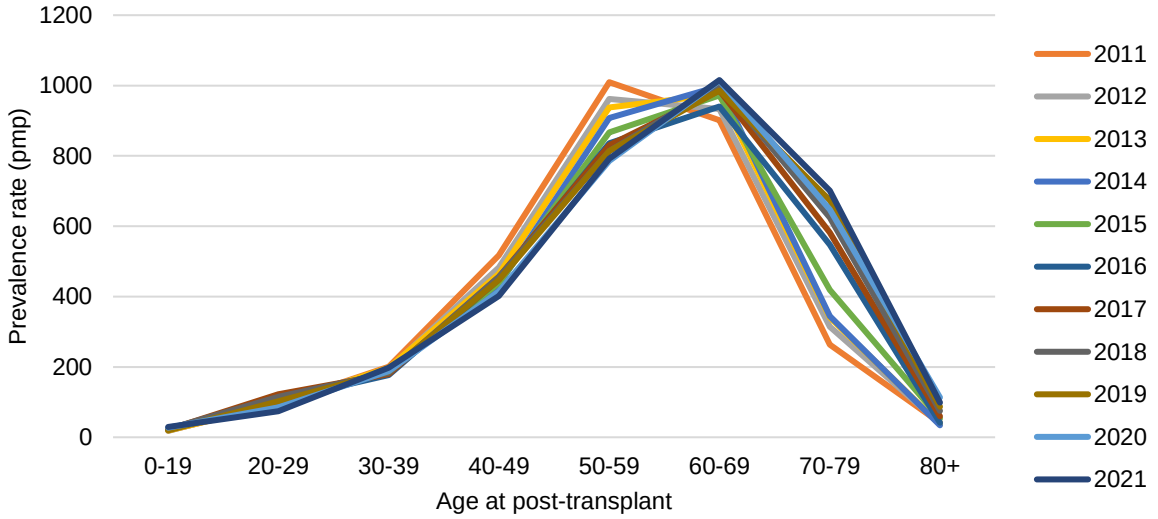
The age-specific prevalence rate of kidney transplant was highest for those aged 60 to 69 years since 2013 (Figure 5.10.2b).

Figure 5.10.2b: Age-specific prevalence rate (pmp) of kidney transplant across years



Prior to 2013, the CPR of kidney transplant peaked at age 50-59 years. However, the peak shifted to age 60-69 years since 2013 (Figure 5.10.3).

Figure 5.10.3: Age-specific prevalence rate (pmp) of kidney transplant across age groups



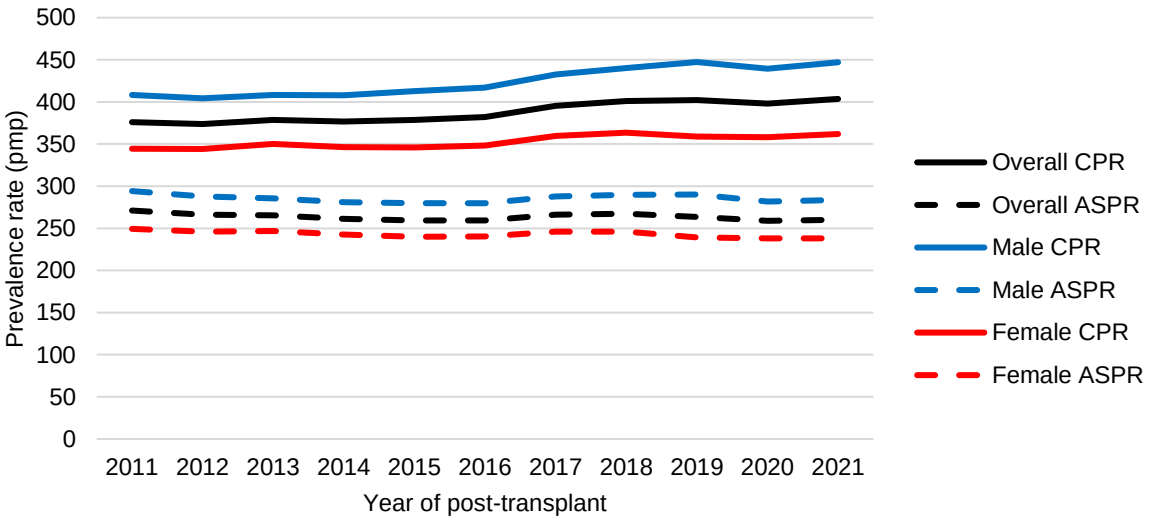
The ASPRs of kidney transplant were consistently higher among males than females across the years (Table 5.10.3 and Figure 5.10.4). In 2021, the ASPR was 283.6 pmp and 238.3 pmp for males and females respectively. The ASPR for males remained stable, while the ASPR for females dropped significantly over the years (p=0.010).

Table 5.10.3: Prevalence number and rate (pmp) of kidney transplant by gender

Male				
Year of post-transplant	**Number**	**%**	**CPR**	**ASPR**
2011	763	53.5	408.4	294.2
2012	760	53.3	404.3	287.9
2013	772	53.0	408.2	285.7
2014	776	53.2	407.9	281.0
2015	791	53.5	412.7	279.9
2016	805	53.6	417.2	279.8
2017	841	53.6	432.7	287.8
2018	861	53.7	440.2	289.8
2019	881	54.4	447.3	290.1
2020	869	54.0	439.4	281.6
2021	873	54.3	447.0	283.6
P for trend	-	-	<0.001	0.466

Female				
Year of post-transplant	**Number**	**%**	**CPR**	**ASPR**
2011	662	46.5	344.6	249.4
2012	667	46.7	344.2	245.9
2013	684	47.0	350.2	246.8
2014	682	46.8	346.5	242.7
2015	687	46.5	345.9	240.0
2016	698	46.4	348.3	240.2
2017	727	46.4	359.5	245.9
2018	741	46.3	363.5	246.1
2019	738	45.6	358.8	239.2
2020	740	46.0	358.1	238.1
2021	736	45.7	361.9	238.3
P for trend	-	-	0.001	0.010

Figure 5.10.4: Prevalence rate (pmp) of kidney transplant by gender

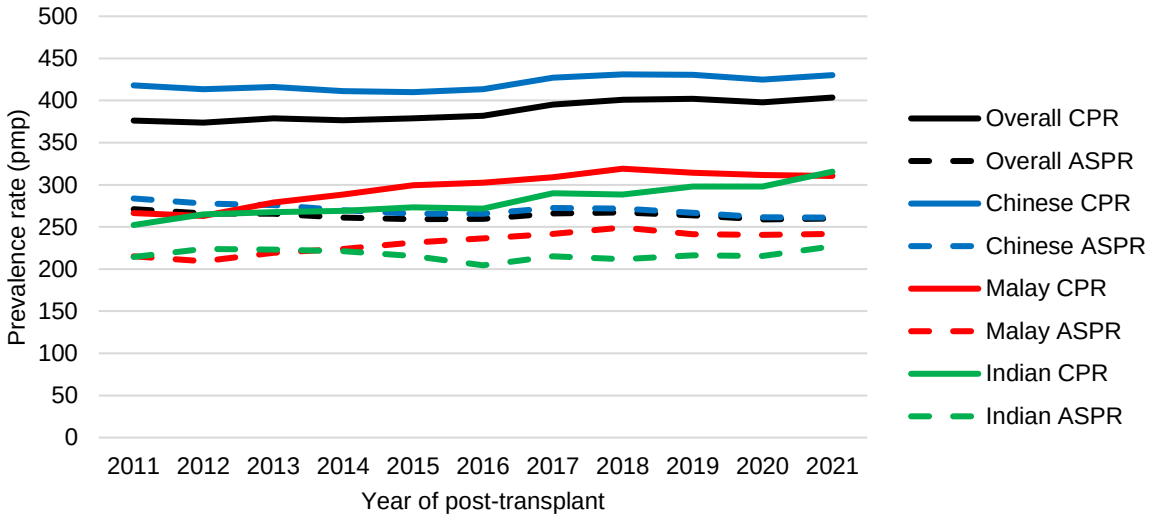


The ASPRs of kidney transplant were consistently higher among Chinese than Malays and Indians across the years (Table 5.10.4 and Figure 5.10.5). While the ASPR for Chinese dropped significantly from 283.8 pmp in 2011 to 261.1 pmp in 2021 (p=0.001), the ASPR for Malays increased significantly from 215.3 pmp in 2011 to 241.7 pmp in 2021 (p<0.001) and the ASPR for Indians remained stable and ranged between 204.5 pmp and 227.0 pmp in the past decade.

Table 5.10.4: Prevalence number and rate (pmp) of kidney transplant by ethnicity

Chinese				
Year of post-transplant	**Number**	**%**	**CPR**	**ASPR**
2011	1174	82.4	418.0	283.8
2012	1171	82.1	413.5	277.8
2013	1188	81.6	416.3	276.1
2014	1182	81.1	411.2	269.7
2015	1189	80.4	410.0	265.7
2016	1209	80.4	413.6	265.7
2017	1259	80.3	427.0	272.4
2018	1280	79.9	431.1	271.8
2019	1289	79.6	430.6	266.7
2020	1278	79.4	425.0	261.6
2021	1273	79.1	430.0	261.1
P for trend	-	-	0.008	0.001
Malay				
Year of post-transplant	**Number**	**%**	**CPR**	**ASPR**
2011	135	9.5	266.6	215.3
2012	134	9.4	263.1	209.3
2013	143	9.8	278.9	219.2
2014	149	10.2	288.4	223.8
2015	156	10.6	299.5	231.4
2016	159	10.6	302.3	236.3
2017	164	10.5	309.0	241.6
2018	171	10.7	319.1	249.3
2019	170	10.5	314.4	241.5
2020	170	10.6	311.6	240.4
2021	169	10.5	310.4	241.7
P for trend	-	-	<0.001	<0.001
Indian				
Year of post-transplant	**Number**	**%**	**CPR**	**ASPR**
2011	88	6.2	252.3	214.5
2012	93	6.5	265.0	223.8
2013	94	6.5	267.4	223.2
2014	95	6.5	269.1	221.2
2015	97	6.6	273.3	215.7
2016	97	6.5	271.8	204.5
2017	104	6.6	289.8	215.2
2018	104	6.5	288.5	211.9
2019	108	6.7	297.8	216.1
2020	108	6.7	298.1	215.6
2021	112	7.0	315.6	227.0
P for trend	-	-	<0.001	0.877

Figure 5.10.5: Prevalence rate (pmp) of kidney transplant by ethnicity



Most of the prevalent kidney transplants were done locally, with 74.2% being local transplants in 2021 (Table 5.10.5). Among the prevalent local transplants, the difference in proportion of transplants between living and deceased donors narrowed over the years, whereby the proportion of transplants from living donors increased and exceeded the proportion from deceased donors in 2021. Transplants done overseas were not further stratified into living or deceased donor as the registry does not have the data.

Table 5.10.5: Prevalence number of kidney transplant by type of donor

Year of post-transplant	Local transplant				Overseas transplant	
	Living donor		Deceased donor			
	Number	%	Number	%	Number	%
2011	388	27.2	602	42.2	435	30.5
2012	404	28.3	589	41.3	434	30.4
2013	429	29.5	591	40.6	436	29.9
2014	454	31.1	571	39.2	433	29.7
2015	479	32.4	570	38.6	429	29.0
2016	485	32.3	585	38.9	433	28.8
2017	508	32.4	616	39.3	444	28.3
2018	527	32.9	629	39.3	446	27.8
2019	562	34.7	624	38.5	433	26.7
2020	574	35.7	611	38.0	424	26.4
2021	606	37.7	587	36.5	416	25.9

The proportion of prevalent kidney transplant patients with DN was lower than those with GN (Table 5.10.6). However, while the proportion of prevalent transplant patients with DN increased from 7.5% in 2011 to 10.8% in 2021, those with GN dropped from 71.1% in 2011 to 65.8% in 2021.

Table 5.10.6: Prevalence number of kidney transplant by etiology

Year of post-transplant	DN		GN		Others	
	Number	%	Number	%	Number	%
2011	107	7.5	1013	71.1	305	21.4
2012	113	7.9	1014	71.1	300	21.0
2013	116	8.0	1031	70.8	309	21.2
2014	122	8.4	1021	70.0	315	21.6
2015	134	9.1	1024	69.3	320	21.7
2016	141	9.4	1035	68.9	327	21.8
2017	152	9.7	1074	68.5	342	21.8
2018	155	9.7	1092	68.2	355	22.2
2019	171	10.6	1084	67.0	364	22.5
2020	168	10.4	1073	66.7	368	22.9
2021	173	10.8	1059	65.8	377	23.4

5.11 Survival of kidney transplant

Graft survival: the unadjusted survival rate and median survival duration of new kidney transplants were estimated using the Kaplan-Meier method in Tables 5.11.1 to 5.11.10. Event was defined as graft loss (i.e. return to dialysis or kidney transplant waitlist due to non-functioning graft) or all-cause death. Patients were censored if they neither suffered from graft loss nor died by 30 April 2022. Median survival duration is indicated as “not reached (NR)” if more than half of the patients did not suffer from graft loss and were still alive as of 30 April 2022. Grafts that stopped functioning within 30 days were excluded from this section.

Patient survival: the unadjusted survival rate and median survival duration of new kidney transplant patients were estimated using the Kaplan-Meier method in Tables 5.11.1 to 5.11.10. Event was defined as all-cause death. Patients were censored if they were alive as of 30 April 2022. Median survival duration is indicated as “not reached (NR)” if more than half of the patients were alive as of 30 April 2022. Multivariable Cox regression was used to estimate the adjusted risk of death among patients with transplant done locally, accounting for the effects of potential confounders in Table 5.11.11.

The age, gender, ethnicity, etiology and co-morbidities in Tables 5.11.1 to 5.11.11 were based on data captured by the registry around the date of kidney transplant.

Multivariable Cox regression was used to estimate the adjusted risk of death among patients on dialysis and those with transplant done locally, accounting for the effects of potential confounders in Table 5.11.12. For patients who underwent dialysis prior to transplant, their survival time were counted twice: (1) as dialysis patients where their survival time = time from start of definitive dialysis to transplant, they were censored at the date of transplant, and the potential confounders were based on data captured by the registry at the start of definitive dialysis; (2) as transplant patients where their survival time = time from date of transplant to death or 30 April 2022 (whichever earlier), and the potential confounders were based on data captured by the registry around the date of transplant.

1-, 5- and 10-year graft survival were high at 97.5%, 89.5% and 75.8% respectively (Table 5.11.1). 1-, 5- and 10-year patient survival were also high at 98.3%, 93.7% and 84.9% respectively and outperformed patients on dialysis (90.6%, 56.5% and 29.5% at 1-, 5- and 10-year from the start of definitive dialysis; Table 5.7.2).

Table 5.11.1: Graft and patient survival of kidney transplant

	Graft	Patient
1-year survival (%)	97.5	98.3
5-year survival (%)	89.5	93.7
10-year survival (%)	75.8	84.9
Median survival (years)	19.6	NR

Among patients with transplants done locally, those who received kidney from living donors had significantly better graft (p<0.001) and patient (p<0.001) survival than those who received kidney from deceased donors (Table 5.11.2).

Table 5.11.2: Graft and patient survival of kidney transplant by type of donor

	Living		Deceased	
	Graft	**Patient**	**Graft**	**Patient**
1-year survival (%)	99.3	99.3	96.2	97.6
5-year survival (%)	93.9	96.3	85.9	91.6
10-year survival (%)	82.7	89.3	68.0	81.2
Median survival (years)	NR	NR	15.9	22.6

Younger patients aged below 60 years had significantly better graft (p=0.002) and patient (p<0.001) survival than older patients aged 60 years and above (Table 5.11.3).

Table 5.11.3: Graft and patient survival of kidney transplant by age group

	Age <60 years		Age ≥60 years	
	Graft	**Patient**	**Graft**	**Patient**
1-year survival (%)	97.8	98.6	95.3	95.8
5-year survival (%)	90.0	94.4	85.2	87.3
10-year survival (%)	76.7	86.5	67.4	68.8
Median survival (years)	20.0	NR	15.5	15.5

Graft and patient survival were fairly similar between the two genders (Table 5.11.4).

Table 5.11.4: Graft and patient survival of kidney transplant by gender

	Male		Female	
	Graft	**Patient**	**Graft**	**Patient**
1-year survival (%)	97.4	98.3	97.7	98.4
5-year survival (%)	89.1	93.9	89.9	93.4
10-year survival (%)	74.5	84.7	77.5	85.2
Median survival (years)	18.3	NR	21.7	NR

Chinese had significantly better graft survival than Malays (p<0.001) and Indians (p<0.001) (Table 5.11.5). However, patient survival was fairly similar across the three ethnic groups.

Table 5.11.5: Graft and patient survival of kidney transplant by ethnicity

	Chinese		Malay		Indian	
	Graft	**Patient**	**Graft**	**Patient**	**Graft**	**Patient**
1-year survival (%)	97.7	98.5	96.3	97.1	98.1	98.8
5-year survival (%)	90.7	94.1	85.6	92.8	83.4	91.1
10-year survival (%)	78.1	85.2	66.9	85.3	63.9	81.1
Median survival (years)	20.4	NR	16.2	22.0	12.8	NR

Patients without DN had significantly better graft (p<0.001) and patient (p<0.001) survival than those with DN (Table 5.11.6).

Table 5.11.6: Graft and patient survival of kidney transplant by etiology

	Non-DN		DN	
	Graft	Patient	Graft	Patient
1-year survival (%)	97.7	98.5	96.7	97.4
5-year survival (%)	90.2	94.6	84.5	87.8
10-year survival (%)	77.1	86.5	67.0	73.6
Median survival (years)	20.8	NR	12.8	15.4

Patients without IHD had significantly better graft (p=0.002) and patient (p<0.001) survival than those with IHD (Table 5.11.7).

Table 5.11.7: Graft and patient survival of kidney transplant by presence of IHD

	No IHD		IHD	
	Graft	Patient	Graft	Patient
1-year survival (%)	97.5	98.5	98.1	98.1
5-year survival (%)	90.1	94.7	87.1	89.7
10-year survival (%)	76.8	86.4	71.4	77.9
Median survival (years)	20.4	NR	15.0	16.9

Patients without CVD had significantly better patient (p=0.002) survival than those with CVD (Table 5.11.8).

Table 5.11.8: Graft and patient survival of kidney transplant by presence of CVD

	No CVD		CVD	
	Graft	Patient	Graft	Patient
1-year survival (%)	97.9	98.6	90.7	94.2
5-year survival (%)	89.8	94.0	86.8	91.5
10-year survival (%)	76.1	85.4	75.0	77.9
Median survival (years)	19.9	NR	14.8	15.0

Patients without PVD had significantly better patient (p=0.001) survival than those with PVD (Table 5.11.9).

Table 5.11.9: Graft and patient survival of kidney transplant by presence of PVD

	No PVD		PVD	
	Graft	Patient	Graft	Patient
1-year survival (%)	97.7	98.5	94.1	97.1
5-year survival (%)	89.8	94.1	84.5	87.4
10-year survival (%)	76.1	85.4	74.2	72.0
Median survival (years)	19.9	NR	12.9	12.9

There was no significant difference in graft and patient survival among those with cancer compared to those without cancer (Table 5.11.10).

Table 5.11.10: Graft and patient survival of kidney transplant by presence of cancer

	No cancer		Cancer	
	Graft	**Patient**	**Graft**	**Patient**
1-year survival (%)	97.9	98.7	96.4	96.4
5-year survival (%)	90.5	94.7	80.9	86.5
10-year survival (%)	76.7	86.0	68.4	73.5
Median survival (years)	19.9	NR	NR	NR

Among patients with transplants done locally, transplant from deceased donor, old age, DN and IHD remained as significant risk factors of death in the multivariable analysis (Table 5.11.11).

Table 5.11.11: Adjusted risk of death by factors associated with patient survival among kidney transplant patients

	Hazard ratio	95% confidence interval	P-value
Transplant from			
Living donor	1.00	Reference	<0.001
Deceased donor	2.48	1.85-3.32	
Age group			
<60 years	1.00	Reference	<0.001
≥60 years	3.02	1.89-4.83	
Gender			
Male	1.00	Reference	0.800
Female	0.97	0.76-1.24	
Ethnicity			
Chinese	1.00	Reference	
Malay	1.09	0.78-1.52	0.632
Indian	1.39	0.91-2.14	0.132
Etiology			
Non-DN	1.00	Reference	<0.001
DN	2.61	1.69-4.02	
IHD			
No	1.00	Reference	0.010
Yes	1.57	1.11-2.21	
CVD			
No	1.00	Reference	0.100
Yes	1.70	0.90-3.20	
PVD			
No	1.00	Reference	0.182
Yes	1.67	0.79-3.56	
Cancer			
No	1.00	Reference	0.454
Yes	1.34	0.63-2.86	

Aside from transplant patients, Table 5.11.12 also includes dialysis patients without transplant. Patients with kidney transplant, be it from living or deceased donors, had significantly lower risk of death than dialysis patients without transplant. Old age, DN, IHD, CVD, PVD and cancer were also significant risk factors of death among dialysis and transplant patients.

Table 5.11.12: Adjusted risk of death by factors associated with patient survival among definitive dialysis and kidney transplant patients

	Hazard ratio	95% confidence interval	P-value
Renal replacement therapy			
Dialysis	1.00	Reference	
Transplant from living donor	0.20	0.16-0.26	<0.001
Transplant from deceased donor	0.45	0.39-0.53	<0.001
Age group			
<60 years	1.00	Reference	<0.001
≥60 years	1.87	1.79-1.94	
Gender			
Male	1.00	Reference	0.676
Female	0.99	0.96-1.03	
Ethnicity			
Chinese	1.00	Reference	
Malay	0.90	0.86-0.95	<0.001
Indian	0.97	0.90-1.04	0.407
Etiology			
Non-DN	1.00	Reference	<0.001
DN	1.68	1.61-1.75	
IHD			
No	1.00	Reference	<0.001
Yes	1.46	1.40-1.52	
CVD			
No	1.00	Reference	<0.001
Yes	1.34	1.28-1.40	
PVD			
No	1.00	Reference	<0.001
Yes	1.46	1.39-1.54	
Cancer			
No	1.00	Reference	<0.001
Yes	1.41	1.32-1.51	

6. CONCLUSION

Although survival among dialysis patients has improved over the years, on top of the direct costs from medical expenses, there are also lifestyle changes required to accommodate the treatment. Kidney transplant is a good alternative treatment to dialysis as transplant patients have better survival and quality of life with fewer disruptions to their daily living, compared to dialysis patients who must set aside several hours for each dialysis session. However, the incidence rate of CKD5 is rising faster than the incidence rate of transplant. Moreover, the incidence rate of CKD5 is expected to further accelerate in future with an ageing population and concomitant increase in chronic diseases prevalence in Singapore. It is therefore important for individuals who have not been diagnosed with CKD to take preventive action.

CKD can be prevented by leading a healthy lifestyle, such as eating all food in moderation and opting for healthier products, exercising and maintaining a healthy weight, not smoking and going for regular appropriate health screening. As diabetes and hypertension are common chronic diseases that increase the risk of CKD, individuals with these conditions should seek regular review with their family doctor for timely intervention. For individuals who have been diagnosed with CKD in the early stages, progression to late stages can be controlled with appropriate medication and healthy lifestyle behaviours.

Annex

Prevalent patients by service providers as of 31 December 2021

Public hospitals and affiliated dialysis centres	HD	PD	Transplant
SINGAPORE GENERAL HOSPITAL	27	494	813
TAN TOCK SENG RENAL CENTRE	25	161	37
CHANGI GENERAL HOSPITAL	12	67	2
KHOO TECK PUAT HOSPITAL	3	136	0
NG TENG FONG GENERAL HOSPITAL	4	48	0
SENGKANG GENERAL HOSPITAL	7	37	0
NATIONAL UNIVERSITY HOSPITAL	5	163	566
NUH DIALYSIS CENTRE	55	0	0
NUH RENAL CENTRE	19	0	0
SHAW NKF - NUH CHILDREN'S KIDNEY CENTRE	5	19	42
SINGAPORE GENERAL HOSPITAL	27	494	813
Subtotal	**162**	**1125**	**1460**
Voluntary Welfare Organisations	**HD**	**PD**	**Transplant**
ANG MO KIO THYE HUA KWAN HOSPITAL DIALYSIS CENTRE	49	0	0
FOO HAI - NKF DIALYSIS CENTRE	71	0	0
HONG LEONG - NKF DIALYSIS CENTRE (ALJUNIED CRESCENT)	106	0	0
IFPAS - NKF DIALYSIS CENTRE (SERANGOON)	107	0	0
IHSAN KIDNEY CARE (IKC)	63	0	0
JO & GERRY ESSERY NKF DIALYSIS CENTRE (BLK 204 MARSILING)	124	0	0
KDF - BISHAN CENTRE	96	0	0
KDF - GHIM MOH CENTRE (HD)	85	0	0
KDF - KRETA AYER (HD)	69	0	0
KDF - SAN WANG WU TI CENTRE @ ADMIRALTY LINK	9	0	0
KWAN IM THONG HOOD CHO TEMPLE - NKF DIALYSIS CENTRE (KOLAM AYER)	142	0	0
KWAN IM THONG HOOD CHO TEMPLE - NKF DIALYSIS CENTRE (SIMEI)	154	0	0
LE CHAMP - NKF DIALYSIS CENTRE (BLK 639 YISHUN ST 61)	115	0	0
LEONG HWA CHAN SI TEMPLE - NKF DIALYSIS CENTRE (TECK WHYE)	103	0	0
MTFA DIALYSIS CENTRE (MDC)	0	0	0
NEW CREATION CHURCH - NKF DIALYSIS CENTRE	92	0	0
NKF BUKIT PANJANG DIALYSIS CENTRE	93	0	0
NKF DIALYSIS CENTRE (BLK 365 WOODLANDS II)	101	0	0
NKF DIALYSIS CENTRE SUPPORTED BY KEPPEL	94	0	0
NKF DIALYSIS CENTRE SUPPORTED BY MAN FATT LAM BUDDHIST TEMPLE (105 BEDOK NORTH)	49	0	0
NKF DIALYSIS CENTRE SUPPORTED BY NGIAM KIA HUM & FAMILY	207	0	0
NKF HOUGANG PUNGGOL DIALYSIS CENTRE	121	0	0
NKF INTEGRATED RENAL CENTRE (CP1)	216	0	0
NKF INTEGRATED RENAL CENTRE (CP2)	36	0	0
NKF JURONG EAST DIALYSIS CENTRE SUPPORTED BY YUHUA GRASSROOTS ORGANISATIONS	116	0	0
NTUC INCOME - NKF DIALYSIS CENTRE (BUKIT BATOK)	88	0	0
NTUC/SINGAPORE POOLS - NKF DIALYSIS CENTRE (TAMPINES)	138	0	0

PEI HWA FOUNDATION - NKF DIALYSIS CENTRE (ANG MO KIO)	122	0	0
QUEENSTOWN - NKF DIALYSIS CENTRE	105	0	0
SAF - NKF DIALYSIS CENTRE (CLEMENTI)	114	0	0
SAKYADHITA -NKF DIALYSIS CENTRE (UPPER BOON KENG)	102	0	0
SCAL - NKF DIALYSIS CENTRE (YISHUN)	76	0	0
SECK HONG CHOON - NKF DIALYSIS CENTRE	118	0	0
SHENG HONG TEMPLE - NKF DIALYSIS CENTRE (JURONG WEST)	114	0	0
SIA - NKF DIALYSIS CENTRE (TOA PAYOH)	0	0	0
SINGAPORE BUDDHIST WELFARE SERVICES - NKF DIALYSIS CENTRE (HOUGANG)	158	0	0
SINGAPORE POOLS - NKF DIALYSIS CENTRE (BEDOK)	0	0	0
TAMPINES CHINESE TEMPLE - NKF DIALYSIS CENTRE (PASIR RIS)	113	0	0
TAY CHOON HYE - NKF DIALYSIS CENTRE (KIM KEAT)	111	0	0
THE HOUR GLASS - NKF DIALYSIS CENTRE (WEST COAST)	73	0	0
THE HOUR GLASS NKF DIALYSIS CENTRE (ADMIRALTY BRANCH)	100	0	0
THE SINGAPORE BUDDHIST LODGE - NKF DIALYSIS CENTRE (128 BUKIT MERAH VIEW)	100	0	0
THE SIRIVADHANABHAKDI FOUNDATION NKF DIALYSIS CENTRE (JW2)	118	0	0
THONG TECK SIAN TONG LIAN SIN SIA - NKF DIALYSIS CENTRE (WOODLANDS)	112	0	0
TOA PAYOH SEU TECK SEAN TONG - NKF DIALYSIS CENTRE (YISHUN)	75	0	0
WESTERN DIGITAL - NKF DIALYSIS CENTRE (ANG MO KIO)	159	0	0
WOH HUP - NKF DIALYSIS CENTRE (GHIM MOH)	71	0	0
WONG SUI HA EDNA - NKF DIALYSIS CENTRE	128	0	0
Subtotal	**4713**	**0**	**0**
Private clinics and dialysis centres	**HD**	**PD**	**Transplant**
ADVANCE DIALYSIS SERVICES PTE LTD	27	0	0
ADVANCE RENAL CARE (KOVAN) PTE LTD	42	0	0
ADVANCE RENAL CARE (NOVENA)	9	0	0
AEGIS DIALYSIS CENTRE	36	0	0
ARCA (FARRER PARK) DIALYSIS PTE LTD	30	0	0
ASIA KIDNEY DIALYSIS CENTRE (BEDOK)	60	0	0
ASIA KIDNEY DIALYSIS CENTRE (JURONG)	31	0	0
ASIA KIDNEY DIALYSIS CENTRE (TAMPINES) BLK 139	87	0	0
ASIA KIDNEY DIALYSIS CENTRE (TECK WHYE)	37	0	0
ASIA KIDNEY DIALYSIS CENTRE (TP) BLK-484	62	0	0
ASIA KIDNEY DIALYSIS CENTRE (TPY)	41	0	0
B. BRAUN DIALYSIS CENTRE (EAST COAST)	0	0	0
COMPLEX MEDICAL CENTRE (CHANGI)	2	0	0
DAVITA MEDICAL & DIALYSIS CENTRE (EAST COAST)	32	0	0
DAVITA MEDICAL & DIALYSIS CENTRE (JURONG EAST)	23	0	0
DAVITA MEDICAL AND DIALYSIS CENTRE @ FARRER PARK MEDICAL CENTRE	23	0	0
DAVITA MEDICAL AND DIALYSIS CENTRE @ ROYAL SQUARE MEDICAL SUITES (NOVENA)	40	0	0
ECON ADVANCE RENAL CARE (YUNG KUANG)	19	0	0
ECON ADVANCE RENAL CARE PTE LTD (BEDOK)	16	0	0

FRESENIUS KIDNEY CARE YISHUN DIALYSIS CLINIC	42	0	0
FRESENIUS KIDNEY CARE ANG MO KIO 128 DIALYSIS CLINIC	29	0	0
FRESENIUS KIDNEY CARE ANG MO KIO DIALYSIS CLINIC (BLK 422)	43	0	0
FRESENIUS KIDNEY CARE ANG MO KIO DIALYSIS CLINIC (BLK 443)	37	0	0
FRESENIUS KIDNEY CARE BEDOK DIALYSIS CLINIC	43	0	0
FRESENIUS KIDNEY CARE BEDOK RESERVOIR DIALYSIS CLINIC	58	0	0
FRESENIUS KIDNEY CARE BUANGKOK DIALYSIS CLINIC	71	0	0
FRESENIUS KIDNEY CARE BUKIT BATOK DIALYSIS CLINIC (BLK 213)	49	0	0
FRESENIUS KIDNEY CARE BUKIT MERAH CENTRAL DIALYSIS CLINIC	17	0	0
FRESENIUS KIDNEY CARE BUKIT MERAH DIALYSIS CLINIC	38	0	0
FRESENIUS KIDNEY CARE CLEMENTI DIALYSIS CLINIC	20	0	0
FRESENIUS KIDNEY CARE EAST COAST DIALYSIS CLINIC	45	0	0
FRESENIUS KIDNEY CARE FENGSHAN DIALYSIS CLINIC	29	0	0
FRESENIUS KIDNEY CARE JURONG BOON LAY DIALYSIS CLINIC (BLK 353)	36	0	0
FRESENIUS KIDNEY CARE JURONG EAST CENTRAL DIALYSIS CLINIC (BLK 104)	51	0	0
FRESENIUS KIDNEY CARE JURONG EAST DIALYSIS CLINIC (BLK 326)	42	0	0
FRESENIUS KIDNEY CARE KEMBANGAN DIALYSIS CLINIC	50	0	0
FRESENIUS KIDNEY CARE KHATIB DIALYSIS CLINIC	41	0	0
FRESENIUS KIDNEY CARE KOVAN DIALYSIS CLINIC	55	0	0
FRESENIUS KIDNEY CARE LUCKY PLAZA DIALYSIS CLINIC	0	0	0
FRESENIUS KIDNEY CARE MARSILING DIALYSIS CLINIC	34	0	0
FRESENIUS KIDNEY CARE MT ELIZABETH DIALYSIS CLINIC	19	0	0
FRESENIUS KIDNEY CARE NAPIER DIALYSIS CLINIC	21	0	0
FRESENIUS KIDNEY CARE RENCI DIALYSIS CLINIC	40	0	0
FRESENIUS KIDNEY CARE SERANGOON DIALYSIS CLINIC	72	0	0
FRESENIUS KIDNEY CARE TAMPINES DIALYSIS CLINIC	46	0	0
FRESENIUS KIDNEY CARE TAMPINES WEST DIALYSIS CLINIC	51	0	0
FRESENIUS KIDNEY CARE TANGLIN DIALYSIS CLINIC	29	0	0
FRESENIUS KIDNEY CARE TECK WHYE DIALYSIS CLINIC	53	0	0
FRESENIUS KIDNEY CARE TIONG BAHRU DIALYSIS CLINIC	30	0	0
FRESENIUS KIDNEY CARE TOA PAYOH DIALYSIS CLINIC (BLK 92)	30	0	0
FRESENIUS KIDNEY CARE WHAMPOA DIALYSIS CLINIC	40	0	0
FRESENIUS KIDNEY CARE WOODLANDS PEAK DIALYSIS CLINIC	38	0	0
FRESENIUS KIDNEY CARE YISHUN RING DIALYSIS CLINIC	42	0	0
FRESENIUS MEDICAL CARE TAMPINES DIALYSIS CLINIC (BLK 107)	1	0	0
GLENEAGLES HOSPITAL	2	0	0
IMMANUEL DIALYSIS CENTRE (MAYFLOWER) PTE LTD	16	0	0
IMMANUEL DIALYSIS CENTRE PTE LTD (ANG MO KIO)	21	0	0
IMMANUEL DIALYSIS CENTRE PTE LTD (MT ALVERNIA)	27	0	0
IMMANUEL DIALYSIS CENTRE PTE LTD (WOODLANDS)	40	0	0
IMMANUEL DIALYSIS CENTRE PTE LTD (YISHUN)	20	0	0
KIDNEY THERAPEUTICS CENTRE PTE LTD	10	0	0

KIDNEYCARE DIALYSIS CENTRE @ PASIR RIS	52	0	0
KIDNEYCARE DIALYSIS CENTRE @ WEST COAST	20	0	0
KIDNEYCARE DIALYSIS CENTRE @ YISHUN	27	0	0
PACIFIC ADVANCE RENAL CARE (CHOA CHU KANG)	33	0	0
PACIFIC ADVANCE RENAL CARE (FAJAR)	38	0	0
PACIFIC ADVANCE RENAL CARE (SENG KANG)	43	0	0
PACIFIC ADVANCE RENAL CARE PTE LTD (PUNGGOL WAY)	38	0	0
PACIFIC ADVANCE RENAL CARE PTE LTD (TAMPINES)	44	0	0
PACIFIC ADVANCE RENAL CARE PTE LTD (WOODLANDS)	51	0	0
RAFFLES DIALYSIS CENTRE	7	0	0
RENAL HEALTH PTE LTD	58	0	0
RENAL LIFE (ALEXANDRA) DIALYSIS CENTRE PTE LTD	17	0	0
RENAL LIFE (HOUGANG) DIALYSIS CENTRE PTE LTD	19	0	0
RENAL LIFE (W) DIALYSIS CENTRE PTE LTD (BLK 207 BUKIT BATOK)	25	0	0
RENAL LIFE DIALYSIS CENTRE PTE LTD (BLK 463 JURONG WEST)	21	0	0
RENAL LIFE (PIONEER) DIALYSIS CENTRE PTE LTD	31	0	0
TAL DIALYSIS CLEMENTI	40	0	0
CENTRE FOR KIDNEY DISEASE PTE LTD (LUCKY PLAZA)	0	1	40
GRACE LEE RENAL AND MEDICAL CLINIC PTE LTD	0	2	7
KIDNEY & MEDICAL CENTRE	0	0	7
KIDNEY LIFE CENTRE	0	1	7
MOUNT ELIZABETH HOSPITAL	0	0	1
RAFFLES HOSPITAL	0	0	2
ROGER KIDNEY CLINIC	0	0	7
SH TAN KIDNEY & MEDICAL CLINIC	0	2	3
STEPHEW CHEW CENTRE FOR KIDNEY DISEASE AND HYPERTENSION (MAH)	0	0	18
STEPHEW CHEW CENTRE FOR KIDNEY DISEASE AND HYPERTENSION (MEH)	0	0	4
T.G. NG KIDNEY & MEDICAL CENTRE	0	0	2
THE KIDNEY & TRANSPLANT PRACTICE	0	3	1
THE KIDNEY CLINIC PTE LTD	0	0	11
THE KIDNEY HEALTH CLINIC PTE LTD	0	0	1
THE SINGAPORE CLINIC FOR KIDNEY DISEASES	0	0	3
WU NEPHROLOGY & MEDICAL CLINIC (WU MEDICAL CLINIC PTE LTD)	0	0	34
Subtotal	**2659**	**9**	**148**
Grand total	**7534**	**1134**	**1608**