Singapore Renal Registry
Annual Report 2019

National Registry of Diseases Office
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Acknowledgement

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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

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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 383.9 per million population (pmp) in 2010 to 503.0 pmp in 2018. While the age-standardised incidence rate (ASIR) of CKD5 remained relatively stable, ranging between 266.7 pmp and 295.3 pmp from 2010 to 2018, the ASIR of definitive dialysis increased significantly from 144.7 pmp in 2010 to 175.7 pmp in 2019. The age-standardised prevalence rate (ASPR) of definitive dialysis also increased significantly from 896.0 pmp in 2010 to 1099.6 pmp in 2019.

Males outnumbered females in both the incidence and prevalence rates of dialysis. The incidence and prevalence rates of dialysis were higher among Malays than Chinese and Indians. Haemodialysis (HD) was the main modality and diabetic nephropathy (DN) was the main cause of CKD5 among new and prevalent dialysis patients.

Cardiac event and infection were the two most common causes of death among prevalent dialysis patients. After adjusting for demographics, etiology and co-morbidities, the risk of death was higher for patients on peritoneal dialysis (PD). 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 among HD patients remained stable while it significantly improved among PD patients.

Frequency of dialysis, management of urea, management of anaemia, and management of mineral and bone disease among prevalent dialysis patients were assessed. 98.6% of the HD patients had thrice weekly dialysis in 2019. Urea was well managed in 96.7% of the HD patients and 40.3% of the PD patients based on their urea reduction ratio or fractional clearance of urea in 2019. Anaemia was well managed in 78.1% of the HD patients and 62.3% of the PD patients based on their haemoglobin level in 2019. Bone metabolism was well managed in 59.0%, 56.5% and 24.7% of the HD patients and 51.6%, 54.8% and 28.6% of the PD patients based on their calcium level, phosphate level and intact parathyroid hormone level respectively in 2019.

Although the ASIR of kidney transplant fluctuated between 13.9 pmp and 21.7 pmp from 2010 to 2019, the ASPR remained relatively stable, ranging between 259.3 pmp to 270.8 pmp during the same period.

Males outnumbered females in both the incidence and prevalence rates of kidney transplant. There was no significant ethnic difference for the incidence rate of transplant, but the Chinese had the highest prevalence rate of transplant. Most of the transplants were performed locally and glomerulonephritis (GN) was the main cause of CKD5 for new and prevalent transplant patients.

Graft and patient survival were better among transplants from living donors. Patients who undergone transplant, be it from living or deceased donor, had better survival than patients 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 2019, about 1 in 15 Singapore residents have diabetes[2]. Our ageing population, whereby decline in kidney function rises with age, further compounds the situation in Singapore[3].

Estimated glomerular filtration rate (eGFR; glomerular filtration rate corrected to the 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: HD and PD. Older patients and/or those with medical conditions are preferentially placed on PD, which is 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 2019 (Household Interview). Ministry of Health, Singapore. www.moh.gov.sg/docs/librariesprovider5/default-document-library/nphs-2019-survey-report.pdf Accessed on 1 Mar 2021.
[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 collects and analyses epidemiological data to support policy planning and programme evaluation.

In most renal registries, only patients who initiated dialysis are captured. There are also others, such as the United States Renal Data System, which capture only patients who survived >90 days after initiation on dialysis. However, these registries may underestimate the burden of kidney failure in the country and the workload of healthcare professionals. As such, the Singapore Renal Registry (SRR) captures patients with CKD5 since 1999, regardless whether they have initiated dialysis or survived >90 days after initiation of dialysis.

In 2007, the Singapore General Hospital started to provide the SRR their list of patients with eGFR <15 ml/min/1.73m^2. 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.

<u>Data sources</u>

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 for at least six months 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[4].

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 June 2020 by matching the patients' unique National Registration Identity Card number with information from the Death Registry.

[4] Chronic Kidney Disease: Evaluation, Classification, and Stratification 2002. National Kidney Foundation, New York.

Population estimates

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[5]. The Segi World population estimates used for age standardisation are available on the World Health Organisation website[6].

This report focuses on Singapore residents with CKD5 and underwent dialysis or kidney transplant in 2010 to 2019, as they stood on 8 September 2020. 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.

[5] 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 1 Mar 2021.

[6] 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 last five years - 2015 to 2019. The number of new dialysis and kidney transplant patients, deaths among dialysis and transplant patients, and prevalent dialysis and kidney transplant patients all increased over the years.

Table 5.1.1: Stock and flow in 2015 – 2019

	2015	2016	2017	2018	2019
Incidence					
Definitive dialysis	1090	1170	1174	1254	1202
Transplant	90	97	115	114	100
Death					
Definitive dialysis	800	800	879	915	904
Transplant	35	26	20	39	33
Prevalence					
Definitive dialysis	6231	6672	7006	7405	7754
Transplant	1478	1503	1568	1602	1613

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 restructured hospital (RH)[7], they also have routine follow-up at the dialysis centre, where they go for their regular dialysis. In 2019, the majority of the prevalent HD patients were last followed up at dialysis centres run by the Voluntary Welfare Organisations (VWO, 61.1%), followed by the private clinics and dialysis centres (37.0%), then the public hospitals and affiliated dialysis centres (1.9%).

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 (99.5%) were last followed up at the public hospitals and affiliated dialysis centres in 2019.

Similarly, follow-up among transplant patients is typically for consultation with their nephrologists, where transplant was done. Almost all the prevalent transplant patients (90.8%) were followed up at the public hospitals and affiliated dialysis centres in 2019.

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

[7] 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 2019

	HD		PD		Transplant	
	Number	%	Number	%	Number	%
Public hospitals and affiliated dialysis centres	128	1.9	1048	99.5	1465	90.8
Dialysis centres under Voluntary Welfare Organisations	4095	61.1	0	0.0	NA	NA
Private clinics and dialysis centres	2478	37.0	5	0.5	148	9.2
Overseas	0	0.0	0	0.0	0	0.0
Total	6701	100.0	1053	100.0	1613	100.0

NA: not applicable

5.2 Incidence of CKD5

The incidence rate 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 standardisation weights.

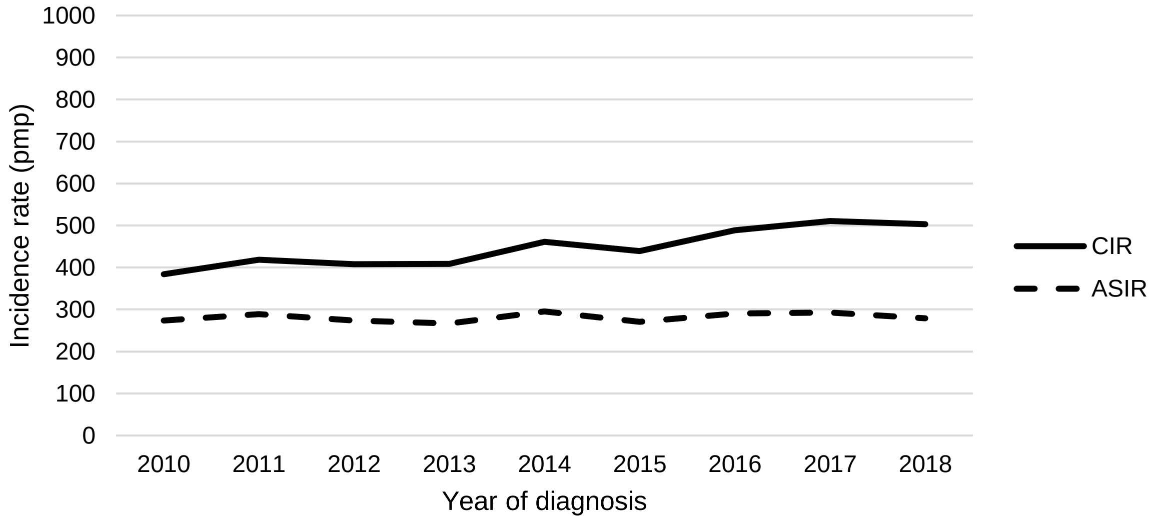
As the registry monitors the patient's eGFR readings for at least six months before accepting a case as CKD5 to allow for accurate case ascertainment, all statistics related to new CKD5 patients for 2019 are not shown in this section.

The number of new patients diagnosed with CKD5 increased from 1,448 in 2010 to 2,009 in 2018 (Table 5.2.1 and Figure 5.2.1). Correspondingly, the CIR increased significantly from 383.9 pmp in 2010 to 503.0 pmp in 2018 ($p<0.001$). However, the ASIR remained relatively stable, ranging between 266.7 pmp to 295.3 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
2010	1448	383.9	273.8
2011	1587	418.8	288.9
2012	1557	407.8	274.0
2013	1570	408.4	266.7
2014	1786	461.4	295.3
2015	1712	438.7	270.4
2016	1923	488.9	290.6
2017	2025	510.6	292.6
2018	2009	503.0	279.0
P for trend	-	<0.001	0.443

Figure 5.2.1: Incidence rate (pmp) of CKD5



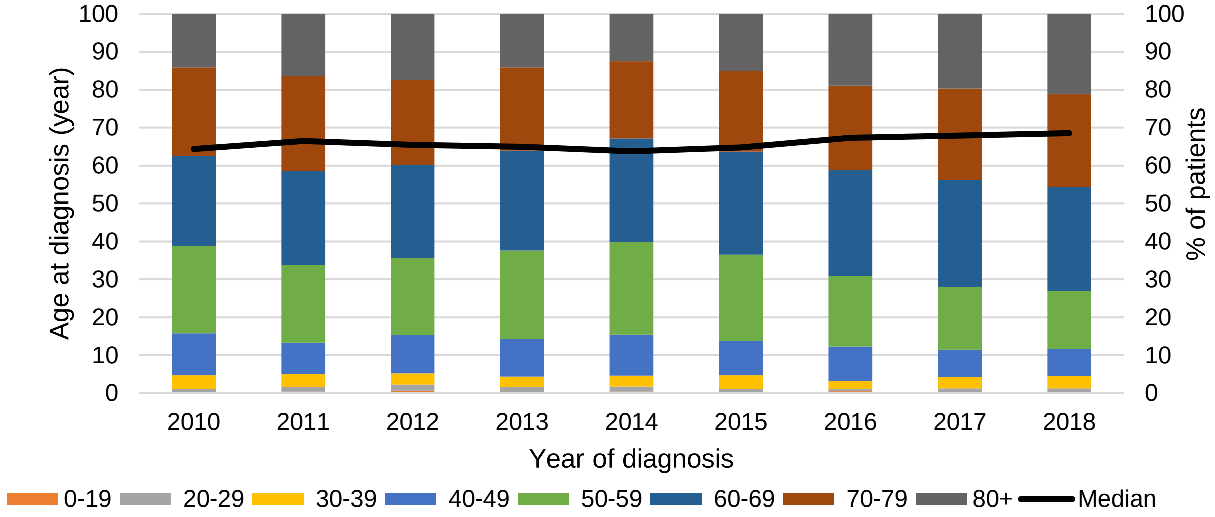
The majority of the new CKD5 patients were aged 60 years or older, with more than 7 in 10 of the patients in this age group in 2018 (Table 5.2.2).

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
2010	5	0.3	5.4	12	0.8	23.1	51	3.5	82.4	161	11.1	254.3
2011	7	0.4	7.8	19	1.2	36.7	55	3.5	89.6	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	193	10.8	309.0
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	39	2.0	66.4	176	9.2	286.4
2017	4	0.2	4.8	22	1.1	40.1	61	3.0	105.1	146	7.2	237.4
2018	5	0.2	6.1	21	1.0	38.4	63	3.1	107.7	145	7.2	237.1
P for trend	-	-	0.778	-	-	0.924	-	-	0.246	-	-	0.666
Year of diagnosis	Age 50-59			Age 60-69			Age 70-79			Age 80+		
	Number	%	CIR	Number	%	CIR	Number	%	CIR	Number	%	CIR
2010	333	23.0	603.5	343	23.7	1131.3	339	23.4	2149.7	204	14.1	2948.0
2011	323	20.4	568.1	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	436	24.4	722.0	487	27.3	1240.1	363	20.3	1982.4	224	12.5	2566.0
2015	389	22.7	637.5	464	27.1	1097.1	363	21.2	1974.5	259	15.1	2771.6
2016	359	18.7	583.6	537	27.9	1193.7	426	22.2	2221.6	364	18.9	3721.9
2017	335	16.5	545.2	569	28.1	1219.4	489	24.1	2312.6	399	19.7	3939.7
2018	308	15.3	502.2	550	27.4	1136.9	491	24.4	2145.3	426	21.2	3985.8
P for trend	-	-	0.438	-	-	0.768	-	-	0.876	-	-	0.236

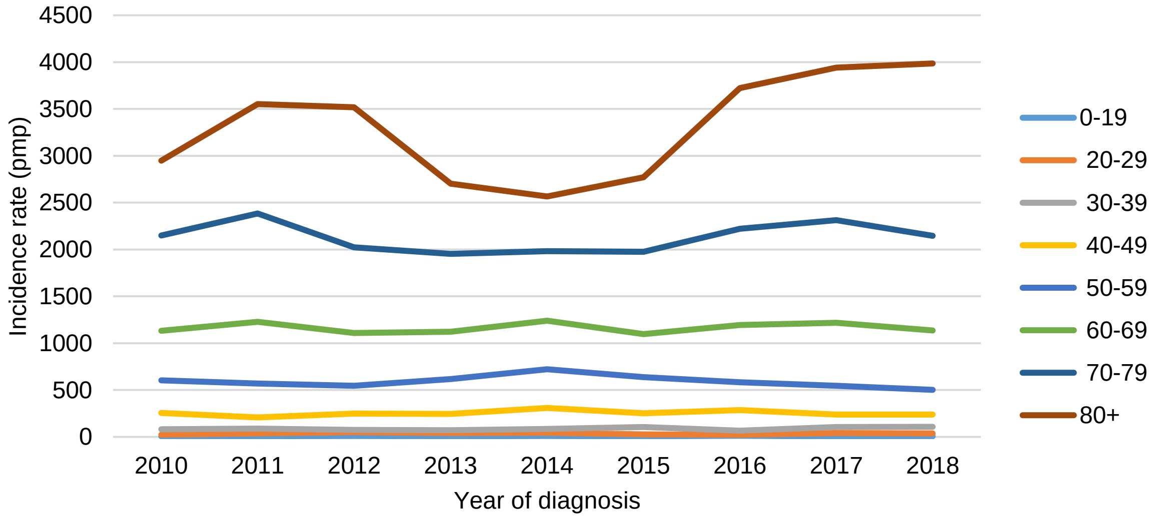
The median age at diagnosis of CKD5 increased slightly from 64.4 years in 2010 to 68.6 years in 2018 (Figure 5.2.2a).

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



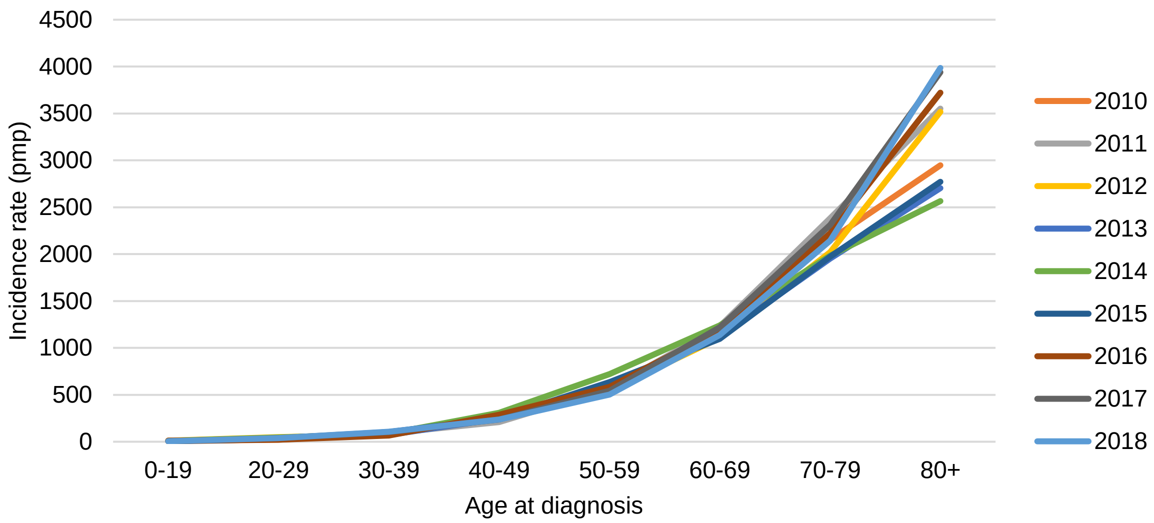
The incidence of CKD5 is mainly driven by the oldest age group (Figure 5.2.2b). The age-specific incidence rate for those aged 80 years and above dropped between 2011 and 2014 but increased steadily thereafter. The age-specific incidence rates remained stable over the years for all the other age groups.

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



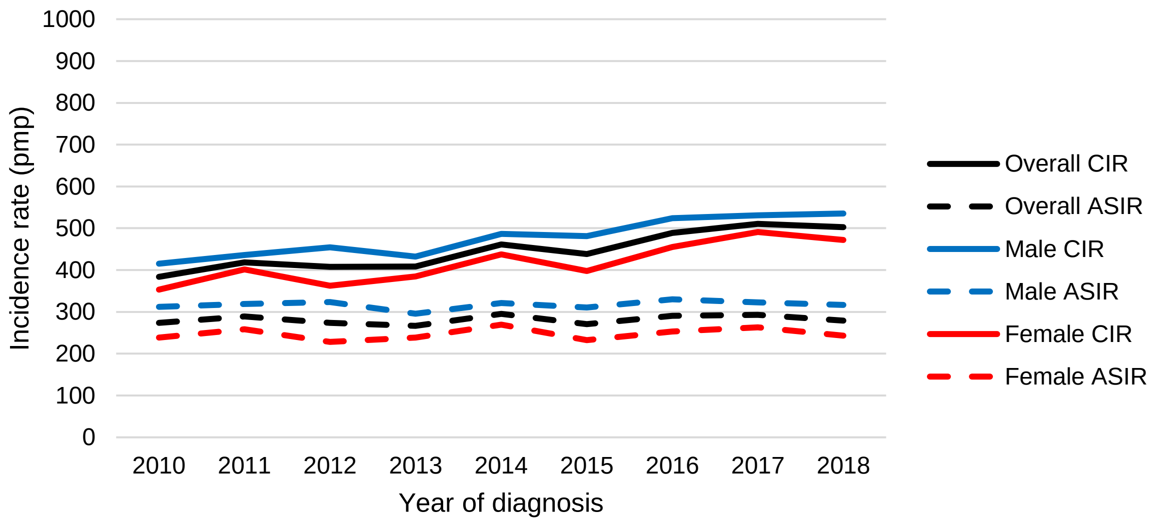
The ASIRs of CKD5 were consistently higher among males than females across the years (Table 5.2.3 and Figure 5.2.4). In 2018, the ASIR was 316.6 pmp and 242.9 pmp for males and females respectively. The ASIRs for both genders remained stable over the years.

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

Male				
Year of diagnosis	**Number**	**%**	**CIR**	**ASIR**
2010	773	53.4	415.3	312.2
2011	815	51.4	436.2	319.1
2012	854	54.8	454.3	323.5
2013	818	52.1	432.5	295.7
2014	925	51.8	486.2	321.2
2015	922	53.9	481.1	310.5
2016	1011	52.6	524.0	330.1
2017	1032	51.0	531.0	323.1
2018	1047	52.1	535.3	316.6
P for trend	-	-	<0.001	0.497

Female				
Year of diagnosis	**Number**	**%**	**CIR**	**ASIR**
2010	675	46.6	353.3	238.6
2011	772	48.6	401.9	258.7
2012	703	45.2	362.8	228.3
2013	752	47.9	385.0	238.8
2014	861	48.2	437.4	269.5
2015	790	46.1	397.8	232.1
2016	912	47.4	455.1	253.4
2017	993	49.0	491.0	262.9
2018	962	47.9	471.9	242.9
P for trend	-	-	0.002	0.541

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



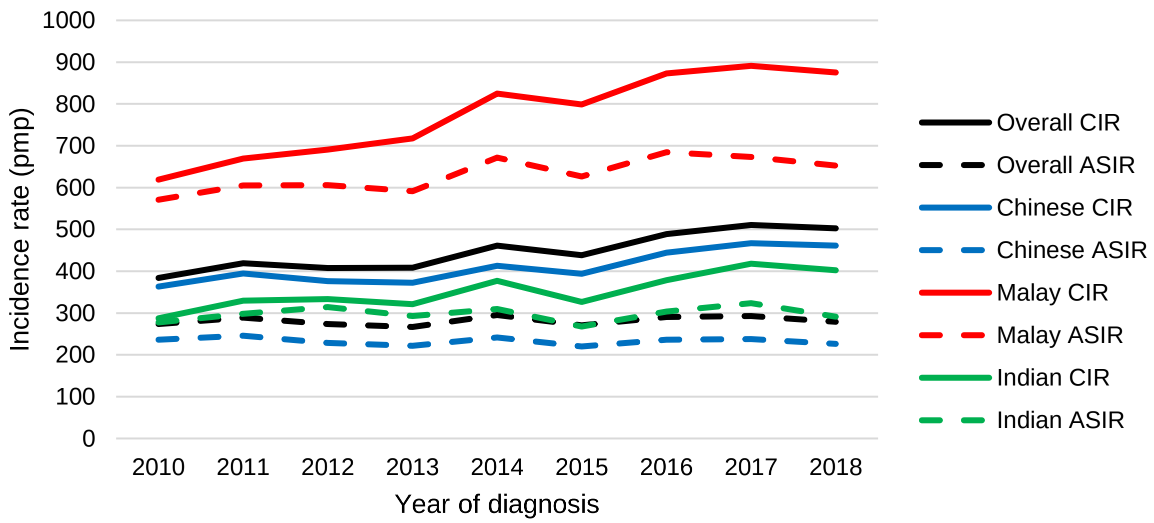
The ASIRs of CKD5 were consistently higher among Malays than Chinese and Indians across the years (Table 5.2.4 and Figure 5.2.5). In 2018, the ASIR among Malays was 652.5 pmp, which was about 3-fold compared to Chinese (226.6 pmp) and 2-fold compared to Indians (291.2 pmp). While the ASIR for Malays increased significantly over the years (p=0.007), the ASIRs for Chinese and Indians remained relatively stable.

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

Chinese				
Year of diagnosis	**Number**	**%**	**CIR**	**ASIR**
2010	1015	70.1	363.3	236.0
2011	1109	69.9	394.9	245.8
2012	1065	68.4	376.1	228.8
2013	1063	67.7	372.5	221.6
2014	1188	66.5	413.3	241.2
2015	1142	66.7	393.8	220.1
2016	1298	67.5	444.0	236.5
2017	1377	68.0	467.1	237.5
2018	1369	68.1	461.1	226.6
P for trend	-	-	0.001	0.522

Malay				
Year of diagnosis	**Number**	**%**	**CIR**	**ASIR**
2010	312	21.5	619.0	570.9
2011	339	21.4	669.4	604.8
2012	352	22.6	691.0	606.0
2013	368	23.4	717.8	591.4
2014	426	23.9	824.5	671.5
2015	416	24.3	798.6	626.2
2016	459	23.9	872.8	684.7
2017	473	23.4	891.3	673.0
2018	469	23.3	875.3	652.5
P for trend	-	-	<0.001	0.007
Indian				
Year of diagnosis	**Number**	**%**	**CIR**	**ASIR**
2010	100	6.9	287.4	277.2
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	133	7.4	376.7	310.0
2015	116	6.8	326.8	267.7
2016	135	7.0	378.3	303.6
2017	150	7.4	418.0	323.6
2018	145	7.2	402.2	291.2
P for trend	-	-	0.002	0.580

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



5.3 Incidence of ever-started dialysis

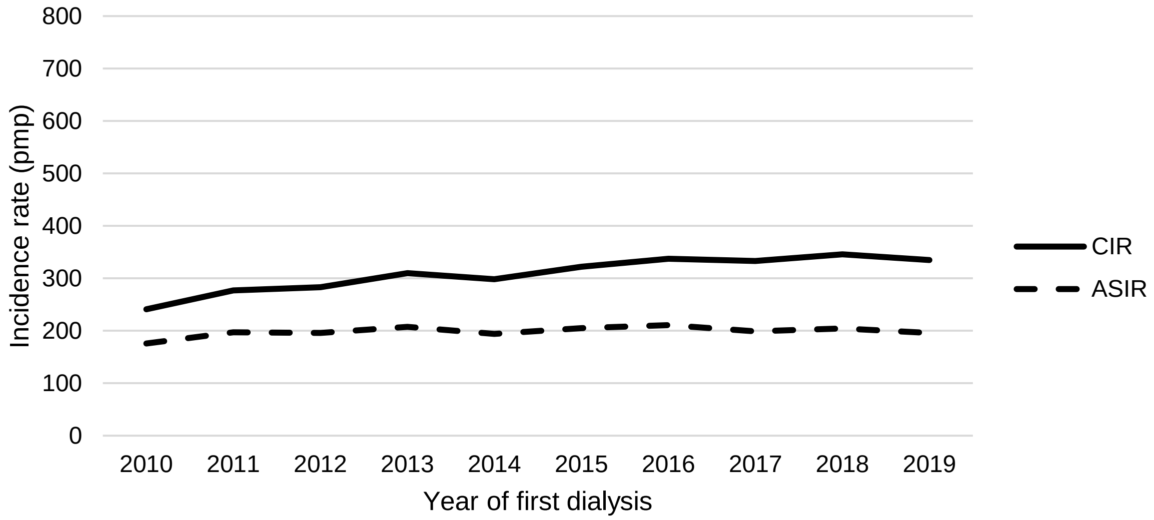
The incidence rate in each year was calculated by taking the number of new patients who ever-started on dialysis in a year, divided by the number of Singapore residents in the same year. The modality was based on the first dialysis. Patients were categorised into 10-year age groups and age standardisation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

The number of new patients who initiated dialysis increased from 909 in 2010 to 1,348 in 2019 (Table 5.3.1 and Figure 5.3.1). Correspondingly, the CIR increased significantly from 241.0 pmp in 2010 to 334.8 pmp in 2019 ($p<0.001$). However, the ASIR remained relatively stable, ranging between 175.8 pmp (lowest value in 2010) to 210.8 pmp (highest value in 2016) during the same period.

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

Year of first dialysis	Number	CIR	ASIR
2010	909	241.0	175.8
2011	1049	276.8	197.1
2012	1080	282.9	195.9
2013	1192	310.1	207.5
2014	1155	298.4	194.1
2015	1258	322.3	205.2
2016	1327	337.4	210.8
2017	1321	333.1	199.0
2018	1381	345.7	204.5
2019	1348	334.8	195.8
P for trend	-	<0.001	0.133

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



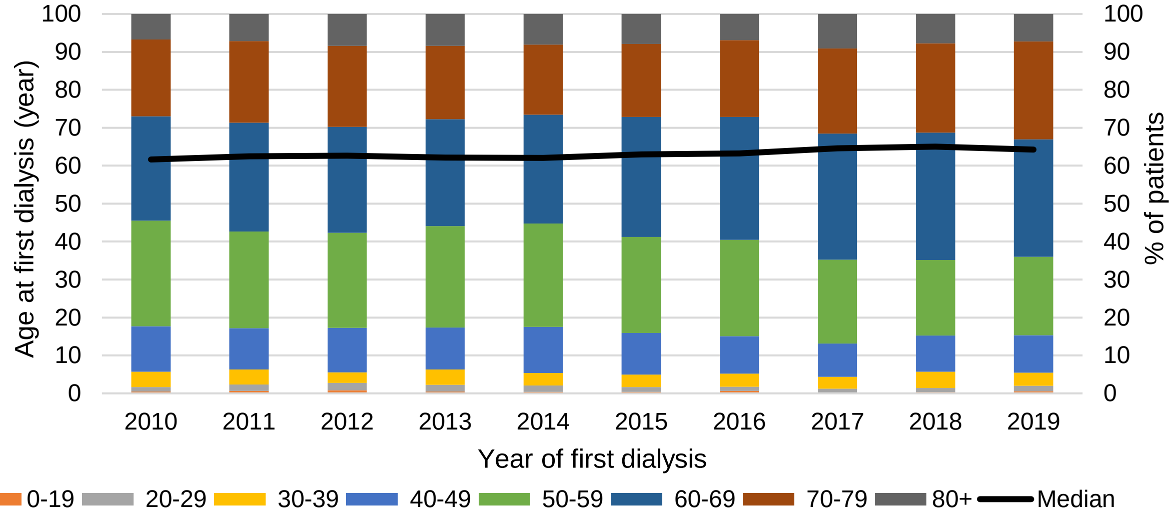
The majority of the new ever-started dialysis patients were aged between 50 to 79 years, with close to 8 in 10 of the patients in this age group in 2019 (Table 5.3.2).

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
2010	4	0.4	4.4	11	1.2	21.2	37	4.1	59.8	109	12.0	172.2
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	134	9.9	218.8
P for trend	-	-	0.996	-	-	0.880	-	-	0.034	-	-	0.066
Year of first dialysis	Age 50-59			Age 60-69			Age 70-79			Age 80+		
	Number	%	CIR	Number	%	CIR	Number	%	CIR	Number	%	CIR
2010	253	27.8	458.5	250	27.5	824.5	184	20.2	1166.8	61	6.7	881.5
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	331	28.7	842.9	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	268	20.2	1397.6	92	6.9	940.7
2017	292	22.1	475.2	439	33.2	940.8	297	22.5	1404.6	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	278	20.6	456.9	417	30.9	833.8	348	25.8	1422.0	98	7.3	847.3
P for trend	-	-	0.899	-	-	0.473	-	-	0.035	-	-	0.609

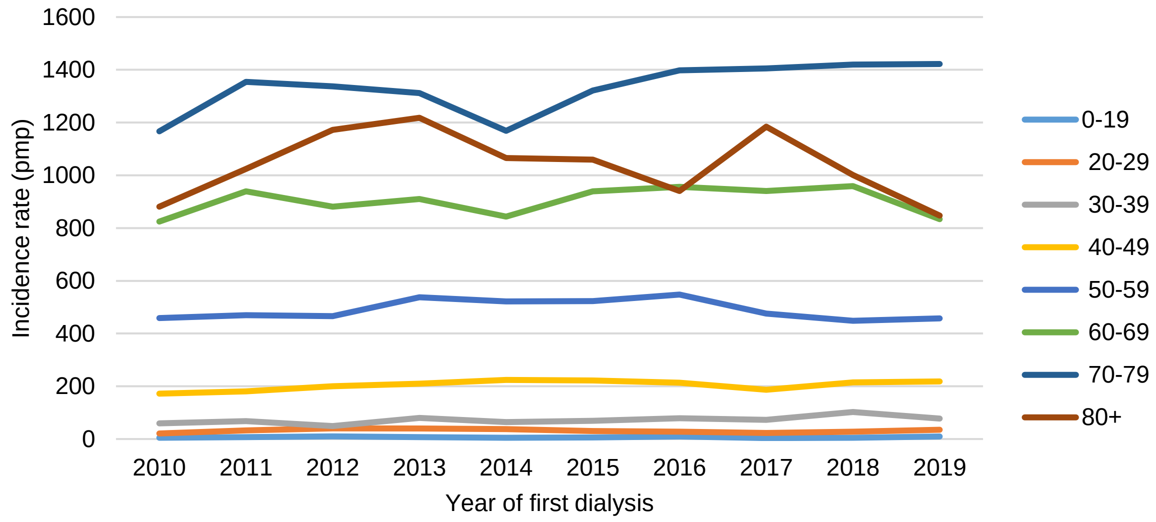
The median age at first dialysis increased slightly from 61.6 years in 2010 to 64.2 years in 2019 (Figure 5.3.2a).

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



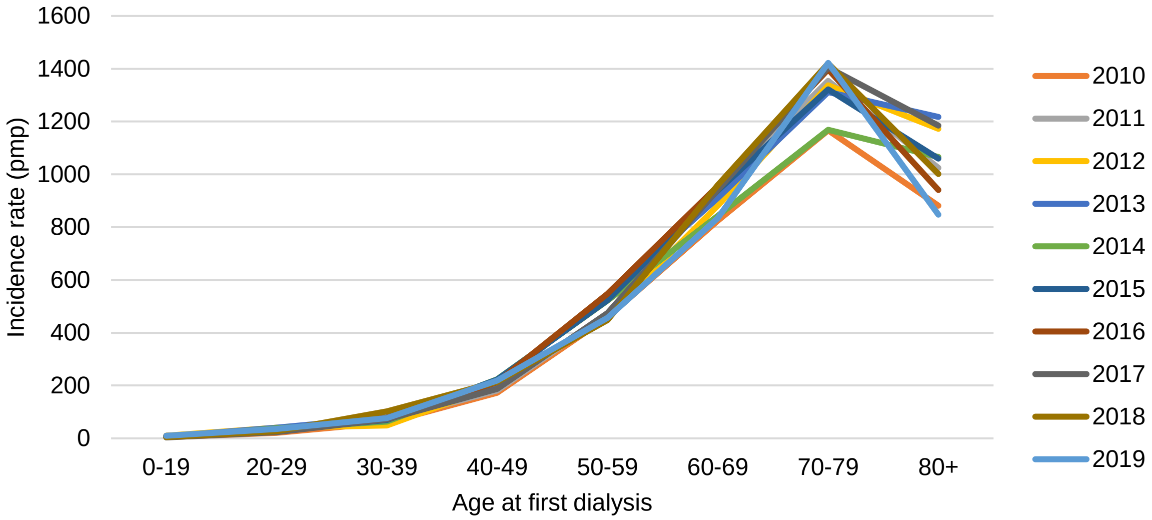
The age-specific incidence rate of ever-started dialysis was highest for those aged 70 to 79 years and it increased significantly over the years (p=0.035) (Figure 5.3.2b). The age-specific incidence rate also increased significantly for those aged 30 to 39 years (p=0.034) (Table 5.3.2).

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 from those aged 80 years and above 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[8].

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 2019, the ASIR was 241.5 pmp and 153.6 pmp for males and females respectively. The ASIRs for both genders remained stable over the years.

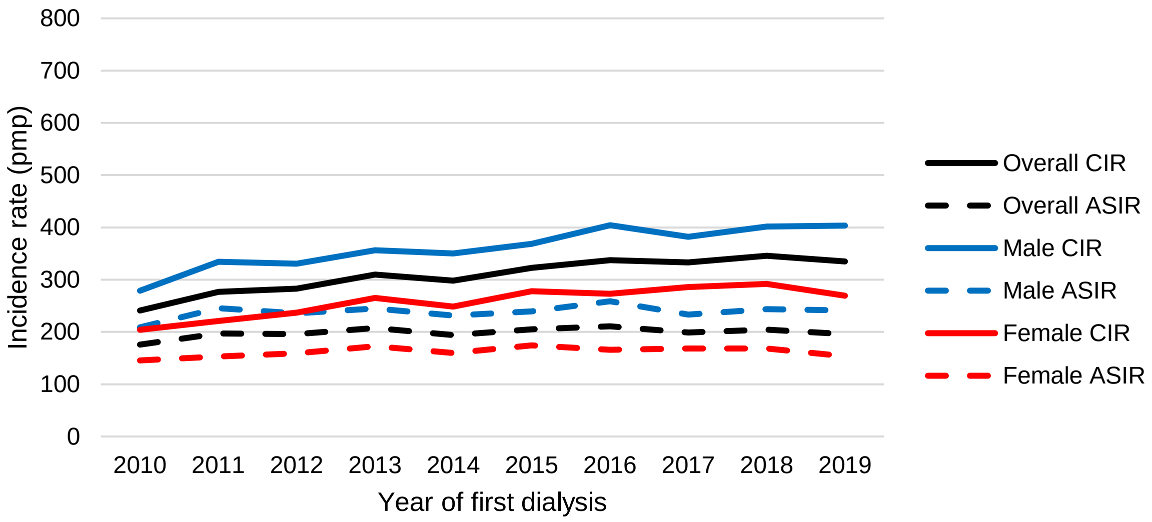
Table 5.3.3: Incidence number and rate (pmp) of ever-started dialysis by gender

Male				
Year of first dialysis	**Number**	**%**	**CIR**	**ASIR**
2010	519	57.1	278.9	208.9
2011	624	59.5	334.0	245.2
2012	621	57.5	330.4	235.4
2013	674	56.5	356.4	245.0
2014	666	57.7	350.1	231.6
2015	706	56.1	368.4	239.1
2016	780	58.8	404.2	258.7
2017	743	56.2	382.3	233.5
2018	786	56.9	401.9	243.4
2019	794	58.9	403.2	241.5
P for trend	-	-	<0.001	0.175

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

Year of first dialysis	Female			
	Number	%	CIR	ASIR
2010	390	42.9	204.1	145.5
2011	425	40.5	221.2	152.8
2012	459	42.5	236.9	158.9
2013	518	43.5	265.2	172.5
2014	489	42.3	248.4	159.6
2015	552	43.9	277.9	174.3
2016	547	41.2	272.9	165.9
2017	578	43.8	285.8	168.0
2018	595	43.1	291.9	168.5
2019	554	41.1	269.3	153.6
P for trend	-	-	0.001	0.199

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

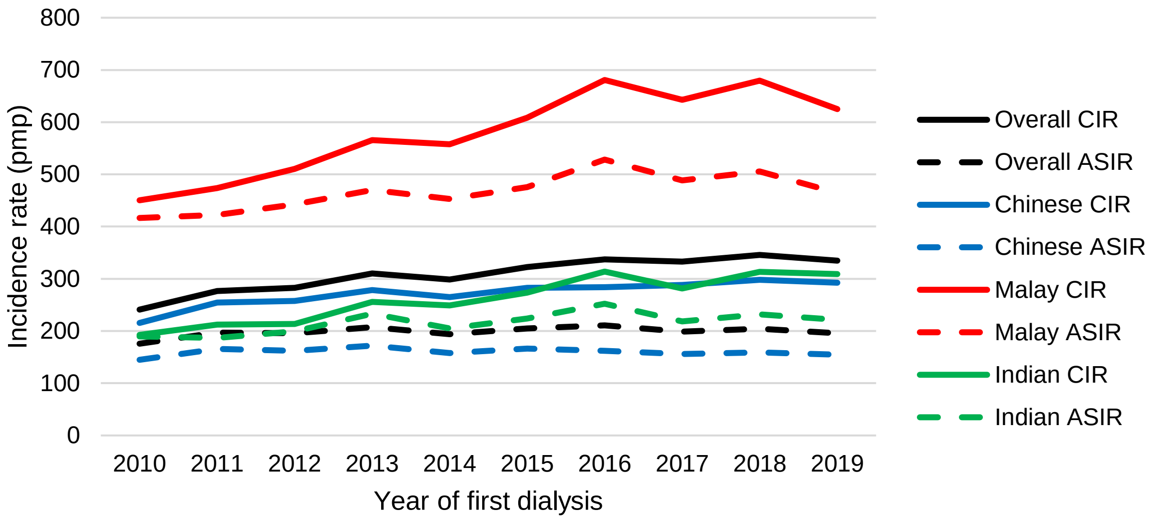


The ASIRs of ever-started dialysis were consistently higher among Malays than Chinese and Indians across the years (Table 5.3.4 and Figure 5.3.5). In 2019, the ASIR was 154.6 pmp, 464.4 pmp and 221.5 pmp for Chinese, Malays and Indians respectively. While the ASIRs for Malays and Indians increased significantly over the years (p=0.010 for Malays; p=0.024 for Indians), the ASIR for Chinese remained relatively stable.

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

Chinese				
Year of first dialysis	**Number**	**%**	**CIR**	**ASIR**
2010	602	66.2	215.5	144.9
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	761	65.9	264.8	157.8
2015	819	65.1	282.4	166.1
2016	830	62.5	283.9	162.1
2017	850	64.3	288.3	155.8
2018	885	64.1	298.1	158.9
2019	876	65.0	292.6	154.6
P for trend	-	-	0.001	0.977
Malay				
Year of first dialysis	**Number**	**%**	**CIR**	**ASIR**
2010	227	25.0	450.4	416.5
2011	240	22.9	473.9	422.4
2012	260	24.1	510.4	442.3
2013	290	24.3	565.6	470.3
2014	288	24.9	557.4	452.9
2015	317	25.2	608.5	475.6
2016	358	27.0	680.8	528.3
2017	341	25.8	642.5	488.7
2018	364	26.4	679.3	505.7
2019	338	25.1	625.0	464.4
P for trend	-	-	<0.001	0.010
Indian				
Year of first dialysis	**Number**	**%**	**CIR**	**ASIR**
2010	67	7.4	192.6	189.6
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	88	7.6	249.3	204.6
2015	97	7.7	273.3	224.1
2016	112	8.4	313.8	252.2
2017	101	7.6	281.5	218.3
2018	113	8.2	313.4	231.7
2019	112	8.3	308.8	221.5
P for trend	-	-	<0.001	0.024

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



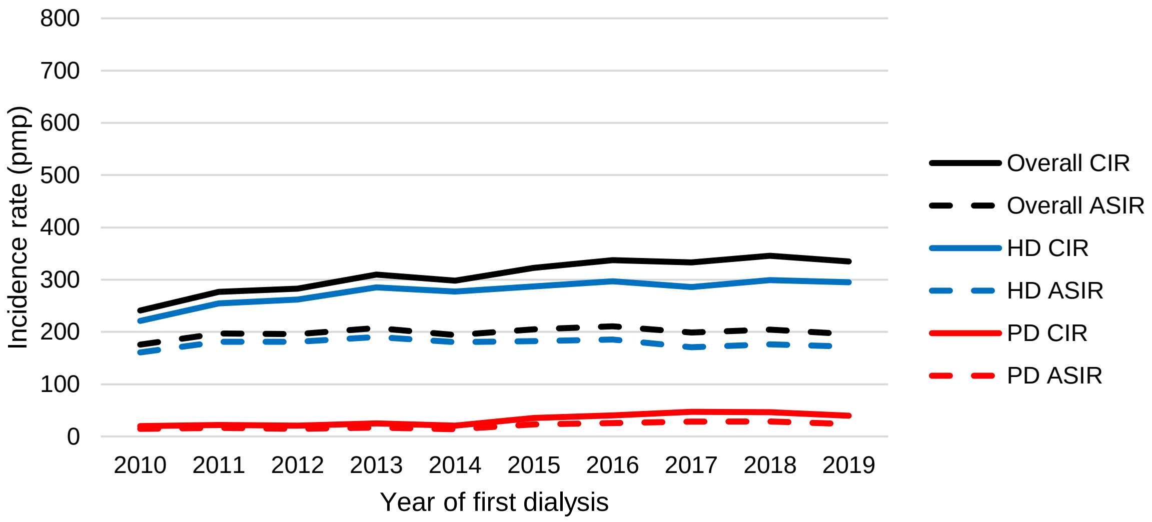
The ASIRs of ever-started dialysis were consistently higher among HD than PD across the years (Table 5.3.5 and Figure 5.3.6). In 2019, the ASIR was 172.1 pmp and 23.6 pmp for HD and PD respectively. While the ASIR for PD increased significantly over the years (p=0.002), the ASIR for HD remained relatively 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**
2010	834	91.7	221.1	160.9
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	1074	93.0	277.5	180.3
2015	1120	89.0	287.0	182.3
2016	1168	88.0	296.9	185.4
2017	1134	85.8	285.9	170.5
2018	1195	86.5	299.2	176.1
2019	1189	88.2	295.3	172.1
P for trend	-	-	0.002	0.960

PD				
Year of first dialysis	**Number**	**%**	**CIR**	**ASIR**
2010	75	8.3	19.9	14.9
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	159	11.8	39.5	23.6
P for trend	-	-	<0.001	0.002

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



5.4 Incidence of definitive dialysis

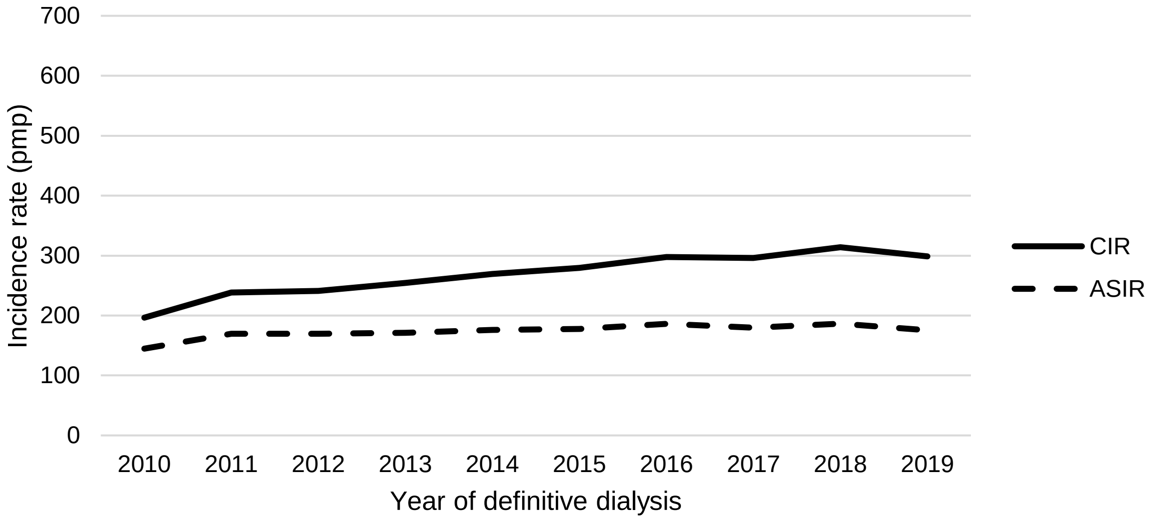
The incidence rate in each year was calculated by taking the number of new patients who survived >90 days after initiation of dialysis in a year, divided by the number of Singapore residents in the same year. The modality was based on the dialysis closest to the 91st day from initiation of dialysis. As some patients did not survive beyond three months from the first dialysis, those on definitive dialysis is a relatively 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 standardisation weights.

The number of new patients on definitive dialysis increased from 741 in 2010 to 1,202 in 2019 (Table 5.4.1 and Figure 5.4.1). Correspondingly, the CIR increased significantly from 196.5 pmp in 2010 to 298.5 pmp in 2019 ($p<0.001$). The rise in ASIR from 144.7 pmp in 2010 to 175.7 pmp in 2019 was also significant ($p=0.012$), 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
2010	741	196.5	144.7
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	1170	297.4	186.2
2017	1174	296.0	179.6
2018	1254	313.9	186.4
2019	1202	298.5	175.7
P for trend	-	<0.001	0.012

Figure 5.4.1: Incidence rate (pmp) of definitive dialysis



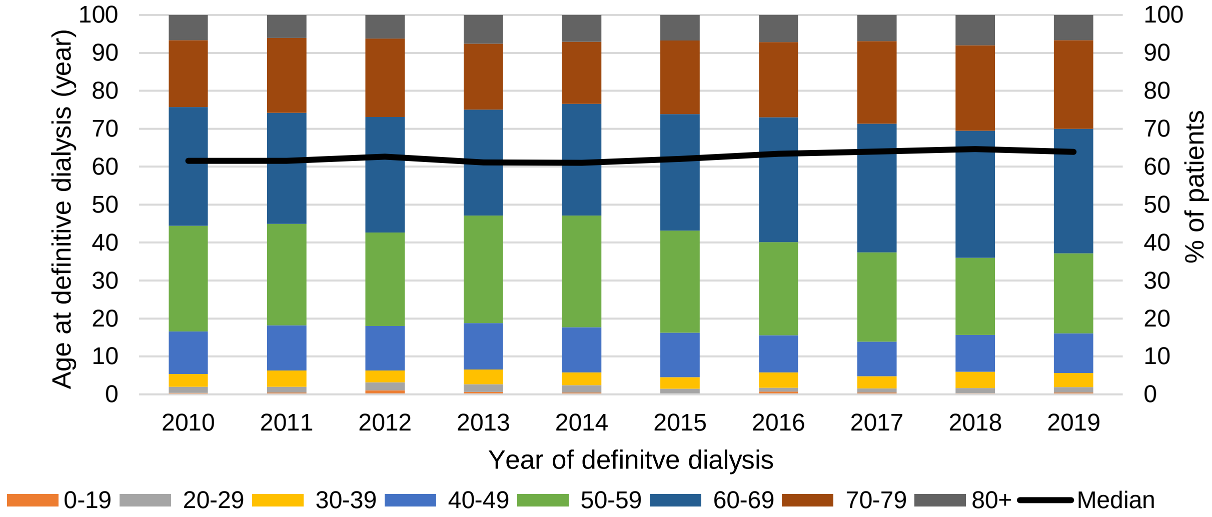
The majority of the new definitive dialysis patients were aged 50 to 79 years, with close to 80% of the patients in this age group in 2019 (Table 5.4.2).

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
2010	3	0.4	3.3	12	1.6	23.1	25	3.4	40.4	83	11.2	131.1
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	125	10.4	204.1
P for trend	-	-	0.535	-	-	0.857	-	-	0.007	-	-	0.027
Year of definitive dialysis	**Age 50-59**			**Age 60-69**			**Age 70-79**			**Age 80+**		
	Number	**%**	**CIR**	**Number**	**%**	**CIR**	**Number**	**%**	**CIR**	**Number**	**%**	**CIR**
2010	206	27.8	373.3	232	31.3	765.2	131	17.7	830.7	49	6.6	708.1
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	232	19.8	1209.9	84	7.2	858.9
2017	276	23.5	449.2	398	33.9	852.9	256	21.8	1210.7	81	6.9	799.8
2018	255	20.3	415.7	420	33.5	868.1	283	22.6	1236.5	100	8.0	935.6
2019	254	21.1	417.5	394	32.8	787.8	281	23.4	1148.2	80	6.7	691.7
P for trend	-	-	0.427	-	-	0.186	-	-	0.016	-	-	0.447

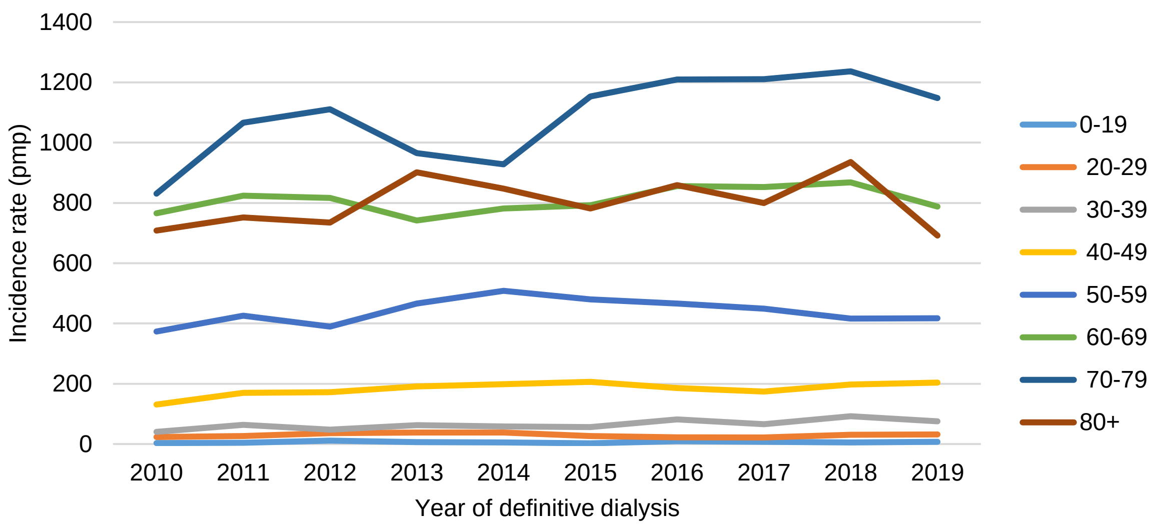
The median age at definitive dialysis increased slightly from 61.5 years in 2010 to 63.9 years in 2019 (Figure 5.4.2a).

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



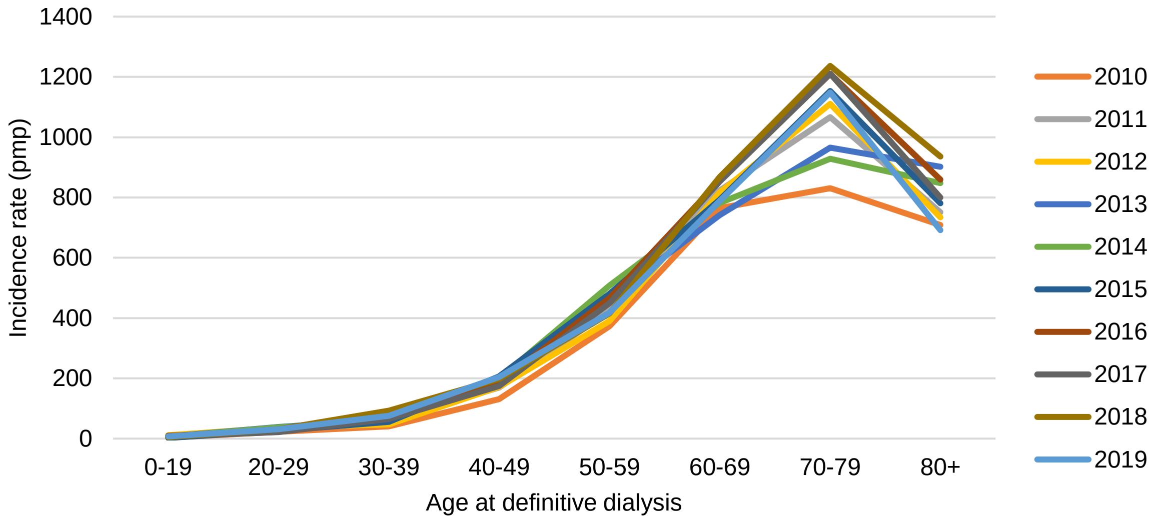
The age-specific incidence rate of definitive dialysis was highest for those aged 70 to 79 years and it increased significantly over the years (p=0.016) (Figure 5.4.2b). The age-specific incidence rate also increased significantly for those aged 30 to 39 years (p=0.007) and 40-49 years (p=0.027) (Table 5.4.2).

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 and above 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.

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



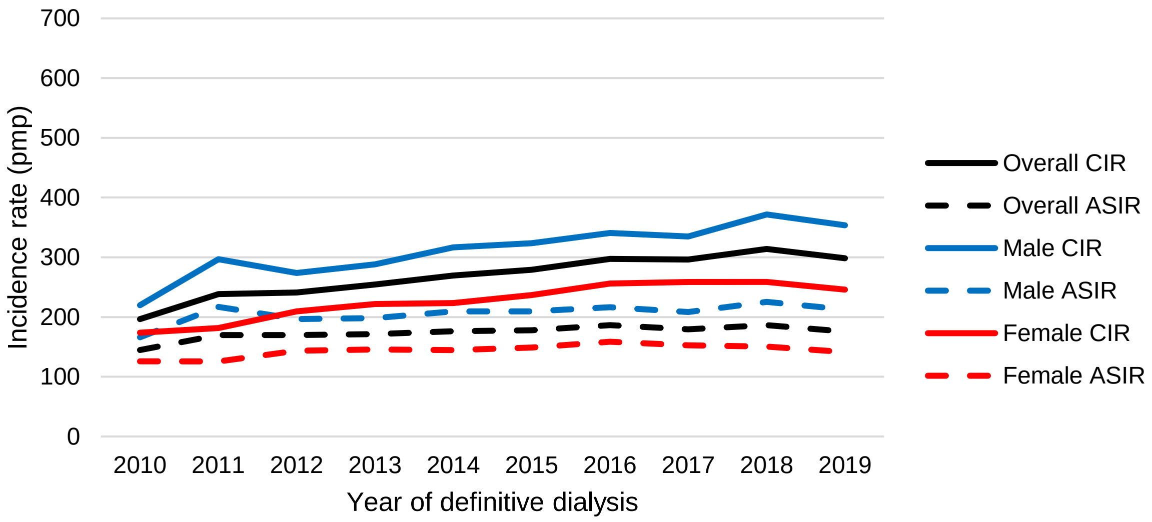
The ASIRs of definitive dialysis were consistently higher among males than females across the years (Table 5.4.3 and Figure 5.4.4). In 2019, the ASIR was 212.6 pmp and 141.2 pmp for males and females respectively. The ASIRs for both genders increased significantly over the years (p=0.039 for males; p=0.027 for females).

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

Male				
Year of definitive dialysis	**Number**	**%**	**CIR**	**ASIR**
2010	409	55.2	219.8	166.1
2011	554	61.4	296.5	217.1
2012	515	55.9	274.0	196.8
2013	545	55.7	288.2	198.4
2014	602	57.8	316.4	209.2
2015	620	56.9	323.5	209.2
2016	657	56.2	340.5	216.6
2017	651	55.5	335.0	208.4
2018	727	58.0	371.7	225.3
2019	696	57.9	353.4	212.6
P for trend	-	-	0.001	0.039

Year of definitive dialysis	Female			
	Number	%	CIR	ASIR
2010	332	44.8	173.8	125.7
2011	349	38.6	181.7	125.6
2012	406	44.1	209.5	143.7
2013	433	44.3	221.7	145.9
2014	440	42.2	223.5	144.4
2015	470	43.1	236.6	148.6
2016	513	43.8	256.0	158.6
2017	523	44.5	258.6	152.6
2018	527	42.0	258.5	150.5
2019	506	42.1	246.0	141.2
P for trend	-	-	<0.001	0.027

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

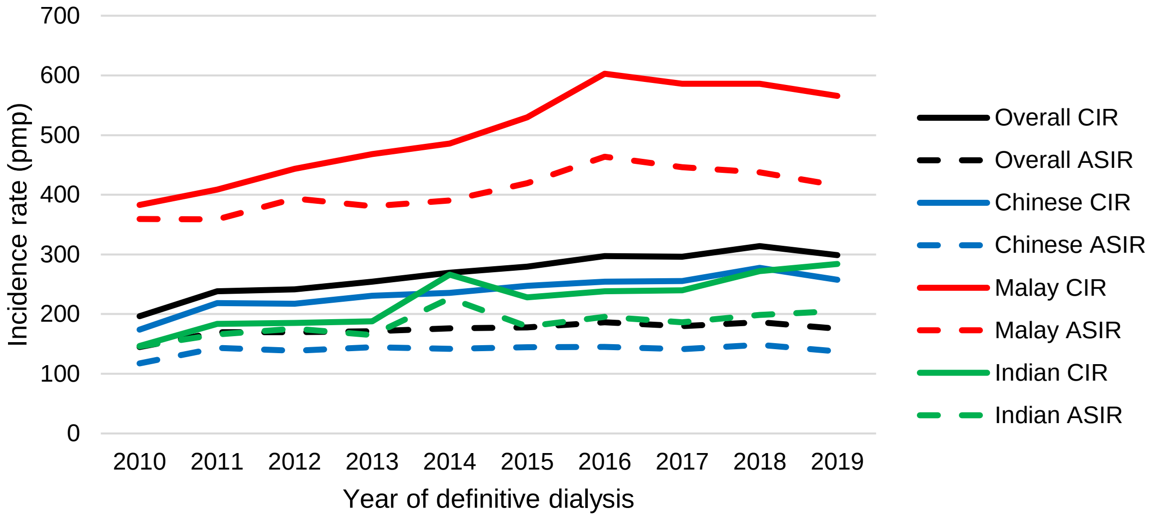


The ASIRs of definitive dialysis were consistently higher among Malays than Chinese and Indians across the years (Table 5.4.4 and Figure 5.4.5). In 2019, the ASIR was 137.3 pmp, 415.8 pmp and 204.9 pmp for Chinese, Malays and Indians respectively. While the ASIRs for Malays and Indians increased significantly over the years (p=0.003 for Malays; p=0.021 for Indians), the ASIR for Chinese remained relatively stable.

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

Chinese				
Year of definitive dialysis	**Number**	**%**	**CIR**	**ASIR**
2010	486	65.6	174.0	117.4
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	743	63.5	254.2	144.9
2017	753	64.1	255.4	141.3
2018	824	65.7	277.5	148.5
2019	771	64.1	257.5	137.3
P for trend	-	-	0.001	0.144
Malay				
Year of definitive dialysis	**Number**	**%**	**CIR**	**ASIR**
2010	193	26.0	382.9	359.3
2011	207	22.9	408.8	358.8
2012	226	24.5	443.7	393.6
2013	240	24.5	468.1	380.7
2014	251	24.1	485.8	390.2
2015	276	25.3	529.8	419.2
2016	317	27.1	602.8	463.7
2017	311	26.5	586.0	446.0
2018	314	25.0	586.0	437.5
2019	306	25.5	565.8	415.8
P for trend	-	-	<0.001	0.003
Indian				
Year of definitive dialysis	**Number**	**%**	**CIR**	**ASIR**
2010	51	6.9	146.6	146.0
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	81	7.4	228.2	179.5
2016	85	7.3	238.2	195.6
2017	86	7.3	239.7	186.5
2018	98	7.8	271.8	198.4
2019	103	8.6	284.0	204.9
P for trend	-	-	<0.001	0.021

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



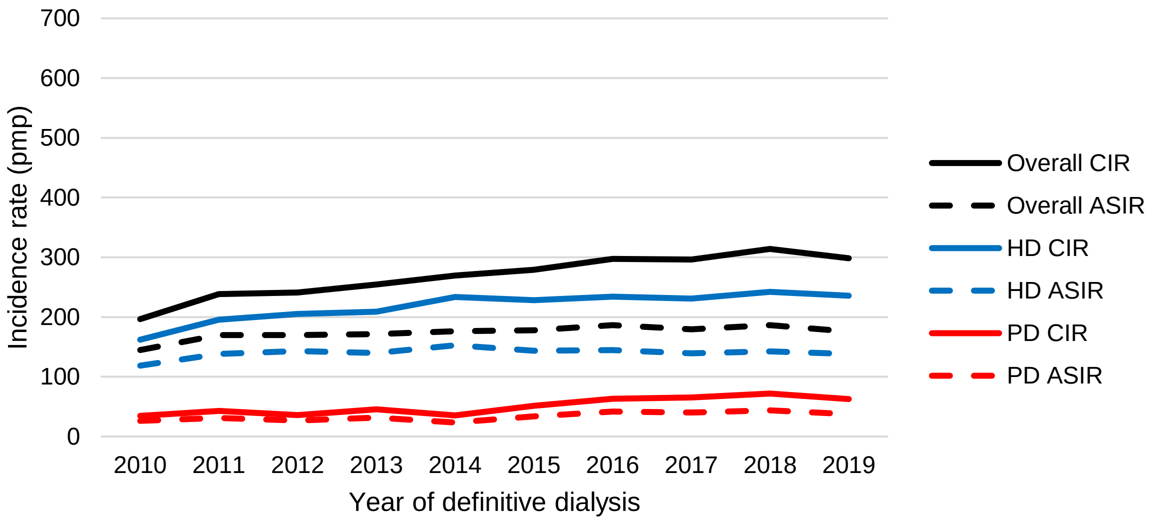
The ASIRs of definitive dialysis were consistently higher among HD than PD across the years (Table 5.4.5 and Figure 5.4.6). In 2019, the ASIR was 138.2 pmp and 37.5 pmp for HD and PD respectively. While the ASIR for PD increased significantly over the years (p=0.010), the ASIR for HD remained relatively stable.

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

	HD			
Year of definitive dialysis	**Number**	**%**	**CIR**	**ASIR**
2010	611	82.5	162.0	118.6
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	921	78.7	234.1	144.8
2017	916	78.0	231.0	139.5
2018	967	77.1	242.1	142.6
2019	949	79.0	235.7	138.2
P for trend	-	-	0.001	0.217

PD				
Year of definitive dialysis	**Number**	**%**	**CIR**	**ASIR**
2010	130	17.5	34.5	26.1
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	253	21.0	62.8	37.5
P for trend	-	-	0.001	0.010

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



Among new patients on definitive dialysis, DN was the biggest contributor to CKD5, followed by GN (Table 5.4.6). In 2019, 68.2% of the new definitive dialysis patients had DN, while 11.7% had GN.

Table 5.4.6: Incidence number of definitive dialysis by etiology

Year of definitive dialysis	**DN**		**GN**		**Others**	
	Number	**%**	**Number**	**%**	**Number**	**%**
2010	470	63.4	137	18.5	134	18.1
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	779	66.6	168	14.4	223	19.1
2017	789	67.2	173	14.7	212	18.1
2018	829	66.1	176	14.0	249	19.9
2019	820	68.2	141	11.7	241	20.0

5.5 Prevalence of definitive dialysis

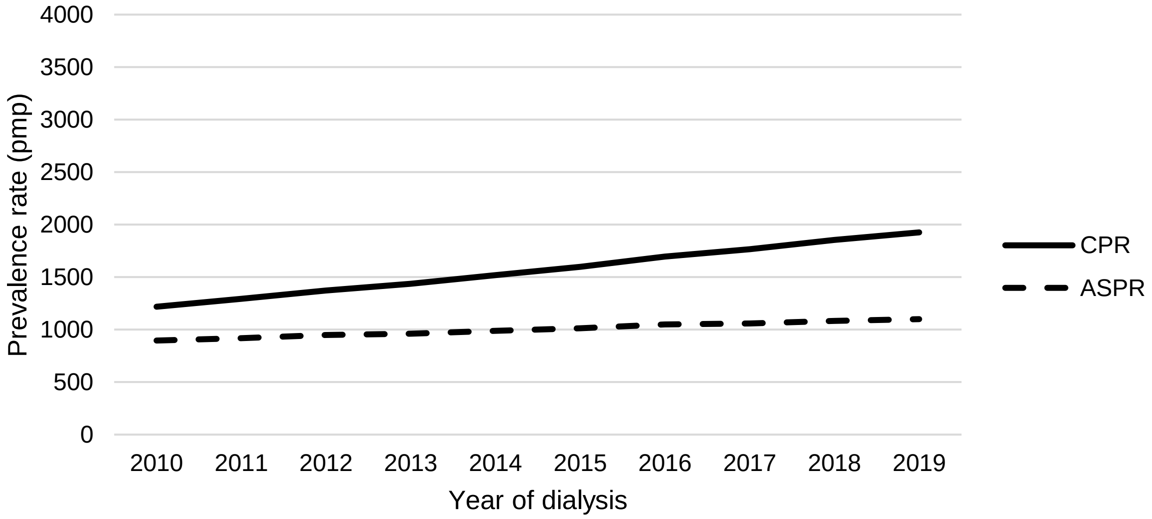
The prevalence rate in each year was calculated by taking the cumulative number of surviving (existing and new) definitive dialysis patients in a year, divided by the number of Singapore residents in the same year. Only patients surviving >90 days after initiation of dialysis were included. The modality 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 standardisation weights.

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 2010 (Table 5.5.1 and Figure 5.5.1). Correspondingly, both the crude prevalence rate (CPR) and ASPR increased significantly over the years (p<0.001 for CPR and ASPR). By the end of 2019, there were a total of 7,754 surviving definitive dialysis patients, with CPR of 1,925.9 pmp and ASPR of 1,099.6 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
2010	4594	1218.0	896.0
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	6672	1696.2	1048.2
2017	7006	1766.6	1058.7
2018	7405	1853.9	1081.6
2019	7754	1925.9	1099.6
P for trend	-	<0.001	<0.001

Figure 5.5.1: Prevalence rate (pmp) of definitive dialysis



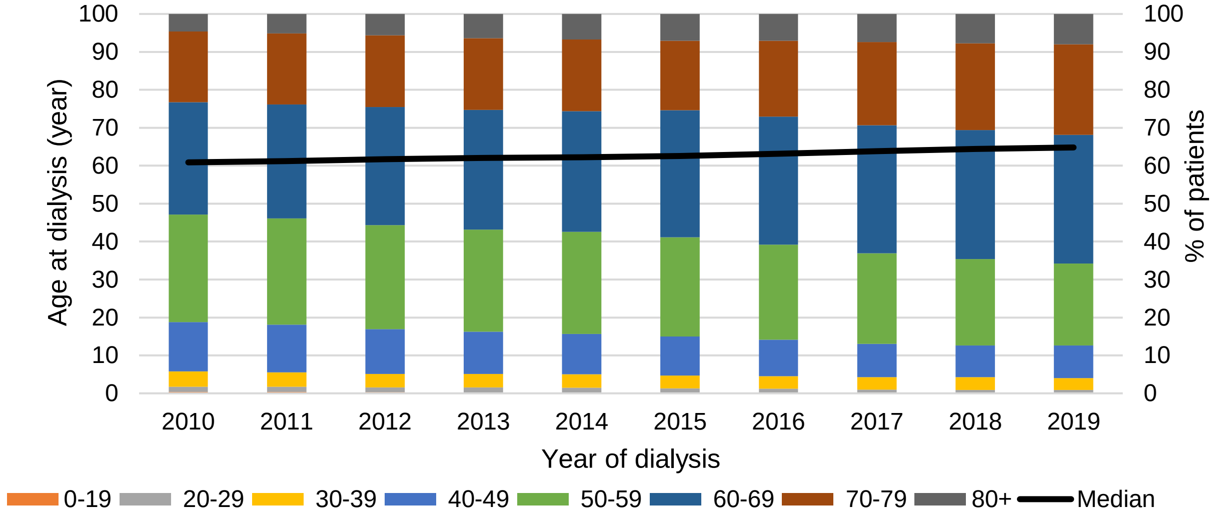
The majority of the prevalent definitive dialysis patients were aged 50 to 79 years, with close to 80% of the patients in this age group in 2019 (Table 5.5.2).

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
2010	17	0.4	18.5	63	1.4	121.2	185	4.0	299.1	599	13.0	946.1
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	58	0.7	108.0	241	3.1	405.5	667	8.6	1089.1
P for trend	-	-	0.186	-	-	0.036	-	-	<0.001	-	-	0.003
Year of dialysis	Age 50-59			Age 60-69			Age 70-79			Age 80+		
	Number	%	CPR	Number	%	CPR	Number	%	CPR	Number	%	CPR
2010	1301	28.3	2357.7	1359	29.6	4482.2	857	18.7	5434.4	213	4.6	3078.0
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	1334	20.0	6956.9	474	7.1	4846.7
2017	1673	23.9	2722.6	2364	33.7	5066.2	1541	22.0	7287.9	516	7.4	5095.0
2018	1685	22.8	2747.2	2520	34.0	5208.9	1693	22.9	7397.1	573	7.7	5361.2
2019	1676	21.6	2754.6	2624	33.8	5246.7	1855	23.9	7579.9	619	8.0	5352.0
P for trend	-	-	<0.001	-	-	<0.001	-	-	<0.001	-	-	<0.001

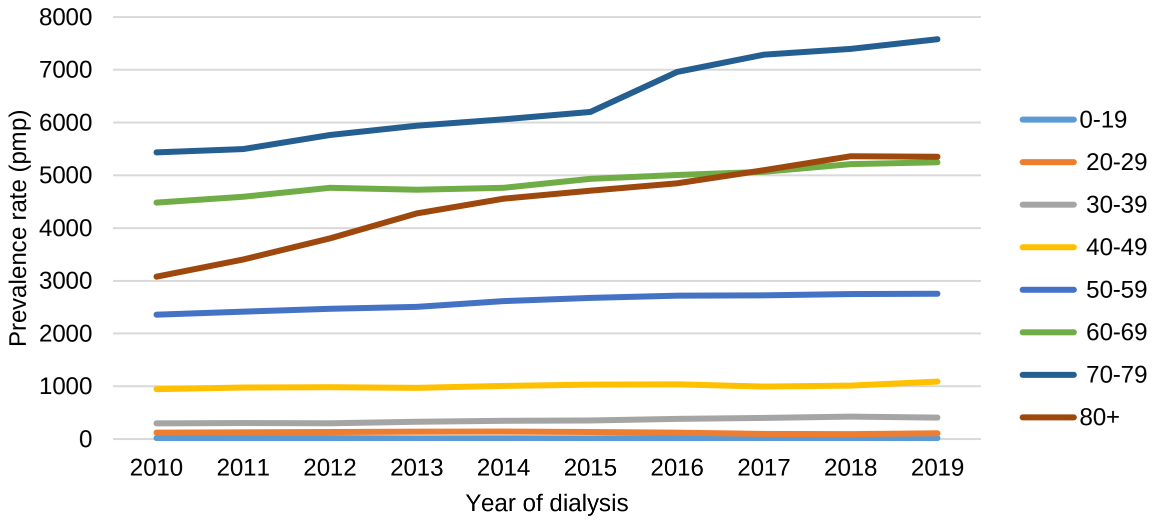
The median age among prevalent definitive dialysis patients increased slightly from 60.9 years in 2010 to 64.8 years in 2019 (Figure 5.5.2a).

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



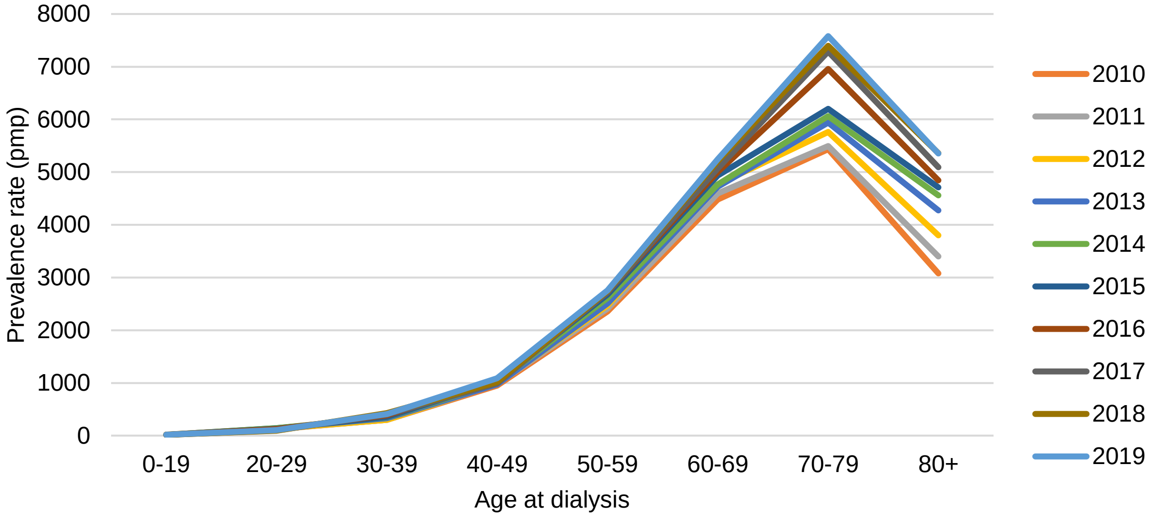
The age-specific prevalence rate of definitive dialysis was highest for those aged 70 to 79 years (Figure 5.5.2b). There was a significant rise in age-specific prevalence rates for all age groups from 20 years and above (p<0.05 for all age groups) (Table 5.5.2).

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).

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



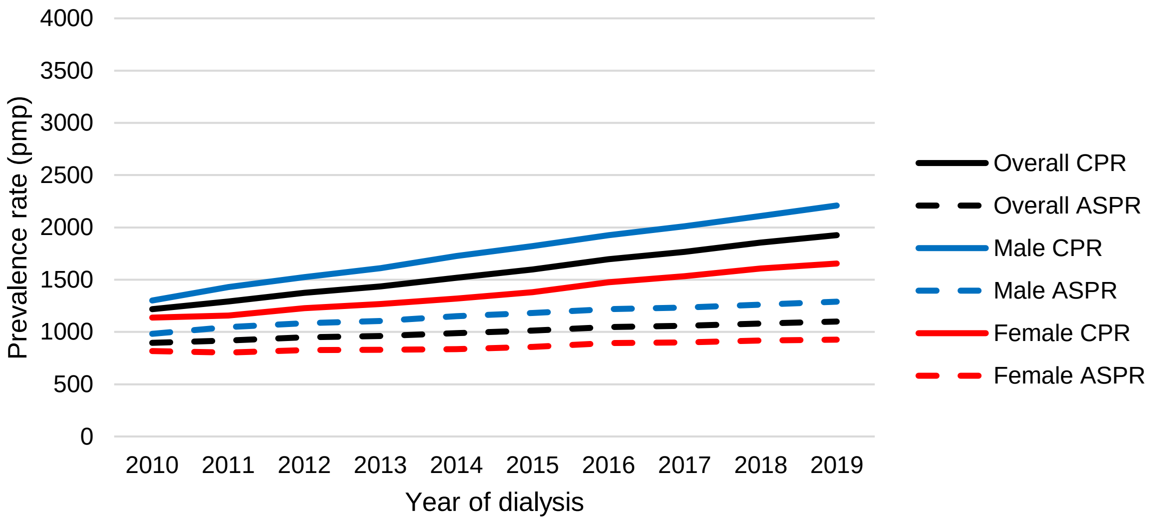
The ASPRs of definitive dialysis were consistently higher among males than females across the years (Table 5.5.3 and Figure 5.5.4). In 2019, the ASPR was 1289.7 pmp and 926.4 pmp for males and females respectively. The ASPRs for both genders increased significantly over the years (p<0.001 for both genders).

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

Male				
Year of dialysis	**Number**	**%**	**CPR**	**ASPR**
2010	2421	52.7	1300.8	982.1
2011	2673	54.6	1430.8	1046.0
2012	2868	54.7	1525.7	1082.5
2013	3044	55.1	1609.5	1105.5
2014	3285	55.9	1726.8	1150.5
2015	3491	56.0	1821.4	1180.7
2016	3715	55.7	1925.3	1218.1
2017	3907	55.8	2010.2	1234.7
2018	4127	55.7	2110.1	1261.1
2019	4351	56.1	2209.3	1289.7
P for trend	-	-	<0.001	<0.001

Year of dialysis	Female			
	Number	%	CPR	ASPR
2010	2173	47.3	1137.3	816.8
2011	2222	45.4	1156.7	802.9
2012	2376	45.3	1226.1	826.2
2013	2477	44.9	1268.2	830.4
2014	2595	44.1	1318.4	836.5
2015	2740	44.0	1379.6	856.8
2016	2957	44.3	1475.5	892.7
2017	3099	44.2	1532.5	898.3
2018	3278	44.3	1608.1	917.9
2019	3403	43.9	1654.5	926.4
P for trend	-	-	<0.001	<0.001

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

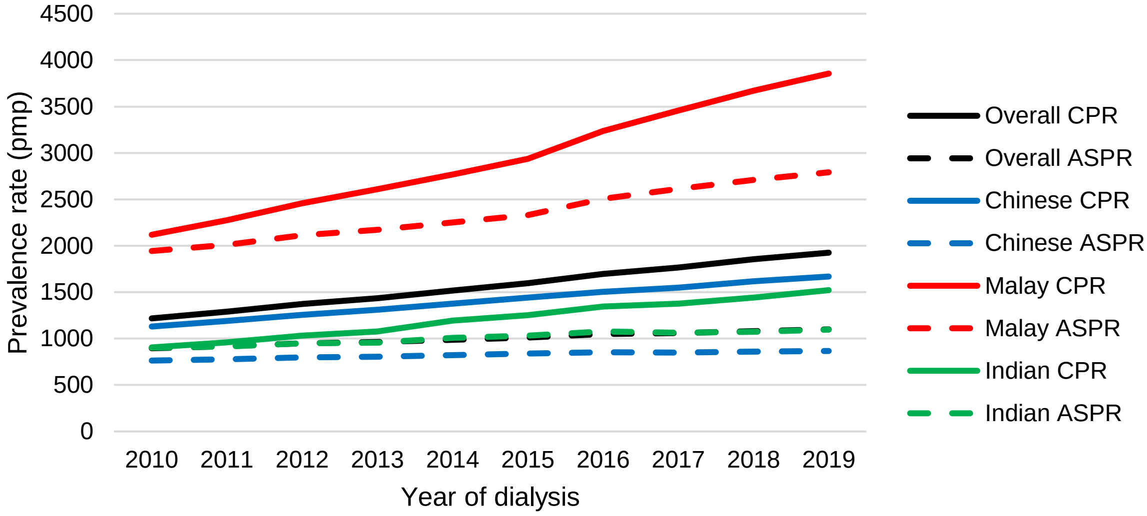


The ASPRs of definitive dialysis were consistently higher among Malays than Chinese and Indians across the years (Table 5.5.4 and Figure 5.5.5). In 2019, the ASPR was 867.0 pmp, 2791.8 pmp and 1096.4 pmp for Chinese, Malays and Indians respectively. While the ASPRs for all the three ethnic groups increased significantly over the years ($p<0.001$ for all the three ethnic groups), the increment for Malays was higher than Chinese and Indians.

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

Chinese				
Year of dialysis	**Number**	**%**	**CPR**	**ASPR**
2010	3158	68.7	1130.3	763.5
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	4398	65.9	1504.5	853.6
2017	4571	65.2	1550.4	849.0
2018	4803	64.9	1617.6	859.9
2019	4996	64.4	1668.8	867.0
P for trend	-	-	<0.001	<0.001
Malay				
Year of dialysis	**Number**	**%**	**CPR**	**ASPR**
2010	1068	23.2	2119.0	1943.9
2011	1153	23.6	2276.9	2010.6
2012	1253	23.9	2459.8	2114.5
2013	1338	24.2	2609.7	2171.9
2014	1430	24.3	2767.8	2250.4
2015	1530	24.6	2937.1	2331.9
2016	1702	25.5	3236.4	2506.2
2017	1834	26.2	3455.7	2613.2
2018	1966	26.5	3669.1	2710.5
2019	2085	26.9	3855.5	2791.8
P for trend	-	-	<0.001	<0.001
Indian				
Year of dialysis	**Number**	**%**	**CPR**	**ASPR**
2010	315	6.9	905.4	901.5
2011	335	6.8	960.4	916.2
2012	362	6.9	1031.3	949.6
2013	379	6.9	1078.2	954.7
2014	421	7.2	1192.6	1009.6
2015	445	7.1	1253.7	1031.8
2016	480	7.2	1345.0	1078.4
2017	494	7.1	1376.7	1061.9
2018	520	7.0	1442.3	1071.8
2019	552	7.1	1522.2	1096.4
P for trend	-	-	<0.001	<0.001

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



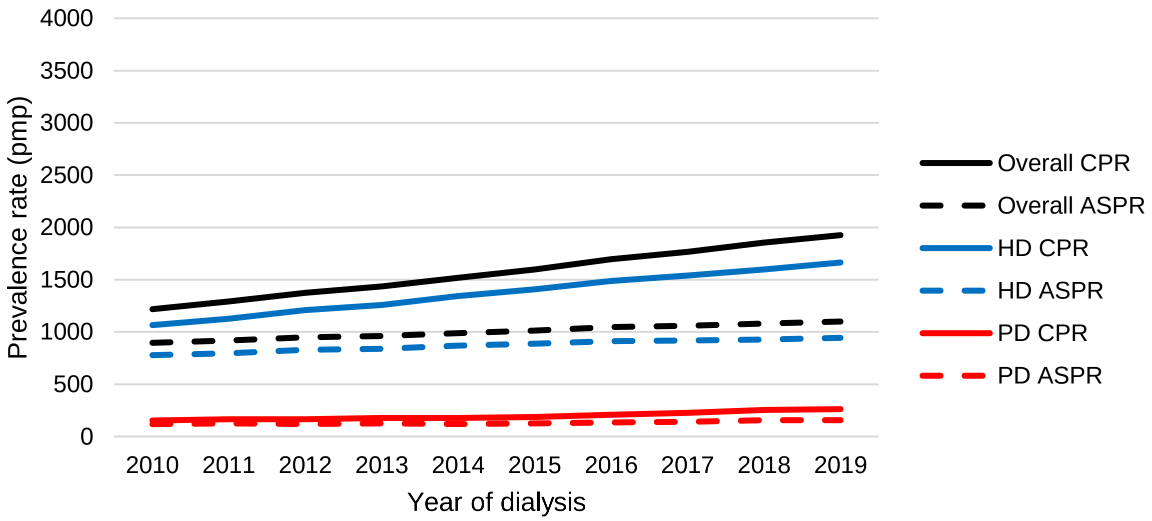
The ASPRs of definitive dialysis were consistently higher among HD than PD across the years (Table 5.5.5 and Figure 5.5.6). In 2019, the ASPR was 943.7 pmp and 155.9 pmp for HD and PD respectively. The ASPRs for both HD and PD increased significantly over the years (p<0.001 for both modalities).

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

HD				
Year of dialysis	**Number**	**%**	**CPR**	**ASPR**
2010	4018	87.5	1065.3	778.0
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	5849	87.7	1486.9	912.9
2017	6109	87.2	1540.4	917.6
2018	6387	86.3	1599.0	926.6
2019	6701	86.4	1664.3	943.7
P for trend	-	-	<0.001	<0.001

PD				
Year of dialysis	**Number**	**%**	**CPR**	**ASPR**
2010	576	12.5	152.7	118.0
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	1053	13.6	261.5	155.9
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 45.3% in 2010 to 55.2% in 2019 (Table 5.5.6). On the other hand, the proportion of prevalent definitive dialysis patients with GN dropped from 32.5% in 2010 to 23.3% in 2019.

Table 5.5.6: Prevalence number of definitive dialysis by etiology

Year of dialysis	DN		GN		Others	
	Number	**%**	**Number**	**%**	**Number**	**%**
2010	2083	45.3	1493	32.5	1018	22.2
2011	2290	46.8	1524	31.1	1081	22.1
2012	2543	48.5	1557	29.7	1144	21.8
2013	2760	50.0	1569	28.4	1192	21.6
2014	2998	51.0	1612	27.4	1270	21.6
2015	3272	52.5	1680	27.0	1279	20.5
2016	3568	53.5	1723	25.8	1381	20.7
2017	3801	54.3	1744	24.9	1461	20.9
2018	4061	54.8	1774	24.0	1570	21.2
2019	4281	55.2	1805	23.3	1668	21.5

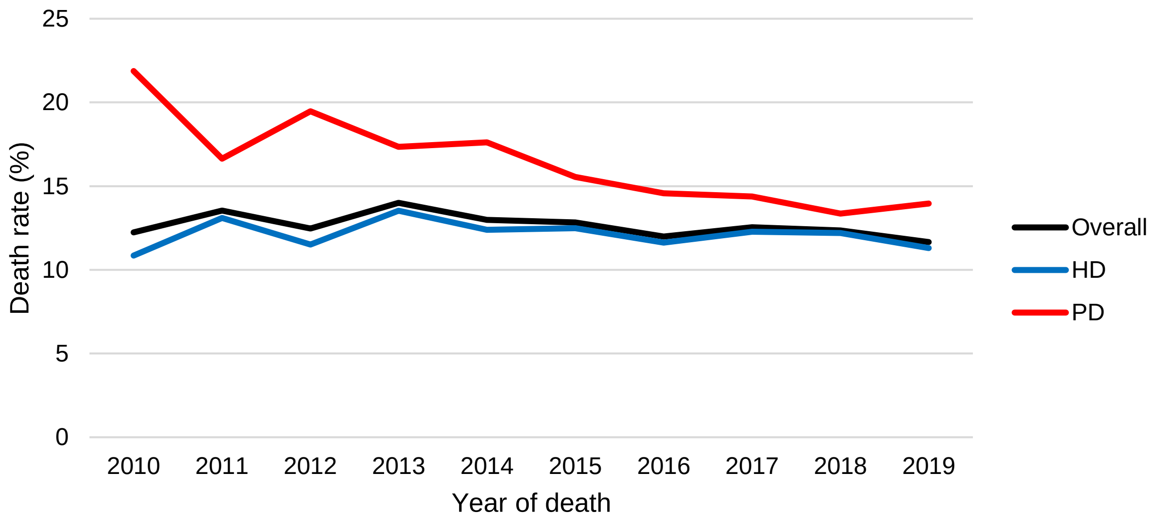
5.6 Mortality of definitive dialysis

Approximately 12% 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. However, disparity in mortality between the two modalities narrowed over the years as the mortality rate dropped from 21.9% in 2010 to 14.0% in 2019 for PD, while it remained relatively stable during the same period, ranging between 10.9% (lowest value in 2010) to 13.5% (highest value in 2013) for HD. 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	%
2010	562	12.2	436	10.9	126	21.9
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	904	11.7	757	11.3	147	14.0

Figure 5.6.1: All-cause mortality by modality



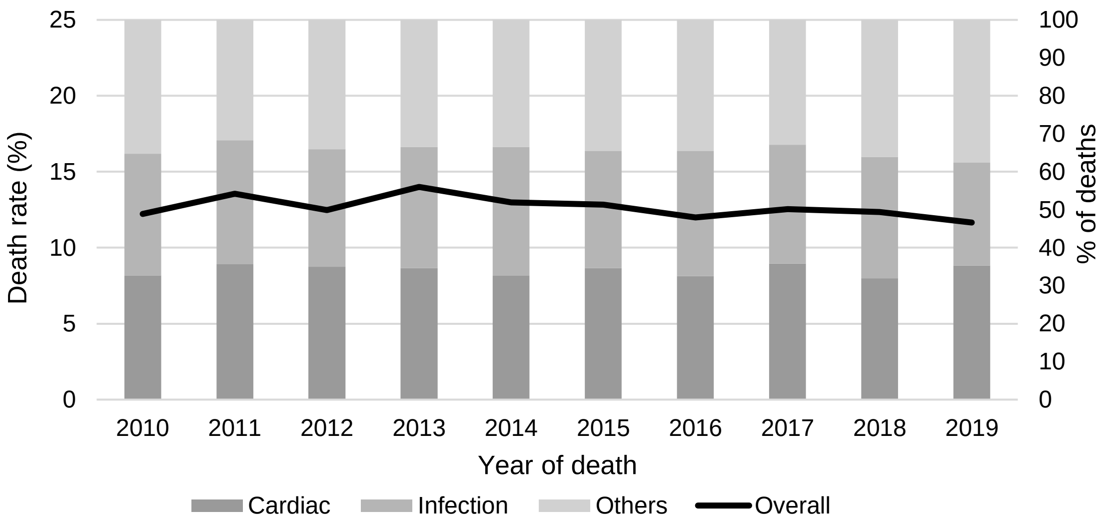
Deaths related to cardiac event and infection were the two most common causes of death and each of them accounted for about a third of all deaths across the years (Table 5.6.2 and Figure 5.6.2).

Table 5.6.2: Mortality by cause of death

Year of death	Overall		Cardiac event		Infection		Others	
	Number	%*	Number	%^	Number	%^	Number	%^
2010	562	12.2	184	32.7	180	32.0	198	35.2
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	904	11.7	319	35.3	245	27.1	340	37.6

*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. The 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 June 2020, the date until which the death status of all patients registered in the registry were updated for this report). Median survival duration is indicated as “not reached (NR)” if more than half of the patients were still alive as of 30 June 2020. Multivariable Cox regression model was used to adjust for the effects of potential confounders on the survival of patients 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 proportions of patients aged 60 years and above ($p<0.001$), Chinese ($p<0.001$), and patients with cerebrovascular disease at the ($p<0.001$) were significantly lower among HD patients (Table 5.7.1). However, HD patients had significantly higher proportions of males ($p<0.001$), patients with peripheral vascular disease ($p=0.031$), and patients with cancer ($p<0.001$).

Table 5.7.1: Baseline characteristics by modality

	HD	PD	Overall
Age group			
≥60 years (%)	53.2%	56.6%	53.9%
Gender			
Male (%)	56.8%	49.6%	55.2%
Ethnicity			
Chinese (%)	66.2%	71.6%	67.4%
Malay (%)	24.6%	20.5%	23.7%
Indian (%)	7.8%	6.2%	7.4%
Etiology			
DN (%)	61.5%	62.7%	61.8%
Co-morbidities			
Ischemic heart disease (%)	45.8%	46.7%	46.0%
Cerebrovascular disease (%)	22.4%	25.9%	23.1%
Peripheral vascular disease (%)	14.7%	13.3%	14.4%
Cancer (%)	8.4%	4.2%	7.5%

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 (%)	90.7	89.4	90.4
5-year survival (%)	61.3	42.3	57.2
10-year survival (%)	35.6	22.0	32.7
Median survival (years)	6.8	4.1	6.1

While survival among HD patients remained stable over the years, survival among PD patients significantly improved during the same period (p<0.001) (Table 5.7.3).

Table 5.7.3: Survival of definitive dialysis by period and modality

	1999-2005			2006-2012			2013-2019		
	HD	PD	Overall	HD	PD	Overall	HD	PD	Overall
1-year survival (%)	90.9	85.8	89.3	89.4	88.9	89.3	91.7	93.0	91.9
5-year survival (%)	60.5	34.3	52.2	60.3	43.0	57.3	62.3	52.5	60.6
10-year survival (%)	37.1	17.2	30.8	33.8	23.0	31.9	-	-	-
Median survival (years)	7.0	3.4	5.3	6.6	4.1	6.0	6.8	5.3	6.6

Younger patients aged below 60 years had significantly better survival than older patients aged 60 years and above (p<0.001 for HD and PD) (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 (%)	93.6	93.1	93.5	88.2	86.5	87.8
5-year survival (%)	73.0	59.9	70.3	50.3	28.0	45.2
10-year survival (%)	51.1	39.2	48.7	19.6	7.6	16.8
Median survival (years)	10.4	6.9	9.6	5.0	3.2	4.4

Survival 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	89.6	90.4	90.9	89.2	90.5
5-year survival (%)	60.9	43.3	57.5	61.9	41.3	56.8
10-year survival (%)	35.6	22.1	33.0	35.7	21.9	32.3
Median survival (years)	6.8	4.3	6.2	6.9	4.0	6.0

Malay HD patients had significantly better survival than their Chinese and Indian counterparts (p=0.012). Survival among PD patients was fairly similar across the three ethnic groups (Table 5.7.6).

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 (%)	90.8	89.6	90.5	90.7	89.0	90.4	90.0	89.6	89.9
5-year survival (%)	60.6	42.4	56.4	63.6	41.3	59.3	59.6	42.5	56.5
10-year survival (%)	35.1	21.8	32.1	38.0	22.8	35.0	32.2	20.2	30.0
Median survival (years)	6.7	4.2	6.0	7.2	3.9	6.5	6.4	3.9	5.9

Patients without DN had significantly better survival than those with DN (p<0.001 for HD and PD) (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	93.1	92.6	89.6	87.2	89.1
5-year survival (%)	73.0	64.2	71.2	53.6	28.9	48.1
10-year survival (%)	54.2	42.4	51.8	21.9	8.9	19.0
Median survival (years)	11.3	7.9	10.6	5.4	3.2	4.8

Patients without ischemic heart disease (IHD) had significantly better survival than those with IHD (p<0.001 for HD and PD) (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	92.6	92.9	88.3	86.1	87.8
5-year survival (%)	71.0	55.5	67.8	50.3	28.7	45.4
10-year survival (%)	47.7	34.8	45.0	20.7	9.1	18.0
Median survival (years)	9.3	5.8	8.6	5.0	3.2	4.4

Patients without cerebrovascular disease (CVD) had significantly better survival than those with CVD (p<0.001 for HD and PD) (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 (%)	91.9	91.1	91.8	86.9	85.3	86.5
5-year survival (%)	65.5	48.3	61.9	47.9	26.9	42.6
10-year survival (%)	40.0	26.7	37.3	19.3	9.7	16.9
Median survival (years)	7.7	4.8	7.0	4.7	3.0	4.2

Patients without peripheral vascular disease (PVD) had significantly better survival than those with PVD (p<0.001 for HD and PD) (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	90.9	91.7	85.2	81.7	84.5
5-year survival (%)	64.8	46.4	60.8	44.0	21.6	39.6
10-year survival (%)	39.4	25.0	36.3	14.5	4.8	12.5
Median survival (years)	7.6	4.6	6.8	4.2	2.6	3.8

Patients without cancer had significantly better survival than those with cancer ($p<0.001$ for HD and PD) (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 (%)	91.9	91.3	91.8	82.8	87.5	83.4
5-year survival (%)	64.0	46.1	60.2	44.6	34.3	43.4
10-year survival (%)	37.6	24.3	34.8	21.1	11.8	19.8
Median survival (years)	7.2	4.5	6.6	4.3	1.7	4.1

PD, old age, DN, IHD, CVD, PVD and cancer remained as significant predictors of death in the multivariable analysis (Table 5.7.12). However, Malay patients no longer had significantly better survival than their Chinese and Indian counterparts.

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. PD patients also visit their healthcare providers less frequently, hence infections and complications may be less recognised and timely attended[9].

[9] 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	1.45-1.60	
Age group			
<60 years	1.00	Reference	<0.001
≥60 years	2.05	1.96-2.15	
Gender			
Male	1.00	Reference	0.762
Female	1.01	0.97-1.05	
Ethnicity			
Chinese	1.00	Reference	
Malay	0.95	0.91-1.00	0.061
Indian	0.99	0.91-1.07	0.742
Etiology			
Non-DN	1.00	Reference	<0.001
DN	1.85	1.76-1.95	
IHD			
No	1.00	Reference	<0.001
Yes	1.50	1.44-1.57	
CVD			
No	1.00	Reference	<0.001
Yes	1.36	1.29-1.42	
PVD			
No	1.00	Reference	<0.001
Yes	1.50	1.42-1.59	
Cancer			
No	1.00	Reference	<0.001
Yes	1.54	1.44-1.66	

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 as follow:

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

The indications of adequacy listed above follow as closely to international guidelines[10,11,12,13] as possible. Notably, the reference range for the lab investigations differ from each healthcare institution and the registry does not capture the reference range for each patient.

All analyses in this section were stratified by service provider (public sector / VWO / private sector) and modality (HD / PD) to look out for groups of patients in need of better management. The most recent reading of each bio-clinical indicator for each patient in each year were taken and patients without measurement of bio-clinical indicators were excluded.

The majority of the prevalent HD patients were dialysed in centres run by the VWO, followed by the private sector, then the public sector. In 2019, the proportions of HD patients under the care of the VWO, private sector and public sector were 61.1%, 37.0% and 1.9% 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 relatively less stable trends.

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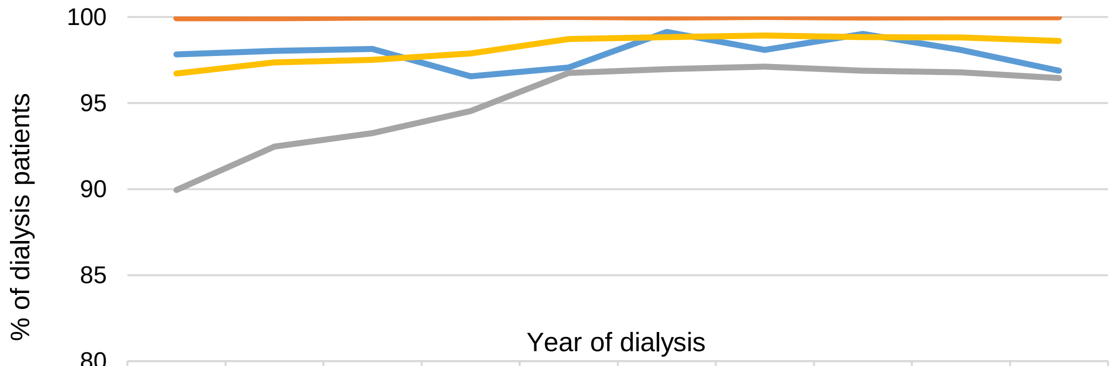
[10] National Kidney Foundation: K/DOQI clinical practice guidelines for hemodialysis adequacy, 2000. American Journal of Kidney Disease. 2001; 37 (suppl 1): S7-S64.
[11] NKF KDOQI Guidelines. National Kidney Foundation, New York. http://kidneyfoundation.cachefly.net/professionals/KDOQI/guideline_upHD_PD_VA/pd_guide2.htm Accessed on 1 Mar 2021.
[12] Mimura I, Tanaka T, Nangaku M. How the target hemoglobin of renal anemia should be? Nephron. 2015; 131: 202-209.
[13] NKF KDOQI Guidelines. National Kidney Foundation, New York. http://kidneyfoundation.cachefly.net/professionals/KDOQI/guidelines_bone/guidestate.htm Accessed on 1 Mar 2021.

On the other hand, almost all the prevalent PD patients were cared for by the public sector. In 2019, 99.5% of the PD patients fell under the care of the public sector, with no patient under the care of the VWO (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 VWO 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 the VWO from 2017 onwards were excluded from this section.

The proportion of prevalent HD patients with thrice weekly dialysis was consistently higher for the public sector and VWO than the private sector across the years (Figure 5.8.1a). However, the disparity narrowed over the years, with 96.4% of the private sector patients undergoing thrice weekly dialysis in 2019, compared to 96.9% and 100% of the public and VWO patients respectively.

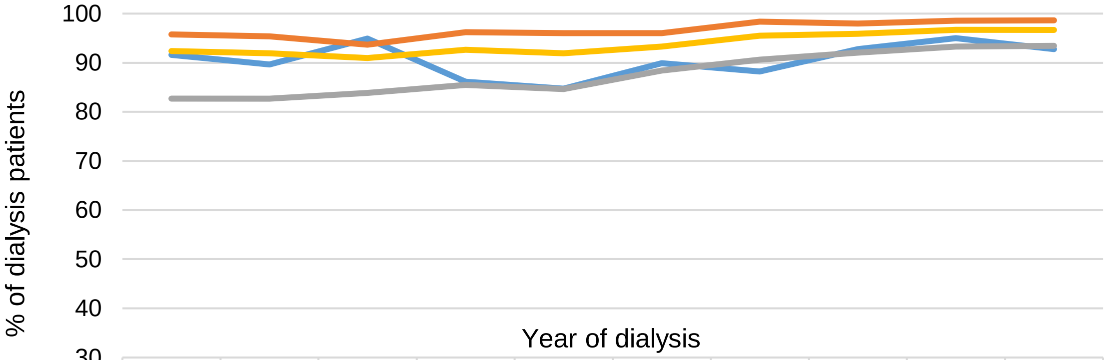
Figure 5.8.1a: Proportion of HD patients with thrice weekly dialysis



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Public	97.8	98.0	98.1	96.6	97.1	99.1	98.1	99.0	98.1	96.9
VWO	99.9	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Private	89.9	92.5	93.2	94.5	96.7	97.0	97.1	96.9	96.8	96.4
Overall	96.7	97.4	97.5	97.9	98.7	98.8	98.9	98.8	98.8	98.6

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 VWO than the public and private sectors (Figure 5.8.1b). However, the private sector was catching up - rising from 82.7% of its patients meeting the criteria in 2010 to 93.4% in 2019. The corresponding proportions of HD patients cared by the public sector and VWO meeting the criteria were 92.8% and 98.6% respectively in 2019.

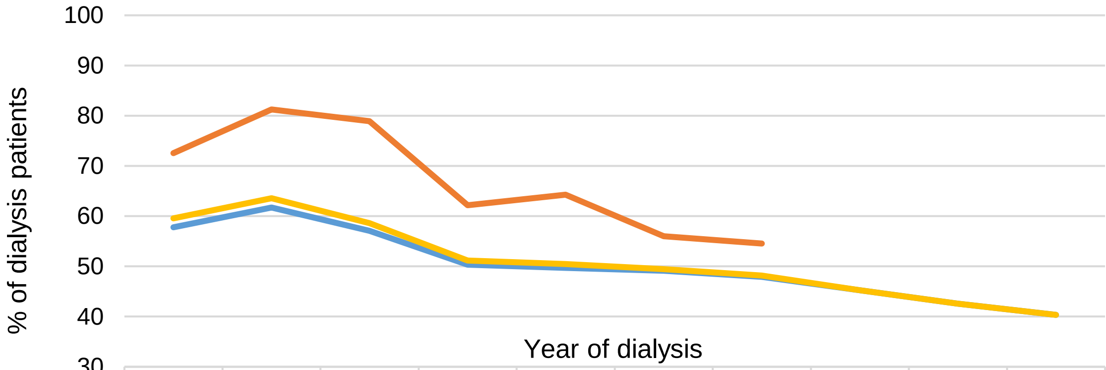
Figure 5.8.1b: Proportion of HD patients with adequate management of urea (URR >=65% or Kt/V >=1.2%)



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Public	91.6	89.7	94.9	86.2	84.7	89.9	88.2	92.8	95.0	92.8
VWO	95.8	95.4	93.7	96.2	96.0	96.0	98.3	98.0	98.6	98.6
Private	82.7	82.7	83.9	85.5	84.7	88.4	90.6	92.1	93.3	93.4
Overall	92.4	91.9	91.0	92.6	91.9	93.3	95.5	95.9	96.7	96.7

The proportion of prevalent PD patients who met the adequate management of urea criteria of Kt/V >=2.0% was consistently higher for the VWO than the public sector across the years till 2016 (Figure 5.8.2). 40.3% of the public sector patients met the criteria in 2019.

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

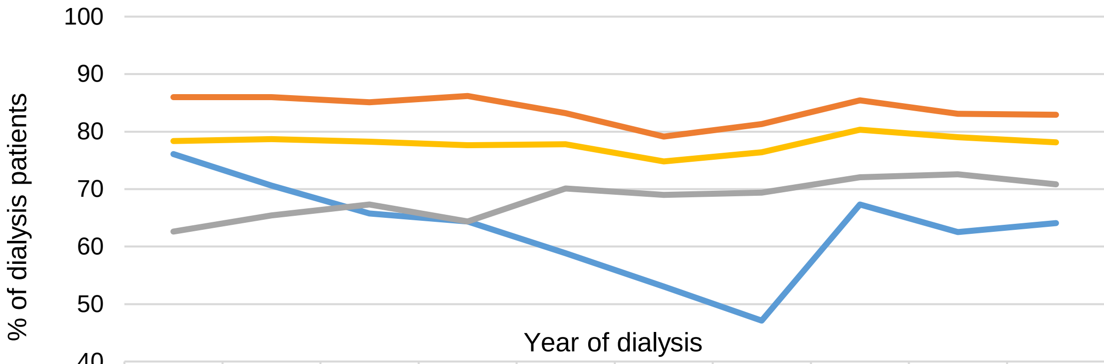


	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Public	57.8	61.7	57.1	50.3	49.7	49.1	47.9	45.2	42.6	40.3
VWO	72.6	81.3	78.9	62.2	64.3	56.0	54.5			
Overall	59.6	63.6	58.6	51.1	50.5	49.4	48.2	45.2	42.6	40.3

The proportion of prevalent HD patients who fulfilled the adequate management of anaemia criteria of hb >=10 g/dL was consistently higher for the VWO than the public and private sectors across the years (Figure 5.8.3a). However, the private sector was catching up - rising from 62.6% of its patients meeting the criteria in 2010 to 70.8% in 2019. The corresponding proportions for the public sector and VWO patients meeting the criteria were 64.1% and 83.0% respectively in 2019.

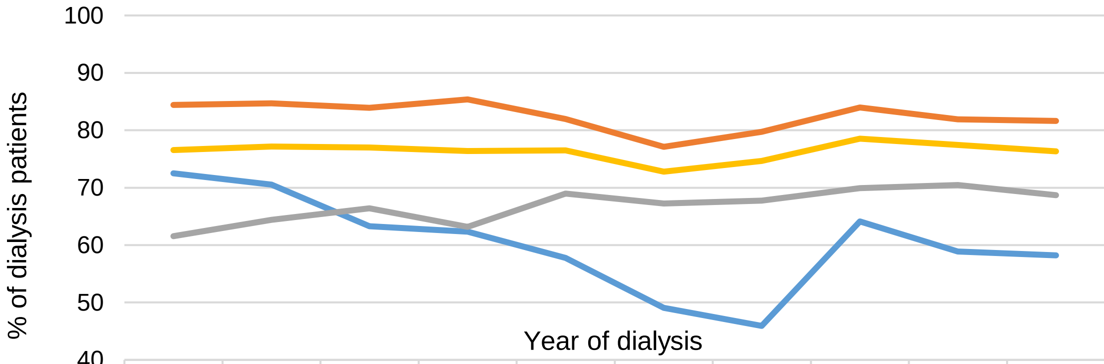
Similar trends were observed after stratification by ESA, a drug that stimulates the production of erythropoietin, a hormone produced primarily by the kidneys and plays a key role in the production of red blood cells (Figures 5.8.3b and 5.8.3c). In addition, the proportion of prevalent HD patients who 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)



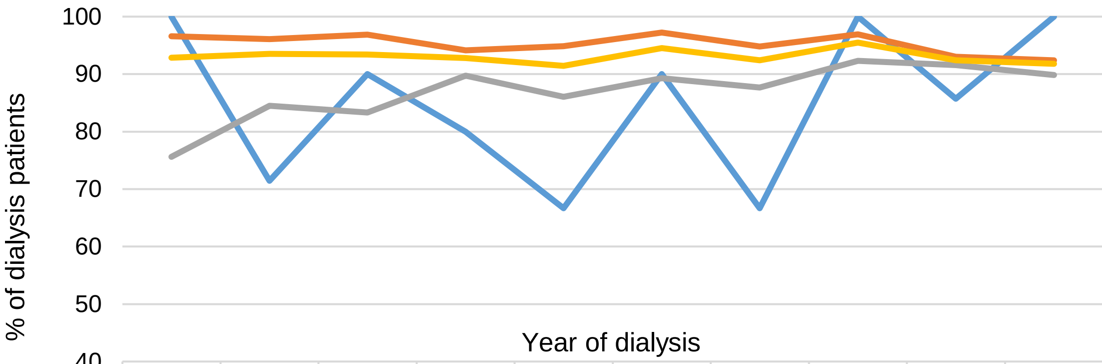
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Public	76.1	70.6	65.7	64.4	58.8	53.0	47.1	67.3	62.5	64.1
VWO	86.0	86.0	85.1	86.2	83.2	79.1	81.3	85.4	83.1	83.0
Private	62.6	65.4	67.3	64.4	70.1	69.0	69.4	72.1	72.6	70.8
Overall	78.4	78.7	78.3	77.6	77.8	74.8	76.4	80.3	79.0	78.1

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



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Public	72.5	70.5	63.3	62.3	57.8	49.0	45.9	64.1	58.9	58.2
VWO	84.4	84.7	83.9	85.4	81.9	77.1	79.7	84.0	81.9	81.6
Private	61.6	64.4	66.4	63.2	69.0	67.2	67.7	69.9	70.5	68.7
Overall	76.5	77.2	77.0	76.4	76.5	72.8	74.7	78.5	77.4	76.3

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

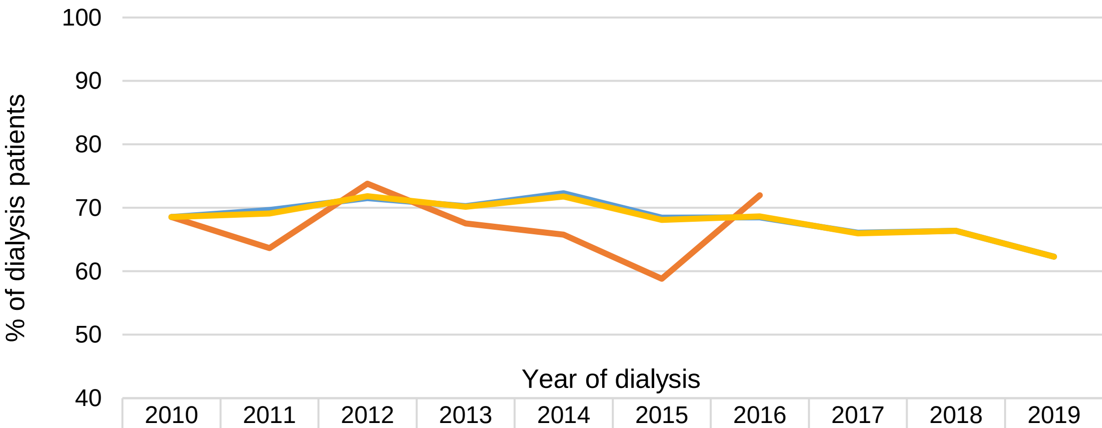


	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Public	100.0	71.4	90.0	80.0	66.7	90.0	66.7	100.0	85.7	100.0
VWO	96.6	96.1	96.9	94.2	94.8	97.2	94.8	96.9	93.0	92.4
Private	75.6	84.5	83.3	89.7	86.0	89.3	87.7	92.3	91.6	89.8
Overall	92.8	93.5	93.4	92.8	91.4	94.5	92.4	95.5	92.4	91.8

The proportion of prevalent PD patients who fulfilled the adequate management of anaemia criteria of hb >=10 g/dL was fairly similar for the public sector and VWO (Figure 5.8.4a). 62.3% of the public sector patients fulfilled the criteria in 2019.

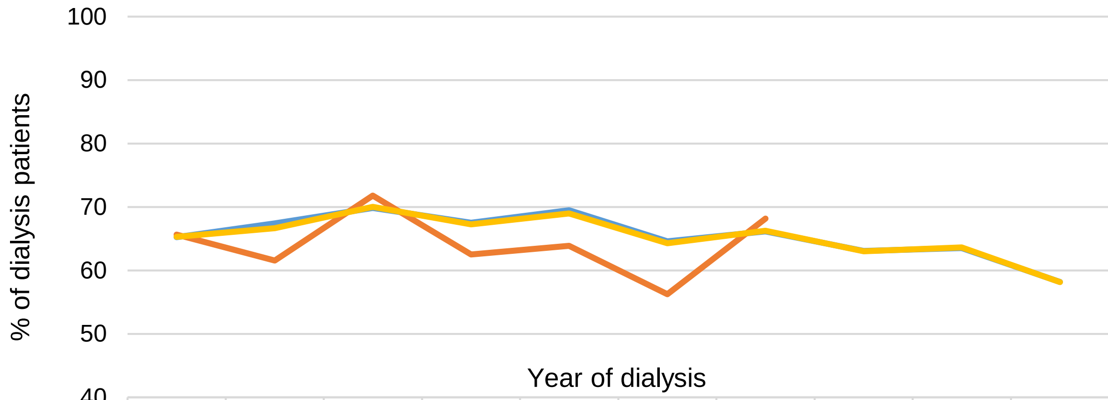
Similar trends were observed among PD patients who were taking ESA (Figure 5.8.4b). However, among PD patients who were not on ESA, all the patients from VWO fulfilled the criteria and their proportion was consistently higher than the public sector across the years (Figure 5.8.4c). Similar to HD patients, 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)



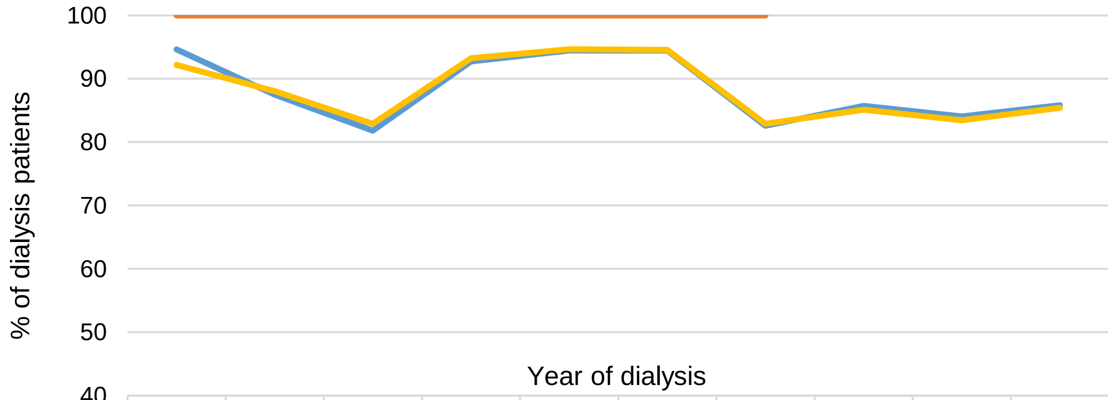
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Public	68.5	69.7	71.5	70.3	72.3	68.4	68.5	66.1	66.4	62.3
VWO	68.6	63.6	73.8	67.6	65.8	58.8	72.0			
Overall	68.6	69.1	71.8	70.1	71.8	68.1	68.7	66.0	66.4	62.3

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



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Public	65.2	67.4	69.8	67.5	69.5	64.6	66.1	63.0	63.5	58.2
VWO	65.6	61.5	71.8	62.5	63.9	56.3	68.2			
Overall	65.3	66.7	70.0	67.3	69.0	64.3	66.2	63.0	63.6	58.2

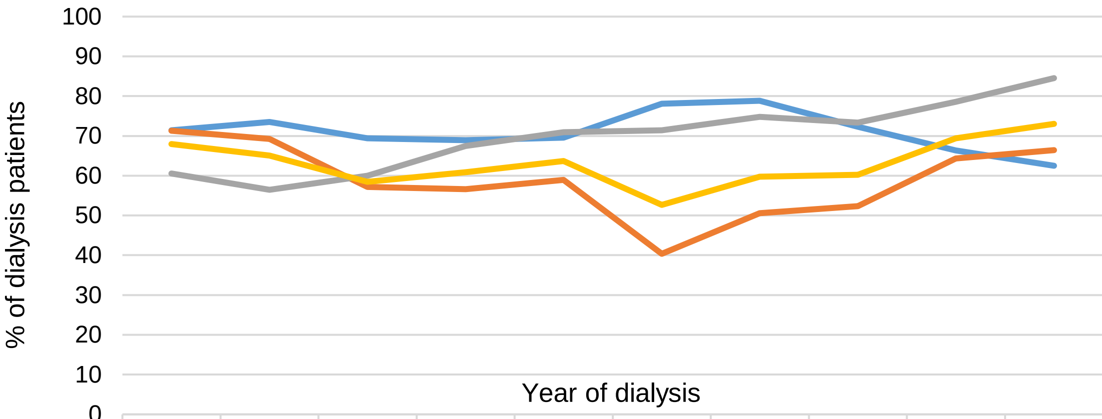
Figure 5.8.4c: Proportion of PD patients not on ESA with adequate management of anaemia (hb >=10 g/dL)



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Public	94.6	87.5	81.8	92.8	94.4	94.4	82.6	85.7	84.1	85.8
VWO	100.0	100.0	100.0	100.0	100.0	100.0	100.0			
Overall	92.2	88.1	82.9	93.2	94.7	94.6	82.9	85.1	83.5	85.4

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 fairly similar across the three broad service providers in 2010 to 2014 (Figure 5.8.5). Although the proportion of patients passing the criteria was higher for the public and private sectors than the VWO in 2015 to 2017, the disparities narrowed in 2018. The proportions of patients passing the criteria were 62.5%, 66.4% and 84.5% for the public sector, VWO and private sector respectively in 2019.

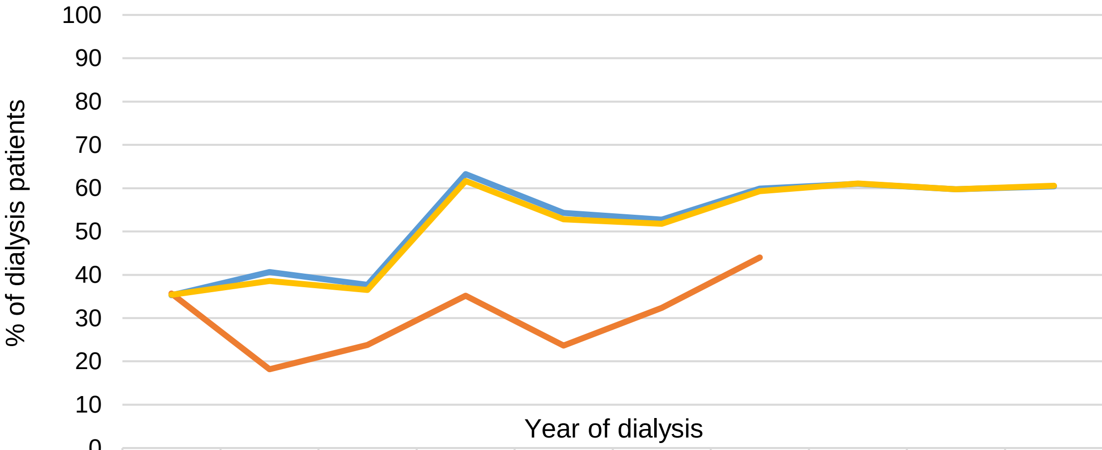
Figure 5.8.5: Proportion of HD patients with adequate management of mineral and bone disease (corrected serum Ca <2.37 mmol/L)



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Public	71.4	73.5	69.4	69.0	69.6	78.1	78.8	72.3	66.3	62.5
VWO	71.3	69.3	57.2	56.6	59.0	40.4	50.6	52.4	64.3	66.4
Private	60.6	56.5	60.0	67.4	71.0	71.4	74.8	73.3	78.6	84.5
Overall	67.9	65.1	58.5	60.9	63.7	52.7	59.8	60.2	69.4	73.0

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 was consistently higher for the public sector than the VWO since 2010 (Figure 5.8.6). 60.4% of the public sector patients passed the criteria in 2019.

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

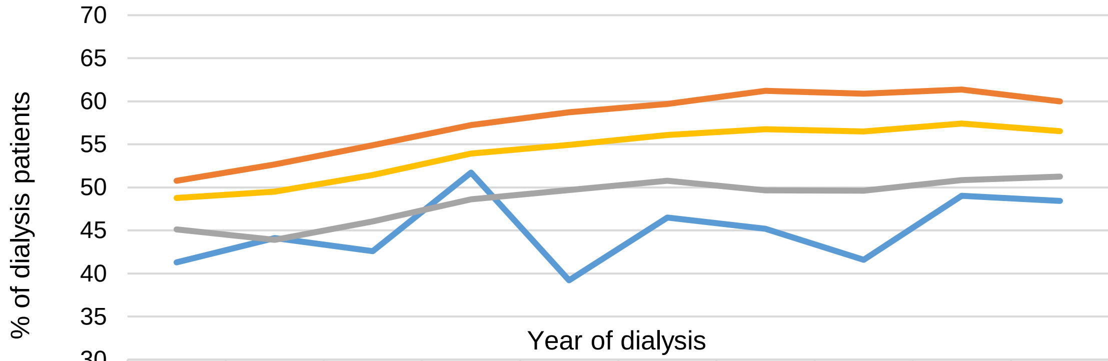


	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Public	35.3	40.6	37.7	63.2	54.3	52.7	59.9	61.0	59.8	60.4
VWO	35.7	18.2	23.8	35.1	23.7	32.4	44.0			
Overall	35.4	38.6	36.5	61.7	52.8	51.8	59.3	61.0	59.8	60.6

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 VWO than the public and private sectors across the years

(Figure 5.8.7). In 2019, the proportions of patients passing the criteria were 48.4%, 60.0% and 51.3% for the public sector, VWO and private sector respectively.

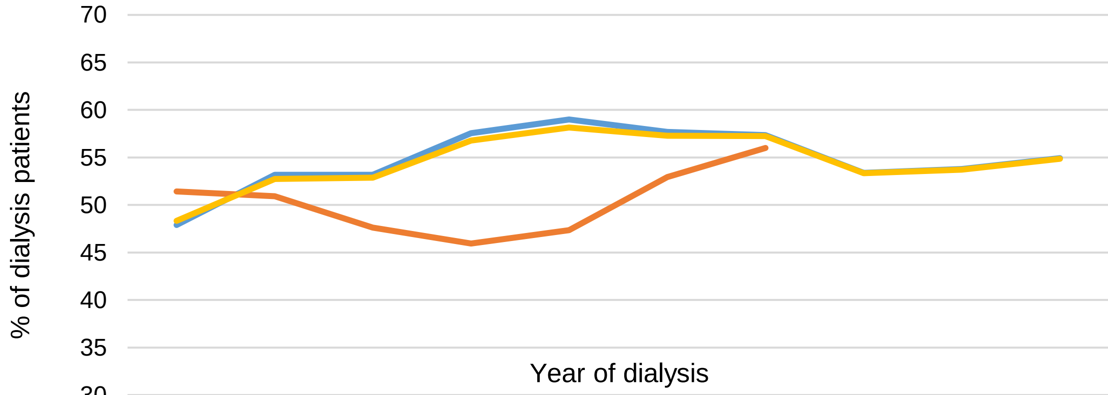
Figure 5.8.7: Proportion of HD patients with adequate management of mineral and bone disease (serum PO_4 >1.13 mmol/L and <1.78 mmol/L)



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Public	41.3	44.1	42.6	51.7	39.2	46.5	45.2	41.6	49.0	48.4
VWO	50.8	52.7	54.9	57.3	58.7	59.7	61.2	60.9	61.4	60.0
Private	45.1	43.9	46.1	48.6	49.7	50.8	49.7	49.6	50.8	51.3
Overall	48.8	49.5	51.4	53.9	54.9	56.1	56.8	56.5	57.4	56.5

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 was consistently higher for the public sector than the VWO since 2011 (Figure 5.8.8). However, the VWO was catching up - rising from 50.9% of its patients passing the criteria in 2011 to 56.0% in 2016. 54.8% of patients in the public sector met the criteria in 2019.

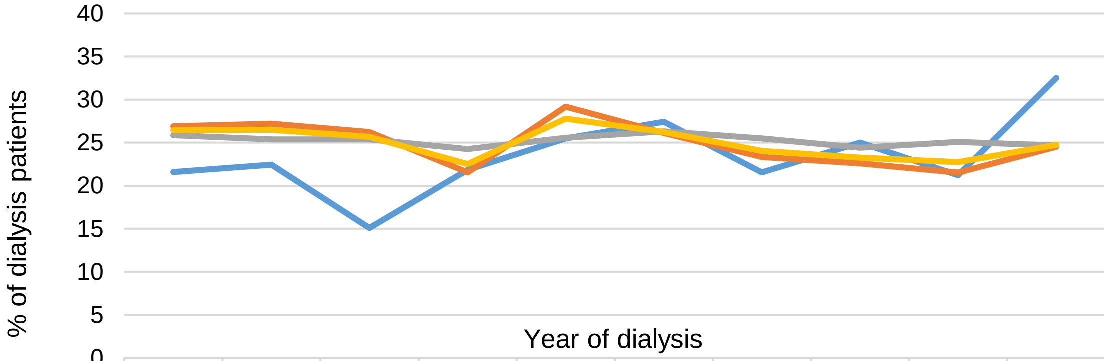
Figure 5.8.8: Proportion of PD patients with adequate management of mineral and bone disease (serum PO_4 >1.13 mmol/L and <1.78 mmol/L)



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Public	47.9	53.2	53.2	57.6	59.0	57.7	57.4	53.4	53.8	54.9
VWO	51.4	50.9	47.6	45.9	47.4	52.9	56.0			
Overall	48.3	52.7	52.9	56.8	58.1	57.3	57.2	53.3	53.7	54.8

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 between the VWO and private sector (Figure 5.8.9). In 2010 to 2012, the proportion of public sector patients passing the criteria was lower than those for the VWO and private sector, but it was the reverse in 2019. In 2019, the proportions of patients passing the criteria were 32.5%, 24.5% and 24.7% for the public sector, VWO and private sector respectively.

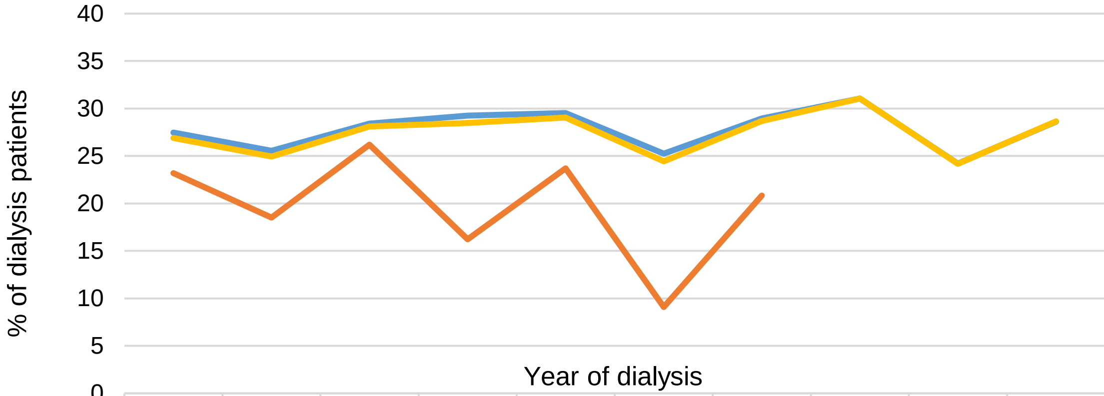
Figure 5.8.9: Proportion of HD patients with adequate management of mineral and bone disease (serum iPTH >16.3 pmol/L and <33.0 pmol/L)



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Public	21.6	22.4	15.1	21.8	25.5	27.4	21.6	25.0	21.2	32.5
VWO	26.9	27.2	26.2	21.5	29.2	26.1	23.3	22.6	21.5	24.5
Private	25.8	25.4	25.4	24.3	25.6	26.3	25.5	24.4	25.1	24.7
Overall	26.5	26.5	25.7	22.5	27.8	26.2	24.0	23.3	22.8	24.7

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 was consistently higher for the public sector than VWO since 2010 (Figure 5.8.10). 28.6% of the public sector patients passed the criteria in 2019.

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)



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Public	27.5	25.6	28.4	29.2	29.5	25.3	29.0	31.1	24.2	28.6
VWO	23.2	18.5	26.2	16.2	23.7	9.1	20.8			
Overall	26.9	25.0	28.1	28.5	29.1	24.4	28.7	31.1	24.2	28.6

5.9 Incidence of kidney transplant

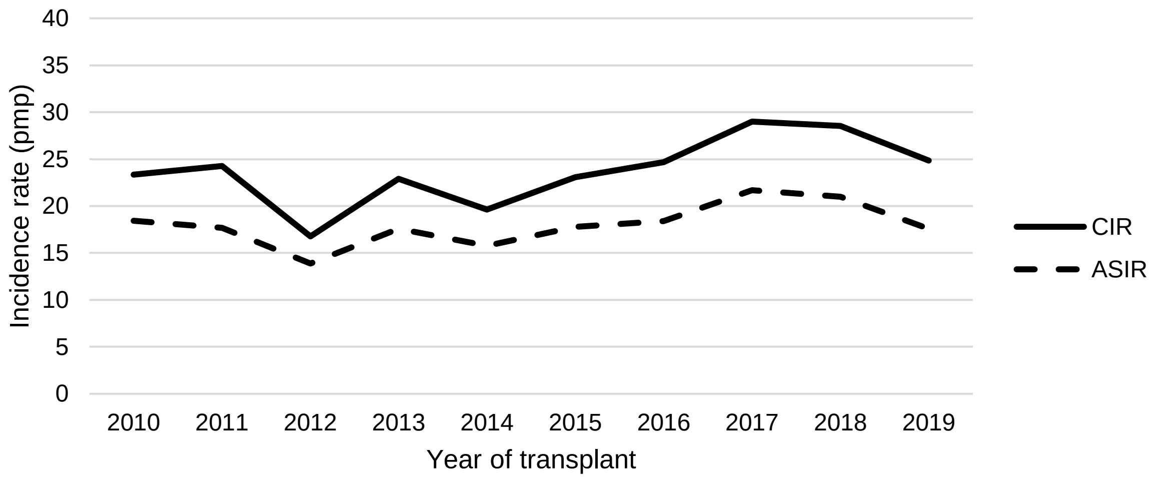
The incidence rate in each year was calculated by taking the number of new patients with kidney transplant in a year, divided by the number of Singapore residents in the same year. Patients (receiving the kidney) were categorised into 10-year age groups and age standardisation was done using the direct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

The number of new kidney transplants fluctuated between 64 (lowest value in 2012) to 115 (highest value in 2017) in the past decade (Table 5.9.1 and Figure 5.9.1). Correspondingly, the CIR fluctuated between 16.8 pmp and 29.0 pmp, while the ASIR fluctuated between 13.9 pmp and 21.7 pmp during the same period.

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

Year of transplant	Number	CIR	ASIR
2010	88	23.3	18.4
2011	92	24.3	17.7
2012	64	16.8	13.9
2013	88	22.9	17.6
2014	76	19.6	15.8
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	100	24.8	17.6
P for trend	-	0.108	0.166

Figure 5.9.1: Incidence rate (pmp) of kidney transplant



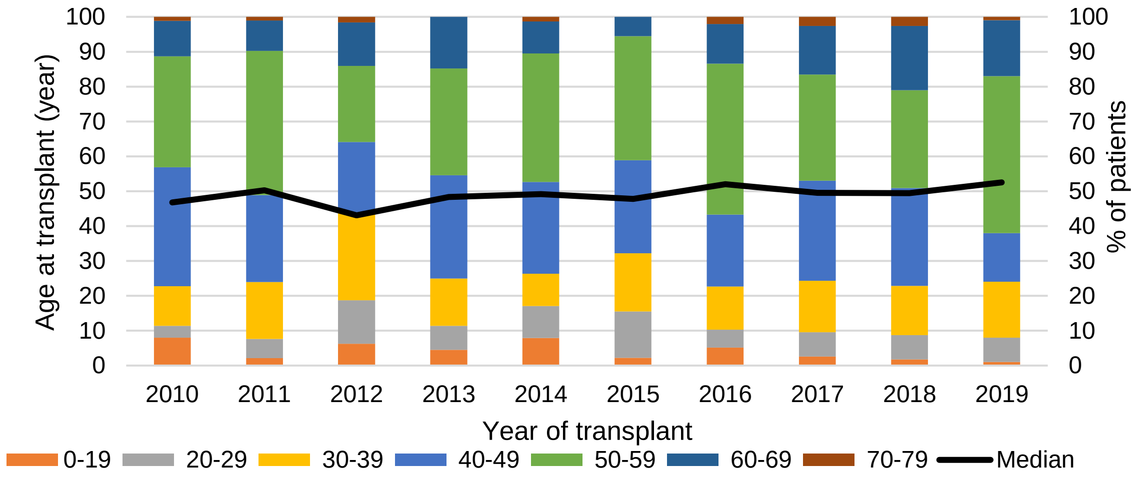
The majority of the new kidney transplant patients were aged 50 to 59 years, with almost half of the patients in this age group in 2019 (Table 5.9.2).

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
2010	7	8.0	7.6	3	3.4	5.8	10	11.4	16.2	30	34.1	47.4
2011	2	2.2	2.2	5	5.4	9.7	15	16.3	24.4	23	25.0	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	7.9	7.0	7	9.2	13.2	7	9.2	11.8	20	26.3	32.0
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	7.0	13.0	16	16.0	26.9	14	14.0	22.9
P for trend	-	-	0.075	-	-	0.149	-	-	0.210	-	-	0.971
Year of transplant	Age 50-59			Age 60-69			Age 70-79			Age 80+		
	Number	%	CIR	Number	%	CIR	Number	%	CIR	Number	%	CIR
2010	28	31.8	50.7	9	10.2	29.7	1	1.1	6.3	0	0.0	0.0
2011	38	41.3	66.8	8	8.7	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	36.8	46.4	7	9.2	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	45	45.0	74.0	16	16.0	32.0	1	1.0	4.1	0	0.0	0.0
P for trend	-	-	0.219	-	-	0.502	-	-	0.403	-	-	-

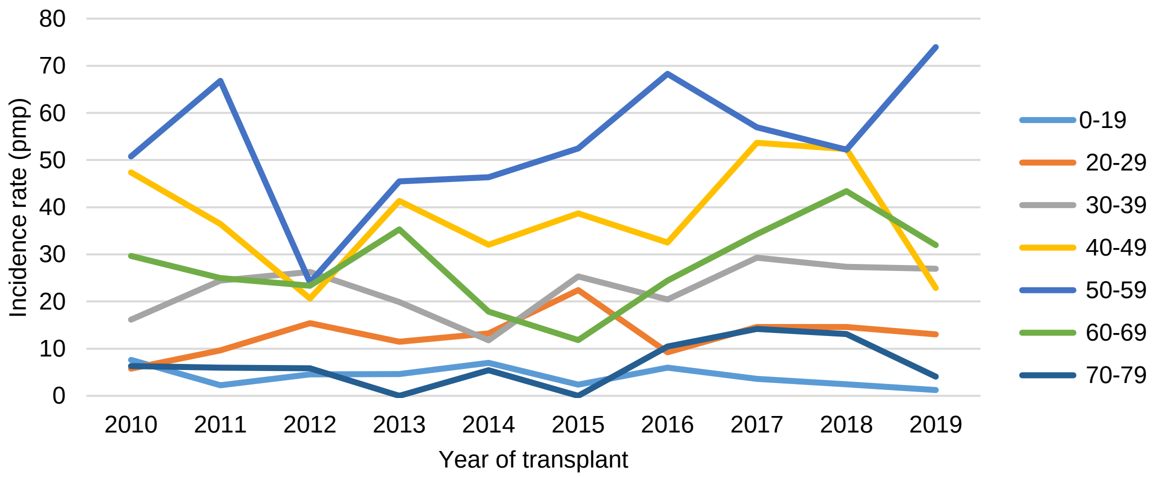
The median age at kidney transplant fluctuated between 43.1 years (lowest value in 2012) and 52.5 years (highest value in 2019) in the past decade (Figure 5.9.2a).

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



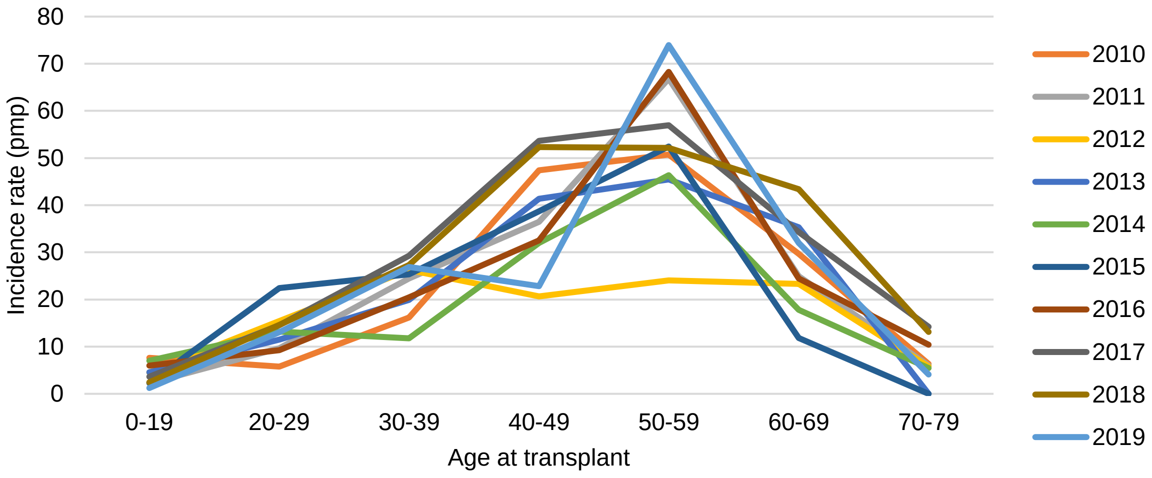
Due to the small number of kidney transplants done each year, the age-specific incidence rates of kidney transplant for all age groups fluctuated randomly over the years (Figure 5.9.2b).

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



The age-specific incidence rate of kidney transplant peaked for the 50-59 years age group for all the years, except for 2012 where the majority of the transplants were almost evenly distributed in the four 10-year age groups between 30-69 years (Figure 5.9.3).

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



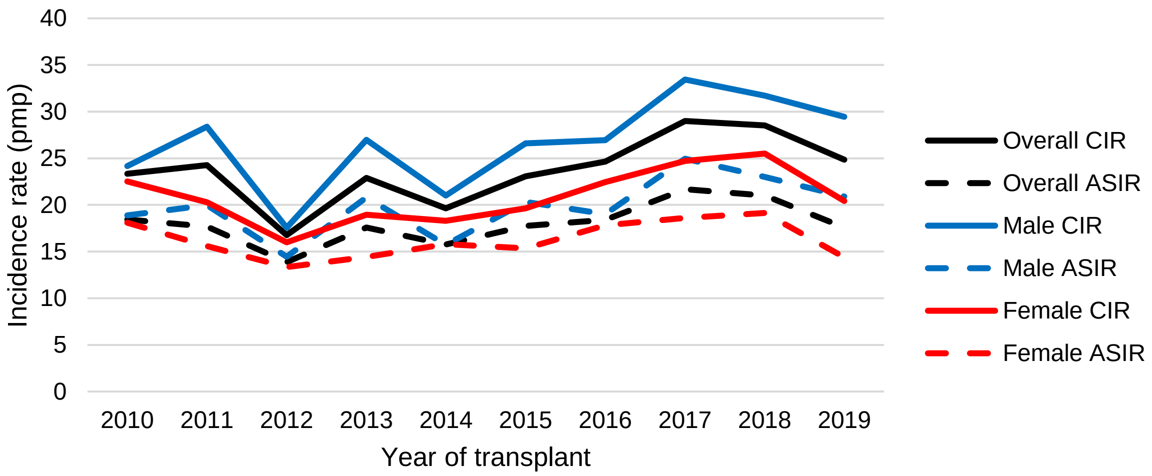
The ASIRs of kidney transplant were generally higher among males than females across the years (Table 5.9.3 and Figure 5.9.4). In 2019, the ASIR was 20.9 pmp and 14.4 pmp for males and females respectively. The ASIRs for both genders fluctuated randomly over the years due to the small number of kidney transplants.

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

Male				
Year of transplant	**Number**	**%**	**CIR**	**ASIR**
2010	45	51.1	24.2	18.9
2011	53	57.6	28.4	20.0
2012	33	51.6	17.6	14.5
2013	51	58.0	27.0	20.8
2014	40	52.6	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	58	58.0	29.5	20.9
P for trend	-	-	0.084	0.123

Female				
Year of transplant	**Number**	**%**	**CIR**	**ASIR**
2010	43	48.9	22.5	18.1
2011	39	42.4	20.3	15.6
2012	31	48.4	16.0	13.3
2013	37	42.0	18.9	14.4
2014	36	47.4	18.3	15.8
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	42.0	20.4	14.4
P for trend	-	-	0.193	0.501

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

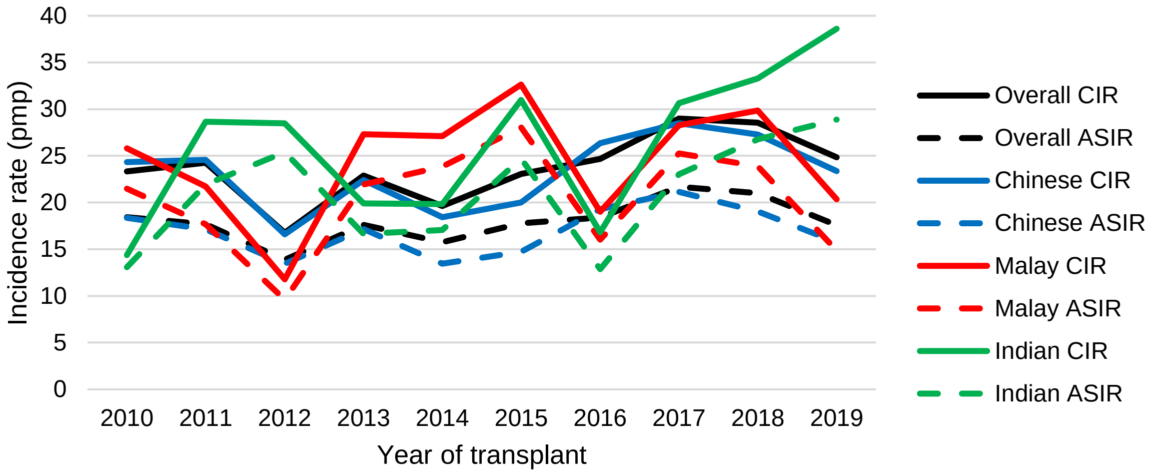


There was no ethnic group with consistently higher or lower incidence rates of kidney transplant across the years (Table 5.9.4 and Figure 5.9.5). In 2019, the ASIR was 15.8 pmp, 14.9 pmp and 28.9 pmp for Chinese, Malays and Indians respectively. The ASIRs for all the three ethnic groups fluctuated randomly over the years due to the small number of kidney transplants.

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

Chinese				
Year of transplant	**Number**	**%**	**CIR**	**ASIR**
2010	68	77.3	24.3	18.3
2011	69	75.0	24.6	17.1
2012	47	73.4	16.6	13.4
2013	64	72.7	22.4	17.2
2014	53	69.7	18.4	13.5
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	70	70.0	23.4	15.8
P for trend	-	-	0.276	0.484
Malay				
Year of transplant	**Number**	**%**	**CIR**	**ASIR**
2010	13	14.8	25.8	21.5
2011	11	12.0	21.7	17.7
2012	6	9.4	11.8	9.6
2013	14	15.9	27.3	21.9
2014	14	18.4	27.1	23.8
2015	17	18.9	32.6	28.1
2016	10	10.3	19.0	16.0
2017	15	13.0	28.3	25.3
2018	16	14.0	29.9	23.9
2019	11	11.0	20.3	14.9
P for trend	-	-	0.543	0.651
Indian				
Year of transplant	**Number**	**%**	**CIR**	**ASIR**
2010	5	5.7	14.4	13.1
2011	10	10.9	28.7	21.9
2012	10	15.6	28.5	25.4
2013	7	8.0	19.9	16.7
2014	7	9.2	19.8	17.1
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	12	10.5	33.3	26.8
2019	14	14.0	38.6	28.9
P for trend	-	-	0.083	0.164

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



Most of the new kidney transplants were done locally, with 87.0% being local transplants in 2019 (Table 5.9.5). The ratio of living donors with reference to deceased donors fluctuated over the years. 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	%
2010	25	28.4	36	40.9	27	30.7
2011	31	33.7	36	39.1	25	27.2
2012	28	43.8	23	35.9	13	20.3
2013	35	39.8	34	38.6	19	21.6
2014	41	53.9	17	22.4	18	23.7
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	54	54.0	33	33.0	13	13.0

GN was the main cause of CKD5 among new kidney transplant patients (Table 5.9.6). The proportion of new kidney transplants with GN was 47.0% in 2019, while the proportion with DN was 23.0%. 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[14,15].

Table 5.9.6: Incidence number of kidney transplant by etiology

Year of transplant	DN		GN		Others	
	Number	%	Number	%	Number	%
2010	11	12.5	56	63.6	21	23.9
2011	9	9.8	58	63.0	25	27.2
2012	9	14.1	46	71.9	9	14.1
2013	8	9.1	55	62.5	25	28.4
2014	11	14.5	43	56.6	22	28.9
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	23	23.0	47	47.0	30	30.0

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

5.10 Prevalence of kidney transplant

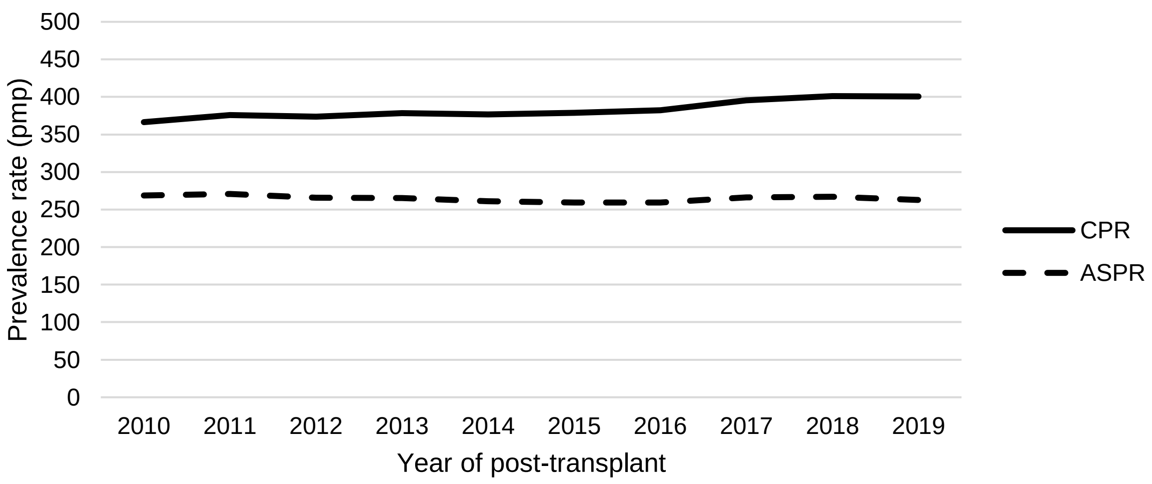
The prevalence rate in each year was calculated by taking the cumulative number of surviving (existing and new) patients with kidney transplant in a year, divided by the number of Singapore residents in the same year. Patients (receiving the kidney) were categorised into 10-year age groups and age standardisation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

Unlike the incidence trends of kidney transplant which fluctuated over the years (Table 5.9.1 and Figure 5.9.1), the number of prevalent patients with kidney transplant increased consistently since 2010, with a significant rise in CPR ($p<0.001$) (Table 5.10.1 and Figure 5.10.1). However, the ASPR remained relatively stable, ranging between 259.3 pmp (lowest value in 2015) to 270.8 pmp (highest value in 2011) 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 age. The stable ASPR trend in relation to the significant rise in CPR suggests that the rise in CPR was driven mainly by Singapore's ageing population.

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

Year of post-transplant	Number	CPR	ASPR
2010	1382	366.4	268.9
2011	1424	375.8	270.8
2012	1426	373.5	266.0
2013	1455	378.5	265.3
2014	1458	376.7	261.2
2015	1478	378.7	259.3
2016	1503	382.1	259.4
2017	1568	395.4	266.1
2018	1602	401.1	267.1
2019	1613	400.6	262.7
P for trend	-	<0.001	0.171

Figure 5.10.1: Prevalence rate (pmp) of kidney transplant



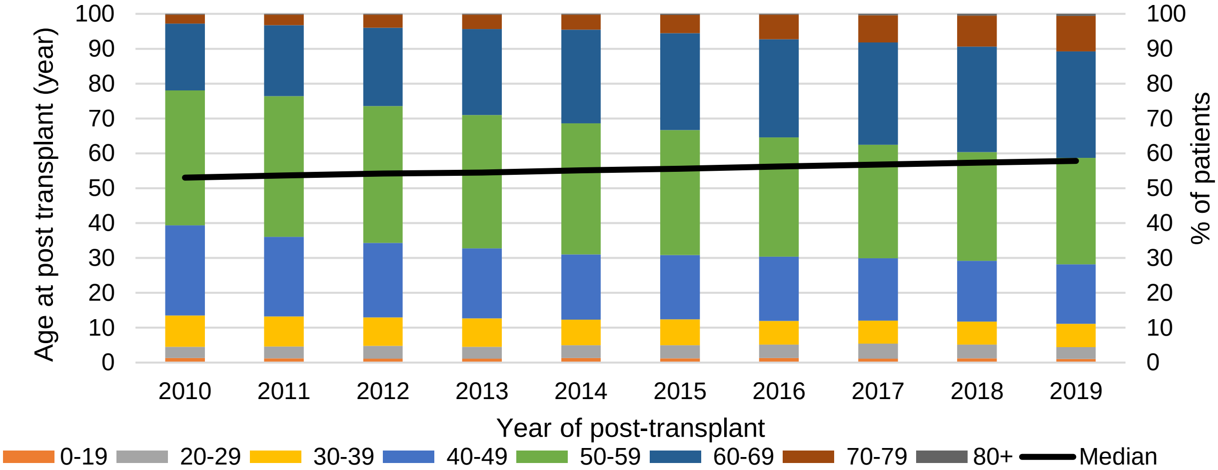
The majority of the prevalent kidney transplant patients were aged 50 to 69 years, with close to two-thirds of the patients in this age group in 2019 (Table 5.10.2).

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
2010	18	1.3	19.6	44	3.2	84.6	124	9.0	200.5	358	25.9	565.5
2011	17	1.2	18.9	48	3.4	92.7	123	8.6	200.4	326	22.9	517.0
2012	16	1.1	18.1	52	3.6	100.2	117	8.2	192.1	304	21.3	482.8
2013	17	1.2	19.5	49	3.4	93.8	118	8.1	195.9	292	20.1	464.4
2014	19	1.3	22.2	53	3.6	100.1	108	7.4	181.7	272	18.7	435.5
2015	18	1.2	21.3	56	3.8	104.6	109	7.4	184.2	273	18.5	440.2
2016	20	1.3	23.9	57	3.8	105.4	103	6.9	175.3	277	18.4	450.7
2017	18	1.1	21.8	67	4.3	122.0	103	6.6	177.5	281	17.9	457.0
2018	19	1.2	23.2	63	3.9	115.1	106	6.6	181.2	280	17.5	457.9
2019	16	1.0	19.7	55	3.4	102.4	109	6.8	183.4	274	17.0	447.4
P for trend	-	-	0.073	-	-	0.005	-	-	0.003	-	-	0.013
Year of post-transplant	Age 50-59			Age 60-69			Age 70-79			Age 80+		
	Number	%	CPR	Number	%	CPR	Number	%	CPR	Number	%	CPR
2010	534	38.6	967.7	265	19.2	874.0	36	2.6	228.3	3	0.2	43.4
2011	574	40.3	1009.5	289	20.3	901.7	44	3.1	263.6	3	0.2	41.0
2012	560	39.3	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	493	30.6	810.3	492	30.5	983.8	164	10.2	670.1	10	0.6	86.5
P for trend	-	-	<0.001	-	-	0.008	-	-	<0.001	-	-	0.008

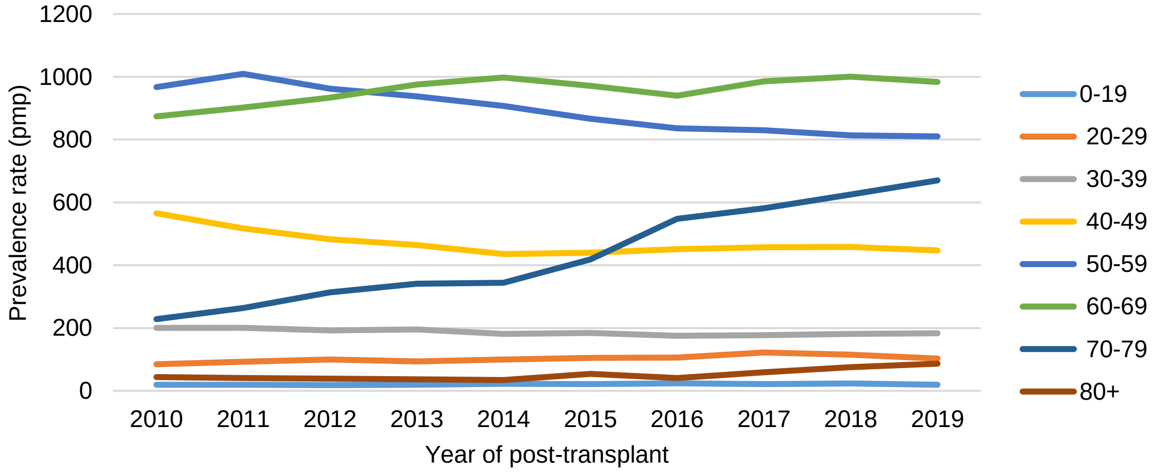
The median age among prevalent kidney transplant patients increased slightly from 52.3 years in 2010 to 57.3 years in 2019 (Figure 5.10.2a).

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



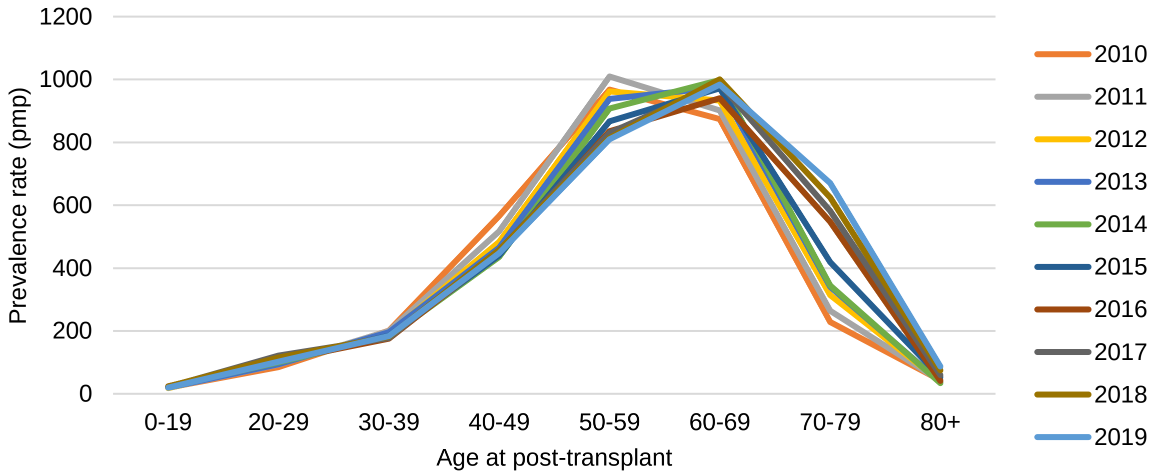
While the CPR of kidney transplant increased significantly for the 20-29 years ($p=0.005$), 60-69 years ($p=0.008$), 70-79 years ($p<0.001$) and 80+ years ($p=0.008$) age groups over the years, it dropped significantly for the 30-39 years ($p=0.003$), 40-49 years ($p=0.013$) and 50-59 years ($p<0.001$) age groups (Figure 5.10.2b and Table 5.10.2).

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 of the CPR shifted to age 60-69 years from 2013 onwards (Figure 5.10.3).

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



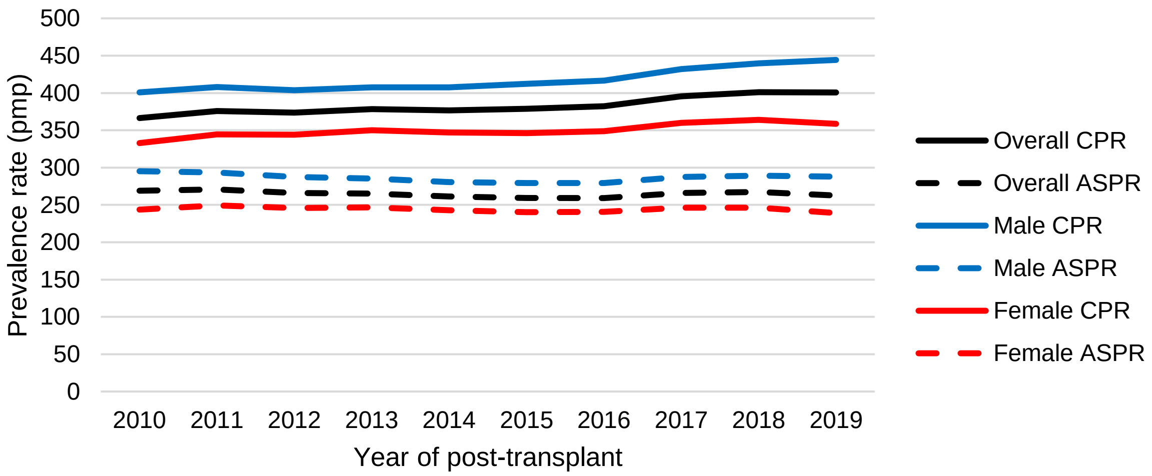
The ASPRs of kidney transplant were consistently higher among males than females across the years (Table 5.10.3 and Figure 5.10.4). In 2019, the ASPR was 288.1 pmp and 239.2 pmp for males and females respectively. The ASPRs for both genders remained stable over the years.

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

Male				
Year of post-transplant	**Number**	**%**	**CPR**	**ASPR**
2010	746	54.0	400.8	295.2
2011	762	53.5	407.9	293.6
2012	759	53.2	403.8	287.5
2013	771	53.0	407.7	285.3
2014	775	53.2	407.4	280.6
2015	790	53.5	412.2	279.5
2016	804	53.5	416.7	279.3
2017	840	53.6	432.2	287.4
2018	860	53.7	439.7	289.4
2019	875	54.2	444.3	288.1
P for trend	-	-	<0.001	0.293

Year of post-transplant	Female			
	Number	%	CPR	ASPR
2010	636	46.0	332.9	243.7
2011	662	46.5	344.6	249.4
2012	667	46.8	344.2	245.9
2013	684	47.0	350.2	246.8
2014	683	46.8	347.0	243.0
2015	688	46.5	346.4	240.3
2016	699	46.5	348.8	240.6
2017	728	46.4	360.0	246.3
2018	742	46.3	364.0	246.5
2019	738	45.8	358.8	239.2
P for trend	-	-	0.001	0.204

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

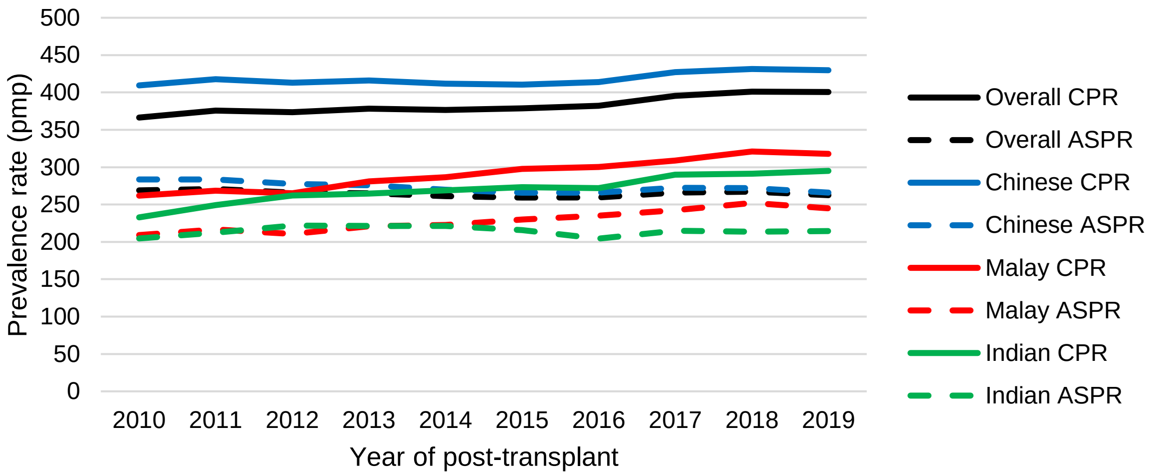


The ASPRs of kidney transplant were consistently higher among Chinese than Malays and Indians across the years (Table 5.10.4 and Figure 5.10.5). While the ASPR for Chinese dropped significantly from 283.6 pmp in 2010 to 266.0 pmp in 2019 (p=0.005), the ASPR for Malays increased significantly from 209.1 pmp in 2010 to 245.0 pmp in 2019 (p<0.001) and the ASPR for Indians fluctuated between 204.4 pmp (lowest value in 2016) and 221.8 pmp (highest value in 2012) over 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**
2010	1144	82.8	409.5	283.6
2011	1173	82.4	417.7	283.3
2012	1170	82.0	413.2	277.5
2013	1187	81.6	415.9	275.8
2014	1183	81.1	411.6	269.9
2015	1190	80.5	410.3	265.9
2016	1210	80.5	413.9	265.9
2017	1260	80.4	427.4	272.5
2018	1281	80.0	431.4	272.0
2019	1286	79.7	429.6	266.0
P for trend	-	-	0.012	0.005
Malay				
Year of post-transplant	**Number**	**%**	**CPR**	**ASPR**
2010	132	9.6	261.9	209.1
2011	136	9.6	268.6	216.8
2012	135	9.5	265.0	210.9
2013	144	9.9	280.9	220.8
2014	148	10.2	286.5	222.5
2015	155	10.5	297.5	230.1
2016	158	10.5	300.4	235.1
2017	164	10.5	309.0	242.5
2018	172	10.7	321.0	252.1
2019	172	10.7	318.1	245.0
P for trend	-	-	<0.001	<0.001
Indian				
Year of post-transplant	**Number**	**%**	**CPR**	**ASPR**
2010	81	5.9	232.8	204.5
2011	87	6.1	249.4	212.5
2012	92	6.5	262.1	221.8
2013	93	6.4	264.6	221.2
2014	95	6.5	269.1	221.2
2015	97	6.6	273.3	215.6
2016	97	6.5	271.8	204.4
2017	104	6.6	289.8	215.1
2018	105	6.6	291.2	213.6
2019	107	6.6	295.1	214.4
P for trend	-	-	<0.001	0.938

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



Most of the prevalent kidney transplants were done locally, with 73.5% being local transplants in 2019 (Table 5.10.5). The number of prevalent kidney transplants from deceased donors were consistently higher than from living donors across the years. However, the proportion of prevalent kidney transplants from living donors generally increased over the years, while the proportion from deceased donors dropped. 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	%
2010	363	26.3	592	42.8	427	30.9
2011	388	27.2	602	42.3	434	30.5
2012	404	28.3	589	41.3	433	30.4
2013	429	29.5	591	40.6	435	29.9
2014	455	31.2	571	39.2	432	29.6
2015	480	32.5	570	38.6	428	29.0
2016	486	32.3	585	38.9	432	28.7
2017	509	32.5	616	39.3	443	28.3
2018	528	33.0	629	39.3	445	27.8
2019	561	34.8	624	38.7	428	26.5

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 kidney transplant patients with DN increased from 7.5% in 2010 to 10.5% in 2019, those with GN dropped from 71.3% in 2010 to 67.0% in 2019.

Table 5.10.6: Prevalence number of kidney transplant by etiology

Year of post-transplant	DN		GN		Others	
	Number	%	Number	%	Number	%
2010	104	7.5	986	71.3	292	21.1
2011	107	7.5	1012	71.1	305	21.4
2012	113	7.9	1013	71.0	300	21.0
2013	116	8.0	1030	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	170	10.5	1081	67.0	362	22.4

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. The 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 June 2020. 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 June 2020. 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. The event was defined as all-cause death. Patients were censored if they did not die by 30 June 2020. Median survival duration is indicated as "not reached (NR)" if more than half of the patients were still alive as of 30 June 2020. Multivariable Cox regression model was used to adjust for the effects of potential confounders on the survival of patients 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.

In Table 5.11.12, multivariable Cox regression model was used to estimate the adjusted risk of death among dialysis and transplant patients. For patients who underwent dialysis prior to kidney transplantation, 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 Jun 2020 (whichever earlier), and the potential confounders were based on data captured by the registry around the date of transplant.

Graft survival were high at 97.4%, 89.3% and 75.7% for one-, five- and ten-year post-transplant (Table 5.11.1). Patient survival was even higher at 98.2%, 93.6% and 85.3% for one-, five- and ten-year post-transplant and outperformed patients on dialysis (90.4%, 57.2% and 32.7% at one-, five- and ten-year from the start of definitive dialysis; Table 5.7.1).

Table 5.11.1: Survival of kidney transplant by outcome

	Graft	Patient
1-year survival (%)	97.4	98.2
5-year survival (%)	89.3	93.6
10-year survival (%)	75.7	85.3
Median survival (years)	19.6	NR

Table 5.11.2 excludes kidney transplants done overseas as the registry does not have the data on whether the donor was living or deceased. Graft and patient survival were significantly better among transplants from living donors than deceased donors ($p<0.001$ for graft and patient survival).

Table 5.11.2: Survival of kidney transplant by type of local donor and outcome

	Living		Deceased	
	Graft	Patient	Graft	Patient
1-year survival (%)	99.2	99.2	96.0	97.5
5-year survival (%)	93.5	96.0	85.8	91.7
10-year survival (%)	82.8	89.6	68.4	82.3
Median survival (years)	19.6	NR	16.2	NR

Younger patients aged below 60 years had significantly better graft and patient survival than older patients aged 60 years or older ($p=0.016$ for graft survival, $p<0.001$ for patient survival) (Table 5.11.3).

Table 5.11.3: Survival of kidney transplant by age group and outcome

	Age <60 years		Age ≥60 years	
	Graft	Patient	Graft	Patient
1-year survival (%)	97.7	98.6	94.7	95.2
5-year survival (%)	89.7	94.2	85.3	87.8
10-year survival (%)	76.3	86.4	69.4	73.4
Median survival (years)	19.6	NR	NR	NR

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

Table 5.11.4: Survival of kidney transplant by gender and outcome

	Male		Female	
	Graft	Patient	Graft	Patient
1-year survival (%)	97.3	98.2	97.6	98.3
5-year survival (%)	88.8	93.9	89.8	93.2
10-year survival (%)	74.2	85.4	77.4	85.3
Median survival (years)	19.5	NR	20.1	NR

Chinese had significantly better graft survival than Malays (p=0.001) and Indians (p<0.001) (Table 5.11.5). However, there was no significant difference in patient survival across the three ethnic groups.

Table 5.11.5: Survival of kidney transplant by ethnicity and outcome

	Chinese		Malay		Indian	
	Graft	Patient	Graft	Patient	Graft	Patient
1-year survival (%)	97.6	98.4	96.0	96.9	98.0	98.7
5-year survival (%)	90.4	94.0	85.1	92.6	82.8	90.7
10-year survival (%)	77.6	85.3	69.5	87.5	61.3	80.0
Median survival (years)	21.1	NR	16.2	NR	12.3	NR

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

Table 5.11.6: Survival of kidney transplant by etiology and outcome

	Non-DN		DN	
	Graft	Patient	Graft	Patient
1-year survival (%)	97.5	98.4	96.4	97.2
5-year survival (%)	90.1	94.6	83.1	87.0
10-year survival (%)	76.9	86.8	66.4	74.8
Median survival (years)	21.1	NR	12.8	15.9

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

Table 5.11.7: Survival of kidney transplant by presence of IHD and outcome

	No IHD		IHD	
	Graft	Patient	Graft	Patient
1-year survival (%)	97.4	98.4	97.8	97.8
5-year survival (%)	90.1	94.8	85.4	88.0
10-year survival (%)	76.7	86.8	70.5	78.3
Median survival (years)	21.1	NR	14.7	16.8

Patients without CVD had significantly better graft and patient survival than those with CVD (p=0.041 for graft survival; p=0.002 for patient survival) (Table 5.11.8).

Table 5.11.8: Survival of kidney transplant by presence of CVD and outcome

	No CVD		CVD	
	Graft	Patient	Graft	Patient
1-year survival (%)	97.8	98.5	89.5	93.4
5-year survival (%)	89.7	94.0	84.9	90.3
10-year survival (%)	75.9	85.8	73.1	79.1
Median survival (years)	19.6	NR	14.8	14.8

Patients without PVD had significantly better graft and patient survival than those with PVD (p=0.023 for graft survival; p=0.002 for patient survival) (Table 5.11.9).

Table 5.11.9: Survival of kidney transplant by presence of PVD and outcome

	No PVD		PVD	
	Graft	**Patient**	**Graft**	**Patient**
1-year survival (%)	97.6	98.4	93.3	96.7
5-year survival (%)	89.7	94.1	81.5	84.9
10-year survival (%)	76.0	85.7	70.5	78.4
Median survival (years)	19.6	NR	12.3	12.9

Patients without cancer seemed to have better graft and patient survival than those with cancer (Table 5.11.10). However, the differences in survival were not statistically significant.

Table 5.11.10: Survival of kidney transplant by presence of cancer and outcome

	No cancer		Cancer	
	Graft	**Patient**	**Graft**	**Patient**
1-year survival (%)	97.7	98.6	96.2	96.2
5-year survival (%)	90.3	94.6	81.2	87.5
10-year survival (%)	76.6	86.4	66.5	75.8
Median survival (years)	19.6	NR	17.2	NR

Table 5.11.11 excludes kidney transplants done overseas as the registry does not have the data on whether the donor was living or deceased. Similar to the univariable analyses (Tables 5.11.2 to 5.11.10), deceased donor, old age, DN and IHD were significant predictors of death, even after adjusting for the other potential confounders. However, CVD and PVD were no longer significant predictors of death.

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			
Local living donor	1.00	Reference	<0.001
Local deceased donor	2.26	1.63-3.13	
Age group			
<60 years	1.00	Reference	0.007
≥60 years	2.31	1.25-4.26	
Gender			
Male	1.00	Reference	0.992
Female	1.00	0.76-1.32	
Ethnicity			
Chinese	1.00	Reference	
Malay	0.99	0.67-1.46	0.962
Indian	1.42	0.88-2.27	0.149
Etiology			
Non-DN	1.00	Reference	0.001
DN	2.36	1.43-3.90	
IHD			
No	1.00	Reference	0.005
Yes	1.73	1.18-2.54	
CVD			
No	1.00	Reference	0.068
Yes	1.92	0.95-3.87	
PVD			
No	1.00	Reference	0.266
Yes	1.64	0.69-3.90	
Cancer			
No	1.00	Reference	0.555
Yes	1.31	0.53-3.21	

Similar to Table 5.11.11, Table 5.11.12 excludes kidney transplants done overseas. 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 a lower risk of death than dialysis patients without transplant. Old age, DN, IHD, CVD, PVD and cancer were significant predictors of death among dialysis and transplant patients, even after adjusting for the other potential confounders.

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 local living donor	0.17	0.13-0.22	<0.001
Transplant from local deceased donor	0.35	0.29-0.41	<0.001
Age group			
<60 years	1.00	Reference	<0.001
≥60 years	1.80	1.72-1.88	
Gender			
Male	1.00	Reference	0.367
Female	1.02	0.98-1.06	
Ethnicity			
Chinese	1.00	Reference	
Malay	0.90	0.85-0.94	<0.001
Indian	0.97	0.90-1.05	0.506
Etiology			
Non-DN	1.00	Reference	<0.001
DN	1.62	1.55-1.70	
IHD			
No	1.00	Reference	<0.001
Yes	1.45	1.39-1.51	
CVD			
No	1.00	Reference	<0.001
Yes	1.33	1.27-1.40	
PVD			
No	1.00	Reference	<0.001
Yes	1.45	1.38-1.54	
Cancer			
No	1.00	Reference	<0.001
Yes	1.42	1.32-1.52	

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 combined (living and deceased) kidney transplant rate is much lower than the demand, which is expected to increase 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 health screening. As diabetes and hypertension are common chronic conditions 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.

Annex

Prevalent patients by service providers as at 31 December 2019

Public hospitals and affiliated dialysis centres	HD	PD	Transplant
SINGAPORE GENERAL HOSPITAL	15	458	830
TAN TOCK SENG RENAL CENTRE	5	156	37
CHANGI GENERAL HOSPITAL	2	70	2
KHOO TECK PUAT HOSPITAL	3	98	0
NG TENG FONG GENERAL HOSPITAL	2	47	1
SENGKANG GENERAL HOSPITAL	0	18	0
TTSH RENAL DIALYSIS CENTRE	13	0	0
NATIONAL UNIVERSITY HOSPITAL	7	187	557
NUH DIALYSIS CENTRE	51	0	0
NUH RENAL CENTRE	24	0	0
SHAW NKF - NUH CHILDREN'S KIDNEY CENTRE	6	14	38
Subtotal	**128**	**1048**	**1465**
Voluntary Welfare Organisations	**HD**	**PD**	**Transplant**
ANG MO KIO THYE HUA KWAN HOSPITAL DIALYSIS CENTRE	62	0	0
FOO HAI - NKF DIALYSIS CENTRE	71	0	0
HONG LEONG - NKF DIALYSIS CENTRE (ALJUNIED CRESCENT)	98	0	0
IFPAS - NKF DIALYSIS CENTRE (SERANGOON)	103	0	0
JAPAN AIRLINE - NKF DIALYSIS CENTRE (ANG MO KIO I)	32	0	0
JO & GERRY ESSERY NKF DIALYSIS CENTRE (BLK 204 MARSILING)	86	0	0
KDF - BISHAN CENTRE	91	0	0
KDF - GHIM MOH CENTRE (HD)	87	0	0
KDF - KRETA AYER (HD)	74	0	0
KWAN IM THONG HOOD CHO TEMPLE - NKF DIALYSIS CENTRE (KOLAM AYER)	141	0	0
KWAN IM THONG HOOD CHO TEMPLE - NKF DIALYSIS CENTRE (SIMEI)	149	0	0
LE CHAMP - NKF DIALYSIS CENTRE (BLK 639 YISHUN ST 61)	113	0	0
LEONG HWA CHAN SI TEMPLE - NKF DIALYSIS CENTRE (TECK WHYE)	104	0	0
MTFA DIALYSIS CENTRE (MDC)	51	0	0
NEW CREATION CHURCH - NKF DIALYSIS CENTRE	88	0	0
NKF BUKIT PANJANG DIALYSIS CENTRE	92	0	0
NKF DIALYSIS CENTRE (BLK 365 WOODLANDS II)	102	0	0
NKF HOUGANG PUNGGOL DIALYSIS CENTRE	112	0	0
NKF INTEGRATED RENAL CENTRE (CP1)	175	0	0
NKF INTEGRATED RENAL CENTRE (CP2)	65	0	0
NTUC INCOME - NKF DIALYSIS CENTRE (BUKIT BATOK)	89	0	0
NTUC/SINGAPORE POOLS - NKF DIALYSIS CENTRE (TAMPINES)	138	0	0
NKF DIALYSIS CENTRE SUPPORTED BY NGIAM KIA HUM & FAMILY	117	0	0
PEI HWA FOUNDATION - NKF DIALYSIS CENTRE (ANG MO KIO)	115	0	0

SAF - NKF DIALYSIS CENTRE (CLEMENTI)	88	0	0
SAKYADHITA -NKF DIALYSIS CENTRE (UPPER BOON KENG)	85	0	0
SCAL - NKF DIALYSIS CENTRE (YISHUN)	75	0	0
SHENG HONG TEMPLE - NKF DIALYSIS CENTRE (JURONG WEST)	102	0	0
SIA - NKF DIALYSIS CENTRE (TOA PAYOH)	77	0	0
SINGAPORE BUDDHIST WELFARE SERVICES - NKF DIALYSIS CENTRE (HOUGANG)	141	0	0
SINGAPORE POOLS - NKF DIALYSIS CENTRE (BEDOK)	104	0	0
TAMPINES CHINESE TEMPLE - NKF DIALYSIS CENTRE (PASIR RIS)	74	0	0
TAY CHOON HYE - NKF DIALYSIS CENTRE (KIM KEAT)	94	0	0
THE HOUR GLASS â€“ NKF DIALYSIS CENTRE (WEST COAST)	67	0	0
THE HOUR GLASS NKF DIALYSIS CENTRE (ADMIRALTY BRANCH)	99	0	0
THE SINGAPORE BUDDHIST LODGE - NKF DIALYSIS CENTRE (128 BUKIT MERAH VIEW)	94	0	0
THE SIRIVADHANABHAKDI FOUNDATION NKF DIALYSIS CENTRE (JW2)	89	0	0
THONG TECK SIAN TONG LIAN SIN SIA - NKF DIALYSIS CENTRE (WOODLANDS)	108	0	0
TOA PAYOH SEU TECK SEAN TONG - NKF DIALYSIS CENTRE (YISHUN)	75	0	0
WESTERN DIGITAL - NKF DIALYSIS CENTRE (ANG MO KIO)	147	0	0
WOH HUP - NKF DIALYSIS CENTRE (GHIM MOH)	98	0	0
WONG SUI HA EDNA - NKF DIALYSIS CENTRE	123	0	0
Subtotal	**4095**	**0**	**0**
Private clinics and dialysis centres	**HD**	**PD**	**Transplant**
ADVANCE DIALYSIS SERVICES PTE LTD	27	1	0
ADVANCE RENAL CARE (KOVAN) PTE LTD	33	0	0
ADVANCE RENAL CARE (NOVENA)	8	0	0
AEGIS DIALYSIS CENTRE	21	0	0
ARCA (FARRER PARK) DIALYSIS PTE LTD	28	0	0
ASIA KIDNEY DIALYSIS CENTRE (BEDOK)	44	0	0
ASIA KIDNEY DIALYSIS CENTRE (JURONG)	21	0	0
ASIA KIDNEY DIALYSIS CENTRE (TAMPINES) BLK-139	45	0	0
ASIA KIDNEY DIALYSIS CENTRE (TECK WHYE)	33	0	0
ASIA KIDNEY DIALYSIS CENTRE (TP)	60	0	0
ASIA KIDNEY DIALYSIS CENTRE (TPY)	43	0	0
B. BRAUN DIALYSIS CENTRE (EAST COAST)	27	0	0
COMPLEX MEDICAL CENTRE (CHANGI)	3	0	0
DAVITA MEDICAL AND DIALYSIS CENTRE @ FARRER PARK MEDICAL CENTRE	1	0	0
DAVITA MEDICAL AND DIALYSIS CENTRE @ ROYAL SQUARE MEDICAL SUITES (NOVENA)	3	0	0
ECON ADVANCE RENAL CARE (YUNG KUANG)	19	0	0
ECON ADVANCE RENAL CARE PTE LTD (BEDOK)	18	0	0
FRESENIUS KIDNEY CARE ANG MO KIO DIALYSIS CLINIC (BLK 422)	42	0	0

FRESENIUS KIDNEY CARE ANG MO KIO DIALYSIS CLINIC (BLK 443)	44	0	0
FRESENIUS KIDNEY CARE BUKIT BATOK DIALYSIS CLINIC (BLK 213)	40	0	0
FRESENIUS KIDNEY CARE CLEMENTI DIALYSIS CLINIC	18	0	0
FRESENIUS KIDNEY CARE JURONG BOON LAY DIALYSIS CLINIC (BLK 353)	38	0	0
FRESENIUS KIDNEY CARE JURONG EAST CENTRAL DIALYSIS CLINIC (BLK 104)	42	0	0
FRESENIUS KIDNEY CARE JURONG EAST DIALYSIS CLINIC (BLK 326)	46	0	0
FRESENIUS KIDNEY CARE KATONG DIALYSIS CLINIC	39	0	0
FRESENIUS KIDNEY CARE KEMBANGAN DIALYSIS CLINIC	49	0	0
FRESENIUS KIDNEY CARE KOVAN DIALYSIS CLINIC	46	0	0
FRESENIUS KIDNEY CARE LUCKY PLAZA DIALYSIS CLINIC	4	1	0
FRESENIUS KIDNEY CARE MT ELIZABETH DIALYSIS CLINIC	18	0	0
FRESENIUS KIDNEY CARE NAPIER DIALYSIS CLINIC	26	2	0
FRESENIUS KIDNEY CARE TANGLIN DIALYSIS CLINIC	18	0	0
FRESENIUS KIDNEY CARE TOA PAYOH DIALYSIS CLINIC (BLK 92)	34	0	0
FRESENIUS KIDNEY CARE WHAMPOA DIALYSIS CLINIC	36	0	0
FRESENIUS MEDICAL CARE (TECK WHYE) DIALYSIS CLINIC	56	0	0
FRESENIUS MEDICAL CARE BEDOK NORTH DIALYSIS CLINIC (BLK 527)	21	0	0
FRESENIUS MEDICAL CARE BEDOK RESERVOIR DIALYSIS CLINIC (BLK 744)	50	0	0
FRESENIUS MEDICAL CARE BUKIT MERAH DIALYSIS CLINIC (BLK 161)	57	0	0
FRESENIUS MEDICAL CARE HOUGANG DIALYSIS CLINIC (BLK 620)	42	0	0
FRESENIUS MEDICAL CARE KHATIB DIALYSIS CLINIC	34	0	0
FRESENIUS MEDICAL CARE MARSILING DIALYSIS CLINIC	34	0	0
FRESENIUS MEDICAL CARE SERANGOON DIALYSIS CLINIC	63	0	0
FRESENIUS MEDICAL CARE TAMPINES DIALYSIS CLINIC (BLK 107)	57	0	0
FRESENIUS MEDICAL CARE YISHUN DIALYSIS CLINIC (BLK 236)	47	0	0
FRESENIUS MEDICAL CARE YISHUN RING DIALYSIS CLINIC	45	0	0
GLENEAGLES HOSPITAL	1	0	1
IMMANUEL DIALYSIS CENTRE (MAYFLOWER) PTE LTD	19	0	0
IMMANUEL DIALYSIS CENTRE PTE LTD (ANG MO KIO)	22	0	0
IMMANUEL DIALYSIS CENTRE PTE LTD (MT ALVERNIA)	31	0	0

IMMANUEL DIALYSIS CENTRE PTE LTD (WOODLANDS)	32	0	0
IMMANUEL DIALYSIS CENTRE PTE LTD (YISHUN)	17	0	0
KIDNEYCARE DIALYSIS CENTRE @ PASIR RIS	50	0	0
KIDNEYCARE DIALYSIS CENTRE @ WEST COAST	21	0	0
KIDNEYCARE DIALYSIS CENTRE @ YISHUN	24	0	0
PACIFIC ADVANCE RENAL CARE (CHAU CHU KANG)	27	0	0
PACIFIC ADVANCE RENAL CARE (FAJAR)	35	0	0
PACIFIC ADVANCE RENAL CARE (SENG KANG)	36	0	0
PACIFIC ADVANCE RENAL CARE PTE LTD (PUNGGOL WAY)	29	0	0
PACIFIC ADVANCE RENAL CARE PTE LTD (TAMPINES)	41	0	0
PACIFIC ADVANCE RENAL CARE PTE LTD (WOODLANDS)	58	0	0
RAFFLES DIALYSIS CENTRE	4	0	0
RENAL HEALTH PTE LTD	59	0	0
RENAL LIFE (ALEXANDRA) DIALYSIS CENTRE PTE LTD	12	0	0
RENAL LIFE (HOUGANG) DIALYSIS CENTRE PTE LTD	15	0	0
RENAL LIFE (W) DIALYSIS CENTRE PTE LTD (BLK 207 BUKIT BATOK)	31	0	0
RENAL LIFE DIALYSIS CENTRE PTE LTD (BLK 463 JURONG WEST)	25	1	0
RENAL LIFE(PIONEER) DIALYSIS CENTRE PTE LTD	34	0	0
RENALTEAM DIALYSIS CENTRE - ANG MO KIO	39	0	0
RENALTEAM DIALYSIS CENTRE - BEDOK	46	0	0
RENALTEAM DIALYSIS CENTRE - BUKIT MERAH	37	0	0
RENALTEAM DIALYSIS CENTRE - JURONG EAST	45	0	0
RENALTEAM DIALYSIS CENTRE - REN CI COMMUNITY HOSPITAL	51	0	0
RENALTEAM DIALYSIS CENTRE - TAMPINES	53	0	0
RENALTEAM DIALYSIS CENTRE FENGSHAN	17	0	0
RENALTEAM DIALYSIS CENTRE WOODLANDS PEAK	44	0	0
TAL DIALYSIS CLEMENTI	43	0	0
CENTRE FOR KIDNEY DISEASE PTE LTD (LUCKY PLAZA)	0	0	37
GRACE LEE RENAL AND MEDICAL CLINIC PTE LTD	0	0	8
KIDNEY & MEDICAL CENTRE	0	0	7
KIDNEY LIFE CENTRE	0	0	7
KU KIDNEY & MEDICAL CENTRE	0	0	1
RAFFLES HOSPITAL	0	0	3
ROGER KIDNEY CLINIC	0	0	7
SH TAN KIDNEY & MEDICAL CLINIC	0	0	1
STEPHEW CHEW CENTRE FOR KIDNEY DISEASE AND HYPERTENSION (MAH)	0	0	20
STEPHEW CHEW CENTRE FOR KIDNEY DISEASE AND HYPERTENSION (MEH)	0	0	4
T.G. NG KIDNEY & MEDICAL CENTRE	0	0	3
THE KIDNEY CLINIC PTE LTD	0	0	15
THE SINGAPORE CLINIC FOR KIDNEY DISEASES	0	0	3
UNKNOWN PRIVATE NEPHROLOGY CLINIC	0	0	1

WU NEPHROLOGY & MEDICAL CLINIC (WU MEDICAL CLINIC PTE LTD)	0	0	30
Subtotal	**2478**	**5**	**148**
Grand total	**6701**	**1053**	**1613**