Singapore Renal Registry Annual Report 2018

National Registry of Diseases Office
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Acknowledgement

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

National Registry of Diseases Office

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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 341.5 per million population (pmp) in 2009 to 504.1 pmp in 2017. While the age-standardised incidence rate (ASIR) of CKD5 remained relatively stable, ranging between 256.5 pmp and 289.2 pmp in 2009 to 2017, the ASIR of definitive dialysis increased significantly from 159.0 pmp in 2009 to 187.0 pmp in 2018. The age-standardised prevalence rate (ASPR) of definitive dialysis also increased significantly from 890.6 pmp in 2009 to 1081.7 pmp in 2018.

Males outnumbered females in both incidence and prevalence rates of dialysis. Malays had the highest incidence and prevalence rates of dialysis. Haemodialysis (HD) was the main modality among new and prevalent dialysis patients. Diabetic nephropathy (DN) was the main cause of CKD5 among new and prevalent dialysis patients.

Cardiac event and infection were the two common causes of death among prevalent dialysis patients. After adjusting for demographics, etiology and co-morbidities, the risk of death was higher for 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 usually placed on PD, a gentler therapy than HD. However, the disparity in survival between HD and PD narrowed over the years. In addition, survival among HD patients remained stable over the years, while survival among PD patients significantly improved over time.

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 2018. Urea was well managed in 96.7% of the HD patients and 42.6% of the PD patients based on their urea reduction ratio or fractional clearance of urea in 2018. Anaemia was well managed in 79.0% of the HD patients and 66.1% of the PD patients based on their haemoglobin level in 2018. Bone metabolism was well managed in 56.6%, 54.2% and 22.8% of the HD patients and 50.9%, 53.8% and 24.1% of the PD patients based on their calcium level, phosphate level and intact parathyroid hormone level respectively in 2018.

The ASIR of kidney transplant was 20.2 pmp in 2009, declined to 13.9 pmp in 2012 (lowest point during the past decade), and increased to 20.6 pmp in 2018. The ASPR of transplant remained relatively stable, ranging between 259.2 pmp and 270.6 pmp from 2009 to 2018.

Males outnumbered females in both incidence and prevalence rates of kidney transplant. There was no distinct ethnic difference for the incidence rate of transplant. Chinese had the highest prevalence rate of transplant. Glomerulonephritis (GN) was the main cause of CKD5 for new and prevalent transplant patients. Most of the transplants were performed locally, with almost equal contribution from both deceased and living donors in 2018.

Graft and patient survival were better among transplants from living donors. Patients who undergone transplant, regardless of the type of 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. In Singapore, 2.3% of the residents aged between 18 and 69 years old had CKD in 2010 based on the National Health Survey 2010[2]. It also showed that the crude prevalence of diabetes increased from 8.6% in 1992 to 11.3% in 2010. In 2010, one in two diabetics were undiagnosed and one in three known diabetics had poor blood sugar control. 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 less than 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 CKD5 patients who were on renal replacement therapy (i.e. dialysis or kidney transplant). There are two main type 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.

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[1] Mallamaci F. Highlights of the 2015 ERA-EDTA congress: chronic kidney disease, hypertension. Nephrology Dialysis Transplant. 2016; 31(7): 1044-1046.
[2] National Health Survey 2010. Ministry of Health, Singapore.
[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) started capturing patients with CKD5 since 1999, regardless of whether they initiated dialysis or survived >90 days after initiation of dialysis.

In 2007, the Singapore General Hospital, which contributes about 50% of the new CKD5 cases each year, 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, kidney transplant centres and private nephrology clinics.

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, 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 allow for the eGFR readings to 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 the medical records.

For this report, the death status of all patients registered in the SRR were updated till 30 April 2019 by matching the patients' unique national registration identity card number with the death information imported from the Ministry of Home Affairs.

[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 rate and prevalence rate 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 Organization website[6].

This report focuses on Singapore residents with CKD5 and underwent dialysis or kidney transplant in 2009 to 2018, as they stood on 13 May 2019. Statistics on prevalence and survival included patients since the start of the SRR. 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.
[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 - 2014 to 2018. 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 2014 – 2018

	2014	2015	2016	2017	2018
Incidence					
Definitive dialysis	1041	1090	1170	1173	1256
Transplant	76	90	97	115	111
Death					
Definitive dialysis	764	800	800	879	914
Transplant	32	35	26	20	38
Prevalence					
Definitive dialysis	5879	6230	6671	7004	7405
Transplant	1457	1477	1502	1567	1601

Renal health condition and follow-up status of all dialysis and transplant patients are tracked by the Registry at the end of every year. Patients can be followed up for dialysis at centre or consultation with nephrologist. The service providers shown in Tables 5.1.2 and 5.1.3 were based on where the patients were followed up closest to 31 December 2018.

The majority of the prevalent HD patients were followed up at dialysis centres run by the Voluntary Welfare Organisations (VWO; 62.8%), followed by the private clinics and dialysis centres (35.6%), then the public hospitals and affiliated dialysis centres (1.6%) (Table 5.1.2).

On the other hand, as PD is done at home, follow-up among PD patients typically pertains to consultation with nephrologist, hence almost all of the prevalent PD patients were followed up at the public hospitals and affiliated dialysis centres (99.7%).

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

Table 5.1.2: Prevalent patients as of 31 December 2018

	HD		PD		Transplant	
	Number	%	Number	%	Number	%
Public hospitals and affiliated dialysis centres	102	1.6	1015	99.7	1446	90.3
Dialysis centres under Voluntary Welfare Organisations	4010	62.8	NA	0.0	NA	0.0
Private clinics and dialysis centres	2275	35.6	3	0.3	154	9.6
Overseas	0	0.0	0	0.0	1	0.1
Total	**6387**	**100.0**	**1018**	**100.0**	**1601**	**100.0**

5.2 Incidence of CKD5

The incidence rate in each year was computed 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. These included all patients (i) initiating renal replacement therapy since 2008, (ii) presenting with serum creatinine ≥10 mg/dl or ≥880 µmol/L in 2008 and 2009, or (iii) presenting with serum creatinine ≥500 µmol/L or eGFR <15 ml/min/1.73m^2 since 2010. 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.

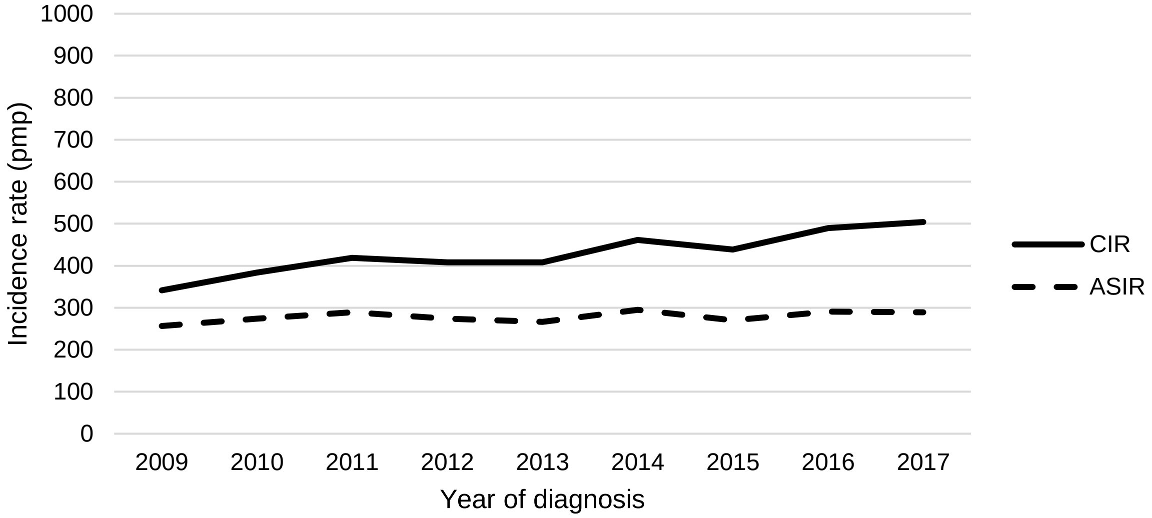
As the SRR monitors the patient's eGFR readings for at least six months before accepting a case as CKD5, the yearly number of new CKD5 patients typically takes two years to stabilise. Hence, all statistics related to new CKD5 patients for 2018 are not shown in this section.

The number of new patients diagnosed with CKD5 increased from 1,275 in 2009 to 1,999 in 2017 (Table 5.2.1 and Figure 5.2.1). Correspondingly, the CIR increased significantly from 341.5 pmp in 2009 to 504.1 pmp in 2017 ($p<0.001$). However, the ASIR remained relatively stable, ranging between 256.5 pmp and 295.0 pmp during this period. These findings imply that the rise in new patients 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
2009	1275	341.5	256.5
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	1785	461.2	295.0
2015	1712	438.7	270.4
2016	1925	489.4	290.9
2017	1999	504.1	289.2
P for trend	-	<0.001	0.102

Figure 5.2.1: Incidence rate (pmp) of CKD5



The majority of the new CKD5 patients were aged 60 years or older (Table 5.2.2). In 2017, more than 7 in 10 of the patients were in this age band.

The median age at diagnosis of CKD5 fluctuated between 63 years to 68 years over the decade (Figure 5.2.2a).

The CIR of CKD5 remained stable over the years for all age groups except for those aged 80 years and above, where there was a rise from 2009 to 2011, a drop from 2012 to 2014 and a rise again from 2014 to 2017 (Figure 5.2.2b).

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
2009	9	0.7	9.7	19	1.5	36.8	44	3.5	71.6	118	9.3	185.7
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	23	1.3	43.4	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	9.1	286.4
2017	4	0.2	4.8	22	1.1	40.1	60	3.0	103.4	147	7.4	239.0
P for trend	-	-	0.692	-	-	0.812	-	-	0.350	-	-	0.095
Year of diagnosis	**Age 50-59**			**Age 60-69**			**Age 70-79**			**Age 80+**		
	Number	**%**	**CIR**	**Number**	**%**	**CIR**	**Number**	**%**	**CIR**	**Number**	**%**	**CIR**
2009	261	20.5	485.7	336	26.4	1175.2	310	24.3	2080.5	178	14.0	2742.7
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	18.6	583.6	538	27.9	1195.9	426	22.1	2221.6	365	19.0	3732.1
2017	328	16.4	533.8	561	28.1	1202.3	487	24.4	2303.2	390	19.5	3850.9
P for trend	-	-	0.409	-	-	0.717	-	-	0.862	-	-	0.339

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

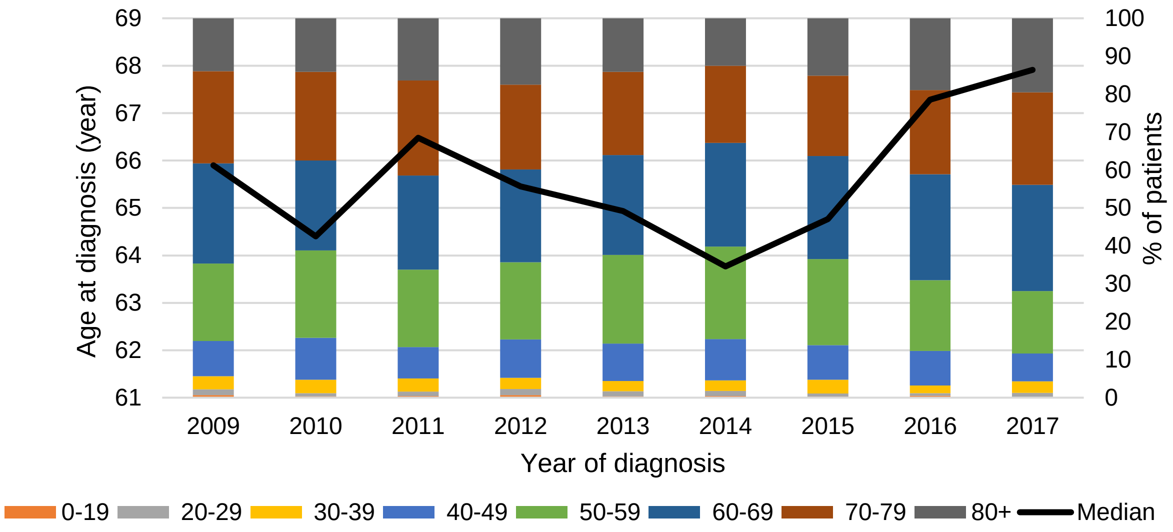
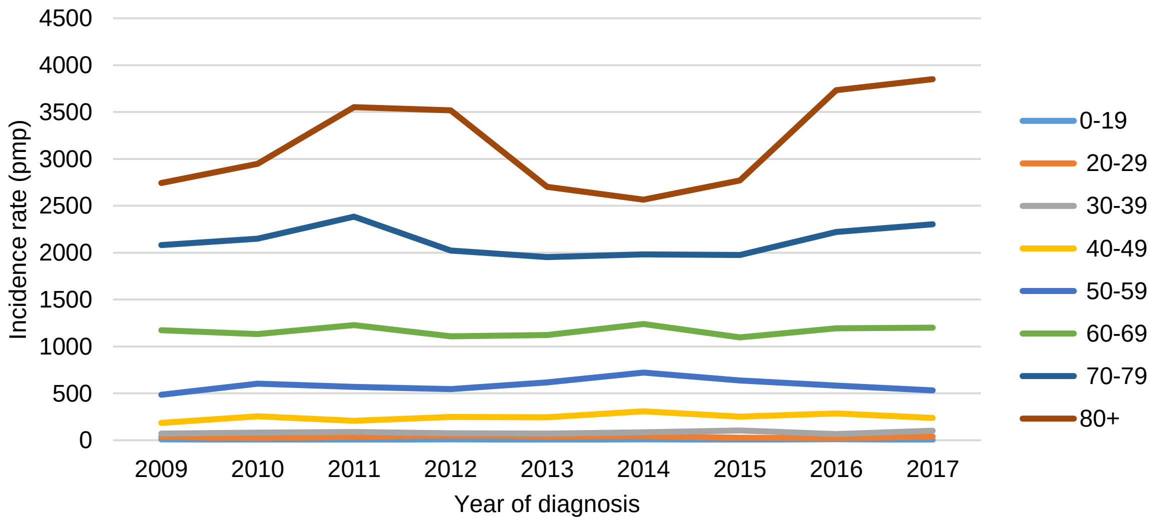
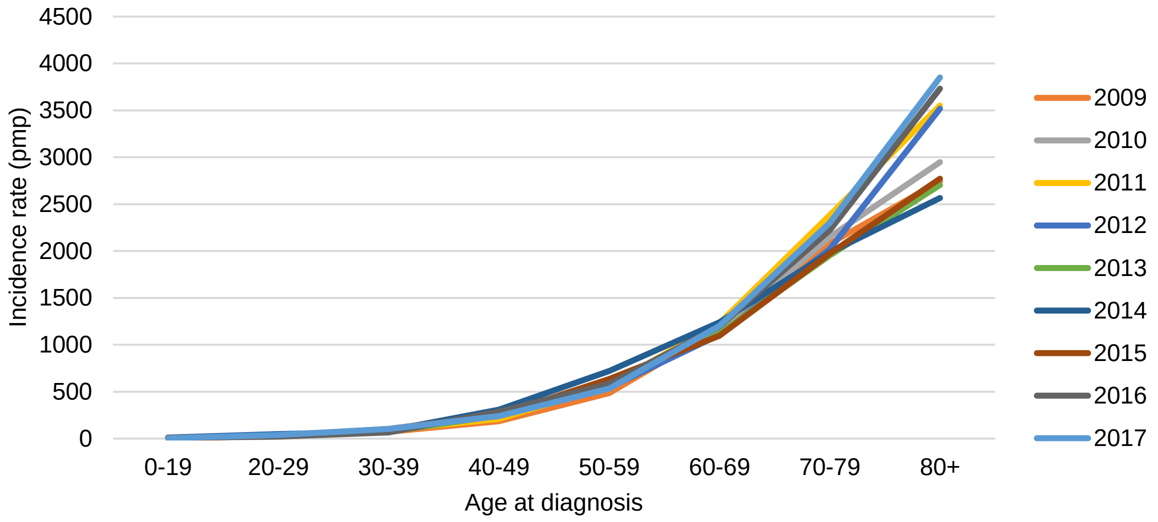


Figure 5.2.2b: Age-specific incidence rate (pmp) of CKD5 across years



The CIR of CKD5 increased with age. The absolute difference in CIR between successive age groups also increased with age (Figure 5.2.3).

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

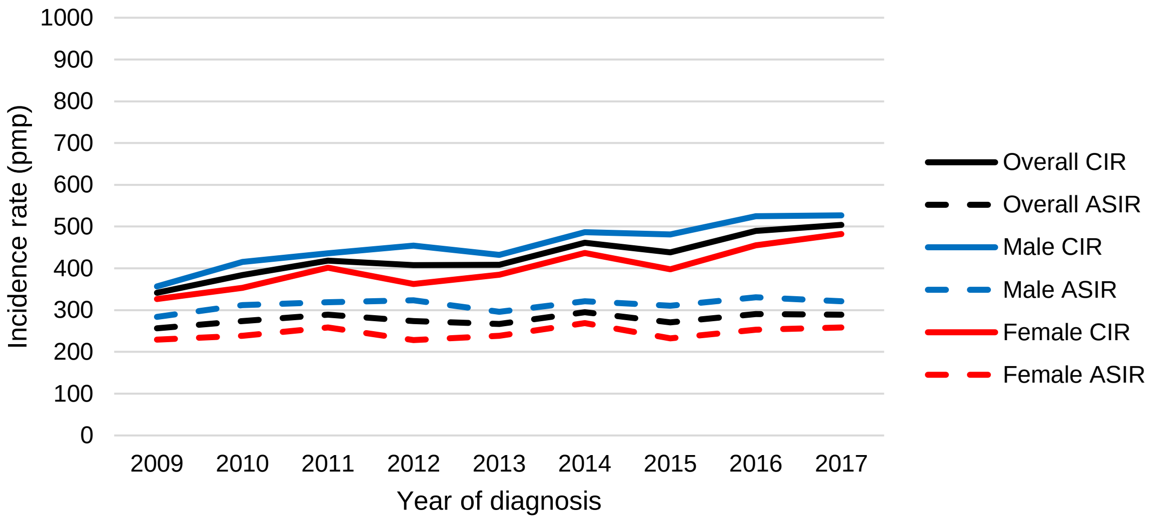


The ASIRs of CKD5 were consistently higher among males than females across the years (Table 5.2.3 and Figure 5.2.4). In 2017, the ASIR was 320.8 pmp and 258.5 pmp for males and females respectively. The ASIRs for both genders remained stable over the years.

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

Male				
Year of diagnosis	**Number**	**%**	**CIR**	**ASIR**
2009	658	51.6	356.7	283.8
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	1013	52.6	525.0	330.7
2017	1024	51.2	526.9	320.8
P for trend	-	-	<0.001	0.110
Female				
Year of diagnosis	**Number**	**%**	**CIR**	**ASIR**
2009	617	48.4	326.6	229.2
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	860	48.2	436.9	268.9
2015	790	46.1	397.8	232.1
2016	912	47.4	455.1	253.4
2017	975	48.8	482.1	258.5
P for trend	-	-	0.001	0.214

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



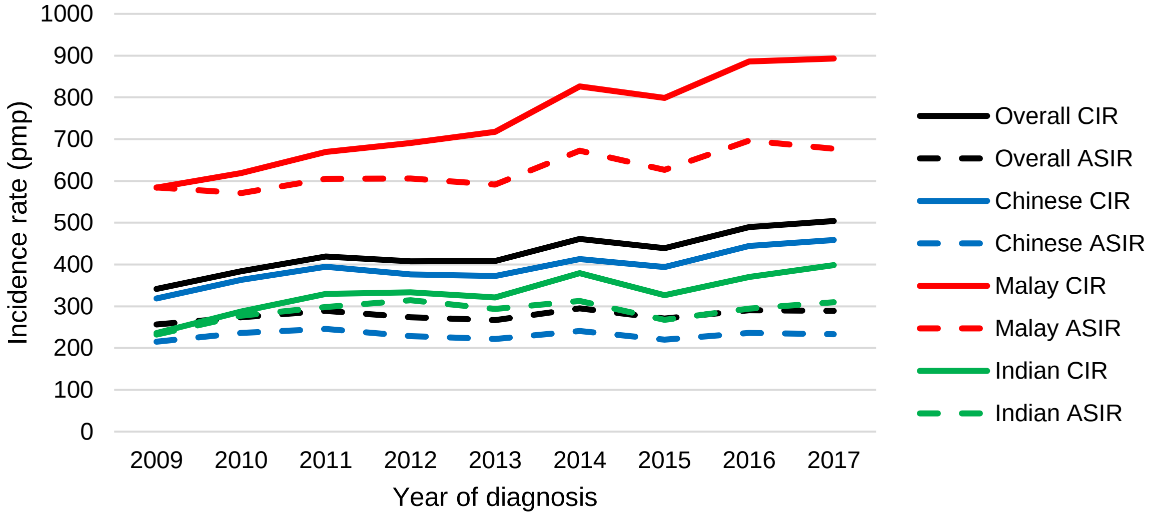
The ASIRs of CKD5 were consistently higher among Malays than Chinese and Indians across the years (Table 5.2.4 and Figure 5.2.5). In 2017, the ASIR among Malays was 676.9 pmp, which was about 3-fold compared to Chinese (233.0 pmp) and 2-fold compared to Indians (309.5 pmp). While the ASIR for Malays increased significantly over the years (p=0.003), the ASIR 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**
2009	883	69.3	318.7	215.2
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	1186	66.4	412.6	240.6
2015	1142	66.7	393.8	220.1
2016	1298	67.4	444.0	236.4
2017	1352	67.6	458.6	233.0
P for trend	-	-	0.001	0.687
Malay				
Year of diagnosis	**Number**	**%**	**CIR**	**ASIR**
2009	292	22.9	584.0	584.4
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	427	23.9	826.5	672.6
2015	416	24.3	798.6	626.2
2016	466	24.2	886.1	696.6
2017	474	23.7	893.1	676.9
P for trend	-	-	<0.001	0.003
Indian				

Year of diagnosis	Number	%	CIR	ASIR
2009	81	6.4	235.9	232.3
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	134	7.5	379.6	312.8
2015	116	6.8	326.8	267.7
2016	132	6.9	369.9	294.5
2017	143	7.2	398.5	309.5
P for trend	-	-	0.003	0.148

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



5.3 Incidence of ever-started dialysis

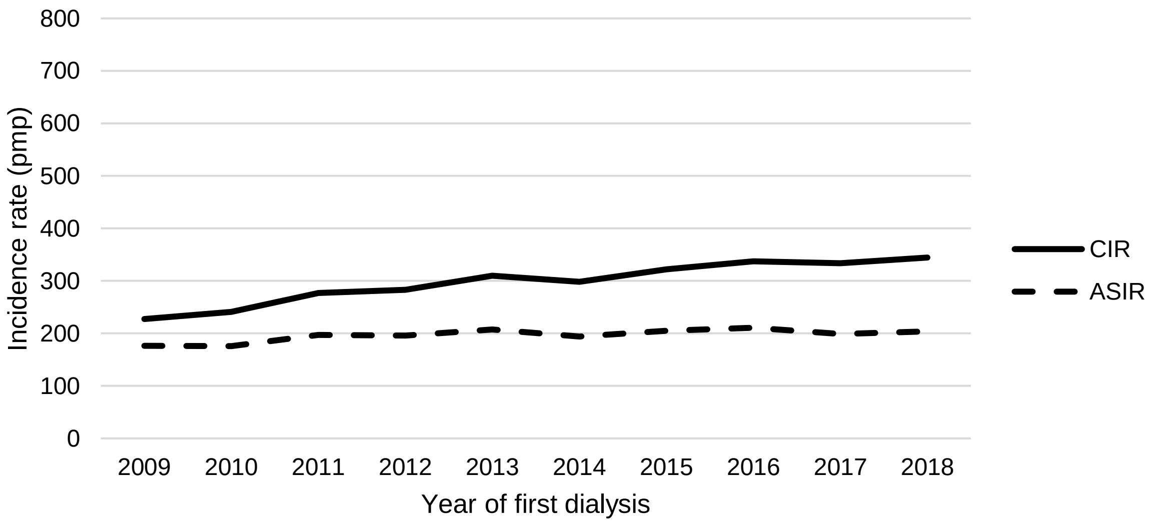
The incidence rate in each year was computed by taking the number of new patients who ever-started on dialysis in a year, divided by the number of Singapore residents in the same year. The count was based on the date of first dialysis and modality was based on the first dialysis. Patients were categorised 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 849 in 2009 to 1,376 in 2018 (Table 5.3.1 and Figure 5.3.1). Correspondingly, the CIR increased significantly from 227.4 pmp in 2009 to 344.5 pmp in 2018 ($p<0.001$). The ASIR also increased significantly, albeit at a smaller magnitude than the CIR, from 176.1 pmp in 2009 to 203.5 pmp in 2018 ($p=0.012$).

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

Year of first dialysis	Number	CIR	ASIR
2009	849	227.4	176.1
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	1154	298.1	193.8
2015	1258	322.3	205.2
2016	1327	337.4	210.8
2017	1322	333.4	199.0
2018	1376	344.5	203.5
P for trend	-	<0.001	0.012

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. In 2018, close to 80% of the patients were in this age band (Table 5.3.2).

The median age at first dialysis increased from 62.0 years in 2009 to 64.9 years in 2018 (Figure 5.3.2a).

The CIR of ever-started dialysis increased significantly for those aged between 30 to 39 years (p=0.024), 40 to 49 years (p=0.019) and 70 to 79 years (p=0.018) (Figure 5.3.2b).

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
2009	7	0.8	7.5	16	1.9	31.0	38	4.5	61.8	98	11.5	154.2
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	19	1.6	35.9	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	43	3.3	74.1	115	8.7	187.0
2018	4	0.3	4.9	15	1.1	27.4	60	4.4	102.5	133	9.7	217.5
P for trend	-	-	0.354	-	-	0.600	-	-	0.024	-	-	0.019
Year of first dialysis	**Age 50-59**			**Age 60-69**			**Age 70-79**			**Age 80+**		
	Number	**%**	**CIR**	**Number**	**%**	**CIR**	**Number**	**%**	**CIR**	**Number**	**%**	**CIR**
2009	198	23.3	368.4	280	33.0	979.4	166	19.6	1114.1	46	5.4	708.8
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	290	21.9	471.9	440	33.3	943.0	297	22.5	1404.6	121	9.2	1194.8
2018	274	19.9	446.7	461	33.5	950.8	324	23.5	1406.9	105	7.6	982.4
P for trend	-	-	0.166	-	-	0.431	-	-	0.018	-	-	0.169

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

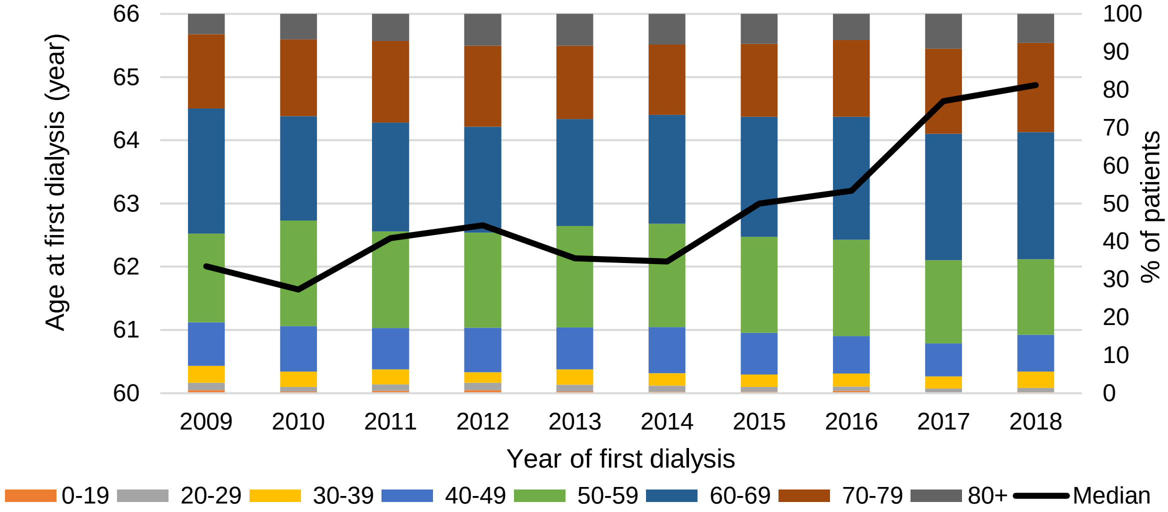
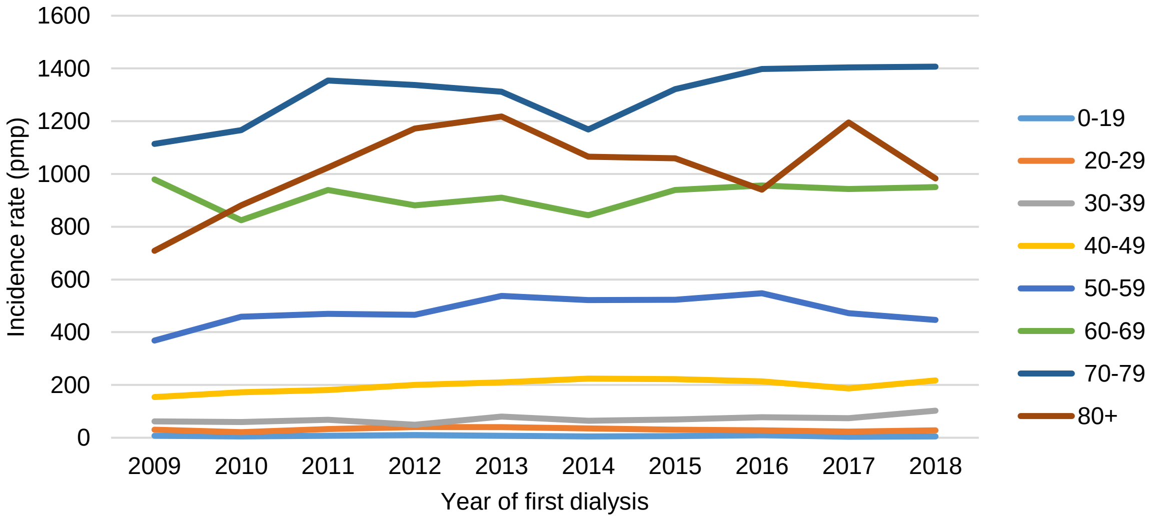


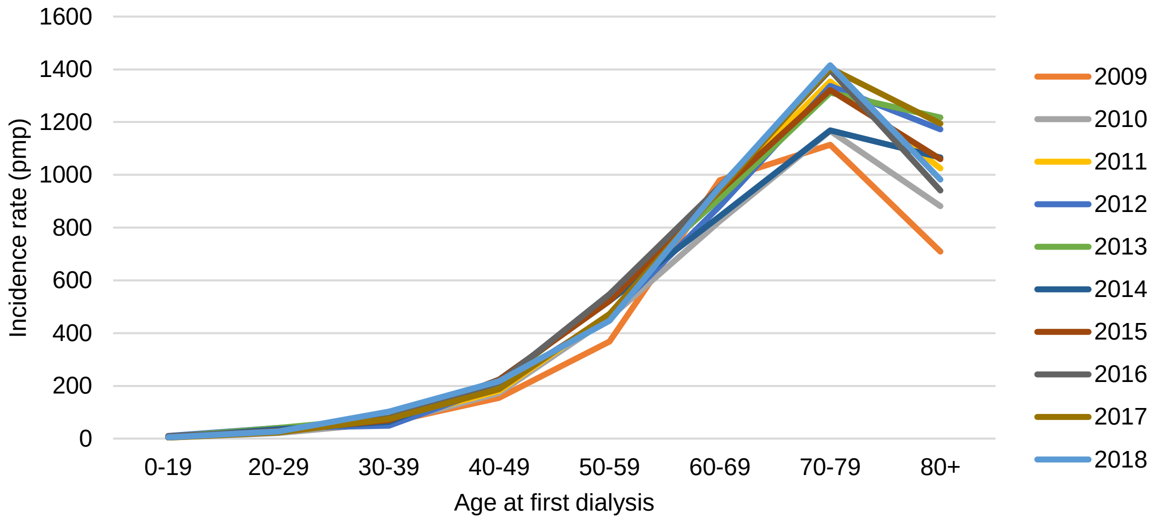
Figure 5.3.2b: Age-specific incidence rate (pmp) of ever-started dialysis across years



The CIR of ever-started dialysis increased with age, but a decline was observed from age 80 years onwards (Figure 5.3.3). Reasons for this may include 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[7].

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

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



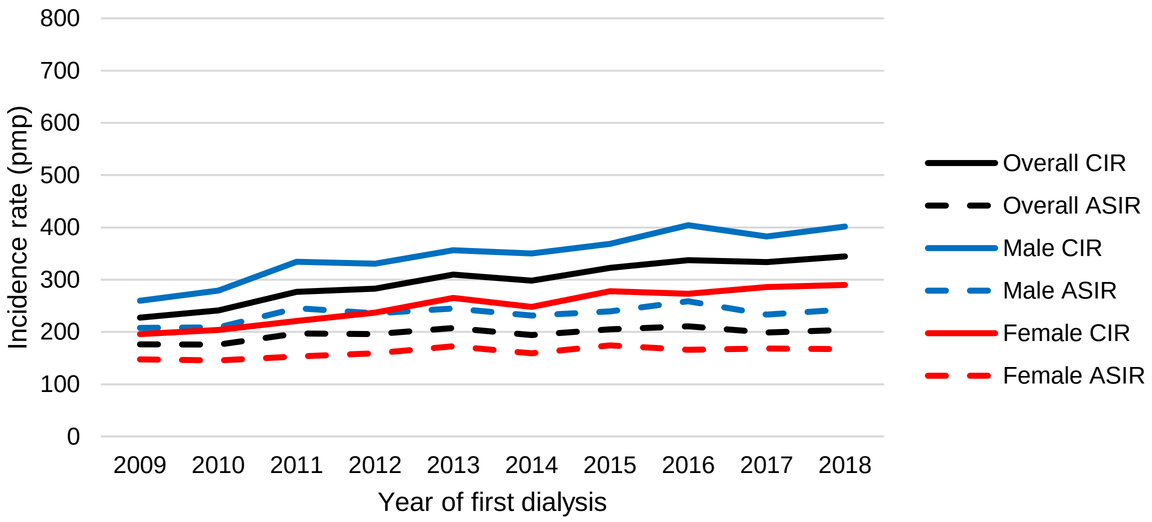
The ASIRs of ever-started dialysis were consistently higher among males than females across the years (Table 5.3.3 and Figure 5.3.4). In 2018, the ASIR was 243.1 pmp and 166.9 pmp for males and females respectively. The ASIRs for both genders increased significantly over the years (p=0.043 for males; p=0.006 for females).

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

Male				
Year of first dialysis	**Number**	**%**	**CIR**	**ASIR**
2009	479	56.4	259.7	207.8
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	744	56.3	382.8	233.5
2018	785	57.0	401.4	243.1
P for trend	-	-	<0.001	0.043

Female				
Year of first dialysis	**Number**	**%**	**CIR**	**ASIR**
2009	370	43.6	195.9	147.3
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	488	42.3	247.9	159.0
2015	552	43.9	277.9	174.3
2016	547	41.2	272.9	165.9
2017	578	43.7	285.8	168.0
2018	591	43.0	289.9	166.9
P for trend	-	-	<0.001	0.006

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

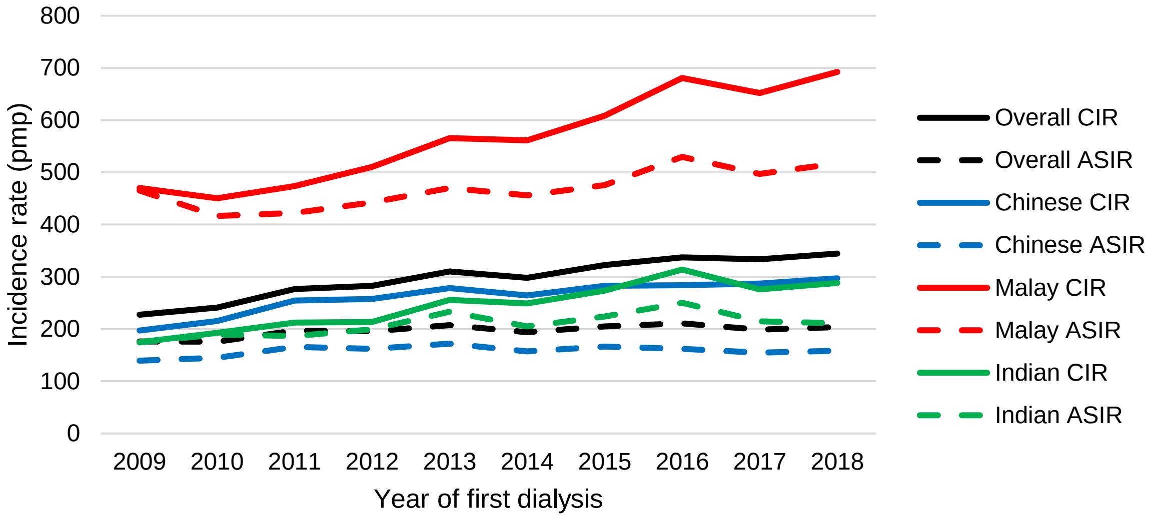


The ASIRs of ever-started dialysis were consistently higher among Malays than Chinese and Indians across the years (Table 5.3.4 and Figure 5.3.5). In 2018, the ASIR was 158.4 pmp, 517.2 pmp and 211.1 pmp for Chinese, Malays and Indians respectively. While the ASIRs for Malays and Indians increased significantly over the years (p=0.005 for Malays; p=0.019 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**
2009	546	64.3	197.1	139.4
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	759	65.8	264.1	157.2
2015	819	65.1	282.4	166.1
2016	830	62.5	283.9	162.1
2017	846	64.0	286.9	154.5
2018	882	64.1	297.0	158.4
P for trend	-	-	0.001	0.223
Malay				
Year of first dialysis	**Number**	**%**	**CIR**	**ASIR**
2009	235	27.7	470.0	465.0
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	290	25.1	561.3	455.8
2015	317	25.2	608.5	475.6
2016	358	27.0	680.8	529.6
2017	346	26.2	652.0	496.8
2018	371	27.0	692.4	517.2
P for trend	-	-	<0.001	0.005
Indian				
Year of first dialysis	**Number**	**%**	**CIR**	**ASIR**
2009	60	7.1	174.7	174.5
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	250.3
2017	99	7.5	275.9	214.7
2018	104	7.6	288.5	211.1
P for trend	-	-	<0.001	0.019

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



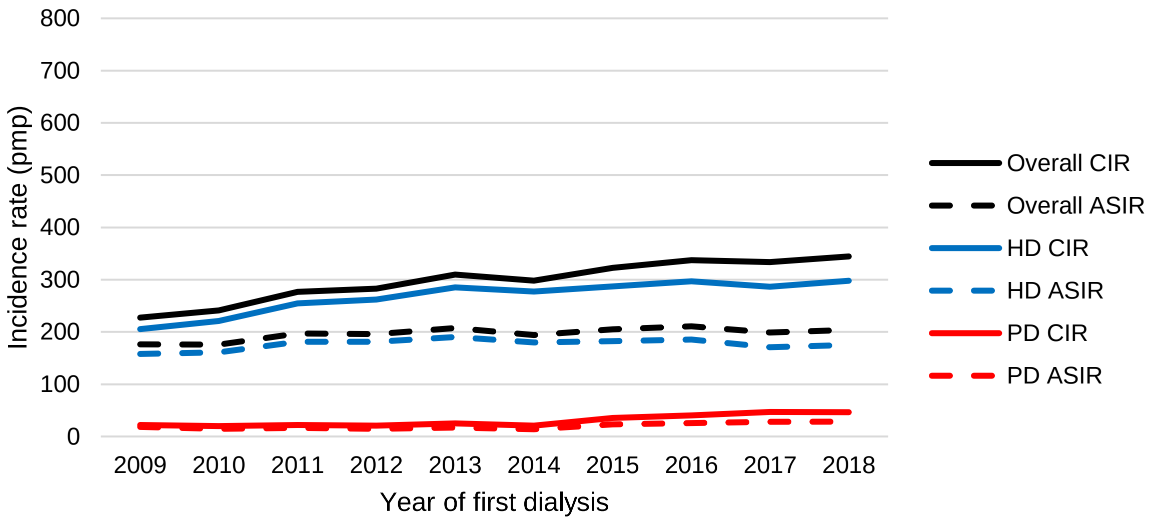
The ASIRs of ever-started dialysis were consistently higher among HD than PD across the years (Table 5.3.5 and Figure 5.3.6). In 2018, the ASIR was 175.1 pmp and 28.4 pmp for HD and PD respectively. While the ASIR for PD increased significantly over the years (p=0.008), the ASIR for HD remained relatively stable.

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

	HD			
Year of first dialysis	**Number**	**%**	**CIR**	**ASIR**
2009	767	90.3	205.4	157.9
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	1073	93.0	277.2	180.0
2015	1120	89.0	287.0	182.3
2016	1168	88.0	296.9	185.4
2017	1136	85.9	286.4	170.7
2018	1190	86.5	297.9	175.1
P for trend	-	-	0.001	0.210

PD				
Year of first dialysis	**Number**	**%**	**CIR**	**ASIR**
2009	82	9.7	22.0	18.2
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	186	14.1	46.9	28.3
2018	186	13.5	46.6	28.4
P for trend	-	-	0.001	0.008

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



5.4 Incidence of definitive dialysis

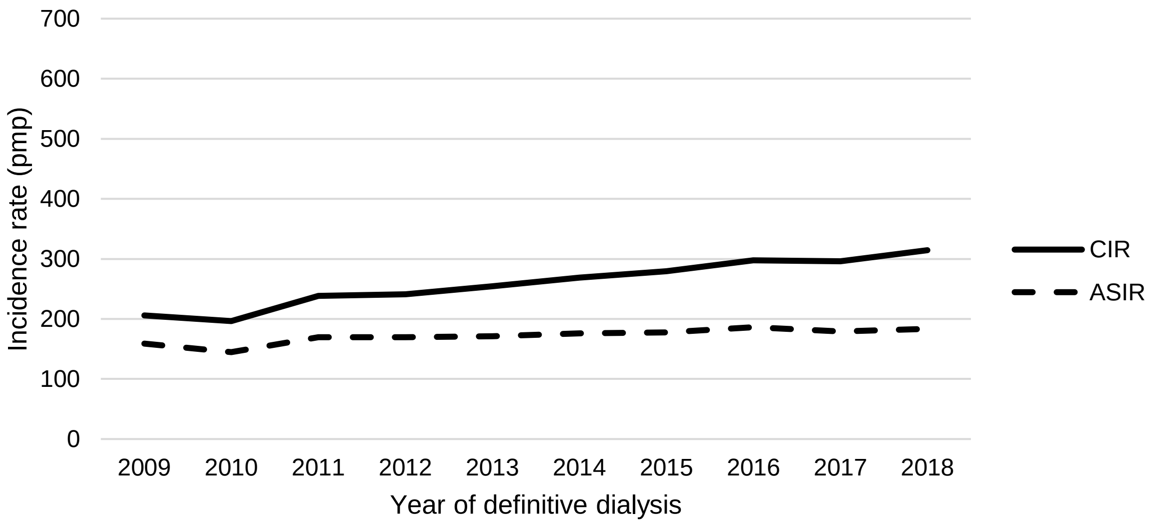
The incidence rate in each year was computed by taking the number of new patients who survived >90 days after initiation of dialysis in a year, divided by the number of Singapore residents in the same year. The count was based on the 91st day from the date of first dialysis. The modality on the date closest and prior to the 91st day was taken. As some patients with pre-existing co-morbidities did not survive past three months from the first dialysis, those on definitive dialysis is a relatively more stable subset of the CKD5 cohort and ever-started dialysis cohort. 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.

Mirroring the incidence trend of ever-started dialysis (Table 5.3.1 and Figure 5.3.1), the number of new patients on definitive dialysis increased from 769 in 2009 to 1,257 in 2018 (Table 5.4.1 and Figure 5.4.1). Correspondingly, the CIR increased significantly from 206.0 pmp in 2009 to 314.7 pmp in 2018 ($p<0.001$). The rise in ASIR from 159.0 pmp in 2009 to 187.0 pmp in 2018 was also significant ($p=0.001$).

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

Year of definitive dialysis	Number	CIR	ASIR
2009	769	206.0	159.0
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	1041	268.9	175.8
2015	1090	279.3	177.7
2016	1170	297.4	186.2
2017	1174	296.0	179.5
2018	1257	314.7	187.0
P for trend	-	<0.001	0.001

Figure 5.4.1: Incidence rate (pmp) of definitive dialysis



The majority of the new definitive dialysis patients were aged 50 to 79 years. In 2018, close to 80% of the patients were in this age band (Table 5.4.2).

The median age at definitive dialysis increased from 61.2 years in 2009 to 64.3 years in 2018 (Figure 5.4.2a).

The CIR of definitive dialysis increased significantly for those aged 30-39 years (p=0.014), 40-49 years (p=0.026), 70-79 years (p=0.018) and 80+ years (p=0.013) (Figure 5.4.2b).

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
2009	9	1.2	9.7	15	2.0	29.1	34	4.4	55.3	101	13.1	159.0
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	19	1.8	35.9	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	55	4.4	94.0	123	9.8	201.2
P for trend	-	-	0.870	-	-	0.656	-	-	0.014	-	-	0.026
Year of definitive dialysis	Age 50-59			Age 60-69			Age 70-79			Age 80+		
	Number	%	CIR	Number	%	CIR	Number	%	CIR	Number	%	CIR
2009	197	25.6	366.6	232	30.2	811.5	150	19.5	1006.7	31	4.0	477.7
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	848.7	255	21.7	1206.0	82	7.0	809.7
2018	254	20.2	414.1	421	33.5	870.2	284	22.6	1240.9	99	7.9	926.3
P for trend	-	-	0.075	-	-	0.106	-	-	0.018	-	-	0.013

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

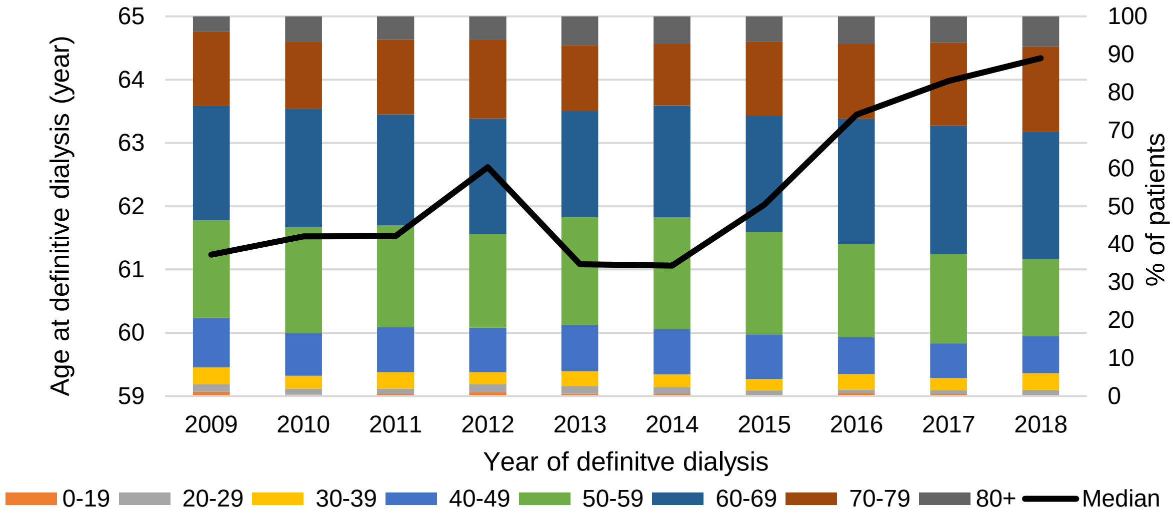
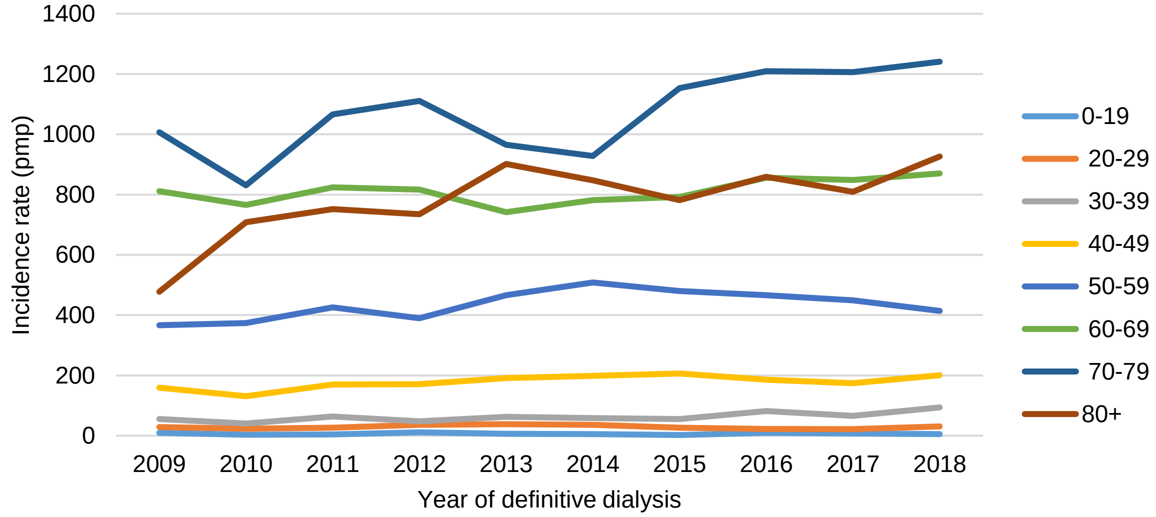


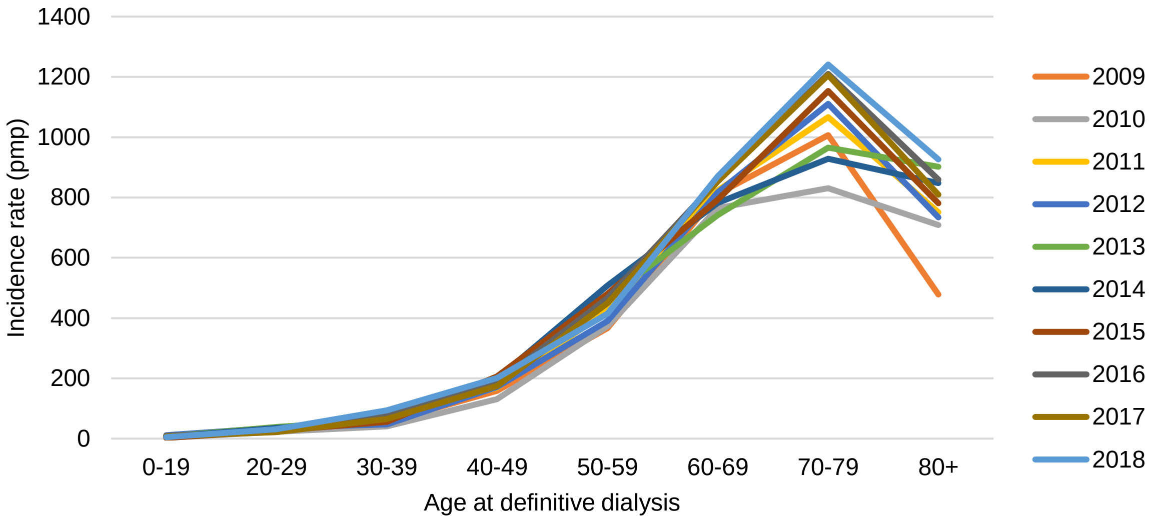
Figure 5.4.2b: Age-specific incidence rate (pmp) of definitive dialysis across years



The CIR of definitive dialysis increased with age, but a decline was observed from age 80 years onwards (Figure 5.4.3). Reasons for this may include 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].

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

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



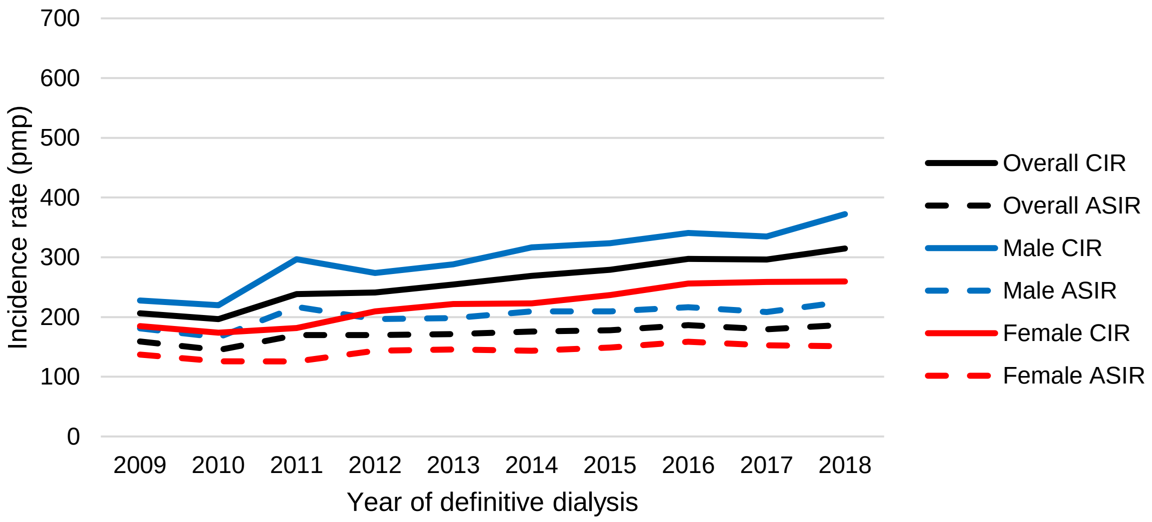
The ASIRs of definitive dialysis were consistently higher among males than females across the years (Table 5.4.3 and Figure 5.4.4). In 2018, the ASIR was 225.8 pmp and 151.3 pmp for males and females respectively. The ASIRs for both genders increased significantly over the years (p=0.012 for males; p=0.004 for females).

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

	Male			
Year of definitive dialysis	**Number**	**%**	**CIR**	**ASIR**
2009	420	54.6	227.7	180.9
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	728	57.9	372.2	225.8
P for trend	-	-	<0.001	0.012

Female				
Year of definitive dialysis	**Number**	**%**	**CIR**	**ASIR**
2009	349	45.4	184.7	137.0
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	439	42.2	223.0	143.8
2015	470	43.1	236.6	148.6
2016	513	43.8	256.0	158.6
2017	523	44.5	258.6	152.5
2018	529	42.1	259.5	151.3
P for trend	-	-	<0.001	0.004

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

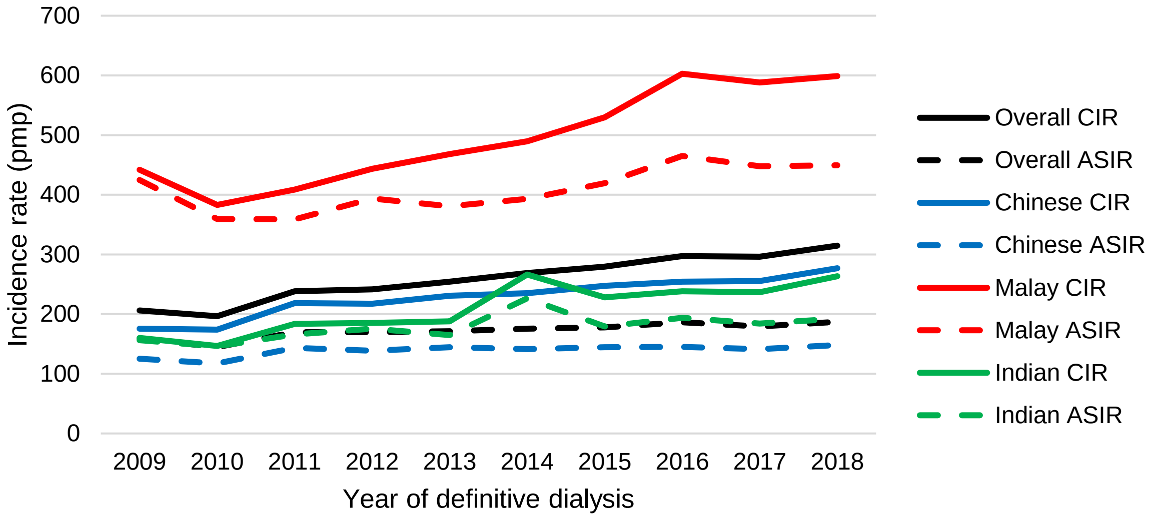


The ASIRs of definitive dialysis were consistently higher among Malays than Chinese and Indians across the years (Table 5.4.4 and Figure 5.4.5). In 2018, the ASIR was 148.1 pmp, 449.2 pmp and 192.2 pmp for Chinese, Malays and Indians respectively. The ASIRs for all the three ethnic groups increased significantly over the years (p=0.015 for Chinese; p=0.023 for Malays; p=0.029 for Indians).

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

Chinese				
Year of definitive dialysis	**Number**	**%**	**CIR**	**ASIR**
2009	486	63.2	175.4	124.9
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	675	64.8	234.8	141.3
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	822	65.4	276.8	148.1
P for trend	-	-	<0.001	0.015
Malay				
Year of definitive dialysis	**Number**	**%**	**CIR**	**ASIR**
2009	221	28.7	442.0	424.7
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	253	24.3	489.7	393.1
2015	276	25.3	529.8	419.2
2016	317	27.1	602.8	465.0
2017	312	26.6	587.9	447.6
2018	321	25.5	599.1	449.2
P for trend	-	-	<0.001	0.023
Indian				
Year of definitive dialysis	**Number**	**%**	**CIR**	**ASIR**
2009	55	7.2	160.2	156.2
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	193.6
2017	85	7.2	236.9	183.9
2018	95	7.6	263.5	192.2
P for trend	-	-	0.001	0.029

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

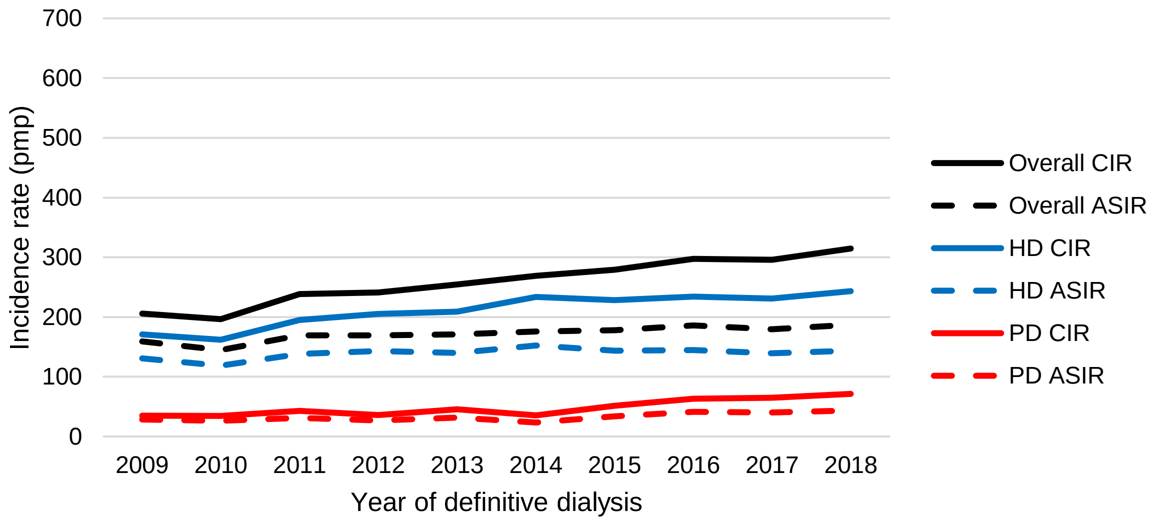


The ASIRs of definitive dialysis were consistently higher among HD than PD across the years (Table 5.4.5 and Figure 5.4.6). In 2018, the ASIR was 143.5 pmp and 43.5 pmp for HD and PD respectively. While the ASIR for PD increased significantly over the years (p=0.012), the ASIR for HD remained relatively stable.

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

HD				
Year of definitive dialysis	**Number**	**%**	**CIR**	**ASIR**
2009	639	83.1	171.1	130.6
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	904	86.8	233.5	152.4
2015	890	81.7	228.0	143.8
2016	921	78.7	234.1	144.8
2017	916	78.0	231.0	139.4
2018	972	77.3	243.3	143.5
P for trend	-	-	<0.001	0.056
PD				
Year of definitive dialysis	**Number**	**%**	**CIR**	**ASIR**
2009	130	16.9	34.8	28.4
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	13.2	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	285	22.7	71.4	43.5
P for trend	-	-	0.001	0.012

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



Among new patients on definitive dialysis, diabetes was the biggest contributor to CKD5, followed by GN. In 2018, 65.8% of the new definitive dialysis patients had DN, while 14.1% had GN.

Table 5.4.6: Incidence number of definitive dialysis by etiology

Year of definitive dialysis	DN		GN		Others	
	Number	%	Number	%	Number	%
2009	475	61.8	144	18.7	150	19.5
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	165	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	172	14.7	213	18.2
2018	827	65.8	177	14.1	253	20.1

5.5 Prevalence of definitive dialysis

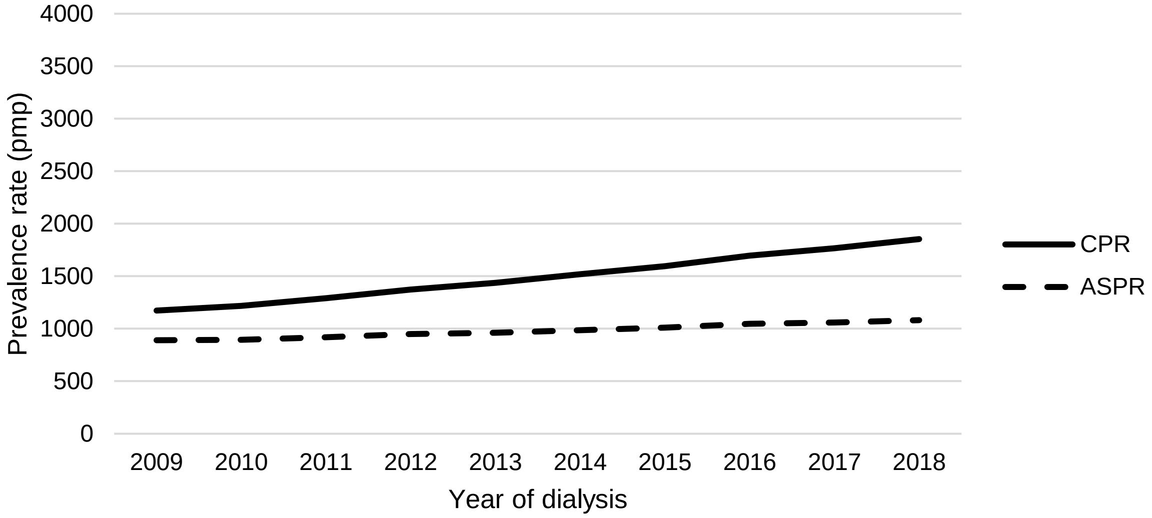
The prevalence rate in each year was computed by taking the cumulative number of surviving (existing and new) definitive dialysis patients in a year, divided by the number of Singapore residents in the same year. Only patients surviving >90 days after initiation of dialysis were included. The count was based on the date of last dialysis and 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 trend of definitive dialysis (Table 5.4.1 and Figure 5.4.1), the number of prevalent patients on definitive dialysis increased consistently since 2009 (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; $p<0.001$ for ASPR). By the end of 2018, there were a total of 7,405 surviving definitive dialysis patients, with CPR and ASPR being 1,853.9 pmp and 1,081.7 pmp respectively. The rise in ASPR implies that the rise in new patients undergoing definitive dialysis was faster than the drop in patients 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
2009	4380	1173.1	890.6
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	5879	1518.8	986.8
2015	6230	1596.3	1011.9
2016	6671	1695.9	1047.9
2017	7004	1766.1	1058.3
2018	7405	1853.9	1081.7
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. In 2018, close to 80% of the patients were in this age band (Table 5.5.2).

The median age among prevalent definitive dialysis patients increased from 60.3 years in 2009 to 64.4 years in 2018 (Figure 5.5.2a).

The significant rise in overall CPR of definitive dialysis was driven by the significant rise in CPR for patients aged 30 years or older (Figure 5.5.2b). Conversely, there was a significant drop in CPR for those aged below 20 years (p=0.014).

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
2009	27	0.6	29.0	58	1.3	112.4	184	4.2	299.4	629	14.4	989.9
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	74	1.3	139.7	207	3.5	348.3	629	10.7	1007.1
2015	12	0.2	14.2	69	1.1	128.9	210	3.4	354.9	639	10.3	1030.4
2016	13	0.2	15.6	66	1.0	122.0	224	3.4	381.2	637	9.5	1036.4
2017	12	0.2	14.5	55	0.8	100.1	233	3.3	401.5	611	8.7	993.6
2018	13	0.2	15.9	51	0.7	93.2	249	3.4	425.6	622	8.4	1017.2
P for trend	-	-	0.014	-	-	0.186	-	-	<0.001	-	-	0.027

Year of dialysis	Age 50-59			Age 60-69			Age 70-79			Age 80+		
	Number	%	CPR	Number	%	CPR	Number	%	CPR	Number	%	CPR
2009	1242	28.4	2311.1	1282	29.3	4484.1	779	17.8	5228.2	179	4.1	2758.1
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	2363	33.7	5064.1	1540	22.0	7283.1	517	7.4	5104.9
2018	1686	22.8	2748.8	2518	34.0	5204.7	1694	22.9	7401.5	572	7.7	5351.8
P for trend	-	-	<0.001	-	-	<0.001	-	-	<0.001	-	-	<0.001

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

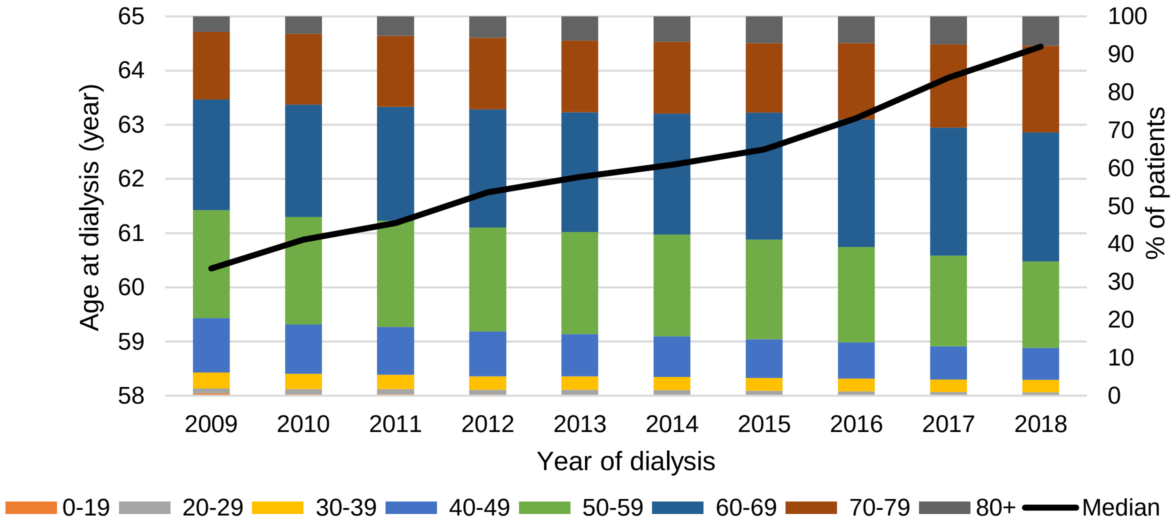
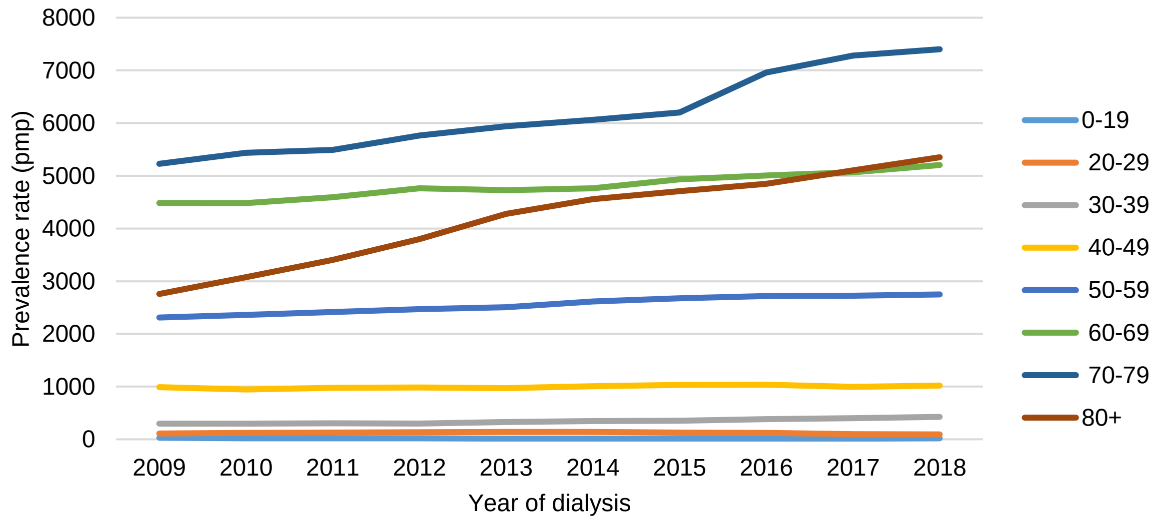
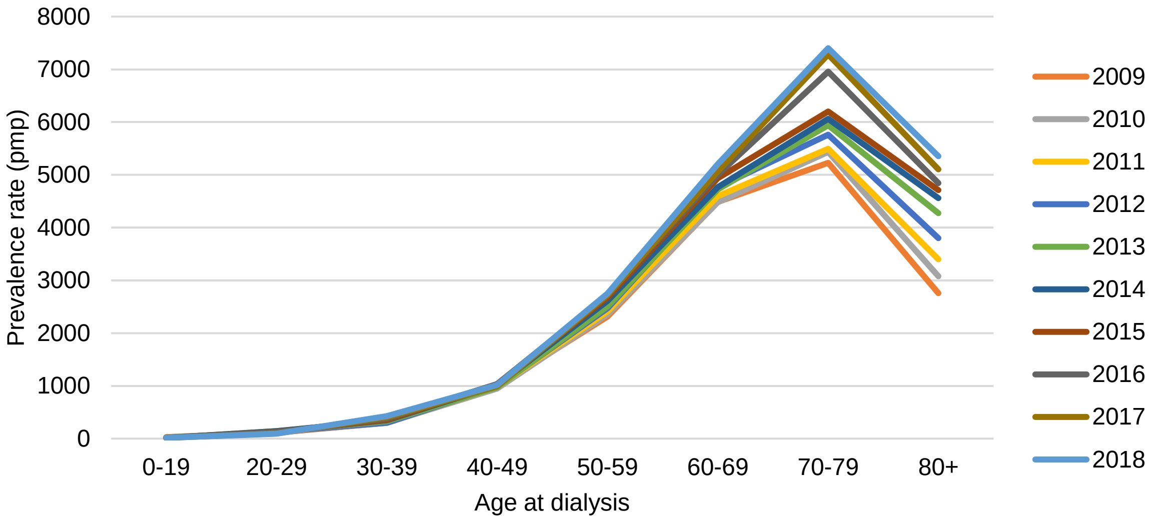


Figure 5.5.2b: Age-specific prevalence rate (pmp) of definitive dialysis across years



The CPR of definitive dialysis increased with age, but a decline was observed from age 80 years onwards (Figure 5.5.3).

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



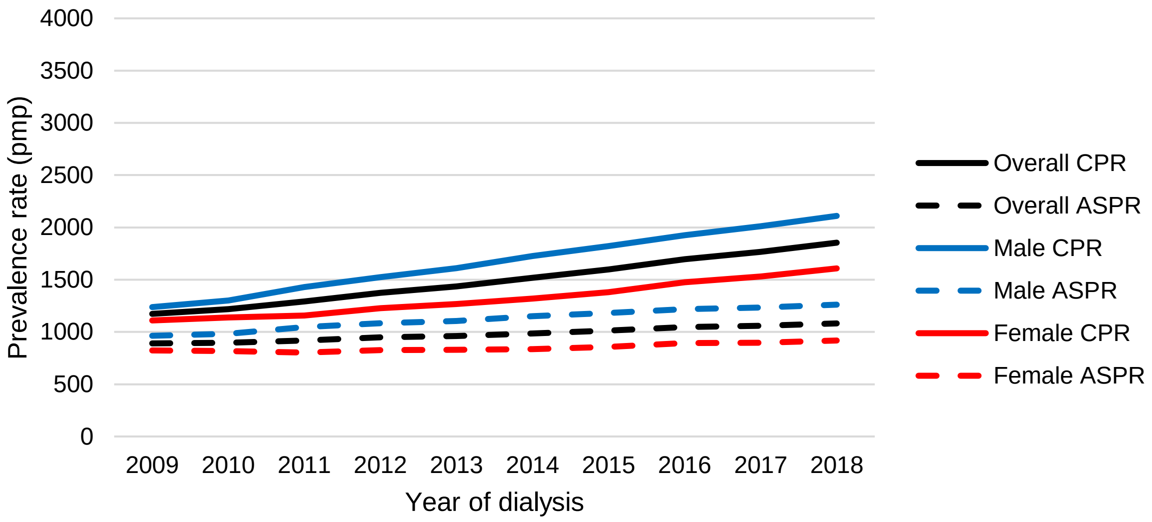
The ASPRs of definitive dialysis were consistently higher among males than females across the years (Table 5.5.3 and Figure 5.5.4). In 2018, the ASPR was 1261.1 pmp and 918.0 pmp for males and females respectively. The ASPRs for both genders increased significantly over the years (p<0.001 for males; p<0.001 for females).

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

Male				
Year of dialysis	**Number**	**%**	**CPR**	**ASPR**
2009	2283	52.1	1237.7	963.6
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	3906	55.8	2009.7	1234.4
2018	4127	55.7	2110.1	1261.1
P for trend	-	-	<0.001	<0.001

Female				
Year of dialysis	**Number**	**%**	**CPR**	**ASPR**
2009	2097	47.9	1110.0	821.9
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	2594	44.1	1317.9	835.9
2015	2739	44.0	1379.1	856.2
2016	2956	44.3	1475.0	892.1
2017	3098	44.2	1532.0	897.8
2018	3278	44.3	1608.1	918.0
P for trend	-	-	<0.001	<0.001

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

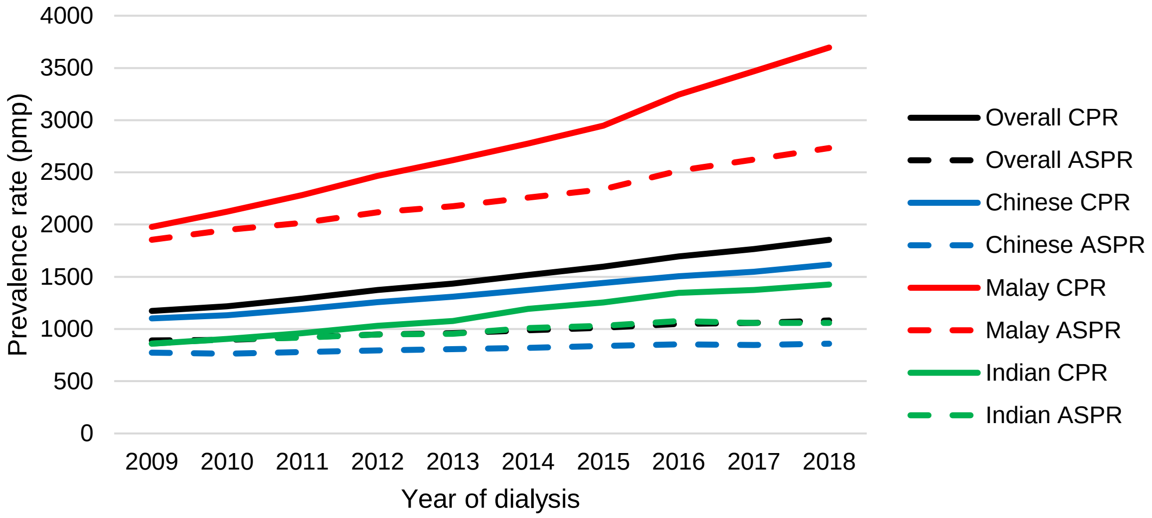


The ASPRs of definitive dialysis were consistently higher among Malays than Chinese and Indians across the years (Table 5.5.4 and Figure 5.5.5). In 2018, the ASPR was 859.4 pmp, 2732.8 pmp and 1057.0 pmp for Chinese, Malays and Indians respectively. The ASPRs for all the three ethnic groups increased significantly over the years (p<0.001 for Chinese; p<0.001 for Malays; p<0.001 for Indians).

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

Chinese				
Year of dialysis	**Number**	**%**	**CPR**	**ASPR**
2009	3052	69.7	1101.7	772.7
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	3952	67.2	1374.9	820.5
2015	4176	67.0	1440.0	839.4
2016	4396	65.9	1503.8	853.0
2017	4568	65.2	1549.4	848.3
2018	4799	64.8	1616.2	859.4
P for trend	-	-	<0.001	<0.001
Malay				
Year of dialysis	**Number**	**%**	**CPR**	**ASPR**
2009	989	22.6	1978.0	1854.3
2010	1071	23.3	2125.0	1948.7
2011	1156	23.6	2282.8	2015.2
2012	1256	24.0	2465.6	2119.1
2013	1341	24.3	2615.6	2176.6
2014	1435	24.4	2777.5	2257.6
2015	1535	24.6	2946.7	2339.3
2016	1707	25.6	3245.9	2514.6
2017	1840	26.3	3467.1	2622.8
2018	1980	26.7	3695.2	2732.8
P for trend	-	-	<0.001	<0.001
Indian				
Year of dialysis	**Number**	**%**	**CPR**	**ASPR**
2009	295	6.7	859.1	860.5
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	1076.5
2017	493	7.0	1373.9	1057.5
2018	514	6.9	1425.7	1057.0
P for trend	-	-	<0.001	<0.001

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



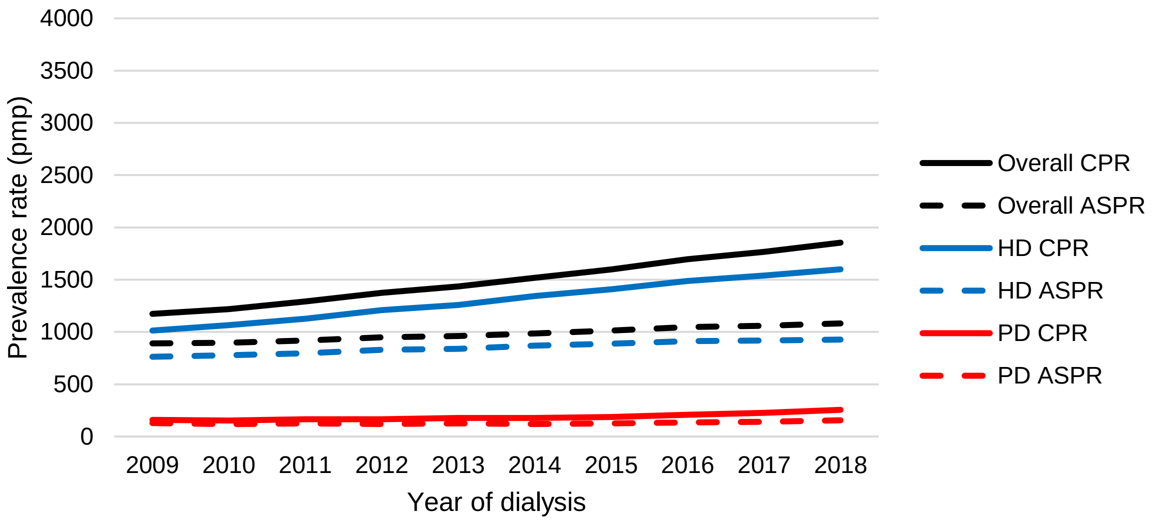
The ASPRs of definitive dialysis were consistently higher among HD than PD across the years (Table 5.5.5 and Figure 5.5.6). In 2018, the ASPR was 926.7 pmp and 155.0 pmp for HD and PD respectively. Although the ASPRs for both HD and PD increased significantly over the years (p<0.001 for HD; p=0.015 for PD), the increment in ASPR for HD was higher than PD.

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

HD				
Year of dialysis	**Number**	**%**	**CPR**	**ASPR**
2009	3783	86.4	1013.2	762.6
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	5198	88.4	1342.9	868.0
2015	5497	88.2	1408.5	886.6
2016	5848	87.7	1486.7	912.6
2017	6107	87.2	1539.9	917.2
2018	6387	86.3	1599.0	926.7
P for trend	-	-	<0.001	<0.001

PD				
Year of dialysis	Number	%	CPR	ASPR
2009	597	13.6	159.9	128.0
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
P for trend	-	-	<0.001	0.015

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



Compared to new definitive dialysis patients with DN (65.8% in 2018, Table 5.4.6), the proportion of prevalent definitive dialysis patients with DN was lower at 54.8% in 2018, albeit increasing consistently since 2009 (Table 5.5.6).

Relative to new definitive dialysis patients with GN (14.1% in 2018, Table 5.4.6), the proportion of prevalent definitive dialysis patients with GN was higher at 24.0% in 2018, albeit dropping consistently since 2009 (Table 5.5.6).

Table 5.5.6: Prevalence number of definitive dialysis by etiology

Year of dialysis	DN		GN		Others	
	Number	%	Number	%	Number	%
2009	1923	43.9	1472	33.6	985	22.5
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	1611	27.4	1270	21.6
2015	3272	52.5	1679	27.0	1279	20.5
2016	3568	53.5	1722	25.8	1381	20.7
2017	3800	54.3	1742	24.9	1462	20.9
2018	4057	54.8	1774	24.0	1574	21.3

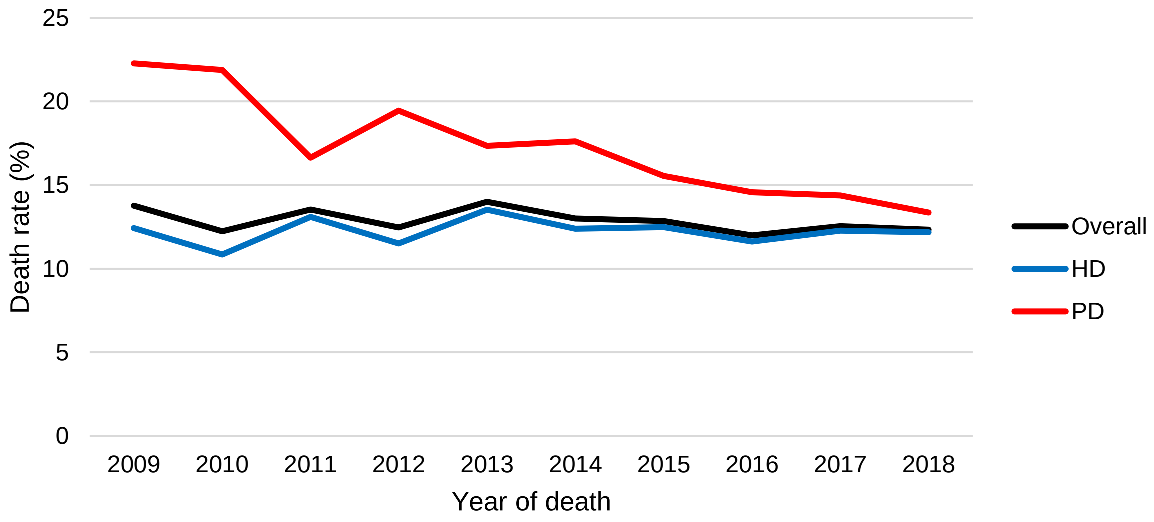
5.6 Mortality of definitive dialysis

Approximately 12% to 14% of the patients on definitive dialysis died every year in the past decade. 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 was receiving in the last 60 days before death (Table 5.6.1 and Figure 5.6.1). However, disparity in mortality between the two modalities narrowed over the years as the death rate dropped from 22.3% in 2009 to 13.4% in 2018 for PD, while remaining relatively stable at between 11.5% to 13.5% for HD.

Table 5.6.1: All-cause mortality by modality

Year of death	Overall		HD		PD	
	Number	%	Number	%	Number	%^
2009	603	13.8	470	12.4	133	22.3
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	914	12.3	778	12.2	136	13.4

Figure 5.6.1: All-cause mortality by modality



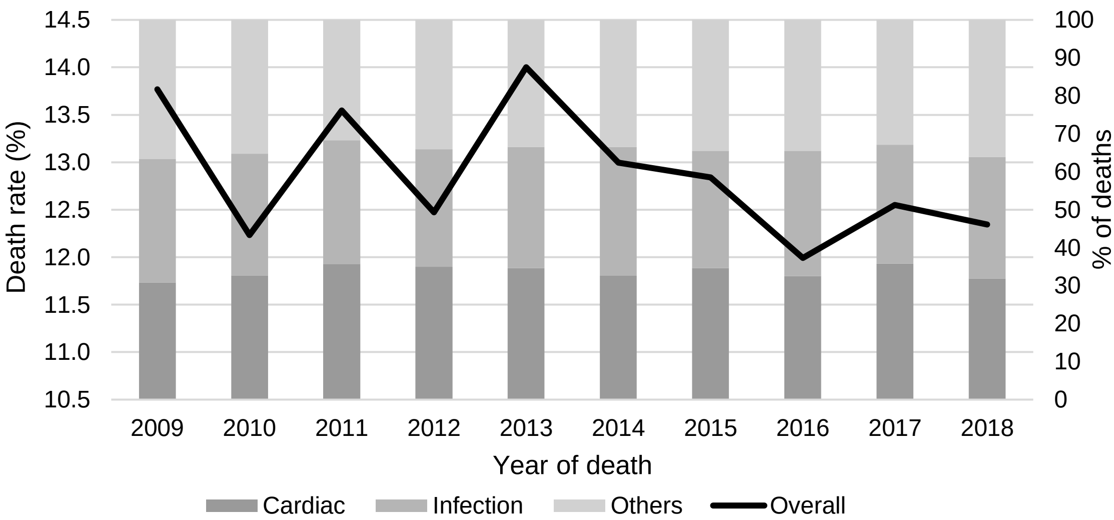
Deaths related to cardiac event and infection were the two most common causes of death and each of them accounted for about a third of all deaths across the years (Table 5.6.2 and Figure 5.6.2).

Table 5.6.2: Mortality by cause of death

Year of death	Overall		Cardiac		Infection		Others	
	Number	%*	Number	%^	Number	%^	Number	%^
2009	603	13.8	186	30.8	196	32.5	221	36.7
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	914	12.3	291	31.8	293	32.1	330	36.1

*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 survival duration of new patients on definitive dialysis were estimated using the Kaplan-Meier method in Tables 5.7.1 to 5.7.10. Event was defined as all-cause death. Patients were censored if they stopped definitive dialysis (i.e. received kidney transplant), or they reached the end of the follow-up period (i.e. neither received kidney transplant nor died by 31 March 2019, the date until which the death status of all patients registered in the SRR were updated). Median survival duration is indicated as "not reached (NR)" if more than half of the patients were still alive as of 31 March 2019. In addition, cox regression model was used to adjust for the effects of potential confounders on the survival of patients simultaneously in Table 5.7.11.

All analyses in this section were stratified by or adjusted for modality as survival differed between HD and PD patients. The modality was based on the last modality that the dialysis patient was receiving in the last 60 days before death.

Compared to PD patients, HD patients had significantly better survival as indicated by their higher survival rates and longer median survival duration ($p<0.001$) (Table 5.7.1).

Table 5.7.1: Survival of definitive dialysis by modality

	HD	PD	Overall
1-year survival (%)	90.7	89.1	90.3
5-year survival (%)	61.3	41.4	57.0
10-year survival (%)	35.8	21.7	32.7
Median survival (years)	6.9	4.0	6.1

While survival among HD patients remained stable over the years, survival among PD patients significantly improved over time ($p<0.001$) (Table 5.7.2).

Table 5.7.2: Survival of definitive dialysis by period and modality

	1999-2003	2004-2008	2009-2013	2014-2018
HD				
1-year survival (%)	90.8	89.8	89.8	91.9
5-year survival (%)	60.9	60.6	60.2	64.0
10-year survival (%)	38.3	34.4	34.4	-
Median survival (years)	7.2	6.7	6.6	NR
PD				
1-year survival (%)	85.3	87.4	90.1	93.3
5-year survival (%)	32.4	38.4	47.8	52.7
10-year survival (%)	16.3	20.3	27.6	-
Median survival (years)	3.3	3.7	4.6	NR
Overall				
1-year survival (%)	89.0	89.2	89.9	92.2
5-year survival (%)	51.4	55.7	58.1	62.2
10-year survival (%)	30.9	31.4	33.2	-
Median survival (years)	5.2	5.9	6.2	NR

Younger patients aged below 60 years had significantly better survival than older patients aged 60 years or older (p<0.001 for HD; p<0.001 for PD) (Table 5.7.3).

Table 5.7.3: Survival of definitive dialysis by age group and modality

	Age <60 years			Age ≥60 years		
	HD	PD	Overall	HD	PD	Overall
1-year survival (%)	93.5	92.9	93.3	88.1	86.0	87.6
5-year survival (%)	72.7	58.8	69.9	50.1	27.1	44.7
10-year survival (%)	50.9	38.3	48.4	19.3	7.5	16.5
Median survival (years)	10.4	6.5	9.5	5.0	3.1	4.3

Survival was fairly similar between the two genders (Table 5.7.4).

Table 5.7.4: Survival of definitive dialysis by gender and modality

	Male			Female		
	HD	PD	Overall	HD	PD	Overall
1-year survival (%)	90.6	89.2	90.3	90.8	89.0	90.3
5-year survival (%)	60.7	42.2	57.2	62.1	40.5	56.7
10-year survival (%)	35.8	21.2	33.0	35.8	22.0	32.4
Median survival (years)	6.8	4.2	6.2	6.9	3.9	6.0

Survival was fairly similar across the three ethnic groups (Table 5.7.5).

Table 5.7.5: Survival of definitive dialysis by ethnicity and modality

	Chinese			Malay			Indian		
	HD	PD	Overall	HD	PD	Overall	HD	PD	Overall
1-year survival (%)	90.9	89.2	90.5	90.4	88.4	90.1	89.8	89.4	89.7
5-year survival (%)	60.8	41.7	56.4	63.3	40.2	58.8	59.5	40.4	56.0
10-year survival (%)	35.5	21.3	32.2	37.7	23.2	34.9	32.3	19.9	30.0
Median survival (years)	6.8	4.1	6.0	7.2	3.8	6.4	6.3	3.7	5.8

Patients without DN had significantly better survival than those with DN ($p<0.001$ for HD; $p<0.001$ for PD) (Table 5.7.6).

Table 5.7.6: Survival of definitive dialysis by etiology and modality

	Non-DN			DN		
	HD	PD	Overall	HD	PD	Overall
1-year survival (%)	92.5	92.7	92.5	89.5	86.9	88.9
5-year survival (%)	73.0	63.2	71.0	53.3	28.0	47.6
10-year survival (%)	54.5	41.8	51.8	21.4	8.6	18.5
Median survival (years)	11.3	7.7	10.6	5.4	3.2	4.7

Patients without ischemic heart disease (IHD) had significantly better survival than those with IHD ($p<0.001$ for HD; $p<0.001$ for PD) (Table 5.7.7).

Table 5.7.7: Survival of definitive dialysis by presence of IHD and modality

	No IHD			IHD		
	HD	PD	Overall	HD	PD	Overall
1-year survival (%)	93.0	92.3	92.8	88.2	85.8	87.6
5-year survival (%)	71.0	55.2	67.7	50.2	27.5	44.9
10-year survival (%)	47.7	34.6	45.1	20.6	9.0	17.8
Median survival (years)	9.3	5.7	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; $p<0.001$ for PD) (Table 5.7.8).

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

	No CVD			CVD		
	HD	PD	Overall	HD	PD	Overall
1-year survival (%)	91.8	90.9	91.6	87.0	84.7	86.4
5-year survival (%)	65.3	47.4	61.6	48.0	26.1	42.4
10-year survival (%)	40.0	26.2	37.1	19.6	9.7	17.0
Median survival (years)	7.7	4.6	7.0	4.7	3.0	4.1

Patients without peripheral vascular disease (PVD) had significantly better survival than those with PVD ($p<0.001$ for HD; $p<0.001$ for PD) (Table 5.7.9).

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

	No PVD			PVD		
	HD	PD	Overall	HD	PD	Overall
1-year survival (%)	91.9	90.5	91.6	84.7	81.8	84.2
5-year survival (%)	64.9	45.5	60.6	43.6	20.3	39.0
10-year survival (%)	39.7	24.8	36.4	14.2	2.7	12.0
Median survival (years)	7.6	4.5	6.8	4.1	2.5	3.7

Patients without cancer had significantly better survival than those with cancer ($p<0.001$ for HD; $p=0.001$ for PD) (Table 5.7.10).

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

	No cancer			Cancer		
	HD	**PD**	**Overall**	**HD**	**PD**	**Overall**
1-year survival (%)	91.9	91.1	91.7	82.9	88.2	83.6
5-year survival (%)	64.1	45.5	60.1	44.4	33.2	43.0
10-year survival (%)	37.8	24.1	34.8	21.7	13.4	20.6
Median survival (years)	7.3	4.5	6.6	4.3	3.3	4.1

Similar to the univariable analyses (Tables 5.7.1 and 5.7.3 to 5.7.10), PD, old age, DN, IHD, CVD, PVD and cancer were significant predictors of death, even after adjusting the other potential confounders simultaneously (Table 5.7.11).

Table 5.7.11: Adjusted risk of death by factors associated with survival of definitive dialysis

	Hazard ratio	95% confidence interval	P-value
Modality			
HD	Reference		
PD	1.53	1.45-1.61	<0.001
Age group			
<60 years	Reference		
≥60 years	2.05	1.95-2.15	<0.001
Gender			
Male	Reference		
Female	0.99	0.95-1.04	0.791
Ethnicity			
Chinese	Reference		
Malay	0.98	0.93-1.03	0.384
Indian	1.00	0.92-1.09	0.967
Etiology			
Non-DN	Reference		
DN	1.85	1.76-1.95	<0.001
IHD			
No	Reference		
Yes	1.50	1.44-1.58	<0.001
CVD			
No	Reference		
Yes	1.34	1.27-1.40	<0.001
PVD			
No	Reference		
Yes	1.51	1.43-1.60	<0.001
Cancer			
No	Reference		
Yes	1.54	1.43-1.67	<0.001

5.8 Management of definitive dialysis

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) >2.10 mmol/L and <2.37 mmol/L
		Serum phosphate (PO_4) >1.13 mmol/L and <1.78 mmol/L
		Serum intact parathyroid hormone (iPTH) >16.3 mmol/L and <33.0 mmol/L

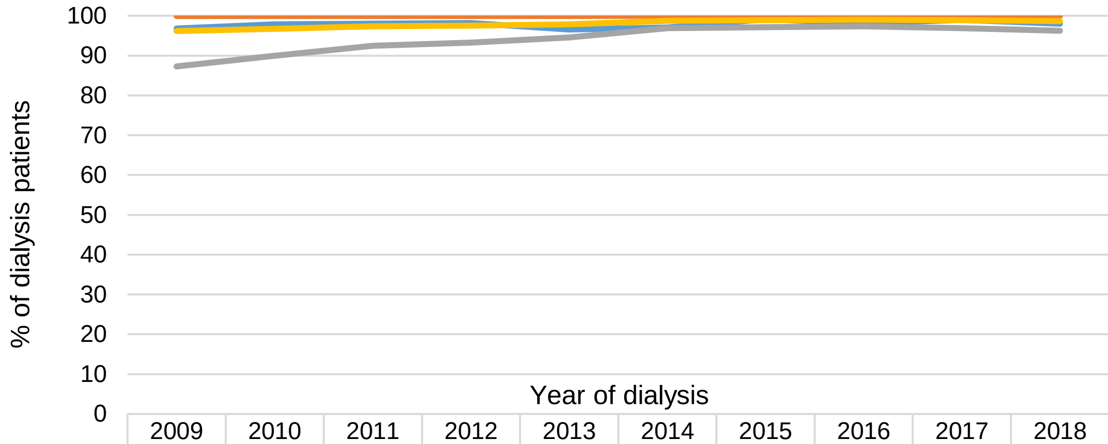
All analyses in this section were stratified by service provider (public sector / VWO / private sector) and modality (HD / PD) so as to sieve out groups of patients in need of better management. The most recent reading of each bio-clinical indicators for each patient in each year were taken and patients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

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 2018, the proportions of HD patients under the care of the VWO, private sector and public sector were 62.8%, 35.6% and 1.6% 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.

On the other hand, almost all of the prevalent PD patients were cared for by the public sector. In 2018, 99.7% 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 in 2017 and 2018, 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 in 2017 and 2018 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 96.3% of the private sector patients undergoing thrice weekly dialysis in 2018, compared to 98.0% and 100% of the public and VWO patients respectively.

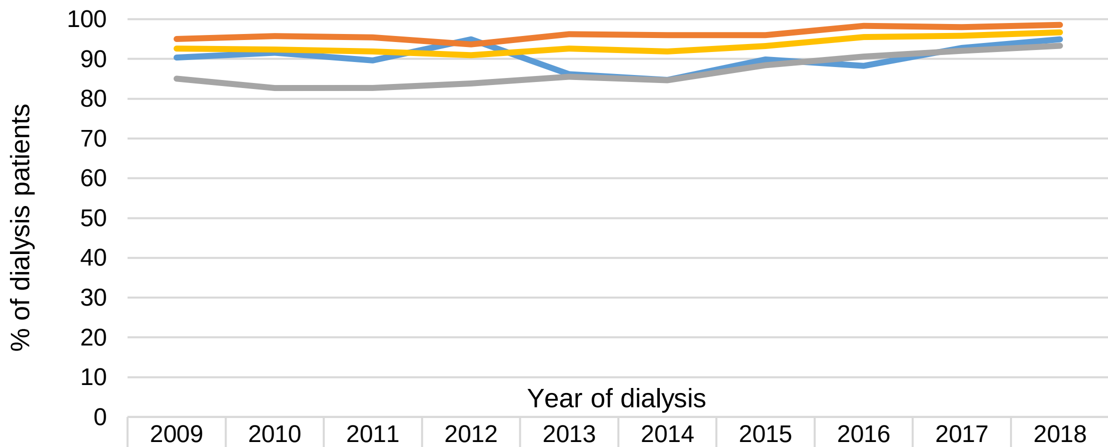
Figure 5.8.1a: Proportion of HD patients with thrice weekly dialysis



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Public	96.8	97.8	98.0	98.1	96.6	97.0	99.1	98.1	99.0	98.0
VWO	99.9	99.9	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Private	87.3	89.9	92.5	93.2	94.5	96.8	97.1	97.4	96.9	96.3
Overall	96.2	96.7	97.4	97.5	97.9	98.7	98.9	99.0	98.9	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 85.1% of its patients meeting the criteria in 2009 to 93.3% in 2018. The corresponding proportions of HD patients cared by the public sector and VWO meeting the criteria were 94.9% and 98.6% respectively in 2018.

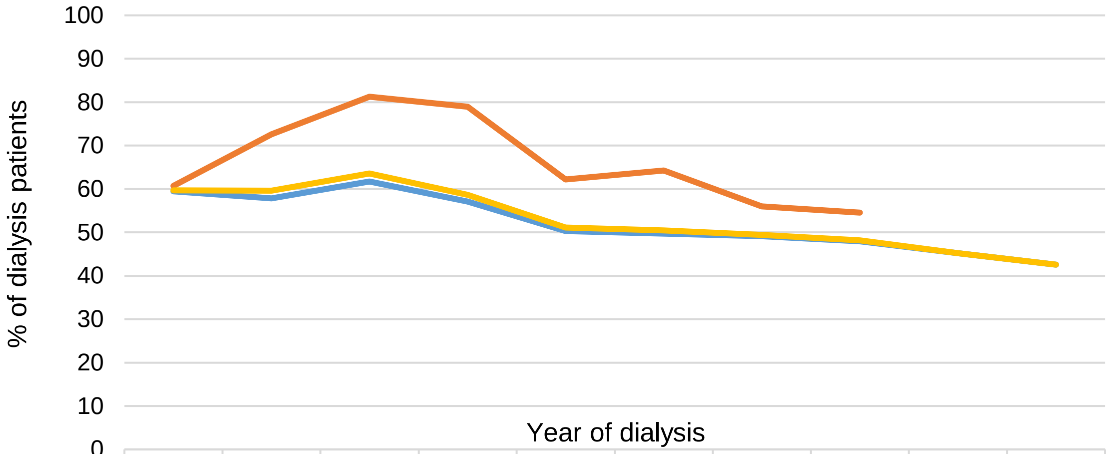
Figure 5.8.1b: Proportion of HD patients with adequate management of urea (URR >=65% or Kt/V >=1.2%)



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Public	90.4	91.6	89.7	94.9	86.2	84.7	89.9	88.2	92.8	94.9
VWO	95.0	95.8	95.4	93.7	96.2	96.0	96.0	98.3	98.0	98.6
Private	85.1	82.7	82.7	83.9	85.5	84.7	88.4	90.6	92.1	93.3
Overall	92.6	92.4	91.9	91.0	92.6	91.9	93.3	95.5	95.9	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 (Figure 5.8.2). In 2016, 47.9% of the public sector patients and 54.5% of the VWO patients met the criteria.

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

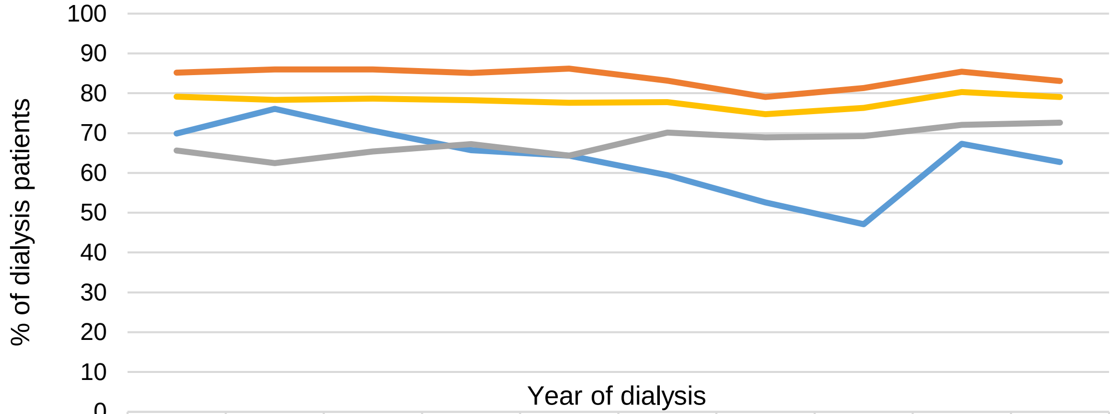


	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Public	59.4	57.8	61.7	57.1	50.3	49.7	49.1	47.9	45.2	42.6
VWO	60.7	72.6	81.3	78.9	62.2	64.3	56.0	54.5		
Overall	59.6	59.6	63.6	58.6	51.1	50.5	49.4	48.2	45.2	42.6

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 65.6% of its patients meeting the criteria in 2009 to 72.6% in 2018. The corresponding proportions for the public sector and VWO patients meeting the criteria were 62.7% and 83.1% respectively in 2018.

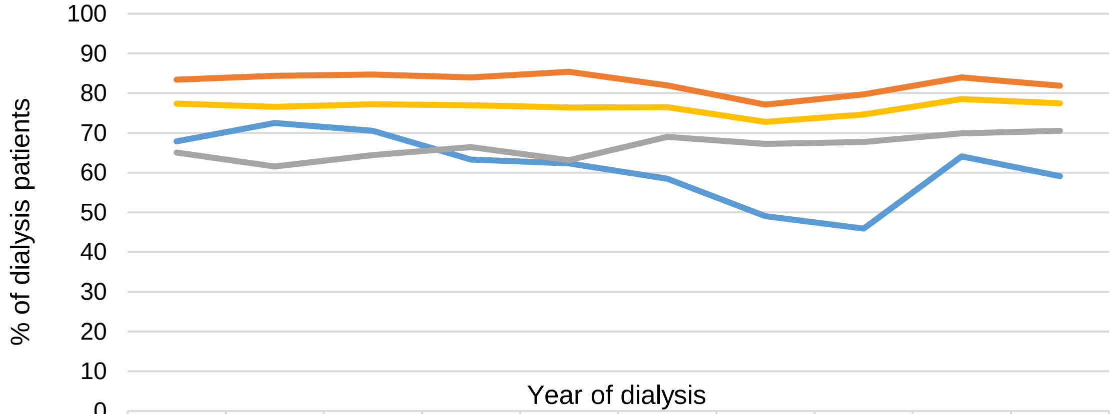
Similar trends were observed after stratification by ESA, a drug that stimulates the production of erythropoietin, a hormone produced primarily by the kidneys and plays a key role in the production of red blood cells (Figures 5.8.3b and 5.8.3c). In addition, the proportion of prevalent HD patients who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



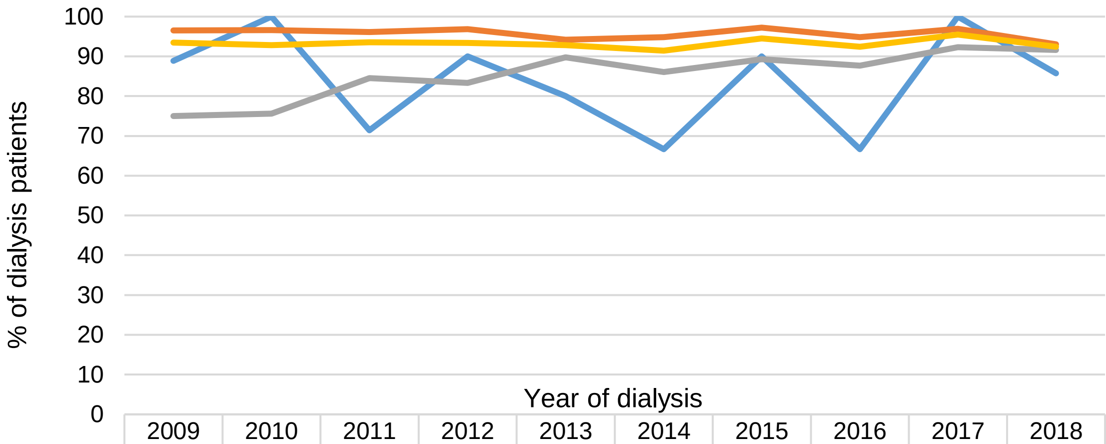
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Public	69.9	76.1	70.6	65.7	64.4	59.4	52.6	47.1	67.3	62.7
VWO	85.2	86.0	86.0	85.1	86.2	83.1	79.1	81.3	85.4	83.1
Private	65.6	62.5	65.4	67.3	64.3	70.1	68.9	69.2	72.0	72.6
Overall	79.1	78.3	78.7	78.2	77.6	77.7	74.7	76.4	80.3	79.0

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



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Public	67.9	72.5	70.5	63.3	62.3	58.4	49.0	45.9	64.1	59.1
VWO	83.4	84.4	84.7	83.9	85.4	81.9	77.1	79.7	84.0	81.9
Private	65.1	61.6	64.4	66.4	63.2	69.0	67.2	67.7	69.9	70.5
Overall	77.3	76.5	77.2	77.0	76.4	76.5	72.8	74.7	78.5	77.5

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

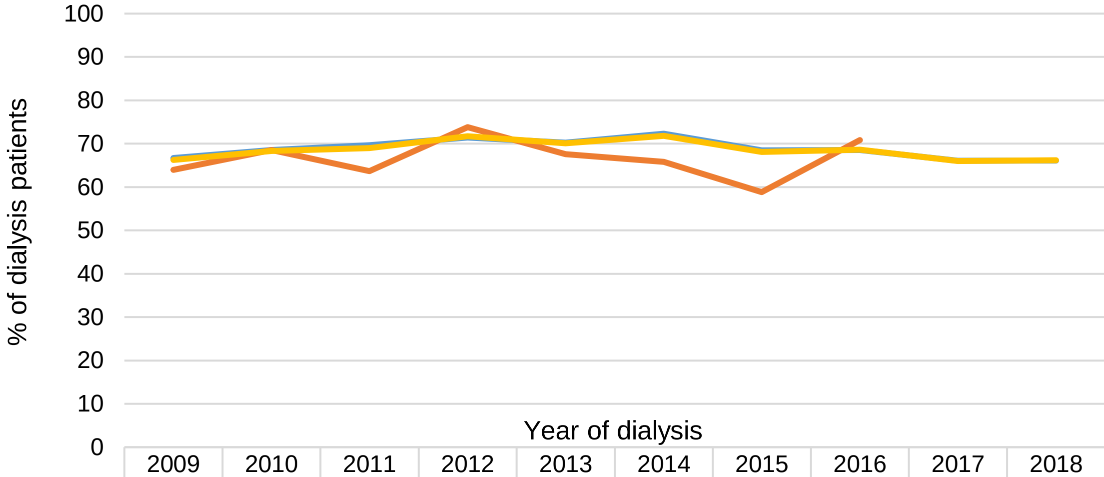


	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Public	88.9	100.0	71.4	90.0	80.0	66.7	90.0	66.7	100.0	85.7
VWO	96.6	96.6	96.1	96.9	94.2	94.8	97.2	94.8	96.9	93.0
Private	75.0	75.6	84.5	83.3	89.7	86.0	89.3	87.7	92.3	91.6
Overall	93.5	92.8	93.5	93.4	92.8	91.4	94.5	92.4	95.5	92.4

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). In 2016, 68.5% of the public sector patients and 70.8% of the VWO patients fulfilled the criteria.

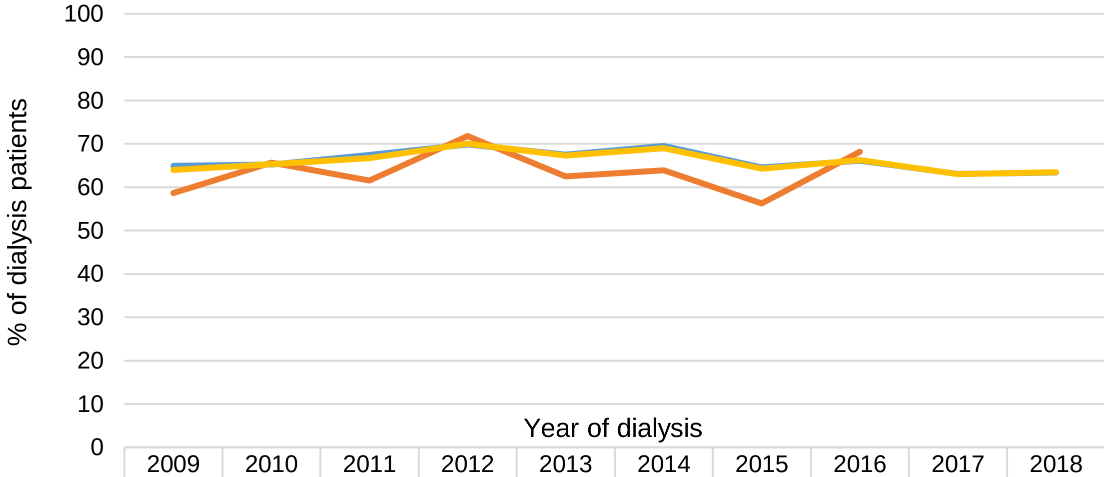
Similar trends were observed among PD patients who were taking ESA (Figure 5.8.4b). However, among PD patients who were not on ESA, all the patients from VWO fulfilled the criteria and their proportion was consistently higher than the public sector across the years (Figure 5.8.4c). Similar to HD patients,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



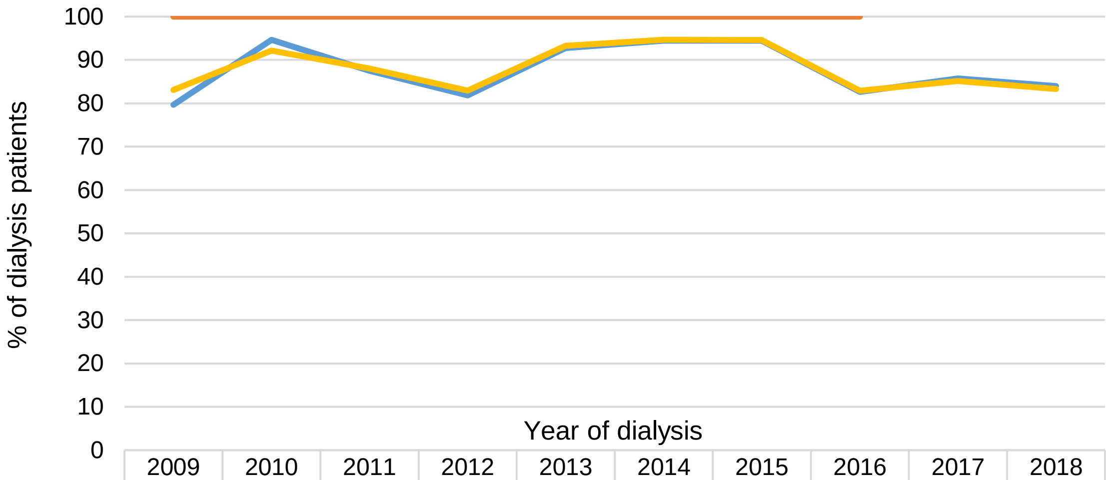
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Public	66.7	68.5	69.7	71.4	70.2	72.3	68.4	68.5	66.1	66.1
VWO	64.0	68.6	63.6	73.8	67.6	65.8	58.8	70.8		
Overall	66.3	68.3	69.0	71.7	70.1	71.8	68.1	68.6	66.0	66.1

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



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Public	64.9	65.2	67.4	69.8	67.5	69.5	64.6	66.1	63.0	63.4
VWO	58.7	65.6	61.5	71.8	62.5	63.9	56.3	68.2		
Overall	64.0	65.3	66.7	70.0	67.3	69.0	64.3	66.2	63.0	63.4

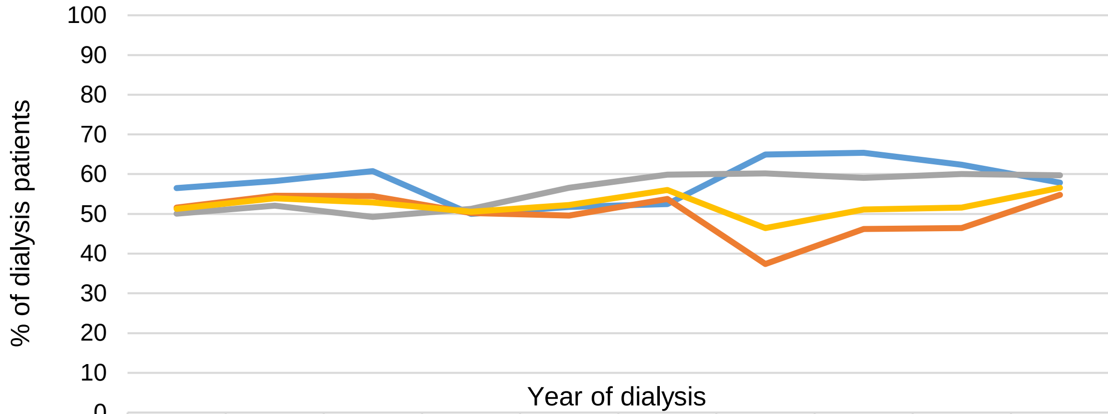
Figure 5.8.4c: Proportion of PD patients not on ESA with adequate management of anaemia (hb >=10 g/dL)



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Public	79.7	94.6	87.5	81.8	92.8	94.4	94.4	82.6	85.7	83.9
VWO	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		
Overall	83.1	92.2	88.1	82.9	93.2	94.7	94.6	82.9	85.1	83.3

The proportion of prevalent HD patients who passed the adequate management of mineral and bone disease criteria of corrected serum Ca >2.10 mmol and <2.37 mmol was fairly similar across the three broad service providers in 2009 to 2014 (Figure 5.8.5). Although the proportion of patients passing the criteria was distinctly highest for the public sector followed by the private sector and then the VWO in 2015 to 2017, the disparities narrowed over time and the proportions of patients passing the criteria were 57.8%, 54.8% and 59.7% for the public sector, VWO and private sector respectively in 2018.

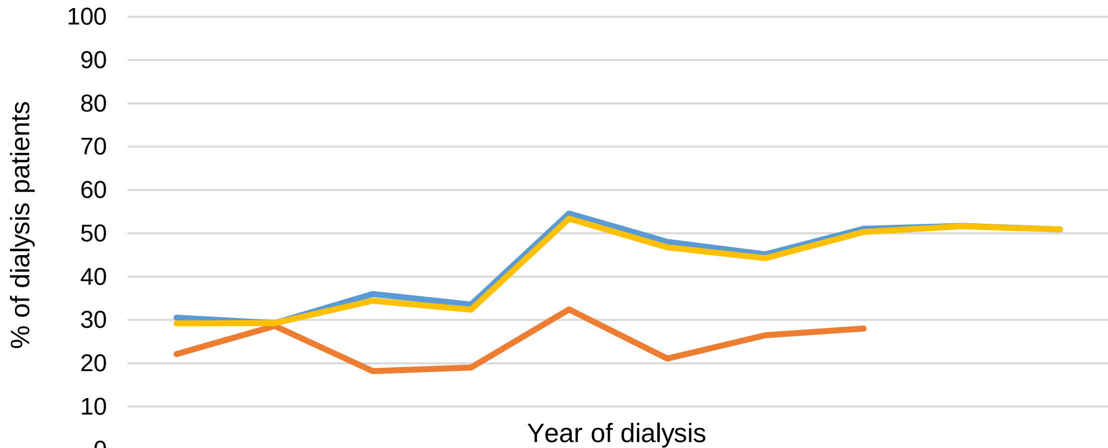
Figure 5.8.5: Proportion of HD patients with adequate management of mineral and bone disease (corrected serum Ca >2.10 mmol/L and <2.37 mmol/L)



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Public	56.5	58.2	60.8	50.0	51.7	52.5	64.9	65.4	62.4	57.8
VWO	51.6	54.6	54.5	50.2	49.6	53.8	37.4	46.2	46.4	54.8
Private	50.1	52.1	49.2	51.2	56.6	59.9	60.2	59.0	60.0	59.7
Overall	51.3	53.9	52.9	50.6	52.2	56.0	46.4	51.1	51.6	56.6

The proportion of prevalent PD patients who passed the adequate management of mineral and bone disease criteria of corrected serum Ca >2.10 mmol and <2.37 mmol was consistently higher for the public sector than the VWO since 2009 (Figure 5.8.6). In 2016, 51.1% of the public sector patients and 28.0% of the VWO patients passed the criteria.

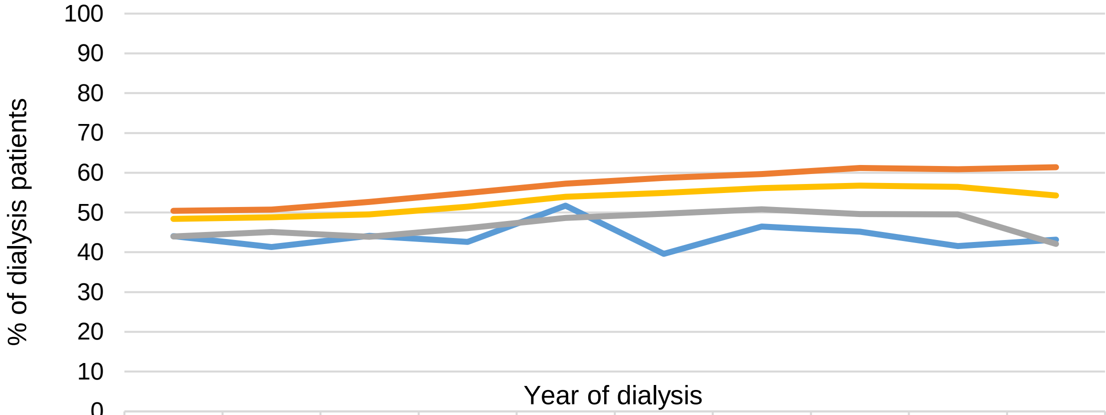
Figure 5.8.6: Proportion of PD patients with adequate management of mineral and bone disease (corrected serum Ca >2.10 mmol/L and <2.37 mmol/L)



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Public	30.5	29.3	36.0	33.6	54.6	48.0	45.1	51.1	51.7	50.9
VWO	22.1	28.6	18.2	19.0	32.4	21.1	26.5	28.0		
Overall	29.2	29.2	34.4	32.4	53.4	46.8	44.3	50.3	51.7	50.9

The proportion of prevalent HD patients who passed the adequate management of mineral and bone disease criteria of serum PO_4 >1.13 mmol and <1.78 mmol was consistently higher for the VWO than the public and private sectors across the years (Figure 5.8.7). In 2018, the proportions of patients passing the criteria were 43.1%, 61.4% and 42.1% for the public sector, VWO and private sector respectively.

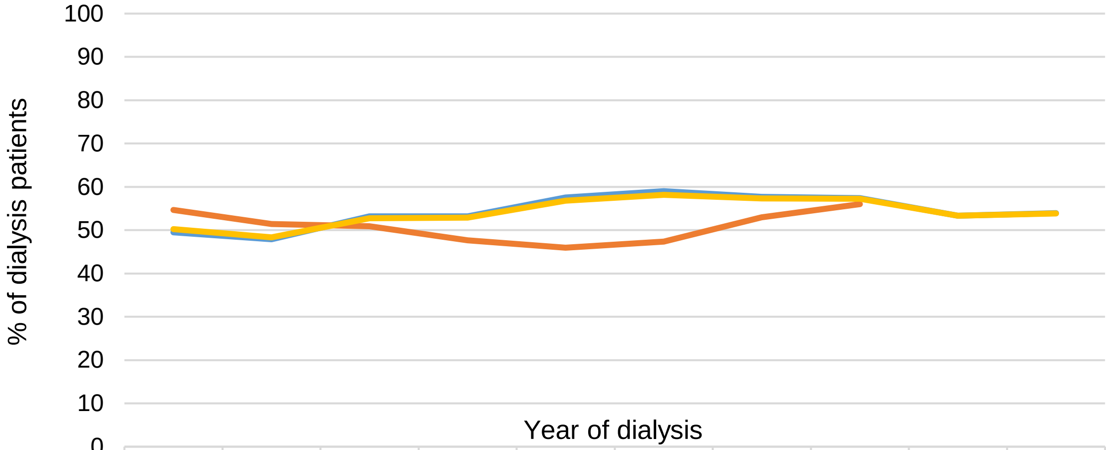
Figure 5.8.7: Proportion of HD patients with adequate management of mineral and bone disease (serum PO_4 >1.13 mmol/L and <1.78 mmol/L)



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Public	44.1	41.3	44.1	42.6	51.7	39.6	46.5	45.2	41.6	43.1
VWO	50.4	50.8	52.7	54.9	57.3	58.7	59.7	61.2	60.9	61.4
Private	44.0	45.1	43.9	46.1	48.6	49.7	50.8	49.6	49.6	42.1
Overall	48.4	48.8	49.5	51.4	53.9	54.9	56.1	56.8	56.5	54.2

The proportion of prevalent PD patients who passed the adequate management of mineral and bone disease criteria of serum PO_4 >1.13 mmol and <1.78 mmol was consistently higher for the public sector than the VWO from 2011 onwards (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. The corresponding proportion for the public sector patients meeting the criteria was 57.4% in 2016.

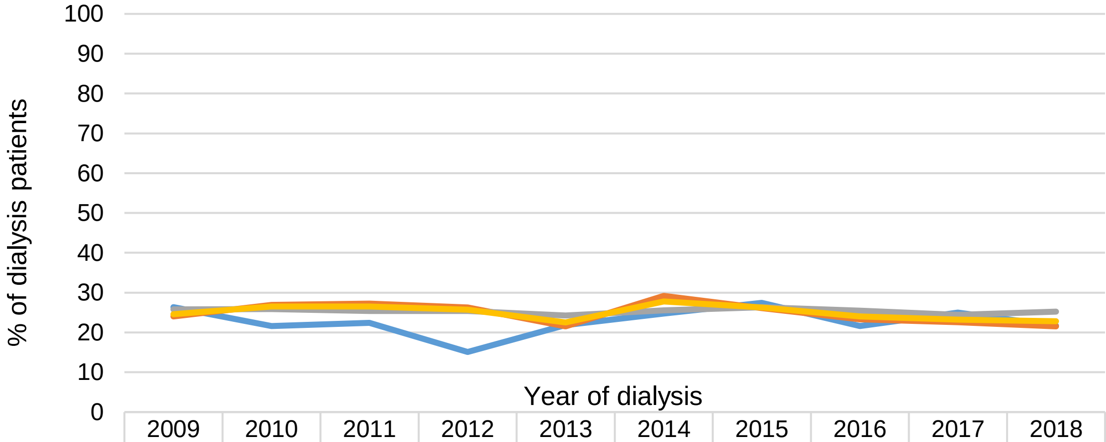
Figure 5.8.8: Proportion of PD patients with adequate management of mineral and bone disease (serum PO_4 >1.13 mmol/L and <1.78 mmol/L)



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Public	49.5	47.9	53.2	53.2	57.6	59.0	57.7	57.4	53.4	53.9
VWO	54.7	51.4	50.9	47.6	45.9	47.4	52.9	56.0		
Overall	50.3	48.3	52.7	52.9	56.8	58.1	57.3	57.2	53.3	53.8

The proportion of prevalent HD patients who passed the adequate management of mineral and bone disease criteria of serum iPTH >16.3 mmol and <33.0 mmol was fairly similar across the three broad service providers with the exception of the period 2010 to 2012, where the proportion of public sector patients passing the criteria was clearly lower than those for the VWO and private sector (Figure 5.8.9). In 2018, the proportions of patients passing the criteria were 21.6%, 21.5% and 25.2% for the public sector, VWO and private sector respectively.

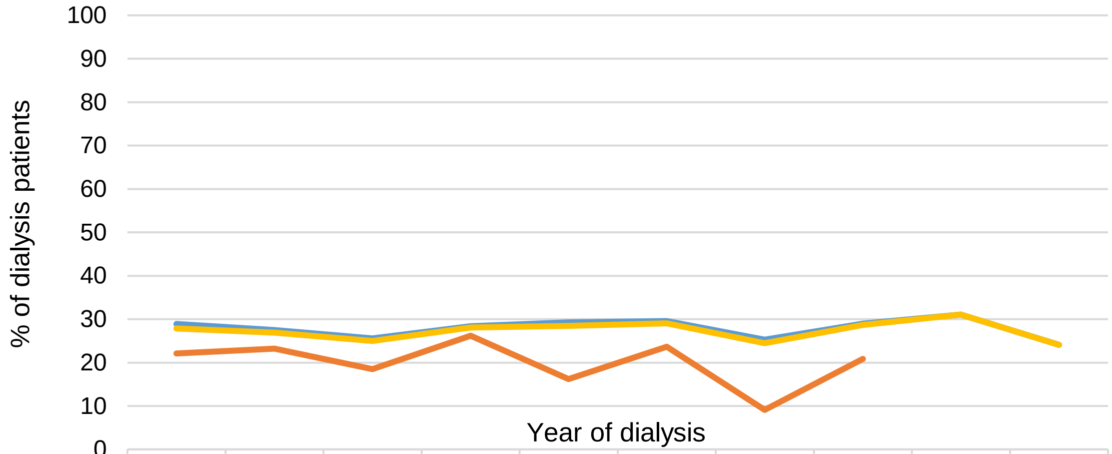
Figure 5.8.9: Proportion of HD patients with adequate management of mineral and bone disease (serum iPTH >16.3 mmol/L and <33.0 mmol/L)



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Public	26.4	21.6	22.4	15.1	21.8	24.7	27.4	21.6	25.0	21.6
VWO	24.0	26.9	27.2	26.2	21.5	29.2	26.1	23.3	22.6	21.5
Private	25.8	25.8	25.4	25.4	24.3	25.6	26.3	25.5	24.4	25.2
Overall	24.6	26.5	26.5	25.7	22.5	27.8	26.2	24.0	23.3	22.8

The proportion of prevalent PD patients who passed the adequate management of mineral and bone disease criteria of serum iPTH >16.3 mmol and <33.0 mmol was consistently higher for the public sector than VWO since 2009 (Figure 5.8.10). In 2016, 29.0% of the public sector patients and 20.8% of the VWO patients passed the criteria.

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



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Public	28.9	27.5	25.6	28.4	29.2	29.5	25.3	29.0	31.1	24.1
VWO	22.1	23.2	18.5	26.2	16.2	23.7	9.1	20.8		
Overall	27.8	26.9	25.0	28.1	28.5	29.1	24.4	28.7	31.1	24.1

5.9 Incidence of kidney transplant

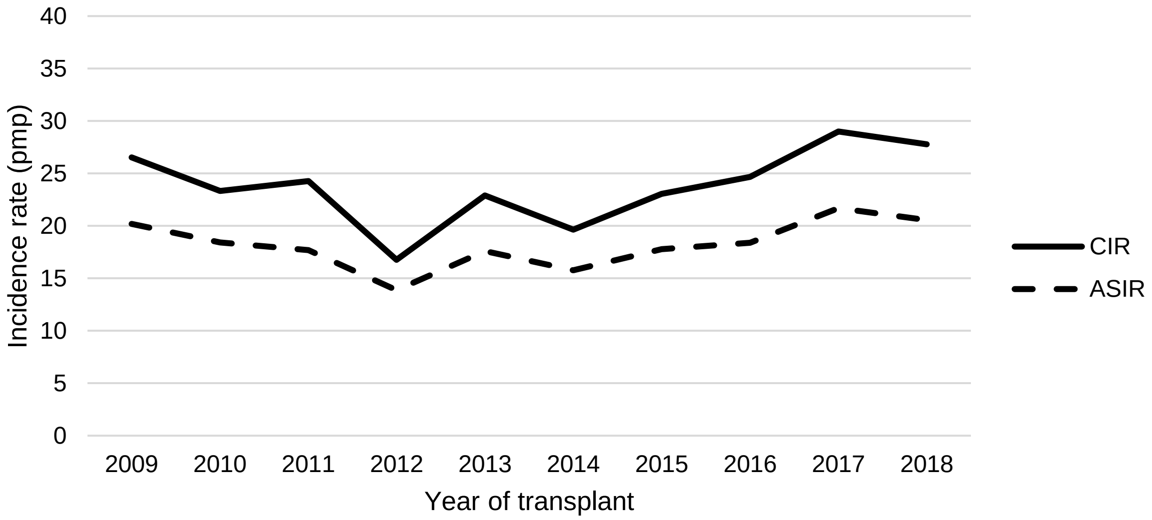
The incidence rate in each year was computed by taking the number of new kidney transplants in a year, divided by the number of Singapore residents in the same year. The count was based on the date of nephrectomy. The data had been cleaned with reference to data from the National Organ Transplant Unit. 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 decreased from 99 in 2009 to 64 in 2012, but increased thereafter to 111 in 2018 (Table 5.9.1 and Figure 5.9.1). Correspondingly, the CIR and ASIR dropped to the lowest point of 16.8 pmp and 13.9 pmp respectively in 2012, but increased to almost the same rates as those in 2009 by 2018.

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

Year of transplant	Number	CIR	ASIR
2009	99	26.5	20.2
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	111	27.8	20.6
P for trend	-	0.365	0.392

Figure 5.9.1: Incidence rate (pmp) of kidney transplant



The majority of the new kidney transplant patients were aged 40 to 59 years. In 2018, close to 60% of the patients were in this age band (Table 5.9.2).

The median age at kidney transplant fluctuated between 43 years and 52 years in 2009 to 2018 (Figure 5.9.2a).

Due to the small number of kidney transplants done each year, the CIR of kidney transplant for every age group fluctuated randomly over the years (Figure 5.9.2b).

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
2009	2	2.0	2.1	11	11.1	21.3	9	9.1	14.6	34	34.3	53.5
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	7.2	14.6	16	14.4	27.3	32	28.8	52.3
P for trend	-	-	0.961	-	-	0.610	-	-	0.140	-	-	0.772

Year of transplant	Age 50-59			Age 60-69			Age 70-79			Age 80+		
	Number	%	CIR	Number	%	CIR	Number	%	CIR	Number	%	CIR
2009	36	36.4	67.0	7	7.1	24.5	0	0.0	0.0	0	0.0	0.0
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	30	27.0	48.9	20	18.0	41.3	3	2.7	13.1	0	0.0	0.0
P for trend	-	-	0.940	-	-	0.688	-	-	-	-	-	-

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

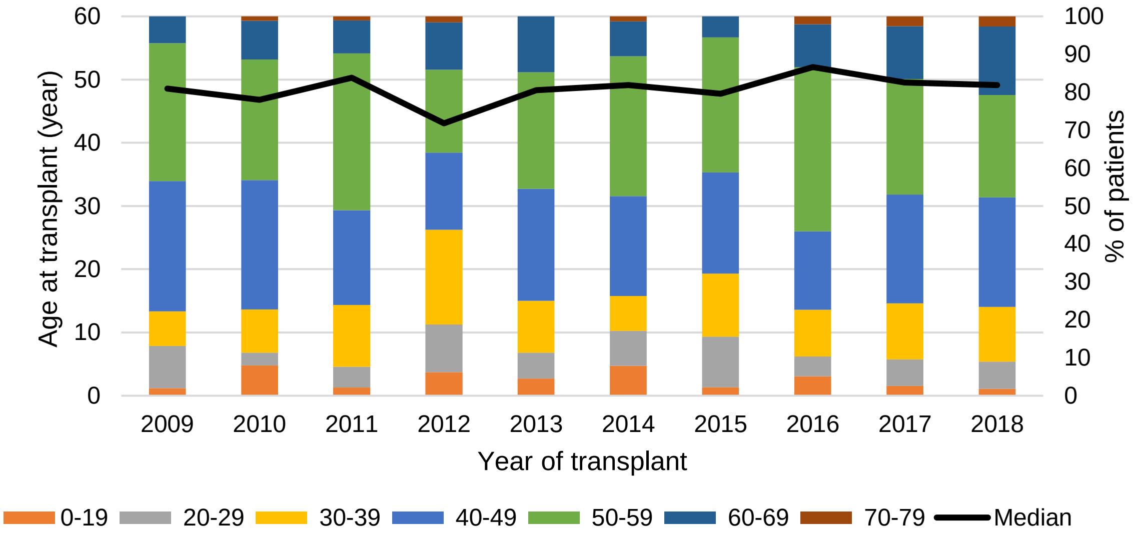
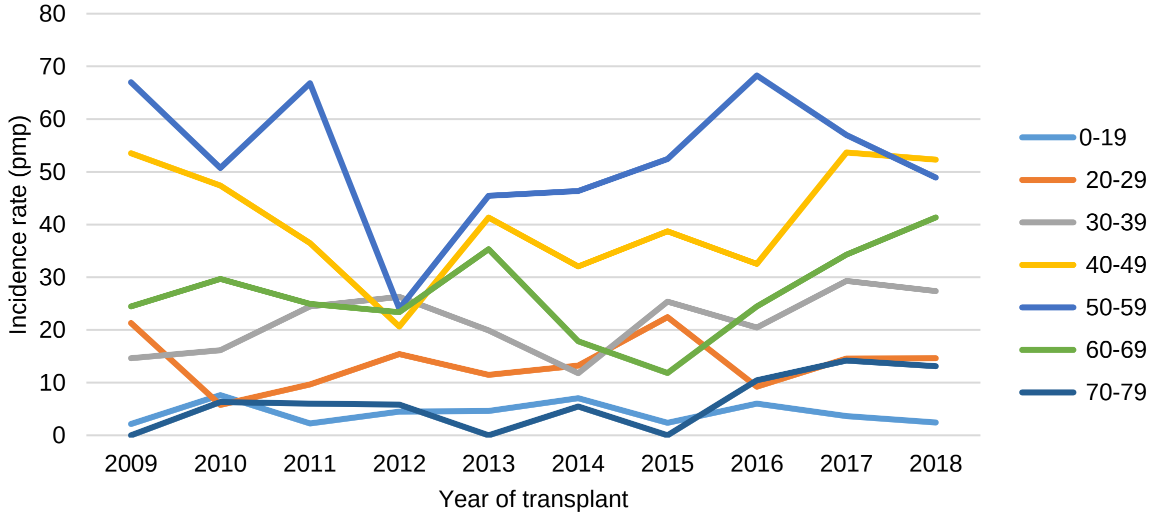
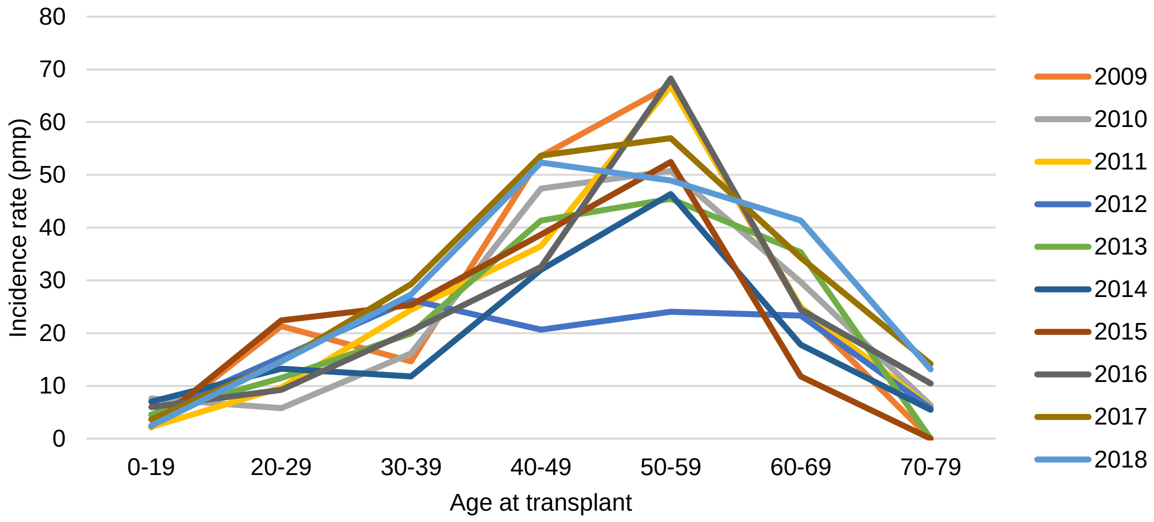


Figure 5.9.2b: Age-specific incidence rate (pmp) of kidney transplant across years



The CIR 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 and for 2018 where the majority of the transplants came from the 40-49 years age group (Figure 5.9.3).

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



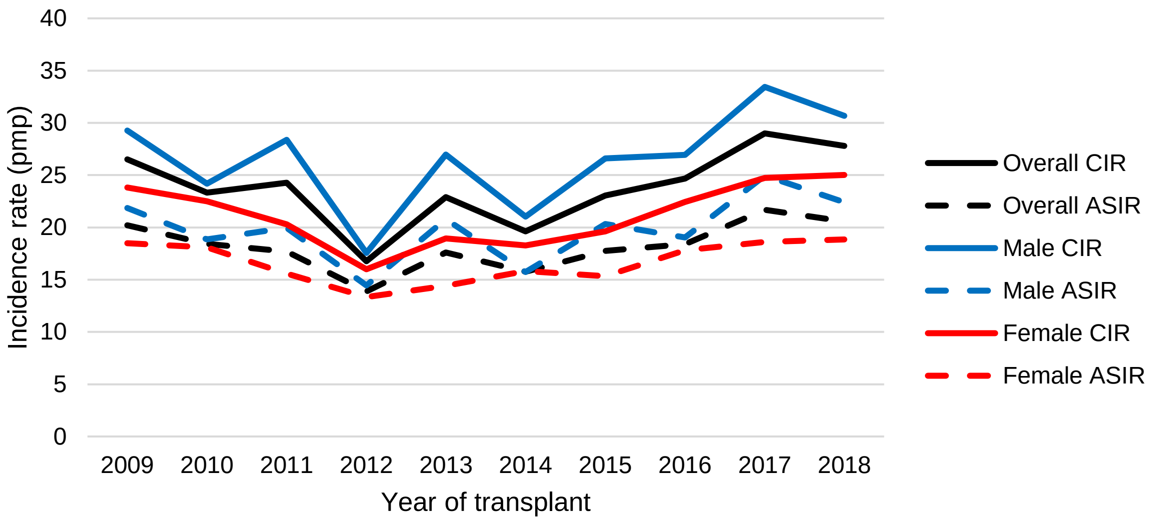
The ASIRs of kidney transplant were generally higher among males than females across the years (Table 5.9.3 and Figure 5.9.4). In 2018, the ASIR was 22.4 pmp and 18.8 pmp for males and females respectively. The ASIRs for both genders fluctuated randomly over the years due to the small number of kidney transplants.

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

Male				
Year of transplant	**Number**	**%**	**CIR**	**ASIR**
2009	54	54.5	29.3	21.9
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	60	54.1	30.7	22.4
P for trend	-	-	0.350	0.403

Female				
Year of transplant	**Number**	**%**	**CIR**	**ASIR**
2009	45	45.5	23.8	18.5
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	51	45.9	25.0	18.8
P for trend	-	-	0.442	0.529

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

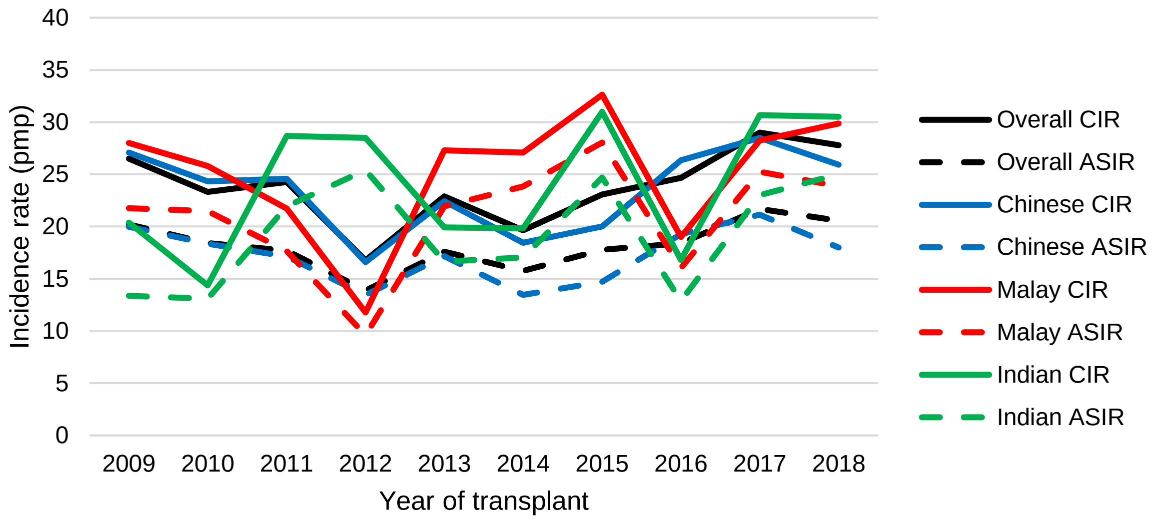


There was no ethnic group with distinctly or consistently higher or lower incidence rates of kidney transplant across the years (Table 5.9.4 and Figure 5.9.5). In 2018, the ASIR was 18.0 pmp, 23.9 pmp and 25.0 pmp for Chinese, Malays and Indians respectively. The ASIRs for all the three ethnic groups 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**
2009	75	75.8	27.1	20.0
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	77	69.4	25.9	18.0
P for trend	-	-	0.692	0.828
Malay				
Year of transplant	**Number**	**%**	**CIR**	**ASIR**
2009	14	14.1	28.0	21.7
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	14.4	29.9	23.9
P for trend	-	-	0.536	0.423
Indian				
Year of transplant	**Number**	**%**	**CIR**	**ASIR**
2009	7	7.1	20.4	13.4
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	11	9.9	30.5	25.0
P for trend	-	-	0.226	0.198

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



Unlike new patients on definitive dialysis where DN was the most common cause of CKD5 (Table 5.4.6), GN was the main cause of CKD5 among new kidney transplant patients (Table 5.9.5). The proportion of new kidney transplants with GN was 61.3% in 2018, while the proportion of new kidney transplants with DN was 15.3%. 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[9,10].

Table 5.9.5: Incidence number of kidney transplant by etiology

Year of transplant	DN		GN		Others	
	Number	%	Number	%	Number	%
2009	19	19.2	61	61.6	19	19.2
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	15.3	68	61.3	26	23.4

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

Most of the new kidney transplants were done locally (71.1%) in 2018, with slightly higher contribution from living (36.9%) donors than deceased donors (34.2%). Transplants done overseas were not further stratified into living or deceased donor as the Ministry of Home Affairs does not track the death status of foreign donors.

Table 5.9.6: Incidence number of kidney transplant by location of nephrectomy and type of donor

Year of transplant	Local transplant				Overseas transplant		Unknown	
	Living donor		Deceased donor					
	Number	%	Number	%	Number	%	Number	%
2009	28	28.3	41	41.4	30	30.3	0	0
2010	25	28.4	36	40.9	27	30.7	0	0
2011	31	33.7	36	39.1	25	27.2	0	0
2012	28	43.8	23	35.9	13	20.3	0	0
2013	35	39.8	34	38.6	19	21.6	0	0
2014	41	53.9	17	22.4	18	23.7	0	0
2015	40	44.4	32	35.6	18	20.0	0	0
2016	32	33.0	40	41.2	25	25.8	0	0
2017	41	35.7	52	45.2	21	18.3	1	0.9
2018	41	36.9	38	34.2	32	28.8	0	0

5.10 Prevalence of kidney transplant

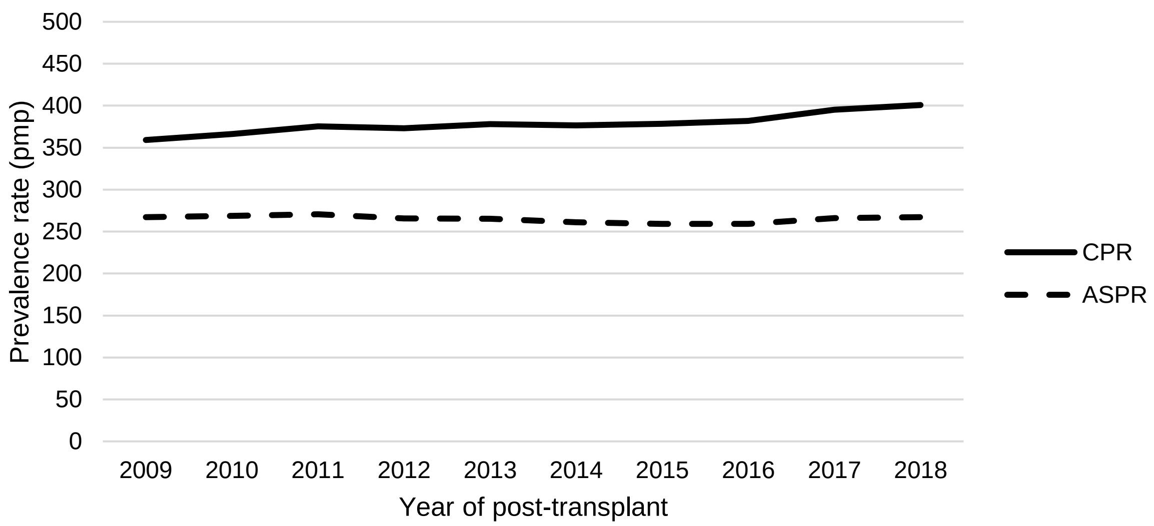
The prevalence rate in each year was computed by taking the cumulative number of surviving (existing and new) patients with kidney transplant in a year, divided by the number of Singapore residents in the same year. Patients (receiving the kidney) were categorised into 10-year age groups and age standardisation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

Unlike the incidence trend of kidney transplant which showed some fluctuations over the years (Table 5.9.1 and Figure 5.9.1), the number of prevalent patients with kidney transplant increased consistently since 2009, 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 259.2 pmp and 270.6 pmp during this period, implying that the rise in new patients undergoing kidney transplant was fairly similar to the drop in prevalent patients from those who died, after adjusting for age. The comparison between CPR and ASPR suggests that the rise in prevalence is largely due to Singapore's ageing population.

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

Year of post-transplant	Number	CPR	ASPR
2009	1341	359.2	267.1
2010	1381	366.1	268.7
2011	1423	375.5	270.6
2012	1425	373.3	265.8
2013	1454	378.2	265.2
2014	1457	376.4	261.0
2015	1477	378.5	259.2
2016	1502	381.8	259.2
2017	1567	395.1	265.9
2018	1601	400.8	267.1
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. In 2018, close to two-thirds of the patients were in this age band (Table 5.10.2).

The median age among prevalent kidney transplant patients increased linearly from 52.3 years in 2009 to 57.3 years in 2018 (Figure 5.10.2a).

The age distribution of prevalent kidney transplant patients shifted away from age 30-39 years, 40-49 years and 50-59 years to 0-19 years, 20-29 years, 60-69 years, 70-79 years and 80+ years over the years (Figure 5.10.2b).

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
2009	16	1.2	17.2	46	3.4	89.1	134	10.0	218.0	373	27.8	587.0
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	282	17.6	461.2
P for trend	-	-	0.001	-	-	<0.001	-	-	<0.001	-	-	0.003

Year of post-transplant	Age 50-59			Age 60-69			Age 70-79			Age 80+		
	Number	%	CPR	Number	%	CPR	Number	%	CPR	Number	%	CPR
2009	495	36.9	921.1	247	18.4	863.9	29	2.2	194.6	1	0.1	15.4
2010	533	38.6	965.9	265	19.2	874.0	36	2.6	228.3	3	0.2	43.4
2011	573	40.3	1007.7	289	20.3	901.7	44	3.1	263.6	3	0.2	41.0
2012	559	39.2	960.2	320	22.5	933.5	54	3.8	314.0	3	0.2	38.7
2013	556	38.2	936.2	359	24.7	975.3	60	4.1	340.7	3	0.2	36.5
2014	547	37.5	905.8	392	26.9	998.2	63	4.3	344.1	3	0.2	34.4
2015	529	35.8	867.0	410	27.8	969.5	77	5.2	418.8	5	0.3	53.5
2016	514	34.2	835.5	422	28.1	938.0	105	7.0	547.6	4	0.3	40.9
2017	510	32.5	830.0	459	29.3	983.7	123	7.8	581.7	6	0.4	59.2
2018	497	31.0	810.3	483	30.2	998.4	143	8.9	624.8	8	0.5	74.9
P for trend	-	-	0.001	-	-	0.002	-	-	<0.001	-	-	0.011

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

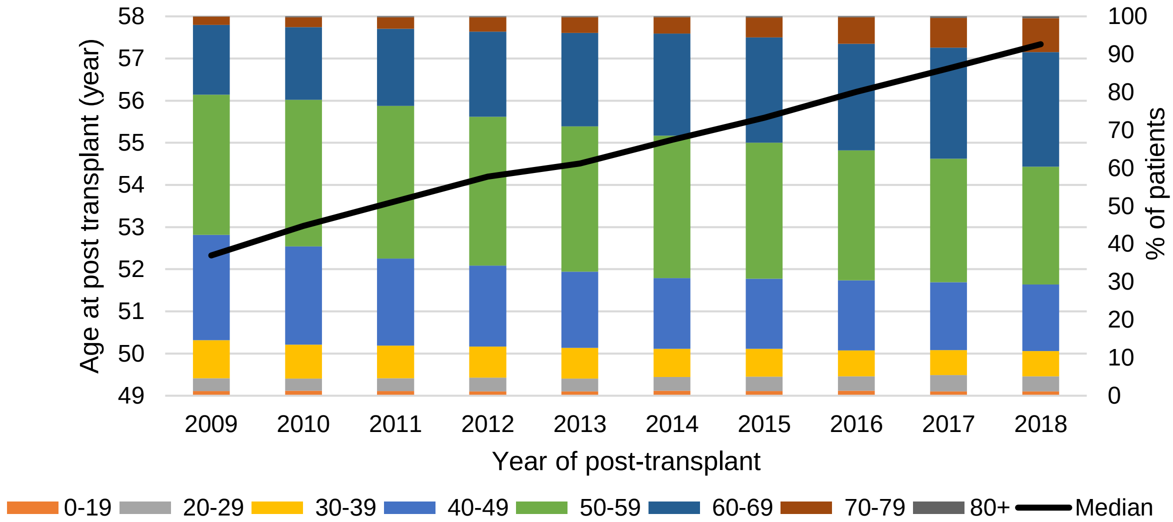
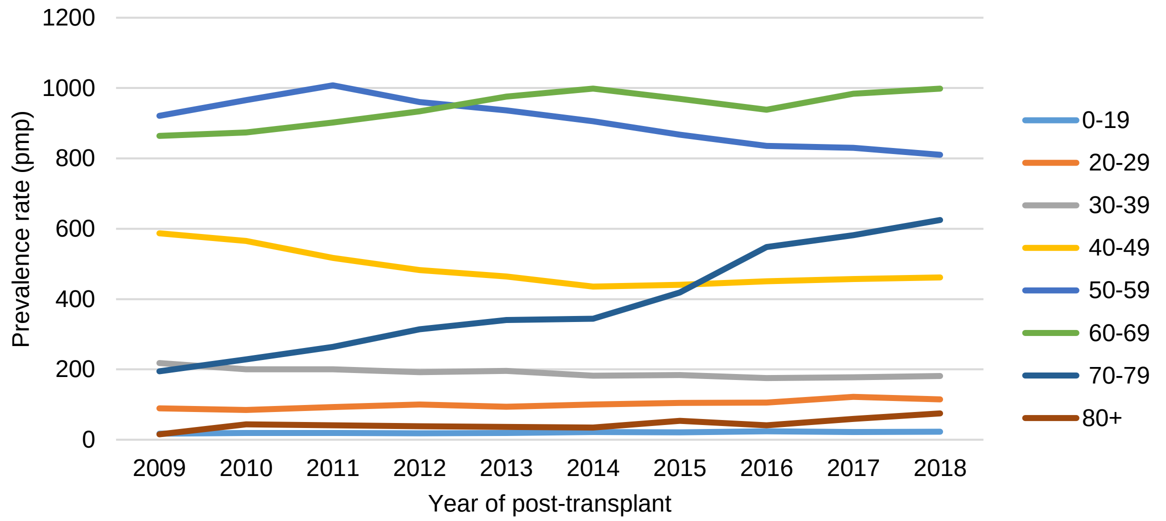
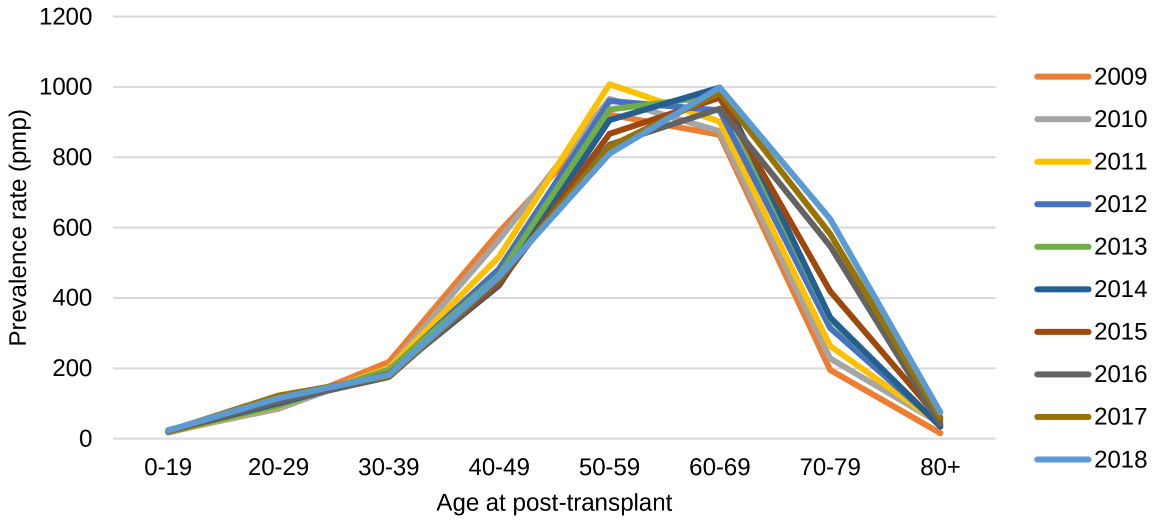


Figure 5.10.2b: Age-specific prevalence rate (pmp) of kidney transplant across years



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



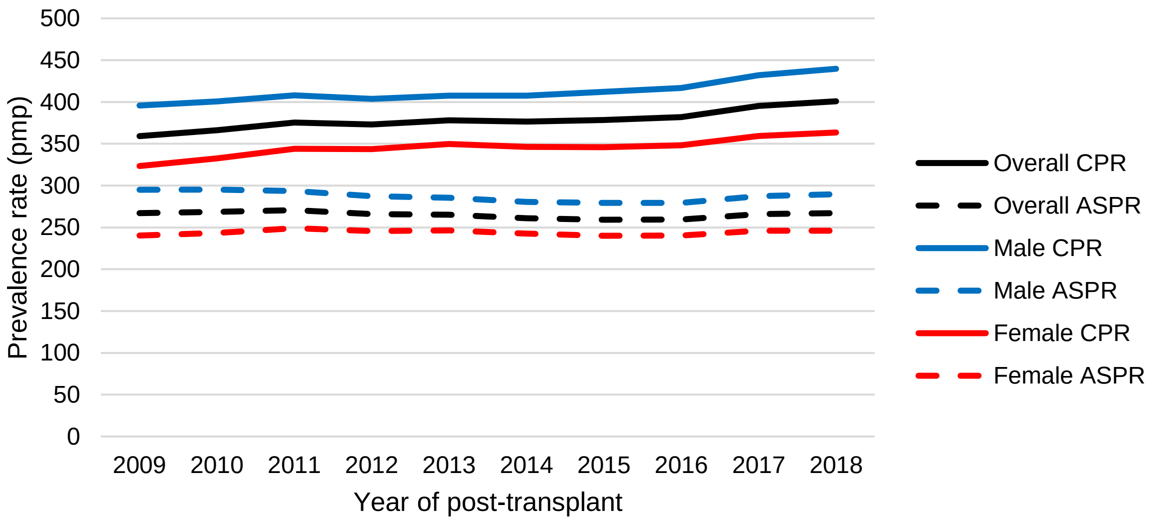
The ASPRs of kidney transplant were consistently higher among males than females across the years (Table 5.10.3 and Figure 5.10.4). In 2018, the ASPR was 289.6 pmp and 246.2 pmp for males and females respectively. The ASPRs for both genders remained stable over the years.

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

Male				
Year of post-transplant	**Number**	**%**	**CPR**	**ASPR**
2009	730	54.4	395.8	295.0
2010	746	54.0	400.8	295.2
2011	762	53.5	407.9	293.6
2012	759	53.3	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	289.6
P for trend	-	-	<0.001	0.065

Year of post-transplant	Female			
	Number	%	CPR	ASPR
2009	611	45.6	323.4	240.4
2010	635	46.0	332.4	243.4
2011	661	46.5	344.1	249.0
2012	666	46.7	343.7	245.6
2013	683	47.0	349.7	246.5
2014	682	46.8	346.5	242.7
2015	687	46.5	345.9	240.0
2016	698	46.5	348.3	240.3
2017	727	46.4	359.5	246.0
2018	741	46.3	363.5	246.2
P for trend	-	-	<0.001	0.917

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

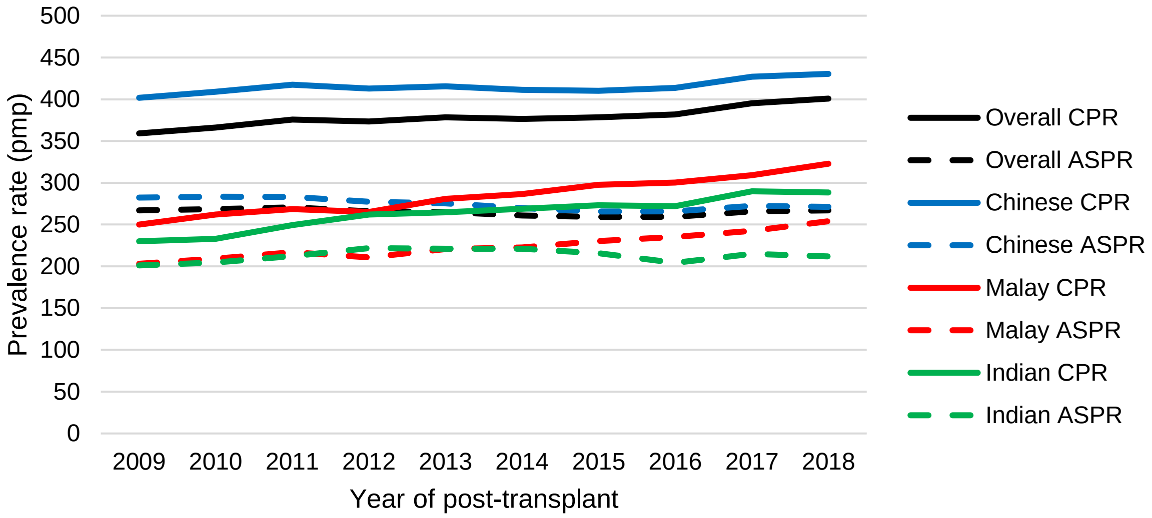


The ASPRs of kidney transplant were consistently higher among Chinese than Malays and Indians across the years (Table 5.10.4 and Figure 5.10.5). While the ASPR for Chinese decreased significantly from 282.3 pmp in 2009 to 271.2 pmp in 2018 (p=0.004), the ASPR for Malays increased significantly from 203.1 pmp in 2009 to 254.0 pmp in 2018 (p<0.001) and the ASPR for Indians fluctuated between 201.2 pmp and 221.8 pmp over the years.

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

Chinese				
Year of post-transplant	**Number**	**%**	**CPR**	**ASPR**
2009	1113	83.0	401.8	282.3
2010	1143	82.8	409.1	283.4
2011	1172	82.4	417.3	283.1
2012	1169	82.0	412.8	277.3
2013	1186	81.6	415.6	275.6
2014	1182	81.1	411.2	269.7
2015	1189	80.5	410.0	265.7
2016	1209	80.5	413.6	265.7
2017	1259	80.3	427.0	272.3
2018	1278	79.8	430.4	271.2
P for trend	-	-	0.010	0.004
Malay				
Year of post-transplant	**Number**	**%**	**CPR**	**ASPR**
2009	125	9.3	250.0	203.1
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	173	10.8	322.9	254.0
P for trend	-	-	<0.001	<0.001
Indian				
Year of post-transplant	**Number**	**%**	**CPR**	**ASPR**
2009	79	5.9	230.1	201.2
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	104	6.5	288.5	211.9
P for trend	-	-	<0.001	0.435

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



The proportion of prevalent kidney transplant patients with DN was lower than those with GN, with fewer than 10% of them having DN and about 70% having GN in the past decade (Table 5.10.5). However, while the proportion of prevalent kidney transplant patients with DN increased consistently since 2009, those with GN decreased. These imply that although more prevalent kidney transplant patients with GN received transplant than those with DN, the gap between them narrowed over the years.

Table 5.10.5: Prevalence number of kidney transplant by etiology

Year of post-transplant	DN		GN		Others	
	Number	%	Number	%	Number	%
2009	97	7.2	965	72.0	279	20.8
2010	104	7.5	985	71.3	292	21.1
2011	107	7.5	1011	71.0	305	21.4
2012	113	7.9	1012	71.0	300	21.1
2013	116	8.0	1029	70.8	309	21.3
2014	122	8.4	1020	70.0	315	21.6
2015	134	9.1	1023	69.3	320	21.7
2016	141	9.4	1034	68.8	327	21.8
2017	152	9.7	1073	68.5	342	21.8
2018	156	9.7	1091	68.1	354	22.1

Most of the prevalent kidney transplants were done locally (72.3%) in 2018, with a slightly higher contribution from deceased donors (39.3%) than living donors (33.0%). Transplants done overseas were not further stratified into living or deceased donor as the Ministry of Home Affairs does not track the death status of foreign donors.

Table 5.10.6: Prevalence number of kidney transplant by type of donor

Year of post-transplant	Local transplant				Overseas transplant		Unknown	
	Living donor		Deceased donor					
	Number	%	Number	%	Number	%	Number	%
2009	350	26.1	583	43.5	408	30.4	0	0.0
2010	363	26.3	592	42.9	426	30.8	0	0.0
2011	388	27.3	602	42.3	433	30.4	0	0.0
2012	404	28.4	589	41.3	432	30.3	0	0.0
2013	429	29.5	591	40.6	434	29.8	0	0.0
2014	455	31.2	571	39.2	431	29.6	0	0.0
2015	480	32.5	570	38.6	427	28.9	0	0.0
2016	486	32.4	585	38.9	431	28.7	0	0.0
2017	509	32.5	615	39.2	442	28.2	1	0.1
2018	528	33.0	629	39.3	443	27.7	1	0.1

5.11 Survival of kidney transplant

Patient survival: the unadjusted survival rate and 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 31 March 2019, the date until which the death status of all patients registered in the SRR were updated. Median survival duration is indicated as “not reached (NR)” if more than half of the patients were still alive as of 31 March 2019.

Graft survival: the unadjusted survival rate and survival duration of new kidney transplant 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 31 March 2019. 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 31 March 2019. Grafts that stopped functioning within 30 days were excluded from this section.

In addition, Cox regression model was used to adjust for the effects of potential confounders on the survival of patients simultaneously in Table 5.11.11 and 5.11.12.

Graft survival were high at 97.3%, 89.0% and 75.6% for one-, five- and ten-year post-transplant (Table 5.11.1). Patient survival was even higher and outperformed survival of patients on dialysis (Table 5.7.1).

Table 5.11.1: Survival of kidney transplant by outcome

	Graft	Patient
1-year survival (%)	97.3	98.2
5-year survival (%)	89.0	93.3
10-year survival (%)	75.6	85.2
Median survival (years)	19.6	NR

Table 5.11.2 excludes kidney transplants done overseas as the Ministry of Home Affairs does not track the death status of foreign donors. Survival was significantly better among transplants from living donors than deceased donors ($p<0.001$ for graft survival; $p=0.001$ for patient survival).

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

	Graft		Patient	
	Living	Deceased	Living	Deceased
1-year survival (%)	99.1	95.9	99.1	97.5
5-year survival (%)	93.8	85.4	95.9	91.4
10-year survival (%)	82.3	68.3	89.3	81.8
Median survival (years)	19.6	16.7	NR	NR

Younger patients aged below 60 years had significantly better survival than older patients aged 60 years or older (p=0.003 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 (%)	97.6	98.5	94.1	94.7
5-year survival (%)	89.5	94.0	84.1	87.0
10-year survival (%)	76.2	86.2	69.0	73.4
Median survival (years)	NR	NR	14.8	14.8

Survival was 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 (%)	97.1	98.1	97.5	98.3
5-year survival (%)	88.3	93.7	89.8	92.9
10-year survival (%)	74.0	85.2	77.5	85.2
Median survival (years)	19.6	NR	19.5	NR

Chinese had significantly better graft survival than Malays (p=0.002) and Indians (p<0.001). Although Chinese also had significant better patient survival than Indians (p=0.019), patient survival was fairly similar between Chinese and Malays (Table 5.11.5).

Table 5.11.5: Survival of kidney transplant by ethnicity and outcome

	Chinese		Malay		Indian	
	Graft	Patient	Graft	Patient	Graft	Patient
1-year survival (%)	97.5	98.4	95.8	96.7	97.8	98.5
5-year survival (%)	90.3	93.7	84.0	92.2	83.0	90.7
10-year survival (%)	77.8	85.4	68.0	86.5	60.3	78.8
Median survival (years)	NR	NR	16.2	NR	12.7	NR

Patients without DN had significantly better survival than those with DN (p<0.001 for graft survival; p<0.001 for 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	96.0	96.9
5-year survival (%)	90.0	94.4	81.3	85.6
10-year survival (%)	76.9	86.7	65.6	74.0
Median survival (years)	NR	NR	12.3	15.5

Patients without IHD had significantly better 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 (%)	97.3	98.4	97.6	97.6
5-year survival (%)	90.0	94.6	84.4	87.5
10-year survival (%)	76.7	86.7	69.6	77.4
Median survival (years)	NR	NR	13.9	16.3

Patients without CVD had significantly better survival than those with CVD (p=0.030 for graft survival; p=0.001 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 (%)	97.7	98.5	88.3	92.7
5-year survival (%)	89.4	93.7	85.1	91.1
10-year survival (%)	75.9	85.7	72.2	78.5
Median survival (years)	NR	NR	12.3	14.8

Patients without PVD had significantly better survival than those with PVD (p=0.023 for graft survival; p=0.003 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 (%)	97.5	98.3	93.1	96.6
5-year survival (%)	89.4	93.8	84.4	88.0
10-year survival (%)	75.9	85.6	71.9	80.0
Median survival (years)	NR	NR	12.3	12.9

Patients without cancer seemed to have better survival than those with cancer (Table 5.11.10). However, the survival difference between patients with and without cancer was not statistically significant due to the small number of patients with cancer and small number of patients who died regardless of cancer status.

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

	No cancer		Cancer	
	Graft	**Patient**	**Graft**	**Patient**
1-year survival (%)	97.6	98.6	95.8	95.8
5-year survival (%)	90.1	94.4	79.6	86.2
10-year survival (%)	76.7	86.3	63.4	73.2
Median survival (years)	NR	NR	17.2	NR

Table 5.11.11 excludes kidney transplants done overseas as the Ministry of Home Affairs does not track the death status of foreign donors. 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 simultaneously. However, CVD and PVD were no longer significant predictors of death in the multivariable analysis.

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
Donor type			
Local living	Reference		<0.001
Local deceased	2.21	1.56-3.12	
Age group			
<60 years	Reference		0.004
≥60 years	2.59	1.36-4.95	
Gender			
Male	Reference		0.936
Female	1.01	0.75-1.36	
Ethnicity			
Chinese	Reference		
Malay	1.01	0.67-1.52	0.972
Indian	1.48	0.91-2.41	0.116
Etiology			
Non-DN	Reference		<0.001
DN	2.86	1.70-4.79	
IHD			
No	Reference		0.009
Yes	1.73	1.15-2.60	
CVD			
No	Reference		0.096
Yes	1.89	0.89-3.99	
PVD			
No	Reference		0.418
Yes	1.48	0.57-3.84	
Cancer			
No	Reference		0.275
Yes	1.65	0.67-4.07	

Similar to Table 5.11.11, Table 5.11.12 excludes kidney transplants done overseas. Aside from transplant patients, Table 5.11.12 also include dialysis patients without transplant. Patients with kidney transplant, be it from living or deceased donors, had lower risk of death than dialysis patients without transplant. Old age, DN, IHD, CVD, PVD and cancer remained as significant predictors of death among dialysis and transplant patients, even after adjusting for the other potential confounders simultaneously.

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
Transplant			
Dialysis	Reference		
Transplant from local living donor	0.19	0.14-0.24	<0.001
Transplant from local deceased donor	0.34	0.28-0.40	<0.001
Age group			
<60 years	Reference		<0.001
≥60 years	1.79	1.71-1.88	
Gender			
Male	Reference		0.703
Female	1.01	0.97-1.05	
Ethnicity			
Chinese	Reference		
Malay	0.92	0.87-0.97	0.002
Indian	0.99	0.91-1.07	0.811
Etiology			
Non-DN	Reference		<0.001
DN	1.62	1.54-1.71	
IHD			
No	Reference		<0.001
Yes	1.45	1.38-1.52	
CVD			
No	Reference		<0.001
Yes	1.31	1.25-1.38	
PVD			
No	Reference		<0.001
Yes	1.46	1.38-1.55	
Cancer			
No	Reference		<0.001
Yes	1.42	1.31-1.53	

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 less disruptions to their daily living compared to dialysis patients who have to 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 in Singapore. It is therefore important for individuals who have not been diagnosed with CKD to take preventive action.

One can reduce his/her chances of developing CKD 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, going for health screening and follow-ups, and controlling blood pressure, cholesterol and glucose levels well. 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 of 31 December 2018

Public hospitals and affiliated dialysis centres	HD	PD	Transplant
SINGAPORE GENERAL HOSPITAL	9	451	839
TAN TOCK SENG RENAL CENTRE	2	142	40
CHANGI GENERAL HOSPITAL	1	69	2
KHOO TECK PUAT HOSPITAL	5	98	0
NG TENG FONG GENERAL HOSPITAL	1	54	1
SENGKANG GENERAL HOSPITAL	2	4	0
NATIONAL UNIVERSITY HOSPITAL	5	182	518
NUH DIALYSIS CENTRE	57	0	0
NUH RENAL CENTRE	18	0	0
SHAW NKF - NUH CHILDREN'S KIDNEY CENTRE	2	15	46
Subtotal	**102**	**1015**	**1446**
Voluntary Welfare Organisations	**HD**	**PD**	**Transplant**
ANG MO KIO THYE HUA KWAN HOSPITAL DIALYSIS CENTRE	57	0	0
FOO HAI - NKF DIALYSIS CENTRE	67	0	0
HONG LEONG - NKF DIALYSIS CENTRE (ALJUNIED CRESCENT)	96	0	0
IFPAS - NKF DIALYSIS CENTRE (SERANGOON)	104	0	0
JAPAN AIRLINE - NKF DIALYSIS CENTRE (ANG MO KIO I)	119	0	0
JO & GERRY ESSERY NKF DIALYSIS CENTRE (BLK 204 MARSILING)	61	0	0
KWAN IM THONG HOOD CHO TEMPLE - NKF DIALYSIS CENTRE (KOLAM AYER)	138	0	0
KWAN IM THONG HOOD CHO TEMPLE - NKF DIALYSIS CENTRE (SIMEI)	153	0	0
LE CHAMP - NKF DIALYSIS CENTRE (BLK 639 YISHUN ST 61)	111	0	0
LEONG HWA CHAN SI TEMPLE - NKF DIALYSIS CENTRE (TECK WHYE)	106	0	0
MTFA DIALYSIS CENTRE (MDC)	25	0	0
NEW CREATION CHURCH - NKF DIALYSIS CENTRE	90	0	0
NKF BUKIT PANJANG DIALYSIS CENTRE	95	0	0
NKF DIALYSIS CENTRE (BLK 365 WOODLANDS II)	100	0	0
NKF HOUGANG PUNGGOL DIALYSIS CENTRE	122	0	0
NKF INTEGRATED RENAL CENTRE (CP1)	177	0	0
NKF INTEGRATED RENAL CENTRE (CP2)	73	0	0
NTUC INCOME - NKF DIALYSIS CENTRE (BUKIT BATOK)	89	0	0
NTUC/SINGAPORE POOLS - NKF DIALYSIS CENTRE (TAMPINES)	130	0	0
PEI HWA FOUNDATION - NKF DIALYSIS CENTRE (ANG MO KIO)	124	0	0
QUEENSTOWN - NKF DIALYSIS CENTRE	0	0	0
SAF - NKF DIALYSIS CENTRE (CLEMENTI)	0	0	0
SAF - NKF DIALYSIS CENTRE (HONG KAH)	0	0	0
SAKYADHITA -NKF DIALYSIS CENTRE (UPPER BOON KENG)	90	0	0
SCAL - NKF DIALYSIS CENTRE (YISHUN)	74	0	0

SHENG HONG TEMPLE - NKF DIALYSIS CENTRE (JURONG WEST)	107	0	0
SIA - NKF DIALYSIS CENTRE (TOA PAYOH)	80	0	0
SINGAPORE BUDDHIST WELFARE SERVICES - NKF DIALYSIS CENTRE (HOUGANG)	153	0	0
SINGAPORE POOLS - NKF DIALYSIS CENTRE (BEDOK)	105	0	0
TAMPINES CHINESE TEMPLE - NKF DIALYSIS CENTRE (PASIR RIS)	76	0	0
TAY CHOON HYE - NKF DIALYSIS CENTRE (KIM KEAT)	103	0	0
THE HOUR GLASS - NKF DIALYSIS CENTRE (WEST COAST)	92	0	0
THE HOUR GLASS NKF DIALYSIS CENTRE (ADMIRALTY BRANCH)	96	0	0
THE SINGAPORE BUDDHIST LODGE - NKF DIALYSIS CENTRE (128 BUKIT MERAH VIEW)	97	0	0
THE SIRIVADHANABHAKDI FOUNDATION NKF DIALYSIS CENTRE (JW2)	88	0	0
THONG TECK SIAN TONG LIAN SIN SIA - NKF DIALYSIS CENTRE (WOODLANDS)	100	0	0
TOA PAYOH SEU TECK SEAN TONG - NKF DIALYSIS CENTRE (YISHUN)	75	0	0
WESTERN DIGITAL - NKF DIALYSIS CENTRE (ANG MO KIO)	149	0	0
WOH HUP - NKF DIALYSIS CENTRE (GHIM MOH)	106	0	0
WONG SUI HA EDNA - NKF DIALYSIS CENTRE	130	0	0
KDF - BISHAN CENTRE	90	0	0
KDF - GHIM MOH CENTRE (HD)	88	0	0
KDF - KRETA AYER (HD)	74	0	0
Subtotal	**4010**	**0**	**0**
Private clinics and dialysis centres	**HD**	**PD**	**Transplant**
ADVANCE DIALYSIS SERVICES PTE LTD	24	0	0
ADVANCE RENAL CARE (KOVAN) PTE LTD	13	0	0
ADVANCE RENAL CARE (NOVENA)	9	0	0
AEGIS DIALYSIS CENTRE	10	0	0
ASIA RENAL CARE MT ELIZABETH PTE LTD	0	0	0
ARCA (FARRER PARK) DIALYSIS PTE LTD	32	0	0
ASIA KIDNEY DIALYSIS CENTRE (BEDOK)	43	0	0
ASIA KIDNEY DIALYSIS CENTRE (JURONG)	21	0	0
ASIA KIDNEY DIALYSIS CENTRE (TAMPINES) BLK-139	35	0	0
ASIA KIDNEY DIALYSIS CENTRE (TECK WHYE)	27	0	0
ASIA KIDNEY DIALYSIS CENTRE (TP)	63	0	0
ASIA KIDNEY DIALYSIS CENTRE (TPY)	44	0	0
B. BRAUN DIALYSIS CENTRE (EAST COAST)	29	0	0
COMPLEX MEDICAL CENTRE (CHANGI)	7	0	0
ECON ADVANCE RENAL CARE (YUNG KUANG)	15	0	0
ECON ADVANCE RENAL CARE PTE LTD (BEDOK)	16	0	0
FRESENIUS KIDNEY CARE ANG MO KIO DIALYSIS CLINIC (BLK 422)	37	0	0
FRESENIUS KIDNEY CARE ANG MO KIO DIALYSIS CLINIC (BLK 443)	40	0	0
FRESENIUS KIDNEY CARE BUKIT BATOK DIALYSIS CLINIC (BLK 213)	38	0	0

FRESENIUS KIDNEY CARE CLEMENTI DIALYSIS CLINIC	28	0	0
FRESENIUS KIDNEY CARE JURONG BOON LAY DIALYSIS CLINIC (BLK 353)	31	0	0
FRESENIUS KIDNEY CARE JURONG EAST CENTRAL DIALYSIS CLINIC (BLK 104)	45	0	0
FRESENIUS KIDNEY CARE JURONG EAST DIALYSIS CLINIC (BLK 326)	33	0	0
FRESENIUS KIDNEY CARE KATONG DIALYSIS CLINIC	38	0	0
FRESENIUS KIDNEY CARE KEMBANGAN DIALYSIS CLINIC	42	0	0
FRESENIUS KIDNEY CARE KOVAN DIALYSIS CLINIC	50	0	0
FRESENIUS KIDNEY CARE LUCKY PLAZA DIALYSIS CLINIC	4	1	0
FRESENIUS KIDNEY CARE MT ELIZABETH DIALYSIS CLINIC	24	0	0
FRESENIUS KIDNEY CARE NAPIER DIALYSIS CLINIC	23	2	0
FRESENIUS KIDNEY CARE TANGLIN DIALYSIS CLINIC	21	0	0
FRESENIUS KIDNEY CARE TOA PAYOH DIALYSIS CLINIC (BLK 92)	35	0	0
FRESENIUS KIDNEY CARE WHAMPOA DIALYSIS CLINIC	27	0	0
FRESENIUS MEDICAL CARE (TECK WHYE) DIALYSIS CLINIC	46	0	0
FRESENIUS MEDICAL CARE ANG MO KIO DIALYSIS CLINIC (BLK 422)	0	0	0
FRESENIUS MEDICAL CARE ANG MO KIO DIALYSIS CLINIC (BLK 443)	0	0	0
FRESENIUS MEDICAL CARE BEDOK NORTH DIALYSIS CLINIC (BLK 527)	26	0	0
FRESENIUS MEDICAL CARE BEDOK RESERVOIR DIALYSIS CLINIC (BLK 744)	55	0	0
FRESENIUS MEDICAL CARE BUKIT BATOK DIALYSIS CLINIC (BLK 213)	0	0	0
FRESENIUS MEDICAL CARE BUKIT MERAH DIALYSIS CLINIC (BLK 161)	54	0	0
FRESENIUS MEDICAL CARE CLEMENTI DIALYSIS CLINIC	0	0	0
FRESENIUS MEDICAL CARE HOUGANG DIALYSIS CLINIC (BLK 620)	48	0	0
FRESENIUS MEDICAL CARE JURONG BOON LAY DIALYSIS CLINIC (BLK 353)	0	0	0
FRESENIUS MEDICAL CARE JURONG EAST CENTRAL DIALYSIS CLINIC (BLK 104)	0	0	0
FRESENIUS MEDICAL CARE JURONG EAST DIALYSIS CLINIC (BLK 326)	0	0	0
FRESENIUS MEDICAL CARE KATONG DIALYSIS CLINIC	0	0	0
FRESENIUS MEDICAL CARE KEMBANGAN DIALYSIS CLINIC	0	0	0
FRESENIUS MEDICAL CARE KHATIB DIALYSIS CLINIC	23	0	0
FRESENIUS MEDICAL CARE KOVAN DIALYSIS CLINIC	0	0	0

FRESENIUS MEDICAL CARE LUCKY PLAZA DIALYSIS CLINIC	0	0	0
FRESENIUS MEDICAL CARE MARSILING DIALYSIS CLINIC	29	0	0
FRESENIUS MEDICAL CARE NAPIER DIALYSIS CLINIC	0	0	0
FRESENIUS MEDICAL CARE SERANGOON DIALYSIS CLINIC	60	0	0
FRESENIUS MEDICAL CARE TAMPINES DIALYSIS CLINIC (BLK 107)	47	0	0
FRESENIUS MEDICAL CARE TANGLIN DIALYSIS CLINIC	0	0	0
FRESENIUS MEDICAL CARE TOA PAYOH DIALYSIS CLINIC (BLK 92)	0	0	0
FRESENIUS MEDICAL CARE WHAMPOA DIALYSIS CLINIC	0	0	0
FRESENIUS MEDICAL CARE YISHUN DIALYSIS CLINIC (BLK 236)	44	0	0
FRESENIUS MEDICAL CARE YISHUN RING DIALYSIS CLINIC	34	0	0
GLENEAGLES HOSPITAL	2	0	0
IMMANUEL DIALYSIS CENTRE (MAYFLOWER) PTE LTD	17	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)	27	0	0
IMMANUEL DIALYSIS CENTRE PTE LTD (YISHUN)	13	0	0
KIDNEYCARE DIALYSIS CENTRE @ PASIR RIS	49	0	0
KIDNEYCARE DIALYSIS CENTRE @ WEST COAST	20	0	0
KIDNEYCARE DIALYSIS CENTRE @ YISHUN	23	0	0
PACIFIC ADVANCE RENAL CARE (CHAU CHU KANG)	21	0	0
PACIFIC ADVANCE RENAL CARE (FAJAR)	32	0	0
PACIFIC ADVANCE RENAL CARE (SENG KANG)	39	0	0
PACIFIC ADVANCE RENAL CARE PTE LTD (PUNGGOL WAY)	35	0	0
PACIFIC ADVANCE RENAL CARE PTE LTD (TAMPINES)	33	0	0
PACIFIC ADVANCE RENAL CARE PTE LTD (WOODLANDS)	49	0	0
RAFFLES DIALYSIS CENTRE	3	0	0
RENAL HEALTH PTE LTD	62	0	0
RENAL LIFE (ALEXANDRA) DIALYSIS CENTRE PTE LTD	13	0	0
RENAL LIFE (HOUGANG) DIALYSIS CENTRE PTE LTD	20	0	0
RENAL LIFE (W) DIALYSIS CENTRE PTE LTD (BLK 207 BUKIT BATOK)	30	0	0
RENAL LIFE DIALYSIS CENTRE PTE LTD (BLK 463 JURONG WEST)	20	0	0
RENAL LIFE(PIONEER) DIALYSIS CENTRE PTE LTD	31	0	0
RENAL TEAM DIALYSIS CENTRE YISHUN	0	0	0
RENAL TEAM DIALYSIS CENTRE - ANG MO KIO	37	0	0

RENAL TEAM DIALYSIS CENTRE - BEDOK	40	0	0
RENAL TEAM DIALYSIS CENTRE - BUKIT MERAH	36	0	0
RENAL TEAM DIALYSIS CENTRE - JURONG EAST	37	0	0
RENAL TEAM DIALYSIS CENTRE - REN CI COMMUNITY HOSPITAL	44	0	0
RENAL TEAM DIALYSIS CENTRE - TAMPINES	49	0	0
RENAL TEAM DIALYSIS CENTRE WOODLANDS PEAK	43	0	0
TAL DIALYSIS CLEMENTI	27	0	0
CENTRE FOR KIDNEY DISEASE PTE LTD (LUCKY PLAZA)	0	0	41
GRACE LEE RENAL AND MEDICAL CLINIC PTE LTD	0	0	9
KIDNEY & MEDICAL CENTRE	0	0	6
KU KIDNEY & MEDICAL CENTRE	0	0	11
RAFFLES HOSPITAL	0	0	3
ROGER KIDNEY CLINIC	0	0	6
SH TAN KIDNEY & MEDICAL CLINIC	0	0	1
STEPHEW CHEW CENTRE FOR KIDNEY DISEASE AND HYPERTENSION (MAH)	0	0	19
STEPHEW CHEW CENTRE FOR KIDNEY DISEASE AND HYPERTENSION (MEH)	0	0	4
T.G. NG KIDNEY & MEDICAL CENTRE	0	0	2
THE KIDNEY CLINIC PTE LTD	0	0	14
THE SINGAPORE CLINIC FOR KIDNEY DISEASES	0	0	3
WU NEPHROLOGY & MEDICAL CLINIC (WU MEDICAL CLINIC PTE LTD)	0	0	35
Subtotal	**2275**	**3**	**154**
Grand total	**6387**	**1018**	**1600**