Singapore Renal Registry
Annual Report 2015

National Registry of Diseases Office
(NRDO)

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Contents

1 GLOSSARY

ASR	*Age-Standardised Rate*
BSA	*Body Surface Area*
CKD5	*Chronic Kidney Disease Stage 5*
CI	*Confidence Interval*
CR	*Crude Rate*
DN	*Diabetic Nephropathy*
eGFR	*Estimated glomerular filtration rate*
ESA	*Erythropoiesis Stimulating Agents*
ESRD	*End Stage Renal Disease*
GN	*Primary glomerulonephritis*
HD	*Haemodialysis*
iPTH	*Intact Parathyroid Hormone*
MOH	*Ministry of Health*
PD	*Peritoneal Dialysis*
PMP	*Per million population*
PTE	*Private Dialysis Centre*
RH	*Restructured Hospital*
SRR	*Singapore Renal Registry*
TX	*Transplant*
URR	*Urea Reduction Ratio*
USRDS	*United States Renal Data System*
VWO	*Voluntary Welfare Organisation*

2 INTRODUCTION

Kidney failure is a worldwide epidemic[1]; and diabetes is a leading cause of renal impairment. In Singapore, it was shown that 2.3% of the residents aged between 18 and 69 years old had renal impairment as defined by eGFR less than 60 mL/min/1.73m^2. The National Health Survey 2010 also showed that the crude prevalence of diabetes mellitus increased from 8.6% in 1992 to 11.3% in 2010.[2] In addition, 1 in 3 diabetics were unaware that they had diabetes. Among the diabetics who were aware of their condition, 1 in 3 had poor diabetic control.[3]. This increase in diabetes is further compounded by ageing of the population which accelerates the increase in kidney failure[4]. The median age of the Singapore resident population increased from 34.0 years in 2000 to 37.4 years in 2010. Correspondingly, the percentage of the population aged 65 years and above increased from 7.2% in 2000 to 11.8% in 2015[5].

Following the progression of kidney disease, patients with renal impairment are at higher risk of progressing to Chronic Kidney Diseases Stage 5 (CKD5). CKD5 is a stage of kidney failure when either the GFR (corrected to the body surface area of 1.73m^2) is less than 15 ml/min. CKD5 patients are generally managed through renal replacement therapy, such as dialysis or transplant, to prolong their long-term survival.

With the increase in the number of CKD5 patients, the economic burden due to kidney failure in Singapore is expected to escalate.

This report is intended to provide epidemiological trends on CKD5 patients on dialysis and renal transplantation for the period from 1999 to 2015.

3 METHODOLOGY

CKD5 includes patients who are approaching End-stage Renal Disease (ESRD) and patients who have reached ESRD. In most registry data, only patients who are initiated on dialysis are captured; in some as in the USRDS, only data on those

[1] Mallamaci. Highlights of the 2015 ERA-EDTA congress: chronic kidney disease, hypertension. Nephrol. Dial. Transplant (2016)
[2] National Health Survey 2010
[3] https://www.moh.gov.sg/content/dam/moh_web/PressRoom/Highlights/2016/cos/factsheets/COS_Factsheet%20-%20Diabetes.pdf. Accessed on 30 Nov 2016
[4] Ayodele and Alebiosu. Burden of chronic kidney disease: an international perspective. Adv chronic Kidney Dis. 2010; 17(3): 215-24
[5] https://www.singstat.gov.sg/docs/default-source/default-document-library/publications/publications_and_papers/population_and_population_structure/population2015.pdf Accessed on 8 July 2016

surviving 90 days are captured. However, these methods may not entirely reflect accurately the burden of kidney failure in the nation and may underestimate the workload of healthcare professionals, especially the nephrologists, who manage this group of patients. As such, in 1999, the Registry started capturing data of cases classified as having CKD5 i.e. patients initiating on renal replacement therapy or all patients with serum creatinine ≥ 10 mg/dl or 880 µmol/L.

In year 2007 the Singapore General Hospital, which contributes about 50% of the new CKD5 cases, started to provide the Registry with listing of patients with estimated glomerular filtration rate (eGFR) < 15 ml/min (corrected for BSA 1.73m^2). This was followed by the National University Hospital in year 2009, and the remaining restructured hospitals in year 2010 when the subsidiary legislation covering CKD5 was put in place by MOH.

Data source for case finding

The main source of data came from the annual collection of data from restructured hospitals, dialysis centres, transplant centres and private nephrology clinics in Singapore (Table 3.1). Since 1999, case finding for CKD5 was guided by serum creatinine ≥ 10 mg/dl or 880 µmol/L, or if patients started renal replacement therapy. Since 2010, this was subsequently changed to serum creatinine ≥ 500 µmol/L, or eGFR < 15 ml/min (corrected for BSA 1.73m^2), or if patients started renal replacement therapy at the national level.

Table 3.1: Category and Number of Participating Centres as of 31st December each year

Category of Participating Centres	Number of Centres by Modality					
	2014			2015		
	HD	PD	TX	HD	PD	TX
Restructured Hospitals and Affiliated Dialysis Centres	9	7	5	8	7	5
Voluntary Welfare Organisations	29	1	0	32	1	0
Private Dialysis Centres/Clinics	58	4	12	64	3	12
Grand Total	96	12	17	104	11	17

Note that KDF is the only VWO providing PD service.

Table 3.2: Stock and Flow (2011 – 2015)

Stock and Flow 2011 – 2015	2011	2012	2013	2014	2015
New Dialysis patients	903	921	976	1041	1088
New Transplants (done locally and overseas)	92	62	87	74	88
Dialysis deaths	663	654	772	764	792
Transplant deaths	20	30	39	31	35
Dialysis as at 31st December	4895	5244	5520	5878	6230
Functioning grafts as at 31st December	1411	1411	1439	1444	1464

Incidence of CKD5

In computing the incidence of CKD5, the population of new CKD5 patients for a particular year was extracted based on the date reached CKD5. These included all patients initiating renal replacement therapy or those presenting with serum creatinine ≥ 10 mg/dl or 880 µmol/L. Since 2010, this was subsequently changed to serum creatinine ≥ 500 µmol/L, or eGFR < 15 ml/min (corrected for BSA 1.73m^2), or if patients started renal replacement therapy.

As CKD5 number typically takes 2 years to stabilise due to monitoring of cases for their serum creatinine level for at least 6 months in accordance with the National Kidney Foundation Kidney Disease Outcomes Quality Initiative[6] guidelines, the CKD5 figure for the most recent 2 years is expected to increase and hence remains tentative.

Incidence of CKD5 on definitive dialysis: 90-day rule

Only patients who survived 90 days after commencement of dialysis (effectively 91 days with respect to the first date of dialysis) were counted in the incidence of CKD5 patients on definitive dialysis. If there was record on the 91st day after commencement of dialysis, the modality was immediately taken for report. Otherwise, the modality on the closest date **before** the 91st day was reported. If there was no record between the first date of modality and the 91st day after initiation, the modality reported on the initiation was utilised. The purpose of this was to determine survival characteristics based on a relatively stable CKD5 cohort. Within the first three months, many patients with pre-existing co-morbidities might not survive. This methodology had been adopted from the USRDS.

Prevalence of patients on definitive dialysis/ transplant

To report the prevalent population at the end of a particular year, all surviving cases up till 31 December of that year were included for analysis. They must have survived 90 days after first initiation. All deceased patients were excluded from analysis.

Death rate: 60-day rule

Deaths were reported according to the last modality that the patient was receiving treatment within the 60 days before death. This rule was also used during survival analysis (see section on survival analysis) for patients who switched modalities.

Survival analysis

The Kaplan-Meier method was used to estimate and compare the unadjusted survival probabilities for patients undergoing definitive haemodialysis, peritoneal dialysis and renal transplantation. Deaths were taken as events in the analysis for

[6] http://www2.kidney.org/professionals/kdoqi/guidelines_ckd/p4_class_g1.htm).

dialysis and transplants. Patients on dialysis were censored if they received transplants.

For analysis of graft survival for kidney transplants, graft loss was defined by return to dialysis or kidney transplant; death with a functioning graft was also defined as an event.

For patients who were alive and not censored for the above reasons, their survival was computed till 28 February 2016, the day when the renal dataset was matched with Ministry of Home Affairs (MHA) death registry.

A proportional hazard Cox regression model was used to examine the effects of multiple covariates on the survival of the patients on definitive dialysis and kidney transplantation. This model assumed that the ratio of hazards for haemodialysis and peritoneal dialysis was constant when comparing the survival between haemodialysis and peritoneal dialysis.

The above-mentioned model took into consideration dialysis modality changes; patients who switched dialysis modality and remained on the switched modality for at least 60 days had their survival experience attributed to the switched modality. Patients who remained on switched modality for less than 60 days had their survival experience attributed to the pre-existing modality.

Bio-clinical indicators

Bio-clinical (e.g. haemoglobin, albumin) values were reported from 2005 onwards when the registry started collecting these data items. Data on serum calcium, phosphate and intact PTH (i-PTH) were added from year 2007 onwards. The most recent reading of the bio-clinical indicators was obtained for each patient in a particular year.

Incidence of kidney transplantation

The incidence of kidney transplant referred to the occurrence of the transplantation in the reporting year. The data had been cleaned with reference to data from the National Organ Transplant Unit, MOH.

Population estimates and age standardisation

In this report, we used the mid-year population estimates from the Department of Statistics (DOS), Singapore to calculate the rates. Segi World Population was used for direct standardisation to calculate age-standardised rates. Both crude and age-standardised rates were expressed in per million population (pmp).

The data presented in this report refers only to Singapore residents i.e. citizens and permanent residents. The data reported here represents the 1999 – 2015 statistics as they stood on 18 May 2016. The figures in this report were rounded to

one decimal place. It is also noted that the median age of Singapore residents has increased disproportionately over the last 10 years.[7] The increase has an impact on the age-specific rates, and hence the age-standardised rates.

[7] Population Trends 2015. Singapore Department of Statistics. Accessed 7 June 2016.

4 EXECUTIVE SUMMARY

While the crude rate of CKD5 increased from 383.6 pmp in 2010 to 431.7 pmp in 2014, the age-standardised incidence rate (ASR) of CKD5 increased from 273.7 pmp in 2010 before increasing to 276.2 pmp in 2014.[8] A similar trend was seen in definitive dialysis patients, where its ASR increased from 144.7 pmp in 2010 to 177.4 pmp in 2015.

Haemodialysis (HD) remained the main dialysis modality among incident (81.6% in 2015) and prevalent (88.3% in 2015) CKD5 patients on dialysis. Although majority of the incident and prevalent definitive dialysis patients was Chinese, an increase in the proportion of incident and prevalent definitive dialysis patients was observed among the Malays in the study period.

Diabetic nephropathy (DN) remained the main cause of CKD5 for incident (69.1% of HD, 56.5% of PD in 2015) and prevalent (52.9% of HD, 49.2% of PD in 2015) dialysis patients.

Infections (30.7% in 2015) and cardiac events (34.8% in 2015) remained the two common causes of death among CKD5 patients. After adjusting for the effects of diabetes as primary disease and co-morbidities such as ischaemic heart disease, patients on PD had a 57% higher chance of dying as compared to those on HD.

Patients on dialysis were evaluated based on the 4 aspects, namely, adequacy of dialysis, management of anaemia, nutrition, as well as mineral and bone disease. 98.3% of the HD patients were dialysed 3 times per week.

While the percentage of HD patients with anaemia had decreased over the years, the percentage of PD patients with anaemia remained relatively constant. The percentages of patients with sufficient iron stores were on the increase within the same period for both haemodialysis and peritoneal dialysis.

The ASR of kidney transplantation was 17.2 pmp in 2015. Overall, primary glomerulonephritis remained the single main cause for CKD5 among incident (54.5% in 2015) and prevalent (68.9% in 2015) kidney transplant patients.

Local living-donor transplants had better 5-year graft survival probability (94.5%) when compared to local deceased-donor (83.7%). Age, diabetes as primary disease, ischaemic heart disease, as well as donor type were significant factors affecting survival of kidney transplant patients.

[8] 2015 figure for CKD5 was not presented as the number typically takes about 2 years to stabilise. The eGFR level of the patients are monitored for at least a 6 month period to assess if it is consistently < 15 ml/min (Corrected for BSA) before being confirmed as a CKD5 diagnosis.

5 FINDINGS

5.1 Incident CKD5

5.1.1 CKD5 Incidence[9]

Over the years, numbers of new CKD5 patients notified to SRR increased from 679 in 1999 to 1671 in 2014. Correspondingly, while the crude incidence (CR) of CKD5 has almost doubled, the age-standardised incidence rate (ASR) has increased by only 37% from 1999 to 2014 ($p<0.001$). See Figure 5.1.1.1 and Table 5.1.1.1. This implies that the increase in the CKD5 cases was mainly driven by the effect of ageing. It can be observed in Figure 5.1.1.3 that as age increased, the incidence of CKD5 increased. Notably, 8.8% of the citizens were aged 65 and above in 2005 and 13.1% in 2015.[10] As diabetes is a major contributor to CKD5, a similar trend was also observed in the National Health Survey 2010. While the crude prevalence of diabetes increased from 8.6% in 1992 to 11.3% in 2010 among all Singapore residents, the age-standardised prevalence of diabetes hovered at about 11.3% in the period of 1992 to 2010.[11]

Notably, the increase in cases was partly due to the change in data extraction criteria in 2007 as described in Methodology and inclusion of data from more service providers. The increasing trend of CKD5 was more apparent among patients aged 65 years and above. The figures encompassed all cases diagnosed by physicians to have CKD5, regardless of whether they started on renal replacement therapy.

From 2011 onwards however, the increase in the annual number of new CKD5 patients seemed to slow down. A similar trend was observed in the age-standardised rates.

[9] Refers to unique patients who have reached eGFR<15 ml/min (corrected for BSA) in the particular year. More details in methodology section
[10] http://population.sg/population-in-brief/files/population-in-brief-2015.pdf. Accessed on 5 July 2016
[11] National Health Survey 2010

Figure 5.1.1.1: Number and Rates of Incident CKD5

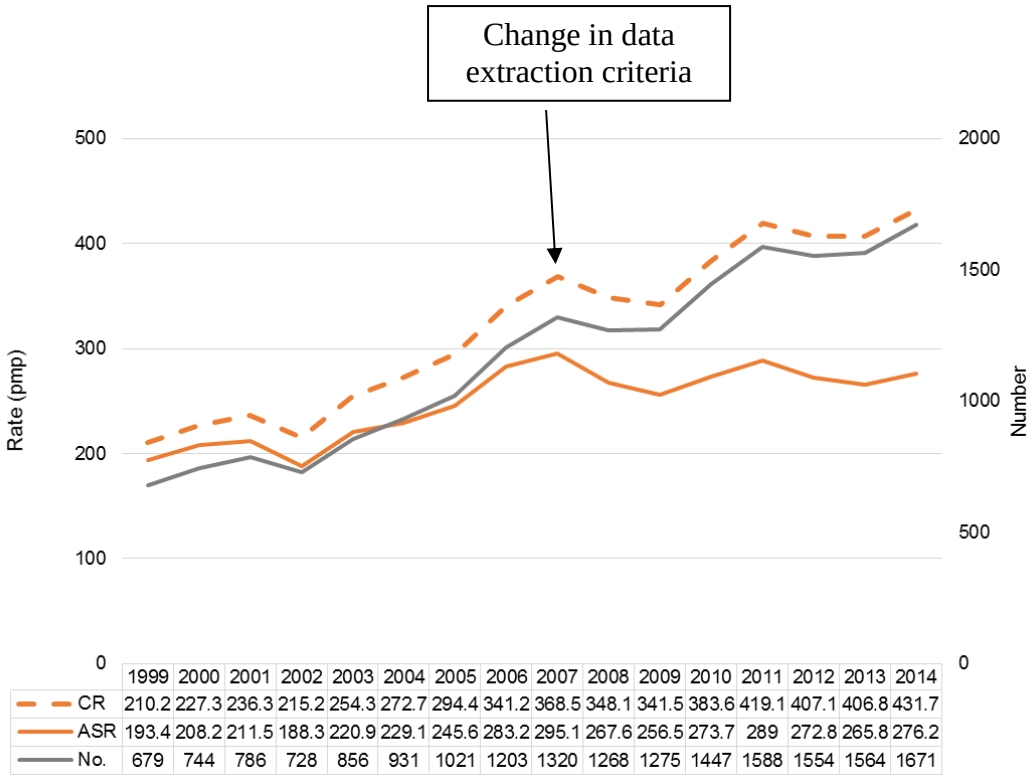


Table 5.1.1.1: Number and Rates of Incident CKD5

Year	No.	CR*	ASR*	ASR 95% CI
1999	679	210.2	193.4	188.7-198.1
2000	744	227.3	208.2	203.4-213.0
2001	786	236.3	211.5	206.8-216.2
2002	728	215.2	188.3	183.9-192.6
2003	856	254.3	220.9	216.1-225.6
2004	931	272.7	229.1	224.4-233.9
2005	1021	294.4	245.6	240.7-250.4
2006	1203	341.2	283.2	278.1-288.4
2007	1320	368.5	295.1	290.0-300.2
2008	1268	348.1	267.6	262.9-272.3
2009	1275	341.5	256.5	252.0-261.0
2010	1447	383.6	273.7	269.2-278.2
2011	1588	419.1	289.0	284.5-293.6
2012	1554	407.1	272.8	268.4-277.1
2013	1564	406.8	265.8	261.6-270.0
2014	1671	431.7	276.2	271.9-280.4
2015 (Prelim)^	983	251.9	157.1	153.9-160.3

** CR and ASR are expressed as per 1,000,000 residential populations (DOS) and ASR is standardised to World Population.*

^ Prelim figure as of analysis. As CKD5 typically takes 2 years to stabilise, the figure is expected to increase to 1770 (CR: 457.5) in 2015. A CKD5 case is only registered if the eGFR readings maintained at < 15 ml/min (corrected for BSA) for at least 6 months or for at least 2 consistent readings.

The incidence of CKD5 was observed to be higher in males as compared to females across the entire study period (Table 5.1.1.2).

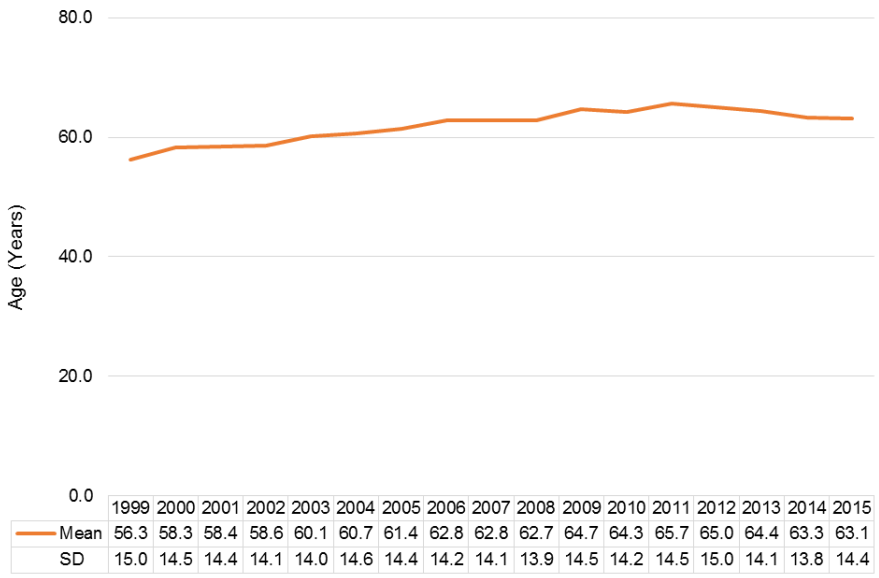
Table 5.1.1.2: Number and Rates of Incident CKD5 by Gender

	Males			Females		
Year	**No.**	**CR***	**ASR***	**No.**	**CR***	**ASR***
1999	334	206.8	198.4	345	213.6	190.3
2000	386	236.1	221.1	358	218.5	195.4
2001	418	252.0	234.2	368	220.7	192.5
2002	373	221.4	198.2	355	209.0	180.2
2003	430	256.9	233.0	426	251.6	211.1
2004	477	281.4	248.4	454	264.2	212.7
2005	538	312.6	271.2	483	276.5	220.0
2006	639	365.5	315.5	564	317.3	246.2
2007	669	376.8	313.1	651	360.3	273.9
2008	665	368.9	293.3	603	327.8	239.7
2009	658	356.7	280.7	617	326.6	227.9
2010	773	415.3	315.8	674	352.8	235.8
2011	814	435.7	319.6	774	402.9	260.3
2012	852	453.2	323.7	702	362.2	229.1
2013	816	431.4	296.0	748	383.0	237.6
2014	902	474.1	311.7	769	390.7	239.2
2015 (Prelim)	605	315.7	202.4	378	190.3	113.0

** CR and ASR are expressed as per 1,000,000 residential populations (DOS) and ASR are standardised to World Population*

Figure 5.1.1.2 shows that the mean age of new CKD5 patients increased from 56.3 years in 1999 to 64.7 years in 2009 before decreasing consistently to 63.1 years in 2015. The decrease in mean age after 2009 could be an artefact due to the change in data extraction criteria.

Figure 5.1.1.2: Average Age of Incident CKD5 Patients



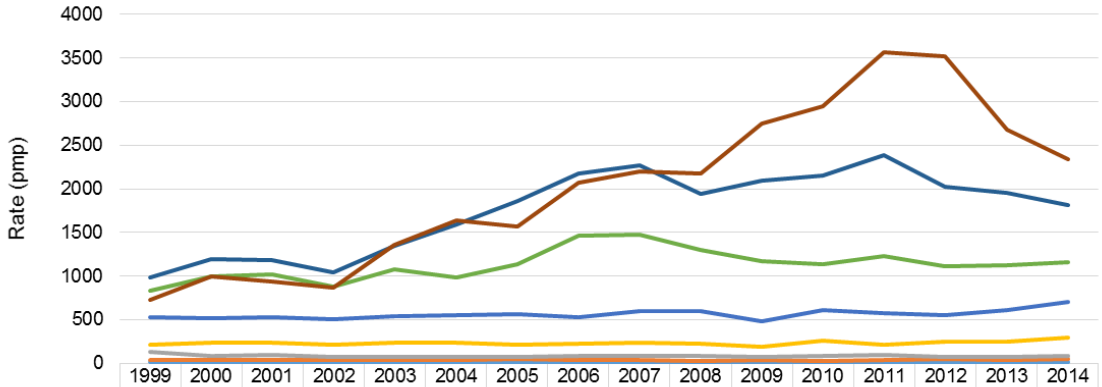
Generally, with the exception of the earlier years from 1999-2001, the incidence of CKD5 was the highest in Malays, followed by the Indians and Chinese (Table 5.1.1.3). In 2014, the ASR for CKD5 among Malays was approximately 3 times as much as the Chinese while that for the Indians was 1.1 times as much as the Chinese.

Table 5.1.1.3: Number and Rates of Incident CKD5 by Ethnic Group

	Chinese			Malays			Indians		
Year	**No.**	**CR**	**ASR**	**No.**	**CR**	**ASR**	**No.**	**CR**	**ASR**
1999	501	201.8	178.3	132	293.7	339.6	37	146.0	139.5
2000	548	218.0	191.1	142	312.0	379.2	47	182.2	179.0
2001	595	233.1	198.7	145	313.9	378.3	42	159.7	150.8
2002	511	197.3	165.4	156	333.1	378.7	52	191.2	178.6
2003	616	239.5	196.0	166	353.4	405.7	56	207.6	215.7
2004	659	253.5	201.0	187	393.0	412.5	76	273.2	284.5
2005	728	277.2	214.4	195	405.7	445.8	86	295.5	301.9
2006	853	321.1	241.5	243	500.1	562.5	95	313.4	331.0
2007	913	339.8	250.3	292	595.4	602.4	103	328.8	324.6
2008	854	313.8	221.1	305	615.9	605.2	92	284.6	276.6
2009	883	318.7	212.8	292	584.0	590.9	81	235.9	230.3
2010	1016	363.6	235.7	314	623.0	580.6	97	278.8	274.3
2011	1108	394.5	245.2	338	667.5	616.4	117	335.4	299.7
2012	1065	376.1	229.0	352	691.0	610.8	114	324.8	311.8
2013	1058	370.7	221.2	369	719.7	588.9	111	315.8	290.1
2014	1109	385.8	224.2	408	789.7	642.9	118	334.3	274.2
2015 (Prelim)	633	218.3	122.6	271	520.2	407.1	59	166.2	130.5

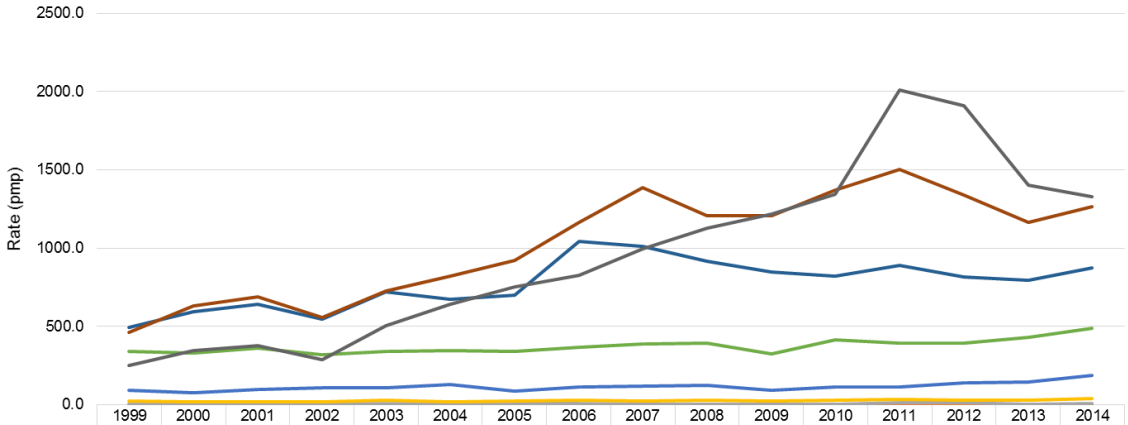
Figure 5.1.1.3b shows that the incidence of patients having CKD5 as a result of diabetic nephropathy (DN) was higher for older age groups. Notably, the rate of increase of the incidence rose over the years for age 70 years and above.

Figure 5.1.1.3a: Age-Specific Incidence Rates of CKD5 Patients



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
0-19	7.561	7.534	7.486	5.328	4.3	11.83	9.675	13.94	12.83	6.422	9.673	6.535	7.798	9.038	5.744	8.184
20-29	39.31	37.55	37.72	39.64	30.02	32.46	45.01	33.95	38.06	28.66	36.81	21.15	36.68	48.15	40.18	41.54
30-39	130.9	83.22	91.85	65.58	71.92	70.77	69.2	84.55	80.48	78.7	69.96	79.21	89.61	73.88	71.38	80.77
40-49	213.4	229.6	229.5	212.4	232.4	234.9	213	218.6	232.6	225.1	184.1	254.3	207.7	249.3	246.5	293
50-59	529.7	518.4	526.6	505.9	542.1	553.8	557.4	531.6	592	592	485.7	603.5	568.1	544.5	612.9	700.5
60-69	832	989.9	1024	872.4	1073	978.1	1130	1459	1472	1297	1175	1135	1229	1109	1122	1154
70-79	985.2	1192	1183	1039	1348	1595	1856	2174	2267	1940	2094	2150	2385	2029	1948	1808
80+	730.5	992.6	939	866.7	1354	1639	1564	2068	2199	2172	2743	2948	3566	3518	2680	2337

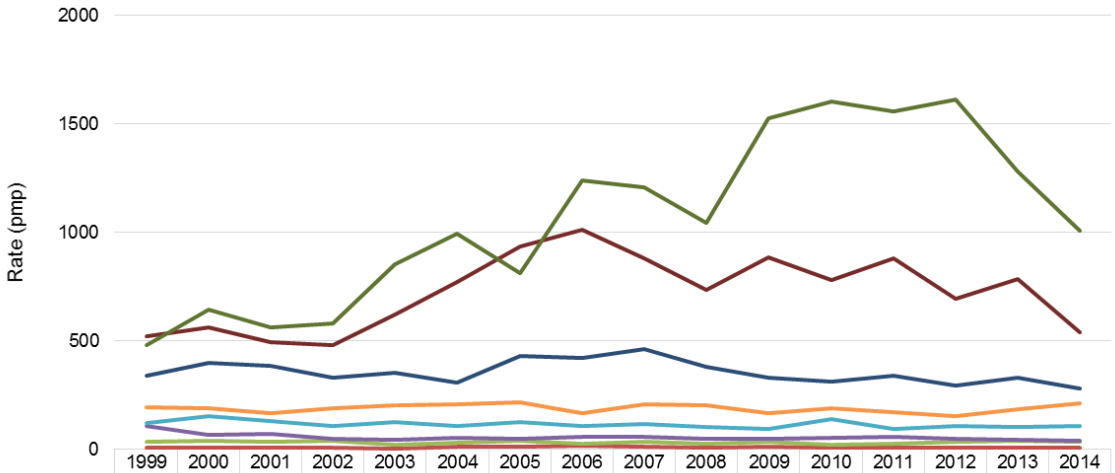
Figure 5.1.1.3b: Age-Specific Incidence Rates of CKD5 Patients due to Diabetic Nephropathy



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
0-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20-29	4.1	0.0	4.2	0.0	8.6	2.2	8.6	8.5	4.2	2.0	1.9	1.9	11.6	15.4	3.8	5.7
30-39	25.8	18.0	19.7	16.4	30.1	20.2	21.9	28.7	23.5	30.1	21.2	27.5	32.6	27.9	29.9	40.4
40-49	93.2	78.3	99.5	107.0	106.4	127.1	89.0	111.7	116.3	121.2	92.9	115.3	115.8	141.3	143.1	185.7
50-59	338.2	328.5	360.6	318.5	340.1	346.1	342.8	365.4	386.0	391.4	321.9	413.2	395.7	393.3	427.7	486.8
60-69	495.0	593.0	639.1	544.1	718.3	671.8	700.2	1040.1	1010.8	916.9	846.4	821.2	889.2	813.9	793.3	873.4
70-79	463.1	629.1	690.0	557.9	727.0	822.3	920.4	1162.3	1388.5	1205.4	1208.1	1369.7	1503.9	1337.2	1164.1	1267.0
80+	251.9	347.4	375.6	288.9	502.2	643.2	752.5	827.1	992.9	1127.7	1217.3	1343.9	2008.2	1907.2	1400.7	1328.8

2015 figure is not presented as it is still preliminary at the time of analysis.

Figure 5.1.1.3c: Age-Specific Incidence Rates of CKD5 Patients not due to Diabetic Nephropathy



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
0-19	7.6	7.5	7.5	5.3	4.3	11.8	9.7	13.9	12.8	6.4	9.7	6.5	7.8	9.0	5.7	8.2
20-29	35.2	37.5	33.5	39.6	21.4	30.3	36.4	25.5	33.8	26.6	34.9	19.2	25.1	32.7	36.4	35.9
30-39	105.0	65.3	72.2	49.2	41.8	50.5	47.3	55.8	57.0	48.6	48.8	51.7	57.0	46.0	41.5	40.4
40-49	120.1	151.3	129.9	105.4	126.0	107.8	124.0	106.9	116.3	103.9	91.3	139.0	92.0	108.0	103.4	107.3
50-59	191.4	189.9	166.0	187.4	202.0	207.7	214.6	166.1	206.0	200.5	163.8	190.3	172.4	151.2	183.5	213.6
60-69	337.0	397.0	384.4	328.3	354.4	306.2	430.2	418.7	461.3	380.2	328.8	313.3	340.1	294.6	328.7	280.1
70-79	522.2	563.4	492.8	480.7	620.6	772.4	936.0	1011.3	878.9	734.7	885.9	780.0	880.8	691.9	783.6	540.7
80+	478.6	645.2	563.4	577.8	851.5	995.9	811.9	1240.6	1205.7	1044.8	1525.4	1604.0	1557.4	1610.8	1278.9	1008.1

2015 figure is not presented as it is still preliminary at the time of analysis.

5.1.2 Incident CKD5 Patients who Ever Started Dialysis

The incidence of CKD5 patients who ever started dialysis was observed to be higher in males as compared to females across the entire study period. In 2015, the ASR was 235.2 pmp for males and 170.0 pmp for females (Table 5.1.2.1).

Table 5.1.2.1: Number and Rates of Incident Patients who Ever Started Dialysis by Gender

	Males			Females			All		
Year	**No.**	**CR***	**ASR***	**No.**	**CR***	**ASR***	**No.**	**CR***	**ASR***
1999	302	187.0	178.8	319	197.5	177.0	621	192.2	177.3
2000	350	214.1	200.0	313	191.0	171.0	663	202.5	185.5
2001	382	230.3	214.2	330	197.9	175.1	712	214.1	193.9
2002	367	217.9	194.4	343	201.9	175.3	710	209.9	184.7
2003	350	209.1	188.7	334	197.3	166.6	684	203.2	176.9
2004	393	231.8	203.1	363	211.3	173.4	756	221.5	187.0
2005	435	252.8	218.0	398	227.9	184.4	833	240.2	200.2
2006	463	264.8	227.2	378	212.7	169.1	841	238.5	197.2
2007	520	292.8	237.3	430	238.0	184.2	950	265.2	210.1
2008	471	261.2	205.1	430	233.7	175.3	901	247.4	190.4
2009	479	259.7	205.6	370	195.9	145.5	849	227.4	174.1
2010	519	278.9	209.1	390	204.1	144.7	909	241.0	175.4
2011	623	333.5	246.5	426	221.8	154.4	1049	276.8	198.5
2012	620	329.8	234.3	459	236.9	160.4	1079	282.6	196.1
2013	672	355.3	244.1	519	265.7	173.4	1191	309.8	207.5
2014	664	349.0	229.4	486	246.9	157.6	1150	297.1	192.2
2015	697	363.7	235.2	540	271.9	170.0	1237	317.0	201.0

** CR and ASR are expressed as per 1,000,000 residential populations (DOS) and ASR are standardised to World Population*

With the exception of 1999-2001, the incidence of CKD5 patients who ever started dialysis was observed to be highest in Malays, followed by Indians and then Chinese. In 2015, the ASR was 480.0 pmp for Malays (nearly 3 times as much as the Chinese), 211.9 pmp for Indians (about 1.3-fold as much as the Chinese) and 161.6 pmp for Chinese (Table 5.1.2.2).

Table 5.1.2.2: Number and Rates of Incident Patients who Ever Started Dialysis by Ethnic Group

	Chinese			Malays			Indians		
Year	**No.**	**CR***	**ASR***	**No.**	**CR***	**ASR***	**No.**	**CR***	**ASR***
1999	458	184.5	163.8	117	260.3	298.3	38	150.0	141.4
2000	488	194.1	170.0	125	274.7	330.8	44	170.5	168.1
2001	539	211.2	181.1	133	287.9	353.2	36	136.9	131.9
2002	497	191.9	161.2	156	333.1	376.5	50	183.9	165.7
2003	480	186.6	154.1	141	300.2	328.3	47	174.3	178.0
2004	533	205.0	164.3	153	321.6	337.4	64	230.1	234.4
2005	580	220.8	173.5	160	332.8	356.7	82	281.8	289.7
2006	584	219.8	168.2	188	386.9	431.9	63	207.9	213.5
2007	644	239.7	176.1	220	448.6	448.7	76	242.6	233.8
2008	580	213.1	153.1	232	468.5	447.8	80	247.4	246.1
2009	546	197.1	137.6	235	470.0	464.7	60	174.7	171.8
2010	603	215.8	144.5	229	454.4	421.2	65	186.8	187.1
2011	715	254.6	166.5	239	472.0	430.1	74	212.2	188.6
2012	730	257.8	162.3	259	508.4	447.9	74	210.8	195.3
2013	794	278.2	172.0	292	569.5	473.8	89	253.2	235.5
2014	754	262.3	154.8	292	565.2	454.4	87	246.4	203.1
2015	806	277.9	161.6	315	604.7	480.0	92	259.2	211.9

** CR and ASR are expressed as per 1,000,000 residential populations (DOS) and ASR are standardised to World Population*

A larger proportion of incident CKD5 patients who ever started dialysis were on HD as compared to PD across the entire study period. In 2015, the ASR was 178.1 pmp for HD patients and 22.9 pmp for PD patients (Table 5.1.2.3).

Table 5.1.2.3: Number and Rates of Incident Patients who Ever Started Dialysis by Modality

	HD			PD		
Year	**No.**	**CR***	**ASR***	**No.**	**CR***	**ASR***
1999	499	154.5	141.4	122	37.8	35.9
2000	557	170.1	154.3	106	32.4	31.2
2001	614	184.6	166.2	98	29.5	27.6
2002	552	163.2	142.7	158	46.7	42.0
2003	588	174.7	151.6	96	28.5	25.3
2004	669	196.0	165.0	87	25.5	22.0
2005	753	217.2	181.0	80	23.1	19.2
2006	768	217.8	178.7	73	20.7	18.5
2007	874	244.0	192.6	76	21.2	17.5
2008	852	233.9	180.2	49	13.5	10.2
2009	767	205.4	156.3	82	22.0	17.8
2010	834	221.1	160.5	75	19.9	14.9
2011	965	254.7	182.2	84	22.2	16.3
2012	999	261.7	181.4	80	21.0	14.8
2013	1095	284.8	190.2	96	25.0	17.3
2014	1069	276.2	178.1	81	20.9	14.1
2015	1099	281.6	178.1	138	35.4	22.9

** CR and ASR are expressed as per 1,000,000 residential populations (DOS) and ASR are standardised to World Population*

Most of the patients were initiated on dialysis in RHs. In 2015, 95.0% of CKD5 patients were initiated on dialysis in RHs (Table 5.1.2.4a).

Table 5.1.2.4(a): Number and Percentage of Incident Patients who Ever Started Dialysis by Service Providers

	RH		VWO		PTE		All
Year	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**
1999	511	82.3	24	3.9	86	13.8	621
2000	543	81.9	24	3.6	96	14.5	663
2001	595	83.6	15	2.1	102	14.3	712
2002	634	89.3	0	0.0	76	10.7	710
2003	596	87.1	5	0.7	83	12.1	684
2004	670	88.6	12	1.6	74	9.8	756
2005	748	89.8	14	1.7	71	8.5	833
2006	774	92.0	8	1.0	59	7.0	841
2007	859	90.4	2	0.2	89	9.4	950
2008	833	92.5	0	0.0	68	7.5	901
2009	787	92.7	2	0.2	60	7.1	849
2010	852	93.7	0	0.0	57	6.3	909
2011	971	92.6	1	0.1	77	7.3	1049
2012	998	92.5	3	0.3	78	7.2	1079
2013	1115	93.6	3	0.3	73	6.1	1191
2014	1092	95.0	0	0.0	58	5.0	1150
2015	1175	95.0	2	0.2	60	4.9	1237

Most of the patients were initiated on HD in RHs. In 2015, 94.4% of the patients initiated on HD were initiated in RHs (Table 5.1.2.4b).

Table 5.1.2.4(b): Number and Percentage of Incident Patients who Ever Started HD by Service Providers

	RH		VWO		PTE		All
Year	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**
1999	399	80.0	24	4.8	76	15.2	499
2000	442	79.4	24	4.3	91	16.3	557
2001	507	82.6	15	2.4	92	15.0	614
2002	486	88.0	0	0.0	66	12.0	552
2003	507	86.2	3	0.5	78	13.3	588
2004	586	87.6	10	1.5	73	10.9	669
2005	674	89.5	11	1.5	68	9.0	753
2006	708	92.2	4	0.5	56	7.3	768
2007	786	89.9	2	0.2	86	9.8	874
2008	785	92.1	0	0.0	67	7.9	852
2009	706	92.0	2	0.3	59	7.7	767
2010	778	93.3	0	0.0	56	6.7	834
2011	888	92.0	1	0.1	76	7.9	965
2012	920	92.1	3	0.3	76	7.6	999
2013	1020	93.2	3	0.3	72	6.6	1095
2014	1012	94.7	0	0.0	57	5.3	1069
2015	1037	94.4	2	0.2	60	5.5	1099

Most of the patients were initiated on PD in RHs. In 2015, 100% of the patients initiated on PD were initiated in the RHs (Table 5.1.2.4c).

Table 5.1.2.4(c): Number and Percentage of Incident Patients who Ever Started PD by Service Providers

	RH		VWO		PTE		All
Year	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**
1999	112	91.8	0	0.0	10	8.2	122
2000	101	95.3	0	0.0	5	4.7	106
2001	88	89.8	0	0.0	10	10.2	98
2002	148	93.7	0	0.0	10	6.3	158
2003	89	92.7	2	2.1	5	5.2	96
2004	84	96.6	2	2.3	1	1.1	87
2005	74	92.5	3	3.8	3	3.8	80
2006	66	90.4	4	5.5	3	4.1	73
2007	73	96.1	0	0.0	3	3.9	76
2008	48	98.0	0	0.0	1	2.0	49
2009	81	98.8	0	0.0	1	1.2	82
2010	74	98.7	0	0.0	1	1.3	75
2011	83	98.8	0	0.0	1	1.2	84
2012	78	97.5	0	0.0	2	2.5	80
2013	95	99.0	0	0.0	1	1.0	96
2014	80	98.8	0	0.0	1	1.2	81
2015	138	100.0	0	0.0	0	0.0	138

5.1.3 Incident CKD5 Patients on Definitive Dialysis

With reference to the CKD5 patients diagnosed, a similar trend was observed among those on dialysis. The increase in the number of patients on definitive dialysis was closely tracked by that of the crude incidence rate over the years. While the number of new cases of CKD5 patients on definitive dialysis increased from 536 in 1999 to 1088 in 2015, the crude incidence rates increased from 165.9 pmp in 1999 to 278.8 pmp in 2015.

Notably, the number and crude incidence rates of CKD5 patients on definitive dialysis dropped in 2003, likely due to SARS epidemic in Singapore as possibly fewer people were diagnosed due to reduced access to hospitals.

The ASR among the definitive dialysis patients remained relatively flat from 1999 to 2015. The age-standardised incidence rates increased from 153.8 pmp in 1999 to 177.4 pmp in 2015 (Table 5.1.3.1). This implies that the increase in number and

crude rate was mainly associated with ageing, since the trend in ASR remained rather constant while CR increased. See Figure 5.1.3.1 and Table 5.1.3.1.

Figure 5.1.3.1: Number and Rates of Incident Definitive Dialysis Patients

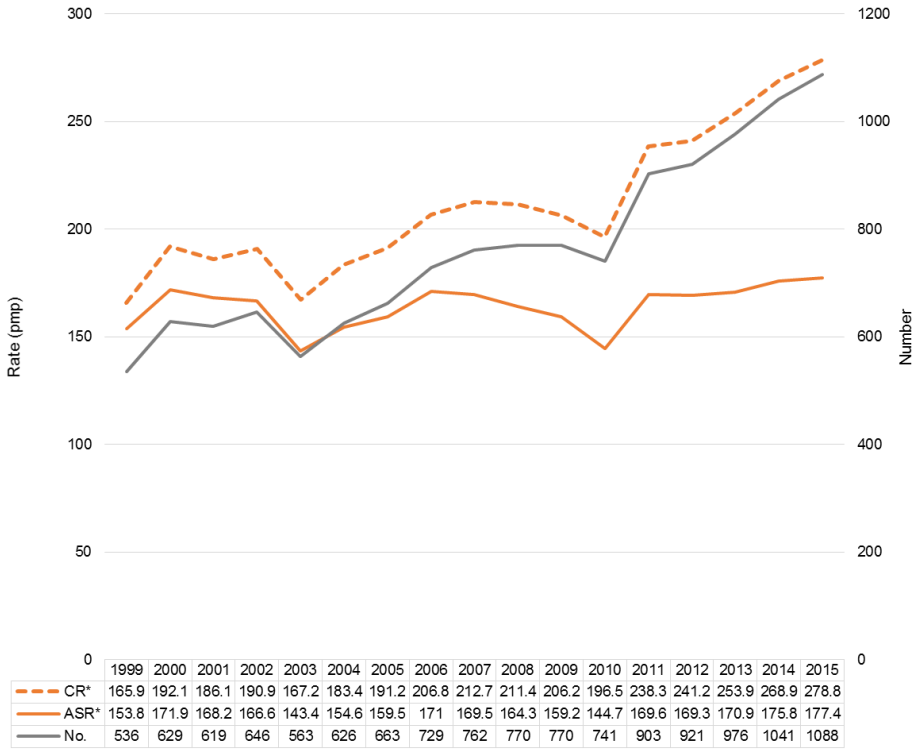


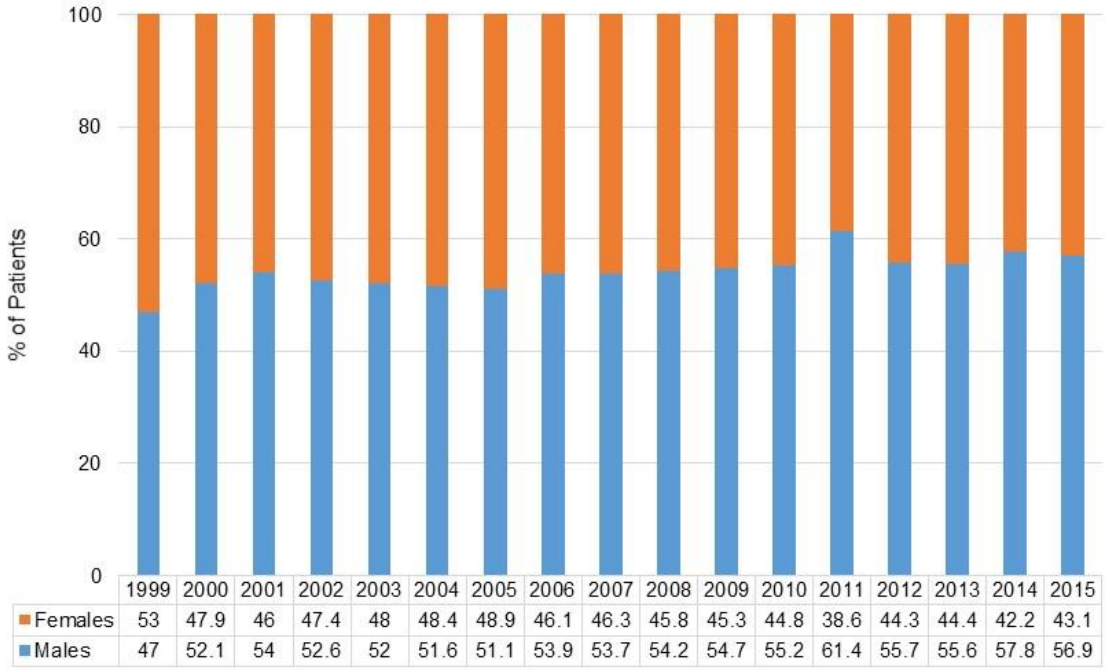
Table 5.1.3.1: Number and Rates of Incident Definitive Dialysis Patients

Year	No.	CR*	ASR*	ASR 95% C.I.
1999	536	165.9	153.8	149.5-158.0
2000	629	192.1	171.9	167.6-176.3
2001	619	186.1	168.2	163.9-172.4
2002	646	190.9	166.6	162.5-170.7
2003	563	167.2	143.4	139.6-147.2
2004	626	183.4	154.6	150.7-158.5
2005	663	191.2	159.5	155.6-163.4
2006	729	206.8	171.0	167.0-175.0
2007	762	212.7	169.5	165.6-173.3
2008	770	211.4	164.3	160.6-168.0
2009	770	206.2	159.2	155.6-162.8
2010	741	196.5	144.7	141.4-148.1
2011	903	238.3	169.6	166.0-173.1
2012	921	241.2	169.3	165.8-172.9
2013	976	253.9	170.9	167.4-174.3
2014	1041	268.9	175.8	172.4-179.2
2015	1088	278.8	177.4	174.0-180.7

* *CR and ASR are expressed as per 1,000,000 residential populations (DOS) and ASR are standardised to World Population.*

Generally there was a higher proportion of male patients on dialysis than females, except in year 1999 (Figure 5.1.3.1). Subsequently, there has been a steady increase in the proportion of men among incident CKD5 (Table 5.1.3.2).

Figure 5.1.3.2: Percentage of Incident Definitive Dialysis Patients by Gender



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Females	53	47.9	46	47.4	48	48.4	48.9	46.1	46.3	45.8	45.3	44.8	38.6	44.3	44.4	42.2	43.1
Males	47	52.1	54	52.6	52	51.6	51.1	53.9	53.7	54.2	54.7	55.2	61.4	55.7	55.6	57.8	56.9

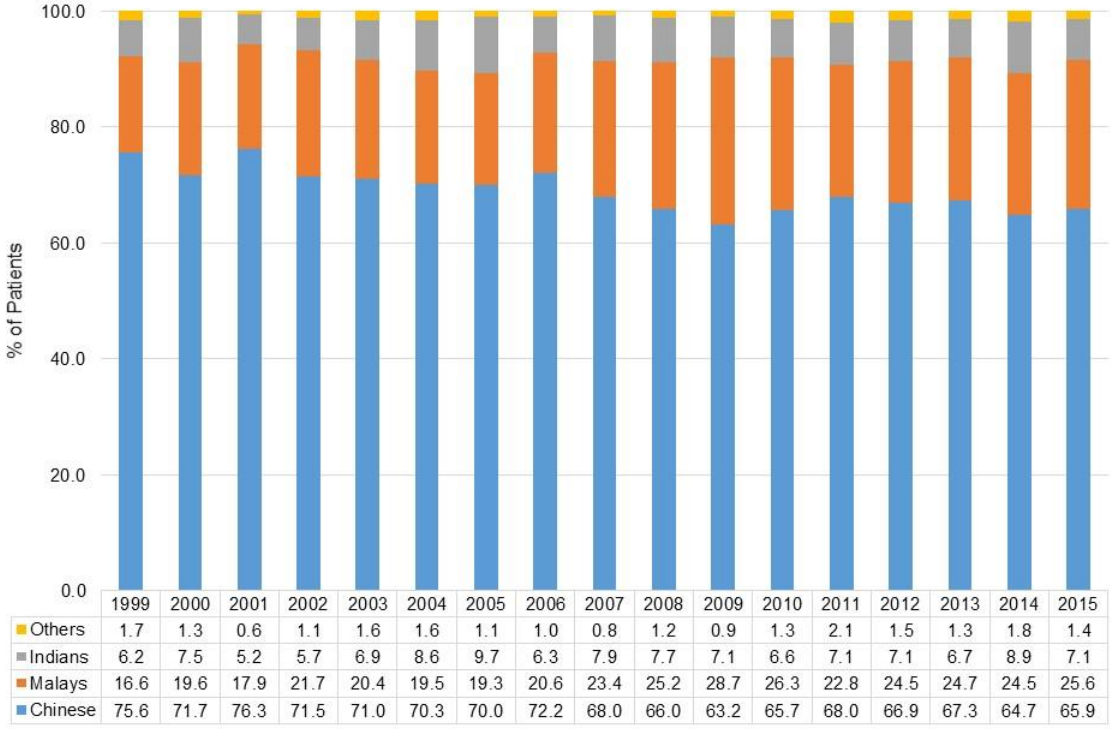
Table 5.1.3.2: Number and Rates of Incident Definitive Dialysis Patients by Gender

	Males			Females		
Year	**No.**	**CR***	**ASR***	**No.**	**CR***	**ASR***
1999	252	156.1	149.4	284	175.8	157.4
2000	328	200.6	184.9	301	183.7	161.4
2001	334	201.4	187.9	285	170.9	151.3
2002	340	201.8	179.1	306	180.1	156.8
2003	293	175.1	154.8	270	159.5	134.6
2004	323	190.5	165.5	303	176.3	145.3
2005	339	197.0	167.4	324	185.5	153.0
2006	393	224.8	193.2	336	189.1	150.1
2007	409	230.3	185.4	353	195.4	153.5
2008	417	231.3	182.6	353	191.9	144.6
2009	421	228.2	179.0	349	184.7	135.5
2010	409	219.8	166.1	332	173.8	125.3
2011	554	296.5	218.3	349	181.7	126.2
2012	513	272.9	195.3	408	210.5	145.9
2013	543	287.1	196.4	433	221.7	146.0
2014	602	316.4	209.7	439	223.0	144.3
2015	619	323.0	207.2	469	236.1	147.9

* *CR and ASR are expressed as per 1,000,000 residential populations (DOS) and ASR are standardised to World Population.*

Although more than 60% of the dialysis patients were Chinese, the proportion of Chinese among the new CKD5 patients on definitive dialysis decreased from 75.6% in 1999 to 65.9% in 2015 (Figure 5.1.3.3). However, ASR for CKD5 on definitive dialysis held steady for the Chinese in this period. The ASR for CKD5 on definitive dialysis has increased steadily among Malays and Indians. The increase in proportion of CKD5 among Malays and Indians corresponded to the increase in proportion of diabetics among these subpopulations (11.3% in 1998 and 16.6% in 2010 for Malays; 15.8% in 1998 and 17.2% in 2010 for Indians; NHS1998 and NHS 2010 respectively). The corresponding rates by ethnic groups are presented in Table 5.1.3.3.

Figure 5.1.3.3: Percentage of Incident Definitive Dialysis Patients by Ethnic Group



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Others	1.7	1.3	0.6	1.1	1.6	1.6	1.1	1.0	0.8	1.2	0.9	1.3	2.1	1.5	1.3	1.8	1.4
Indians	6.2	7.5	5.2	5.7	6.9	8.6	9.7	6.3	7.9	7.7	7.1	6.6	7.1	7.1	6.7	8.9	7.1
Malays	16.6	19.6	17.9	21.7	20.4	19.5	19.3	20.6	23.4	25.2	28.7	26.3	22.8	24.5	24.7	24.5	25.6
Chinese	75.6	71.7	76.3	71.5	71.0	70.3	70.0	72.2	68.0	66.0	63.2	65.7	68.0	66.9	67.3	64.7	65.9

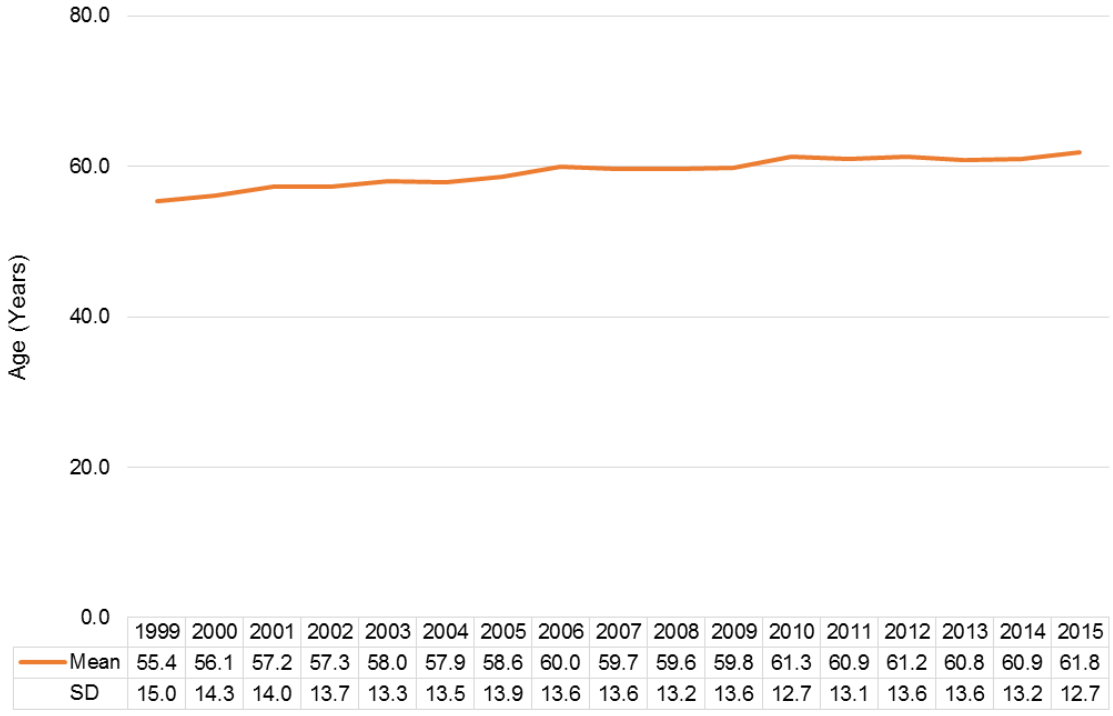
Table 5.1.3.3: Number and Rates of Incident Definitive Dialysis Patients by Ethnic Group

	Chinese			Malays			Indians		
Year	**No.**	**CR***	**ASR***	**No.**	**CR***	**ASR***	**No.**	**CR***	**ASR***
1999	405	163.1	144.4	89	198.0	233.2	33	130.2	128.2
2000	451	179.4	155.6	123	270.3	308.0	47	182.2	177.4
2001	472	184.9	159.4	111	240.3	294.4	32	121.7	113.0
2002	462	178.4	149.3	140	299.0	334.7	37	136.1	127.0
2003	400	155.5	127.2	115	244.8	270.8	39	144.6	138.1
2004	440	169.2	136.2	122	256.4	264.7	54	194.1	195.1
2005	464	176.7	139.3	128	266.3	279.1	64	219.9	229.0
2006	526	198.0	152.8	150	308.7	338.0	46	151.8	149.0
2007	518	192.8	141.7	178	363.0	372.1	60	191.5	189.0
2008	508	186.6	134.8	194	391.8	370.5	59	182.5	185.7
2009	487	175.8	123.1	221	442.0	421.5	55	160.2	159.8
2010	487	174.3	117.2	195	386.9	369.7	49	140.8	136.3
2011	614	218.6	144.1	206	406.8	357.2	64	183.5	170.2
2012	616	217.5	138.5	226	443.7	397.5	65	185.2	178.5
2013	657	230.2	143.8	241	470.1	385.1	65	184.9	162.8
2014	674	234.5	140.9	255	493.6	397.7	93	263.4	229.2
2015	717	247.2	143.1	279	535.6	426.9	77	216.9	171.3

** CR and ASR are expressed as per 1,000,000 residential populations (DOS) and ASR are standardised to World Population.*

Figure 5.1.3.4 shows that the mean age of new definitive dialysis patients increased from 56.4 years in 1999 to 61.8 years in 2015.

Figure 5.1.3.4: Average Age of Incident Definitive Dialysis Patients



There was an increasing trend for HD as a renal replacement therapy option of choice for incident patients at 90 days after initiation of dialysis since 2002. However, the trend seemed to have stabilised after 2008 (Figure 5.1.3.5). This implies that there is a greater dependence on provision of facilities (dialysis centres) and manpower (nursing) if this trend is not reversed. The corresponding rates by modality are presented in Table 5.1.3.4.

Figure 5.1.3.5: Percentage of Incident Definitive Dialysis Patients by Modality

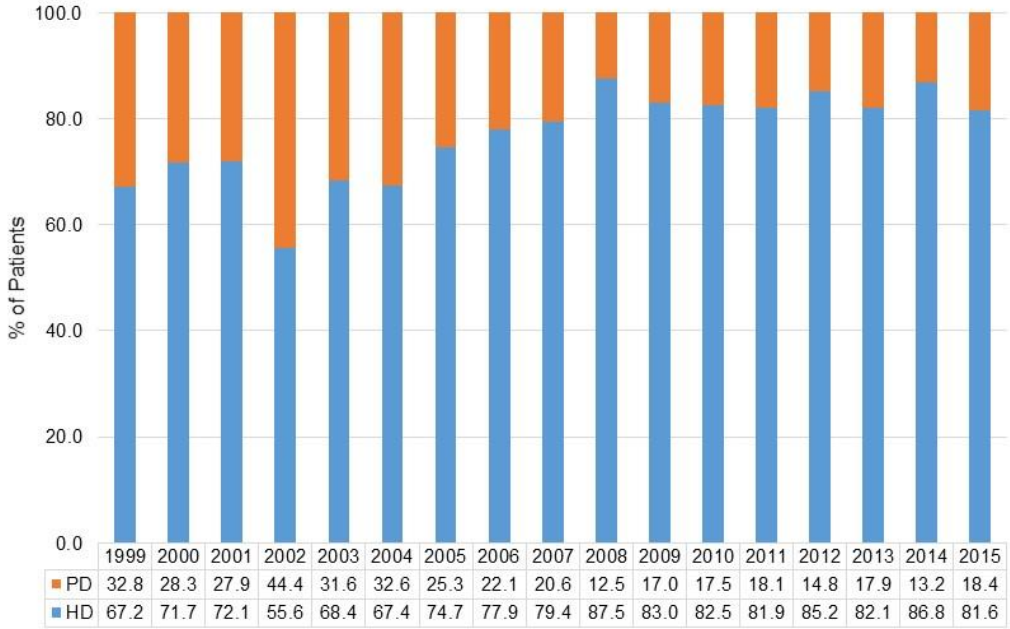
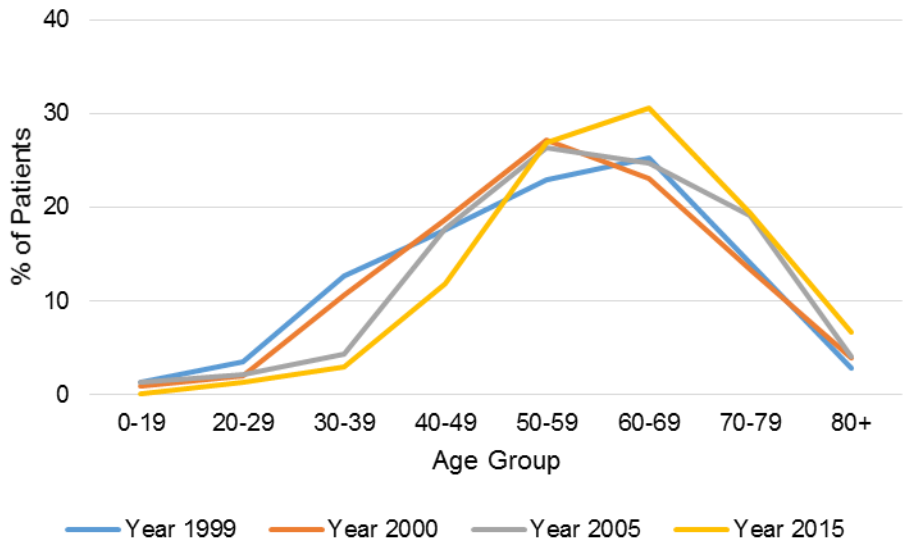


Table 5.1.3.4: Number and Rates of Incident Definitive Dialysis Patients by Modality

	HD			PD		
Year	**No.**	**CR***	**ASR***	**No.**	**CR***	**ASR***
1999	360	111.4	99.7	176	54.5	53.9
2000	451	137.8	121.2	178	54.4	51.9
2001	446	134.1	120.2	173	52.0	49.1
2002	359	106.1	92.2	287	84.8	75.2
2003	385	114.4	97.8	178	52.9	46.4
2004	422	123.6	103.8	204	59.8	51.0
2005	495	142.8	117.4	168	48.4	42.5
2006	568	161.1	131.5	161	45.7	39.5
2007	605	168.9	132.9	157	43.8	36.2
2008	674	185.0	143.4	96	26.4	19.7
2009	639	171.1	129.5	131	35.1	27.9
2010	611	162.0	117.8	130	34.5	26.6
2011	740	195.3	139.8	163	43.0	30.7
2012	785	205.6	143.7	136	35.6	26.3
2013	801	208.4	138.8	175	45.5	31.6
2014	904	233.5	152.4	137	35.4	23.7
2015	888	227.5	142.9	200	51.2	33.5

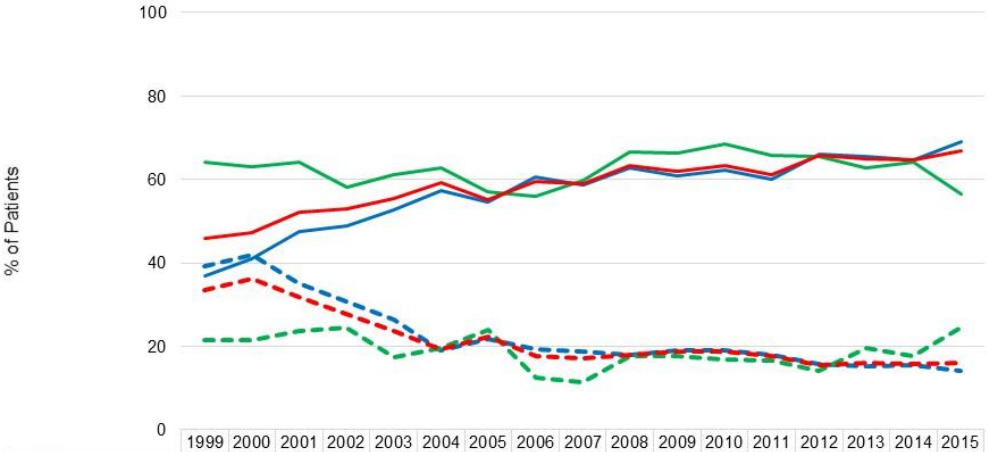
The proportion of dialysis patients in the older age groups has increased in 2015 compared to 1999 (Figure 5.1.3.6), which is consistent with similar changes in Singapore population demographics.

Figure 5.1.3.6: Percentage of Incident Definitive Dialysis Patients by Age Groups



Diabetic nephropathy (DN) was the commonest cause of CKD5 on definitive dialysis for HD and PD patients. DN as an etiology of CKD5 accounted for more than 50% of CKD5 cases in general (Figure 5.1.3.7). In contrast, it is observed among the transplant patients that GN is the major cause instead of DN.

Figure 5.1.3.7: Percentage of Incident Definitive Dialysis Patients by Modality and Etiology (DN and Primary GN)



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
[HD] DN	36.9	41.0	47.5	48.7	52.7	57.3	54.5	60.6	58.7	62.8	60.9	62.4	60.1	66.0	65.5	64.7	69.1
[HD] GN	39.2	41.9	35.0	30.6	26.5	19.0	21.6	19.2	18.7	17.8	19.1	19.0	17.8	15.7	15.2	15.4	14.2
[PD] DN	64.2	62.9	64.2	58.2	61.2	62.7	57.1	55.9	59.9	66.7	66.4	68.5	65.6	65.4	62.9	64.2	56.5
[PD] GN	21.6	21.3	23.7	24.4	17.4	19.6	23.8	12.4	11.5	17.7	17.6	16.9	16.6	14.0	19.4	17.5	24.5
[HD + PD] DN	45.9	47.2	52.2	52.9	55.4	59.1	55.2	59.5	58.9	63.2	61.8	63.4	61.1	65.9	65.1	64.6	66.8
[HD + PD] GN	33.4	36.1	31.8	27.9	23.6	19.2	22.2	17.7	17.2	17.8	18.8	18.6	17.6	15.4	16.0	15.7	16.1

Year

Table 5.1.3.5 showed that regardless of whether the patients had DN or not, about 80% of the patients were on HD in the recent years. This is with the exception of year 2015, where an increase in the proportion of PD patients among the non-DN patients was observed.

Table 5.1.3.5: Number and Rates of Incident Dialysis Patients by Modality and Etiology

	DN				Non-DN			
Year	**No. of HD Patients**	**% of HD Patients**	**No. of PD Patients**	**% of PD Patients**	**No. of HD Patients**	**% of HD Patients**	**No. of PD Patients**	**% of PD Patients**
1999	133	54.1	113	45.9	227	78.3	63	21.7
2000	185	62.3	112	37.7	266	80.1	66	19.9
2001	212	65.6	111	34.4	234	79.1	62	20.9
2002	175	51.2	167	48.8	184	60.5	120	39.5
2003	203	65.1	109	34.9	182	72.5	69	27.5
2004	242	65.4	128	34.6	180	70.3	76	29.7
2005	270	73.8	96	26.2	225	75.8	72	24.2
2006	344	79.3	90	20.7	224	75.9	71	24.1
2007	355	79.1	94	20.9	250	79.9	63	20.1
2008	423	86.9	64	13.1	251	88.7	32	11.3
2009	389	81.7	87	18.3	250	85.0	44	15.0
2010	381	81.1	89	18.9	230	84.9	41	15.1
2011	445	80.6	107	19.4	295	84.0	56	16.0
2012	518	85.3	89	14.7	267	85.0	47	15.0
2013	525	82.7	110	17.3	276	80.9	65	19.1
2014	585	86.9	88	13.1	319	86.7	49	13.3
2015	614	84.5	113	15.5	274	75.9	87	24.1

Table 5.1.3.6a showed that there seemed to be an increasing trend of incident definitive dialysis patients in the private centres. In 2015, 71.1% of the new definitive dialysis patients were in the private dialysis centres.

Table 5.1.3.6(a): Number and Percentage of Incident Definitive Dialysis Patients by Service Providers

	RH		VWO		PTE		All
Year	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**
1999	195	36.4	210	39.2	131	24.4	536
2000	206	32.8	239	38.0	184	29.3	629
2001	221	35.7	113	18.3	285	46.0	619
2002	303	46.9	19	2.9	324	50.2	646
2003	197	35.0	47	8.3	319	56.7	563
2004	214	34.2	151	24.1	261	41.7	626
2005	161	24.3	225	33.9	277	41.8	663
2006	169	23.2	236	32.4	324	44.4	729
2007	177	23.2	204	26.8	381	50.0	762
2008	111	14.4	274	35.6	385	50.0	770
2009	170	22.1	215	27.9	385	50.0	770
2010	149	20.1	164	22.1	428	57.8	741
2011	202	22.4	141	15.6	560	62.0	903
2012	172	18.7	178	19.3	571	62.0	921
2013	216	22.1	159	16.3	601	61.6	976
2014	201	19.3	107	10.3	733	70.4	1041
2015	257	23.6	57	5.2	774	71.1	1088

The percentage of new HD patients in the private centres increased from 34.4% in 1999 to 86.9% in 2015. The corresponding percentage in VWOs decreased from 58.3% in 1999 to 6.3% in 2015 (Table 5.1.3.6b).

Table 5.1.3.6(b): Number and Percentage of Incident Definitive HD Patients by Service Providers

	RH		VWO		PTE		All
Year	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**
1999	26	7.2	210	58.3	124	34.4	360
2000	34	7.5	239	53.0	178	39.5	451
2001	52	11.7	113	25.3	281	63.0	446
2002	35	9.7	17	4.7	307	85.5	359
2003	29	7.5	43	11.2	313	81.3	385
2004	23	5.5	141	33.4	258	61.1	422
2005	37	7.5	185	37.4	273	55.2	495
2006	26	4.6	220	38.7	322	56.7	568
2007	22	3.6	204	33.7	379	62.6	605
2008	26	3.9	265	39.3	383	56.8	674
2009	41	6.4	213	33.3	385	60.3	639
2010	23	3.8	163	26.7	425	69.6	611
2011	41	5.5	141	19.1	558	75.4	740
2012	42	5.4	174	22.2	569	72.5	785
2013	45	5.6	157	19.6	599	74.8	801
2014	67	7.4	104	11.5	733	81.1	904
2015	60	6.8	56	6.3	772	86.9	888

The majority of new PD patients were observed to be in RHs. In 2015, 98.5% of the new PD patients were in the RHs, 0.5% in VWOs and 1.0% in the private dialysis centres (Table 5.1.3.6c).

Table 5.1.3.6(c): Number and Percentage of Incident Definitive PD Patients by Service Providers

	RH		VWO		PTE		All
Year	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**
1999	169	96.0	0	0.0	7	4.0	176
2000	172	96.6	0	0.0	6	3.4	178
2001	169	97.7	0	0.0	4	2.3	173
2002	268	93.4	2	0.7	17	5.9	287
2003	168	94.4	4	2.2	6	3.4	178
2004	191	93.6	10	4.9	3	1.5	204
2005	124	73.8	40	23.8	4	2.4	168
2006	143	88.8	16	9.9	2	1.2	161
2007	155	98.7	0	0.0	2	1.3	157
2008	85	88.5	9	9.4	2	2.1	96
2009	129	98.5	2	1.5	0	0.0	131
2010	126	96.9	1	0.8	3	2.3	130
2011	161	98.8	0	0.0	2	1.2	163
2012	130	95.6	4	2.9	2	1.5	136
2013	171	97.7	2	1.1	2	1.1	175
2014	134	97.8	3	2.2	0	0.0	137
2015	197	98.5	1	0.5	2	1.0	200

The trend of HD patients by service providers remained the same, when stratified by the number of co-morbidities. The private centres received the majority of the HD patients since year 2001 (Table 5.1.3.7).

Table 5.1.3.7: Percentage of Incident Definitive HD Patients by Number of Co-morbidity and Service Providers

%	0 Co-morbidity			1 Co-morbidity			>1 Co-morbidity		
Year	RH	VWO	PTE	RH	VWO	PTE	RH	VWO	PTE
1999	6.4	68.2	25.5	8.1	58.5	33.3	4.8	56.0	39.3
2000	5.3	59.9	34.9	7.3	58.9	33.9	10.3	44.9	44.9
2001	8.7	39.8	51.5	12.9	30.0	57.1	9.4	17.1	73.5
2002	13.6	7.4	79.0	5.3	5.3	89.4	5.9	1.2	92.9
2003	3.9	15.8	80.3	11.9	11.9	76.1	5.5	8.8	85.7
2004	2.8	43.7	53.5	6.5	32.5	61.0	4.2	28.8	66.9
2005	5.6	38.9	55.6	7.5	38.3	54.1	4.8	44.8	50.3
2006	2.9	39.8	57.3	6.0	42.5	51.5	4.7	37.3	58.0
2007	2.1	35.4	62.5	2.6	30.9	66.4	4.6	35.8	59.5
2008	3.2	40.0	56.8	4.2	38.0	57.7	3.5	39.8	56.6
2009	7.4	38.3	54.3	6.3	34.4	59.4	5.5	30.1	64.4
2010	4.9	27.2	67.9	3.4	21.9	74.7	2.2	31.5	66.3
2011	3.7	17.4	78.9	4.4	22.8	72.8	6.4	18.6	75.0
2012	7.3	22.9	69.8	2.2	22.9	74.9	4.4	23.2	72.4
2013	5.8	12.5	81.7	3.5	26.2	70.3	5.4	21.8	72.8
2014	7.7	11.5	80.8	6.6	14.4	79.0	7.5	10.7	81.8
2015	3.4	8.0	88.6	5.5	7.4	87.1	7.0	7.0	86.0

5.2 Prevalent Dialysis Population

As at end of 2015, there were a total of 6230 prevalent patients on dialysis. The number of prevalent patients on dialysis has been increasing since year 1999. The age-standardised prevalence rates increased from 690.2 pmp in 1999 to 1011.8 pmp in 2015 (Table 5.2.1).

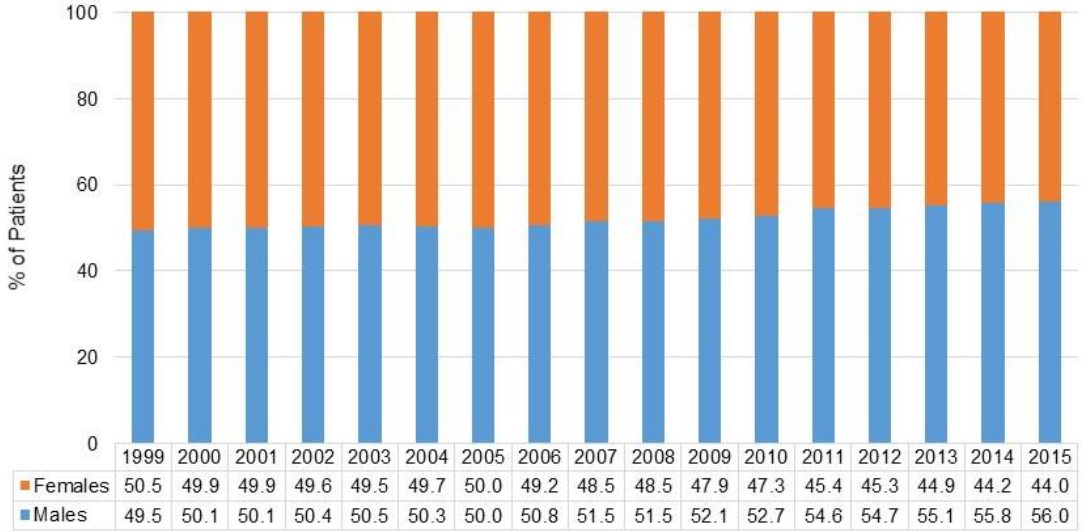
Table 5.2.1: Number and Rates of Prevalent Definitive Dialysis Patients

Year	No.	CR*	ASR*	ASR 95% C.I.
1999	2461	761.9	690.2	681.4-698.9
2000	2757	842.2	746.1	737.2-754.9
2001	2983	896.8	786.4	777.4-795.4
2002	3196	944.6	811.9	803.0-820.9
2003	3299	979.9	833.1	824.0-842.2
2004	3408	998.4	827.9	819.1-836.8
2005	3565	1028.1	837.6	828.8-846.4
2006	3774	1070.5	863.7	854.9-872.5
2007	3943	1100.7	870.2	861.6-878.9
2008	4174	1145.9	884.0	875.5-892.5
2009	4382	1173.6	891.1	882.7-899.4
2010	4596	1218.5	896.4	888.2-904.5
2011	4895	1291.8	919.2	911.0-927.3
2012	5244	1373.6	948.7	940.6-956.8
2013	5520	1435.9	961.4	953.4-969.3
2014	5878	1518.6	986.3	978.4-994.3
2015	6230	1596.3	1011.8	1003.9-1019.7

** CR and ASR are expressed as per 1,000,000 residential populations (DOS) and ASR are standardised to World Population.*

Males outnumbered females slightly among prevalent dialysis population, except in the year 1999 (Figure 5.2.1). The corresponding rates by gender are shown in Table 5.2.2.

Figure 5.2.1: Percentage of Prevalent Definitive Dialysis Patients by Gender



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Females	50.5	49.9	49.9	49.6	49.5	49.7	50.0	49.2	48.5	48.5	47.9	47.3	45.4	45.3	44.9	44.2	44.0
Males	49.5	50.1	50.1	50.4	50.5	50.3	50.0	50.8	51.5	51.5	52.1	52.7	54.6	54.7	55.1	55.8	56.0

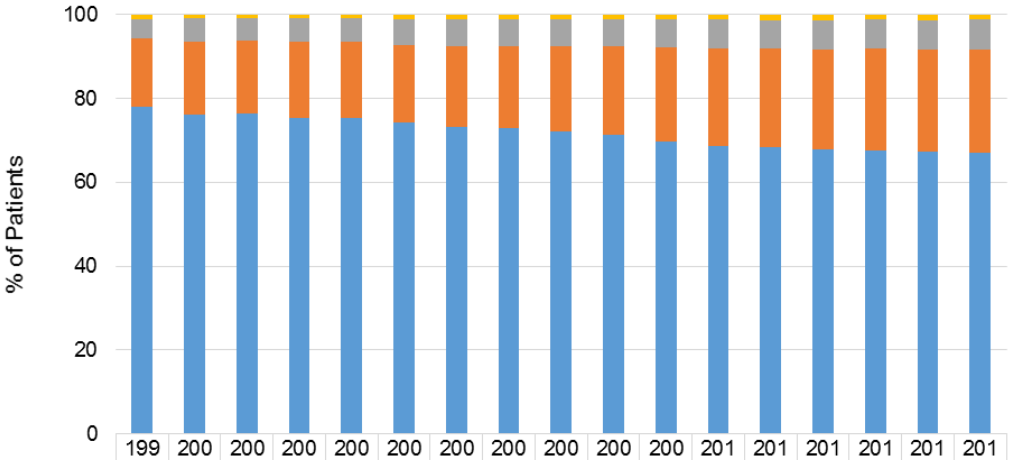
Table 5.2.2: Number and Rates of Prevalent Definitive Dialysis Patients by Gender

	Males			Females		
Year	**No.**	**CR***	**ASR***	**No.**	**CR***	**ASR***
1999	1217	753.7	701.1	1244	770.1	684.8
2000	1380	844.0	769.1	1377	840.3	728.1
2001	1493	900.2	815.7	1490	893.4	769.4
2002	1610	955.8	843.7	1586	933.6	790.8
2003	1666	995.5	869.6	1633	964.4	806.2
2004	1714	1011.0	856.2	1694	985.9	804.7
2005	1781	1034.9	857.4	1784	1021.4	818.4
2006	1916	1096.0	901.0	1858	1045.4	828.3
2007	2029	1142.6	922.0	1914	1059.4	821.4
2008	2150	1192.5	941.3	2024	1100.2	828.1
2009	2284	1238.3	958.3	2098	1110.5	822.1
2010	2421	1300.8	978.5	2175	1138.4	819.2
2011	2673	1430.8	1048.2	2222	1156.7	809.7
2012	2866	1524.6	1081.4	2378	1227.1	830.1
2013	3040	1607.4	1100.9	2480	1269.8	831.3
2014	3281	1724.7	1142.9	2597	1319.4	836.0
2015	3490	1820.9	1172.0	2740	1379.6	853.0

** Crude rates (CR) and age-standardised rates (ASR) are expressed as per 1,000,000 residential populations (DOS) and ASR are standardised to World Population.*

Similar to trends in the incident dialysis patients, the percentage of Chinese prevalent dialysis patients decreased from 78.1% in 1999 to 67.0% in 2015, while the percentage of Malay and Indian patients increased from 16.2% to 24.7% and 4.7% to 7.0% respectively over the entire period (Figure 5.2.2).

Figure 5.2.2: Percentage of Prevalent Definitive Dialysis Patients by Ethnic Group



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Others	1.0	0.9	0.8	0.8	0.9	1.1	1.2	1.0	1.1	1.1	1.0	1.1	1.3	1.4	1.2	1.2	1.2
Indians	4.7	5.5	5.3	5.6	5.5	6.0	6.3	6.4	6.5	6.4	6.7	6.8	6.8	6.9	6.8	7.1	7.0
Malays	16.2	17.4	17.4	18.2	18.3	18.7	19.2	19.5	20.3	21.1	22.5	23.3	23.6	23.9	24.3	24.4	24.7
Chinese	78.1	76.2	76.6	75.4	75.3	74.2	73.3	73.1	72.2	71.3	69.7	68.8	68.3	67.8	67.7	67.2	67.0

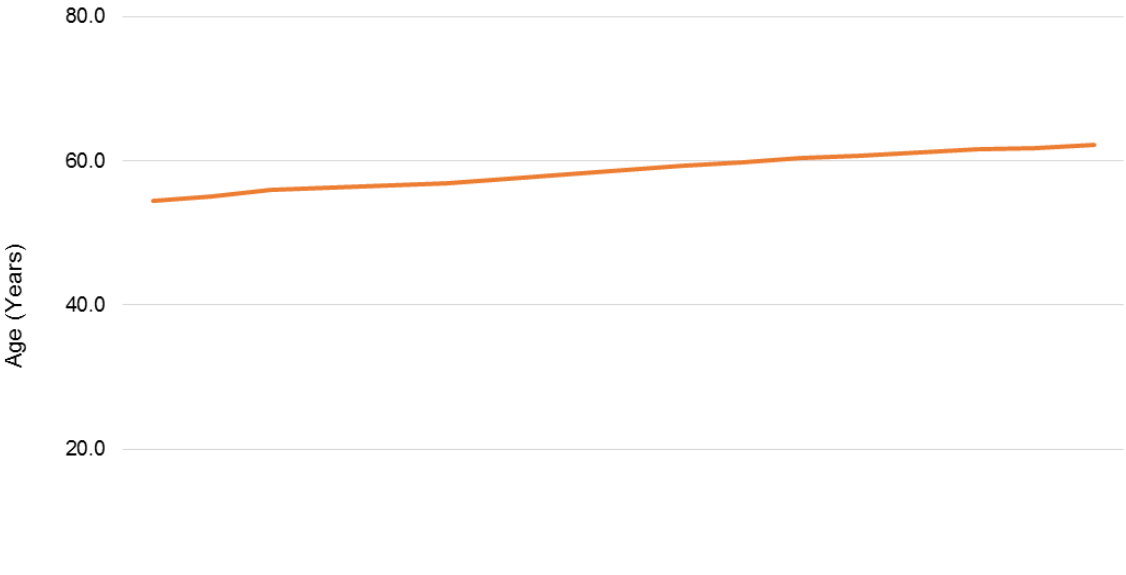
Table 5.2.3: Number and Rates of Prevalent Definitive Dialysis Patients by Ethnic Group

	Chinese			Malays			Indians		
Year	**No.**	**CR***	**ASR***	**No.**	**CR***	**ASR***	**No.**	**CR***	**ASR***
1999	1923	774.6	679.2	399	887.7	991.2	115	453.8	424.8
2000	2102	836.1	715.2	479	1052.5	1157.8	152	589.1	539.4
2001	2284	894.9	757.0	518	1121.2	1251.1	158	600.8	540.5
2002	2410	930.5	768.0	582	1242.8	1359.6	179	658.3	599.6
2003	2485	966.0	781.0	603	1283.8	1377.5	180	667.4	642.9
2004	2529	972.8	764.3	636	1336.7	1392.8	206	740.5	702.8
2005	2614	995.2	761.4	686	1427.1	1460.3	224	769.8	757.7
2006	2758	1038.2	780.5	737	1516.8	1571.4	240	791.8	788.2
2007	2846	1059.3	777.5	799	1629.3	1630.1	256	817.1	817.0
2008	2976	1093.4	779.9	881	1779.1	1714.9	269	832.0	850.5
2009	3054	1102.4	769.2	987	1974.0	1849.9	295	859.1	878.1
2010	3160	1131.0	761.3	1072	2127.0	1965.4	313	899.7	914.6
2011	3344	1190.7	780.5	1155	2280.8	2050.1	333	954.7	930.3
2012	3558	1256.5	796.5	1255	2463.7	2145.4	360	1025.6	960.4
2013	3739	1310.2	803.2	1341	2615.6	2197.8	376	1069.7	956.9
2014	3951	1374.6	815.6	1437	2781.3	2268.9	417	1181.2	1012.0
2015	4177	1440.3	833.3	1541	2958.2	2352.8	436	1228.3	1013.9

* *CR and ASR are expressed as per 1,000,000 residential populations (DOS) and ASR are standardised to World Population.*

Figure 5.2.3 shows that the mean age of prevalent definitive dialysis patients increased from 54.5 years in 1999 to 62.2 years in 2015.

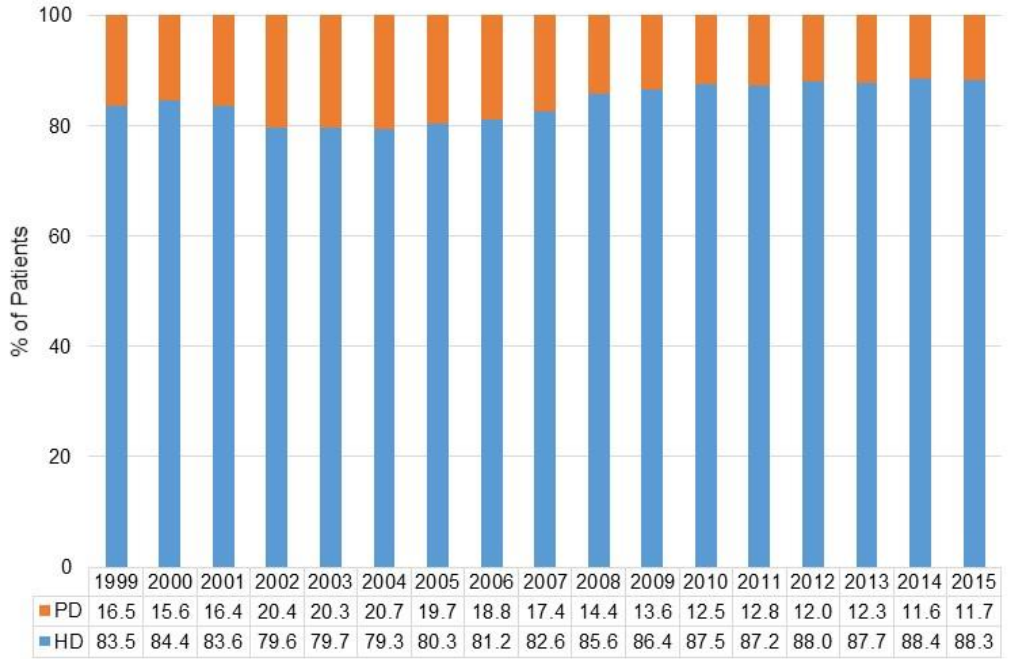
Figure 5.2.3: Average Age of Prevalent Definitive Dialysis Patients



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Mean	54.5	55.1	55.9	56.3	56.6	56.9	57.4	58.2	58.8	59.4	59.7	60.4	60.7	61.2	61.6	61.9	62.2
SD	13.9	13.8	13.6	13.4	13.1	12.9	13.0	12.9	12.8	12.8	12.8	12.6	12.5	12.5	12.6	12.5	12.4

The proportion of prevalent dialysis patients on PD has been decreasing from a high of 20.7% in 2004 to 11.7% in 2015 (Figure 5.2.4). The rates of prevalent dialysis patients by modality is shown in Table 5.2.4.

Figure 5.2.4: Percentage of Prevalent Definitive Dialysis Patients by Modality



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
PD	16.5	15.6	16.4	20.4	20.3	20.7	19.7	18.8	17.4	14.4	13.6	12.5	12.8	12.0	12.3	11.6	11.7
HD	83.5	84.4	83.6	79.6	79.7	79.3	80.3	81.2	82.6	85.6	86.4	87.5	87.2	88.0	87.7	88.4	88.3

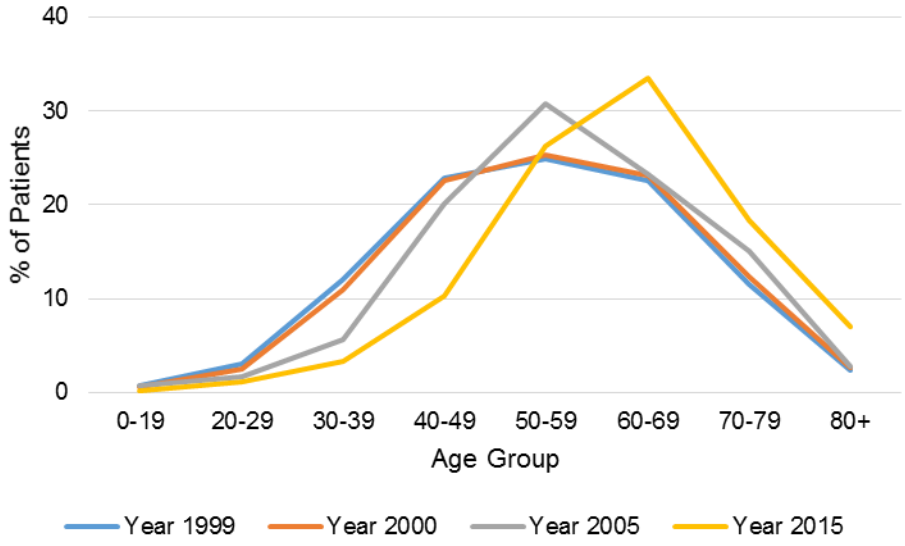
Table 5.2.4: Number and Rates of Prevalent Definitive Dialysis Patients by Modality

	HD			PD		
Year	**No.**	**CR***	**ASR***	**No.**	**CR***	**ASR***
1999	2055	636.2	571.5	406	125.7	120.8
2000	2327	710.8	624.6	430	131.3	123.0
2001	2495	750.1	654.8	488	146.7	136.7
2002	2543	751.6	643.9	653	193.0	172.3
2003	2628	780.6	660.4	671	199.3	175.3
2004	2701	791.3	654.0	707	207.1	175.1
2005	2864	825.9	666.8	701	202.2	169.6
2006	3063	868.8	694.6	711	201.7	168.5
2007	3255	908.6	712.4	688	192.1	157.3
2008	3575	981.4	752.2	599	164.4	130.2
2009	3785	1013.7	762.1	597	159.9	126.4
2010	4020	1065.8	778.1	576	152.7	117.6
2011	4270	1126.9	799.9	625	164.9	123.9
2012	4613	1208.3	830.9	631	165.3	119.9
2013	4841	1259.2	836.5	679	176.6	123.5
2014	5198	1342.9	865.5	680	175.7	117.5
2015	5499	1409.0	882.8	731	187.3	123.4

** CR and ASR are expressed as per 1,000,000 residential populations (DOS) and ASR are standardised to World Population.*

As in incident patients, there was a shift to an increasing proportion of older prevalent dialysis patients from 1999 to 2015 (Figure 5.2.5).

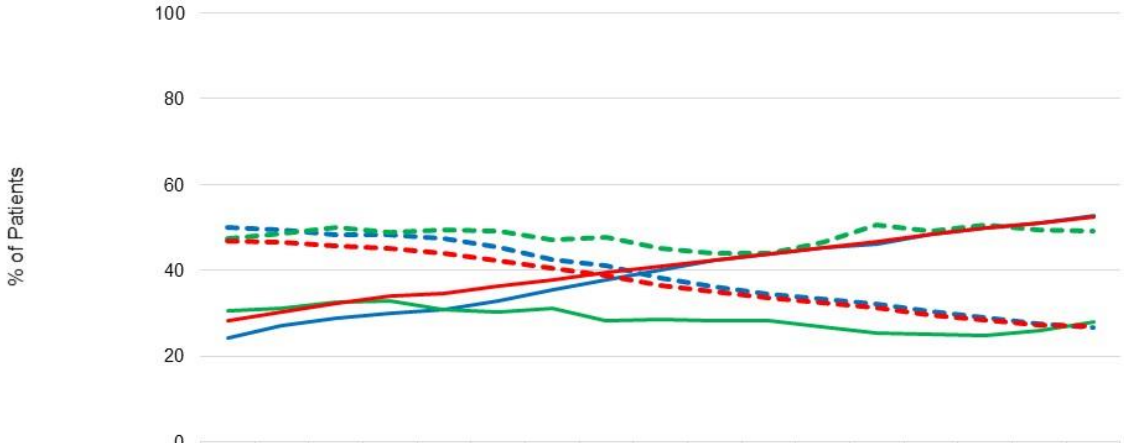
Figure 5.2.5: Percentage of Prevalent Definitive Dialysis Patients by Age Groups



Diabetic Nephropathy (DN) as an aetiology of renal failure increased from 24.4% in 1999 to 52.9% in 2015 among prevalent patients on HD as the main cause of

CKD5. Among prevalent patients on PD, DN contributed a large proportion of prevalent patients for the period from 1999 to 2015, which ranged from 43.9% to 50.7% (Figure 5.2.6).

Figure 5.2.6: Percentage of Prevalent Definitive Dialysis Patients by Modality and Etiology (DN and Primary GN)



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
[HD] DN	24.4	27.0	28.9	30.0	30.9	32.8	35.3	37.6	40.0	42.3	43.9	45.1	46.2	48.3	49.8	51.1	52.9
[HD] GN	50.0	49.5	48.4	48.2	47.3	45.3	42.6	41.1	38.1	36.1	34.5	33.4	32.0	30.3	28.9	27.6	26.8
[PD] DN	47.5	48.6	50.0	49.0	49.3	49.2	47.2	47.7	45.1	43.9	43.9	46.5	50.6	49.3	50.7	49.6	49.2
[PD] GN	30.5	31.2	32.6	32.9	30.8	30.3	31.2	28.4	28.6	28.4	28.3	26.9	25.3	25.0	24.9	25.9	28.0
[HD + PD] DN	28.2	30.4	32.3	33.9	34.7	36.2	37.7	39.5	40.9	42.5	43.9	45.3	46.7	48.4	49.9	50.9	52.5
[HD + PD] GN	46.8	46.7	45.8	45.1	44.0	42.2	40.4	38.7	36.5	35.0	33.6	32.6	31.2	29.7	28.4	27.4	26.9

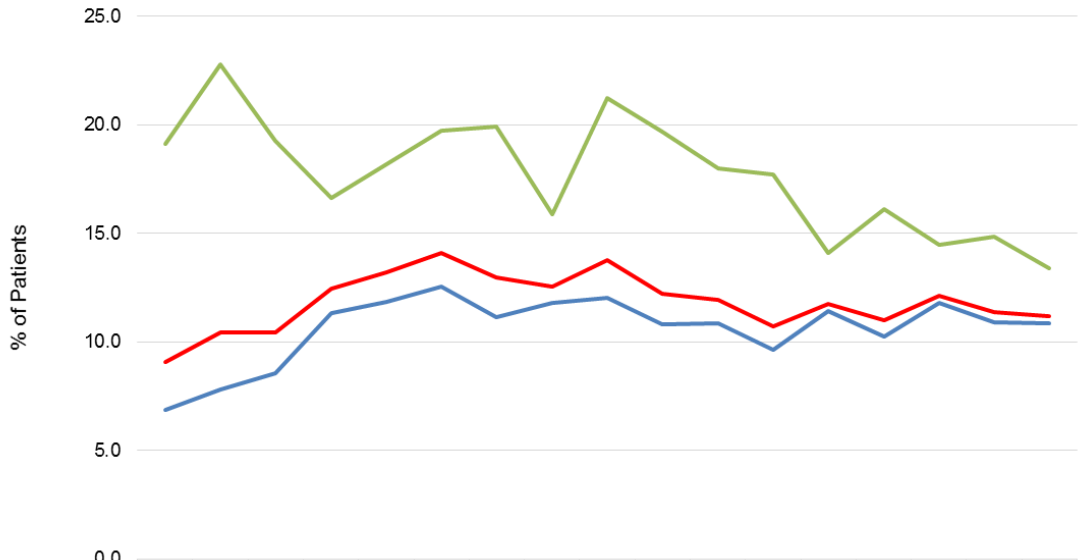
5.3 Mortality in Dialysis Patients

Death rate is defined as the proportion of (all-cause) deaths occurring within the year among all prevalent patients treated by dialysis in the same said year. The denominator in each year comprised of all prevalent patients receiving dialysis in the particular year, and the patient is counted if he is receiving dialysis before death or transplant in the year.

The number of dialysis deaths increased from 254 in 1999 to 792 in 2015. The death rate increased from 10.3% in 1999 to 16.9% in 2004, which then declined to 12.7% in 2015.

The death rates were consistently higher in PD patients than HD patients in the period 1999 to 2015 (Figure 5.3.1). It is likely that the higher death rates seen in PD patients is because of the adverse patient profile of patients who are started on PD. Given that patients with more severe comorbidities may be started on PD as compared to HD, the two patient groups and outcome of mortality are not directly comparable. Despite the increasing age and rising percentage of patients with DN as etiology, the death rate has fallen from 16.9% in 2004 to 12.7% in 2015.

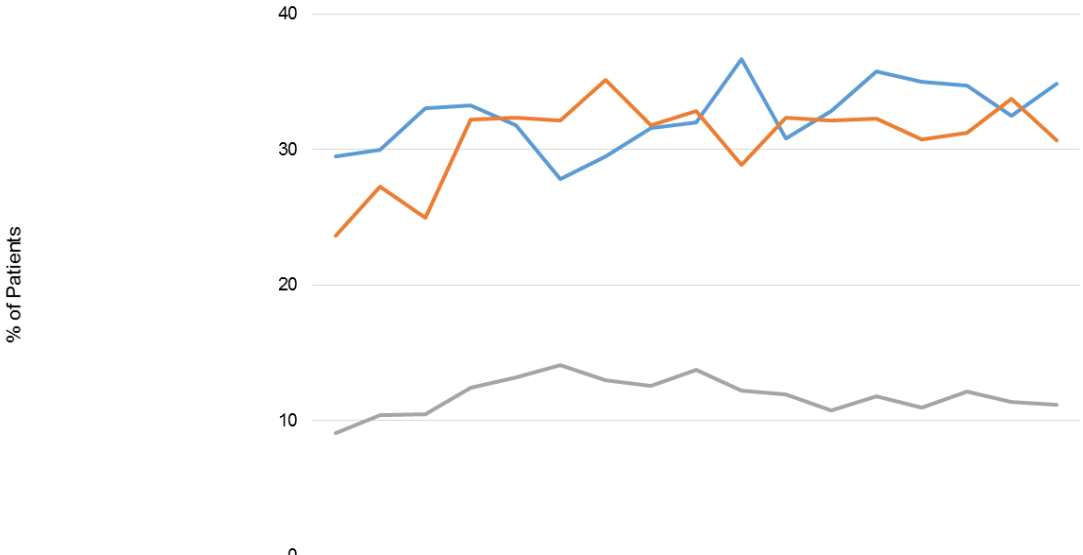
Figure 5.3.1: Percentage of (All-cause) Death by Modality



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
HD	6.9	7.8	8.6	11.3	11.9	12.5	11.1	11.8	12.0	10.8	10.9	9.6	11.4	10.2	11.8	10.9	10.9
PD	19.1	22.8	19.3	16.6	18.2	19.7	19.9	15.9	21.2	19.7	18.0	17.7	14.1	16.1	14.5	14.8	13.4
HD+PD	9.1	10.4	10.5	12.5	13.2	14.1	13.0	12.6	13.7	12.2	11.9	10.7	11.8	11.0	12.1	11.4	11.2

Cardiac events (acute myocardial infarction, acute pulmonary edema and other cardiac causes) accounted for about 27.8% – 36.7% of the deaths while infections accounted for about 23.6% – 35.2% of the deaths (Figure 5.3.2).

Figure 5.3.2: Percentage of Dialysis Death by Infection and Cardiac Related Causes



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Cardiac-related	29.5	30.0	33.1	33.3	31.8	27.8	29.5	31.6	32.0	36.7	30.8	32.9	35.7	35.0	34.7	32.5	34.8
Infection	23.6	27.3	25.0	32.2	32.4	32.2	35.2	31.8	32.8	28.9	32.3	32.1	32.3	30.7	31.2	33.8	30.7
Overall Dialysis Death Rate (%)	9.1	10.4	10.5	12.5	13.2	14.1	13.0	12.6	13.7	12.2	11.9	10.7	11.8	11.0	12.1	11.4	11.2

5.4 Survival of Patients on Definitive Dialysis

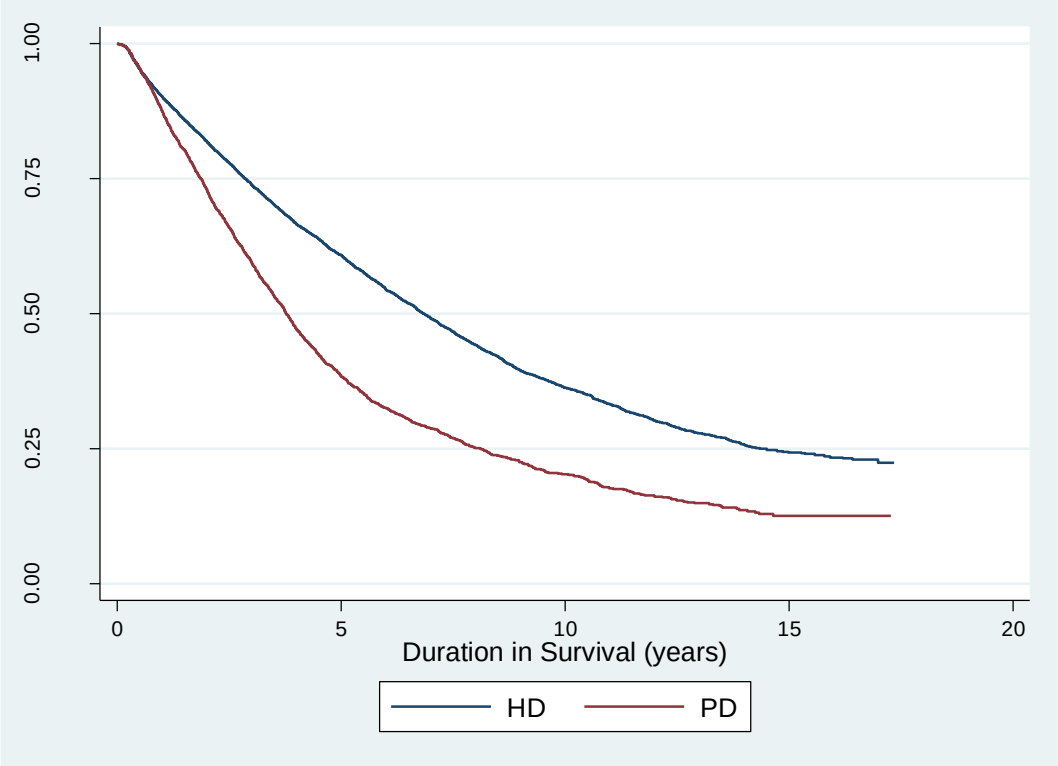
The unadjusted probabilities for surviving 1 year and 5 years for patients on definitive HD were 90.2% and 60.8% respectively, while those for patients on definitive PD were 87.7% and 38.5% respectively (Table 5.4.1, Figure 5.4.1). There was a significant difference in survival probabilities between the dialysis modalities ($p<0.001$). The median survival for patients on definitive HD was 6.8 years while that for patients on definitive PD was 3.8 years. It is likely that comorbidity played an important part in the survival difference between patients on definitive HD and patients on definitive PD.

Table 5.4.1: Survival by Modality

1999-2015	PD	HD
1 year survival (%)	87.7	90.2
5 year survival (%)	38.5	60.8
Median survival (years)[12]	3.8	6.8

[12] Median survival is the duration from the date of definitive dialysis (in this instance), that 50% of the patients on dialysis are still alive.

Figure 5.4.1: Survival by Modality

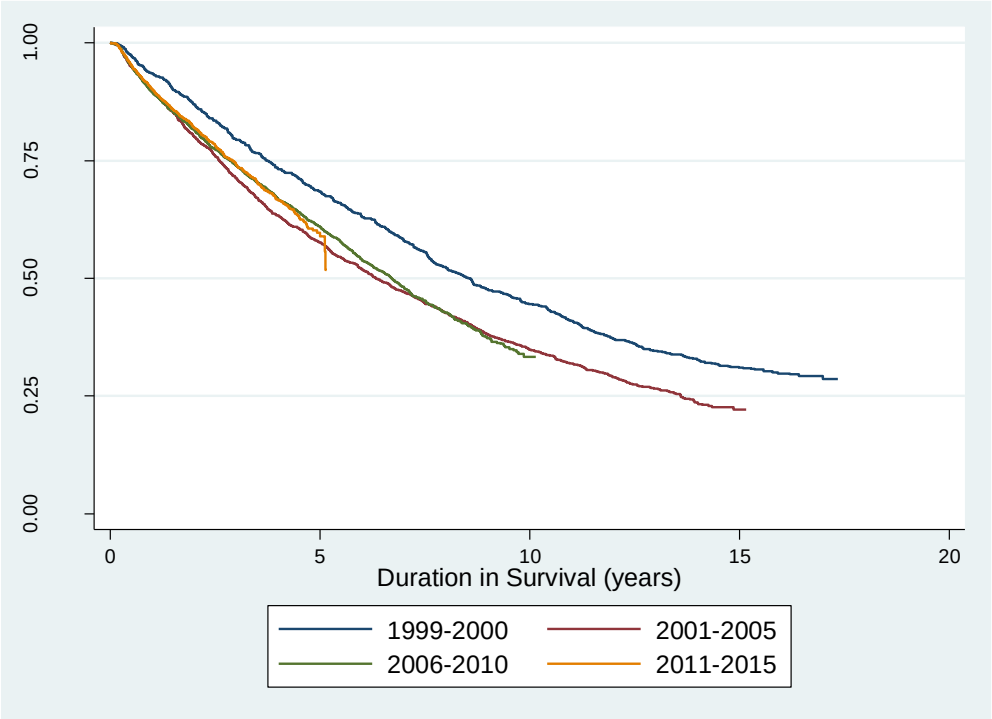


While the 5-year survival for HD patients ranged from 57.7% to 68.4% in the entire study period, the 5-year survival for PD patients increased from 28.5% in 1999-2001 to 52.6% in 2011-2015. (Figure 5.4.2)

Figure 5.4.2: Survival by Period of Definitive Dialysis and Modality

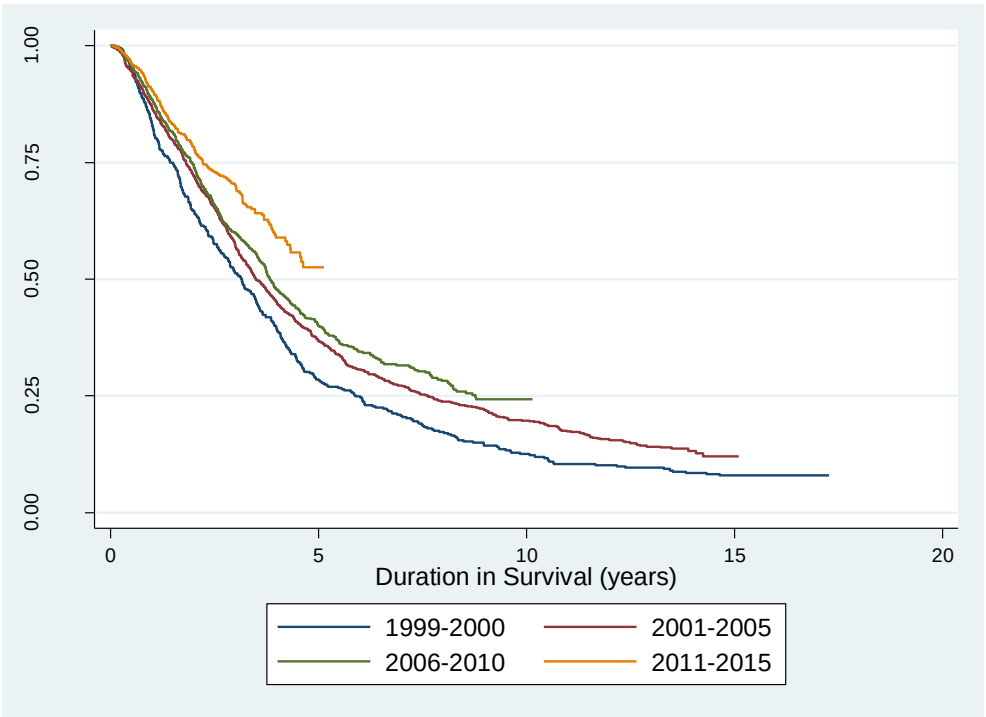
(a) HD

1999-2015	1999-2000	2001-2005	2006-2010	2011-2015
1 year survival (%)	93.5	89.9	89.6	90.2
5 year survival (%)	68.4	57.7	60.9	58.9
Median survival (years)	8.5	6.3	6.7	Not reached



(b) PD

1999-2015	1999-2000	2001-2005	2006-2010	2011-2015
1 year survival (%)	83.1	86.9	88.4	90.4
5 year survival (%)	28.5	36.9	40.1	52.6
Median survival (years)	3.1	3.5	3.8	Not reached



The probabilities for surviving 1 and 5 years were not significantly different between females compared to males for PD (p = 0.53) and HD (p = 0.99) (Table 5.4.2).

Table 5.4.2: Survival by Gender and Modality

1999-2015	Males		Females	
	PD	HD	PD	HD
1 year survival (%)	87.7	90.2	87.7	90.3
5 year survival (%)	39.1	60.4	37.9	61.3
Median survival (years)	3.9	6.8	3.7	6.9

Patients aged below 60 years had significantly better survival than patients aged 60 and above for both PD and HD (p<0.001) (Table 5.4.3).

Table 5.4.3: Survival by Age Groups and Modality

1999-2015	Age < 60		Age ≥ 60	
	PD	HD	PD	HD
1 year survival (%)	91.9	93.4	84.3	87.0
5 year survival (%)	55.2	72.6	24.7	48.2
Median survival (years)	5.7	10.5	3.0	4.7

Regardless of age, non-diabetics had better survival than the diabetics in both PD and HD (p<0.001). Non-diabetic of age<60 years old experienced the best survival (Table 5.4.4).

Table 5.4.4: Survival by Age Groups and Diabetes Status

1999-2015	Diabetics		Non-diabetics	
	Age < 60	Age ≥ 60	Age < 60	Age ≥ 60
1 year survival (%)	90.5	85.7	97.1	88.8
5 year survival (%)	55.7	37.7	88.2	53.3
Median survival (years)	5.7	3.6	Not reached[13]	5.5

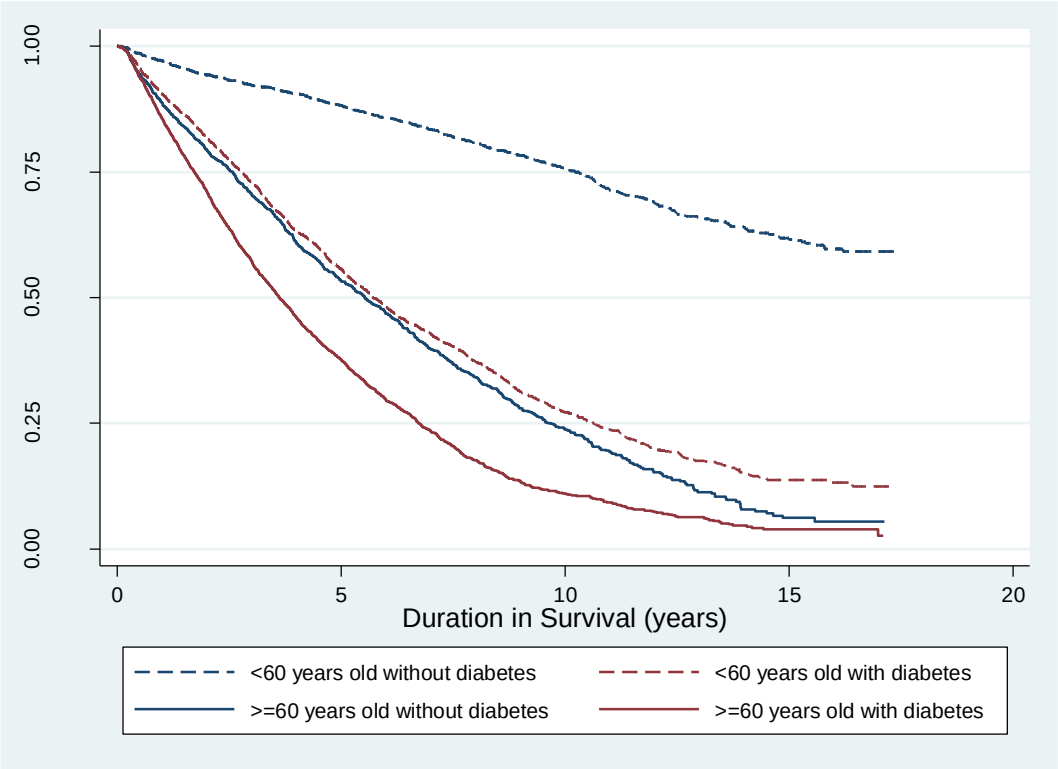
Similarly non-diabetic patients had better survival as compared to diabetics. (Table 5.4.5, Figure 5.4.3). Survival was statistically different among the groups of patients stratified by diabetic status and modality (p<0.001), even after excluding those who were aged less than 60 years and were non-diabetic.

[13] Where median survival is "not reached", it indicates that at the end of the study termination, more than 50% of the patients are still alive.

Table 5.4.5: Survival by Diabetes Status and Modality

1999-2015	DM		Non-DM	
	PD	HD	PD	HD
1 year survival (%)	85.2	88.6	93.3	93.6
5 year survival (%)	26.2	52.4	65.4	76.0
Median survival (years)	3.0	5.3	8.4	12.4

Figure 5.4.3: Survival by Age and Diabetes Status



Generally, patients without any co-morbidity and less than 60 years of age have better survival as compared to the rest of the patients (Table 5.4.6). There was no statistically significant difference in survival for the group of patients without any co-morbidity and less than 60 years old (p = 0.43). However, survival was significantly different for the remaining patients (p<0.001).

Table 5.4.6: Survival by Co-morbidity, Age and Modality

1999-2015	No Co-morbidity and <60 years old		Remaining Patients	
	PD	HD	PD	HD
1 year survival (%)	98.1	98.2	86.2	89.0
5 year survival (%)	90.6	91.9	31.3	55.3
Median survival (years)	Not reached	Not reached	3.4	5.7

Co-morbidities include diabetes mellitus, ischemic heart disease, cerebrovascular disease, peripheral vascular disease, malignancy and smoking.

The Cox regression model (multivariate analysis) showed that several factors affected the survival of patients on dialysis (Table 5.4.7). Age, mode of dialysis, diabetes as primary disease, ischaemic heart disease, cerebrovascular disease, peripheral vascular disease and malignancy were significant risk factors in the model.

Table 5.4.7: Factors Associated with Death in Patients on Definitive Dialysis

Variables	Multivariable		
	HR	95% CI	P-value
Gender:			
-Male	Reference	-	
-Female	0.99	0.95-1.05	0.90
Ethnicity:			0.28
-Chinese	Reference	-	
-Malay	1.04	0.98-1.11	0.17
-Indian	0.97	0.88-1.07	0.58
Age groups:			
<60	Reference	-	
≥60	2.07	1.96-2.19	<0.001
Modality:			
-HD	Reference	-	
-PD	1.57	1.48-1.66	<0.001
Diabetes as primary disease:			
-Absent	Reference	-	
-Present	1.84	1.73-1.95	<0.001
Ischaemic Heart Disease:			
-Absent	Reference	-	
-Present	1.51	1.43-1.60	<0.001
Cerebrovascular Disease:			
-Absent	Reference	-	
-Present	1.40	1.32-1.49	<0.001
Peripheral Vascular Disease:			
-Absent	Reference	-	
-Present	1.52	1.42-1.63	<0.001
Malignancy:			
-Absent	Reference	-	
-Present	1.57	1.43-1.72	<0.001

n= 12,810

5.5 Management of Dialysis Patients

Patients on haemodialysis and peritoneal dialysis were evaluated based on the 4 aspects, namely adequacy of dialysis, management of anaemia, nutrition, as well as presence or absence of mineral and bone disease. The proportions of dialysis patients having relevant readings of various clinical indicators for the evaluation are presented in Tables 5.5.1 and 5.5.2. Results based on year 2015 are presented in the tables. There was not much variation in the results over the years.

While most of the HD were carried out in VWOs (60.7%), 2.0% of the HD patients were in RHs. 99.9% of all patients in VWOs had thrice weekly dialysis. Compared to VWO and private HD patients, a lower proportion of HD patients in RHs had dialysis adequacy measurements (71.4%). The average haemoglobin level was lower at 10.2 g/dl in the RHs, compared to 10.8 g/dl in the VWOs. The average iPTH reading was lowest in the RHs (45.5 pmol/L), and highest in the VWOs (54.3 pmol/L).

Table 5.5.1: Clinical Characteristics of HD Patients in 2015

Locations of Dialysis Centres	RHs No. (%)	VWOs No. (%)	PTE No. (%)	All No. (%)
(1) Site of HD				
Number of Patients on dialysis	112 (2.0)	3336 (60.7)	2051 (37.3)	5499 (100)
(2) Adequacy of Dialysis				
Patients with thrice weekly dialysis	111 (99.1)	3332 (99.9)	1980 (96.5)	5423 (98.6)
Patients with measurements of adequacy of dialysis*	80 (71.4)	3279 (98.3)	1834 (89.4)	5193 (94.4)
(3) Management of Anaemia				
Patients with haemoglobin measurements	111 (99.1)	3290 (98.6)	2048 (99.9)	5449 (99.1)
% of patients with last haemoglobin readings at least 10 (g/dl)	54.1	79.1	69.0	74.8
(3a) Assessments of Iron Stores				
Patients with measurements of iron stores†	111 (99.1)	3286 (98.5)	1906 (92.9)	5303 (96.4)
(4) Management of Mineral and Bone Disease				
(4a) Hormone				
Patients with serum iPTH measurements	109 (97.3)	3288 (98.6)	1942 (94.7)	5339 (97.1)
% of patients with last iPTH between 16.3 and 33.0 pmol/L	27.5	26.1	26.3	26.2
(4b) Calcium				
Patients with corrected serum calcium measurements	109 (97.3)	3290 (98.6)	2033 (99.1)	5432 (98.8)
(4c) Serum Phosphate				
Patients with serum phosphate measurements	109 (97.3)	3289 (98.6)	2039 (99.4)	5437 (98.9)
% of patients with last serum phosphate between 1.13 and 1.78 mmol/L	46.8	59.8	50.9	56.2

** Indicators of adequacy of dialysis are determined by URR or fractional clearance of urea (Kt/V) measurements.*

† Indicators of iron stores are determined by serum ferritin and transferrin saturation measurements.

^ *Note that the latest available value for the year was used for all analyses.*

Majority of the PD were carried out in RHs in year 2015. The average haemoglobin level in PD patients ranged from 10.5 g/dl in the VWOs to 11.3 g/dl in the private dialysis centres. The average iPTH reading was highest in the VWO centres (64.9 pmol/L).

Table 5.5.2: Clinical Characteristics of PD Patients in 2015

	RHs No. (%)	VWOs No. (%)	PTEs No. (%)	All No. (%)
(1) Site of PD				
Number of Patients on PD	693 (94.8)	34 (4.7)	4 (0.5)	731 (100)
(2) Adequacy of Dialysis				
Patients with measurements of adequacy of dialysis*	505 (72.9)	25 (73.5)	0 (0.0)	530 (72.5)
(3) Management of Anaemia				
Patients with haemoglobin measurements	693 (100.0)	34 (100.0)	4 (100.0)	731 (100.0)
% of patients with last haemoglobin readings at least 10 g/dl	68.1	58.8	100.0	67.9
(3a) Assessments of Iron Stores				
Patients with measurements of iron stores†	634 (91.5)	34 (100.0)	3 (75.0)	671 (91.8)
(4) Management of Mineral and Bone Disease				
(4a) Hormone				
Patients with serum iPTH measurements	673 (97.1)	33 (97.1)	3 (75.0)	709 (97.0)
% of patients with last iPTH between 16.3 and 33.0 pmol/L	25.6	9.1	0.0	24.7
(4b) Calcium				
Patients with corrected serum calcium measurements	692 (99.9)	34 (100.0)	3 (75.0)	729 (99.7)
(3c) Serum Phosphate				
Patients with serum phosphate measurements	693 (100.0)	34 (100.0)	3 (75.0)	730 (99.9)
% of patients with last serum phosphate between 1.13 and 1.78 mmol/L	46.8	59.8	50.9	56.2

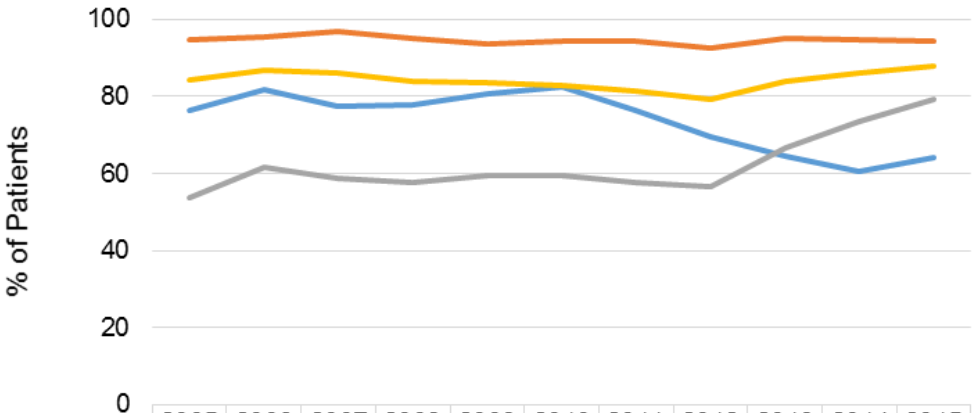
** Indicators of adequacy of dialysis are determined by URR and fractional clearance of urea (Kt/V) measurements*
† Indicators of iron stores are determined by serum ferritin and transferrin saturation measurements
^ Note that the latest available value for the year was used for all analyses.

5.5.1 Adequacy of Dialysis

98.6% of the HD patients were dialysed 3 times per week. See Table 5.5.1. The proportion of these patients with URR ≥ 65% or fractional clearance of urea (Kt/V) ≥ 1.2 was above 80% in the period from 2005 to 2015, with the exception of 2012.

The proportion of patients who met adequacy guidelines ranged from 94.3% in VWOs but was much lower at 64.3% in RHs in year 2015 (Figure 5.5.1.1).

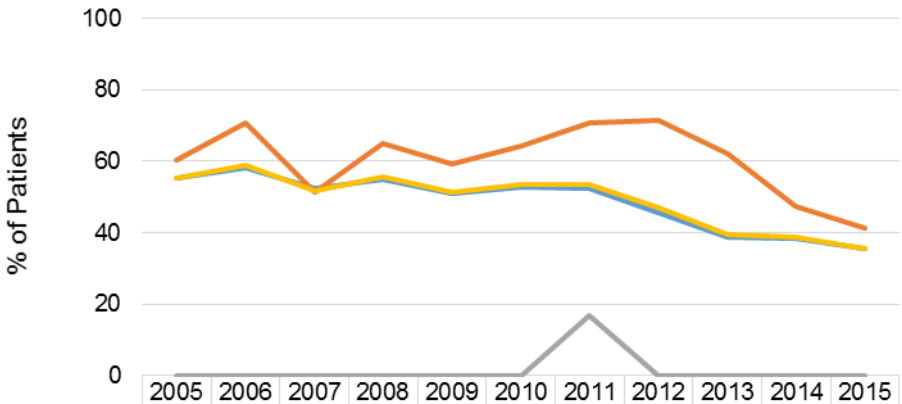
Figure 5.5.1.1: Percentage of HD Patients with URR ≥ 65% or Kt/V ≥ 1.2



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
RH	76.5	81.6	77.3	77.8	80.6	82.6	76.5	69.4	64.4	60.4	64.3
VWO	94.5	95.4	96.7	94.9	93.8	94.3	94.4	92.6	95.1	94.9	94.3
PTE	53.6	61.6	58.7	57.5	59.5	59.3	57.5	56.6	66.7	73.4	79.1
ALL	84.4	86.6	86.0	83.9	83.5	83.0	81.5	79.1	83.9	86.1	88.0

Among all prevalent patients on PD, the proportion of patients with Kt/V ≥ 2 ranged between 35.6% and 58.8% in the period from 2005 to year 2015. The proportion of patients who met adequacy guidelines was higher in the VWOs (41.2%) than the RHs (35.5%) in 2015 (Figure 5.5.1.2).

Figure 5.5.1.2: Percentage of PD Patients with Kt/V ≥ 2

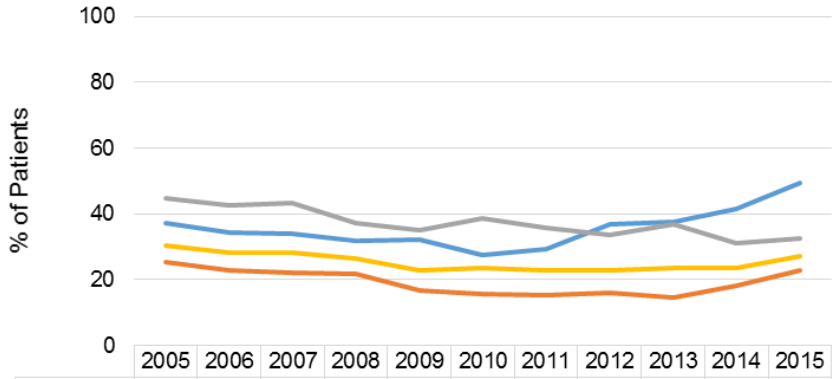


	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
RH	55.4	58.1	52.4	54.8	50.8	52.7	52.3	45.7	38.6	38.4	35.5
VWO	60.3	70.8	51.3	65.0	59.3	64.3	70.9	71.4	62.2	47.4	41.2
PTE	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	0.0	0.0	0.0
ALL	55.3	58.8	51.6	55.8	51.3	53.5	53.6	46.9	39.5	38.7	35.6

5.5.2 Management of Anaemia (Hb < 10 g/dL)

Overall, the proportion of prevalent HD patients with ESA and Hb level below 10 g/dl decreased from 30.3% in year 2005 to 27.1% in year 2015. The proportion of anaemic patients was highest in the RHs and lowest among the VWOs in year 2014 (Figure 5.5.2.1).

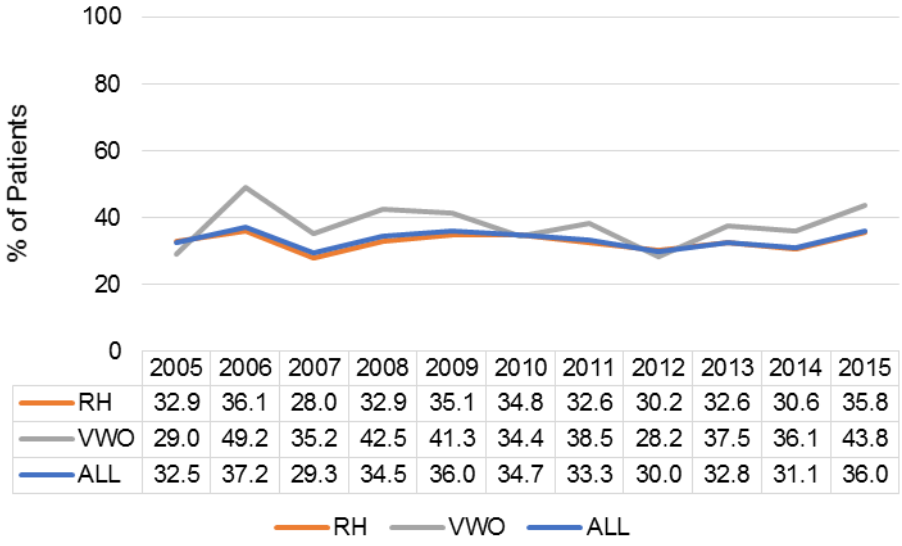
Figure 5.5.2.1: Percentage of HD Patients with Hb < 10 g/dl among those with ESA



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
RH	37.4	34.4	34.1	31.6	32.1	27.5	29.5	36.7	37.7	41.6	49.5
VWO	25.3	22.9	22.1	21.6	16.6	15.6	15.3	16.1	14.6	18.0	22.8
PTE	44.8	42.6	43.3	37.2	34.9	38.5	35.6	33.6	36.8	31.1	32.7
ALL	30.3	28.4	28.1	26.4	22.7	23.5	22.8	23.0	23.6	23.5	27.1

Overall, the proportion of prevalent PD patients with ESA and Hb level below 10 g/dl ranged from about 29.3% to 37.2% in the period from 2005 to 2015 (Figure 5.5.2.2).

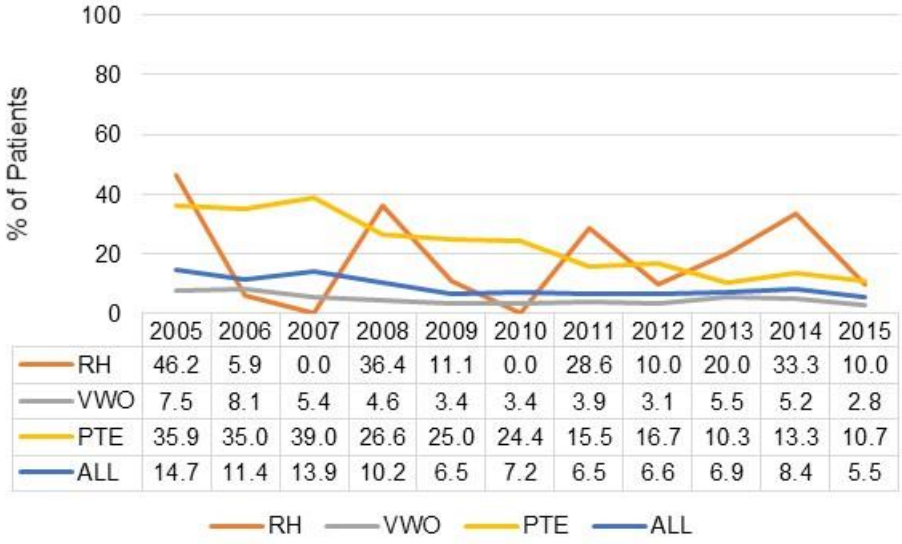
Figure 5.5.2.2: Percentage of PD Patients with ESA and Hb < 10 g/dl



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
RH	32.9	36.1	28.0	32.9	35.1	34.8	32.6	30.2	32.6	30.6	35.8
VWO	29.0	49.2	35.2	42.5	41.3	34.4	38.5	28.2	37.5	36.1	43.8
ALL	32.5	37.2	29.3	34.5	36.0	34.7	33.3	30.0	32.8	31.1	36.0

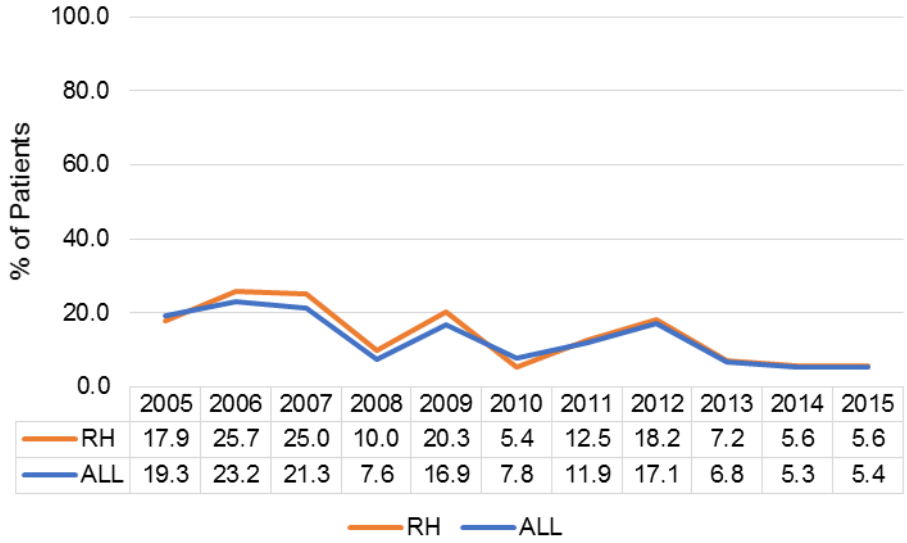
** PTE patients not presented due to small counts*

Figure 5.5.2.3: Percentage of HD Patients without ESA and Hb < 10 g/dl



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
RH	46.2	5.9	0.0	36.4	11.1	0.0	28.6	10.0	20.0	33.3	10.0
VWO	7.5	8.1	5.4	4.6	3.4	3.4	3.9	3.1	5.5	5.2	2.8
PTE	35.9	35.0	39.0	26.6	25.0	24.4	15.5	16.7	10.3	13.3	10.7
ALL	14.7	11.4	13.9	10.2	6.5	7.2	6.5	6.6	6.9	8.4	5.5

Figure 5.5.2.4: Percentage of PD Patients without ESA and Hb < 10 g/dl



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
RH	17.9	25.7	25.0	10.0	20.3	5.4	12.5	18.2	7.2	5.6	5.6
ALL	19.3	23.2	21.3	7.6	16.9	7.8	11.9	17.1	6.8	5.3	5.4

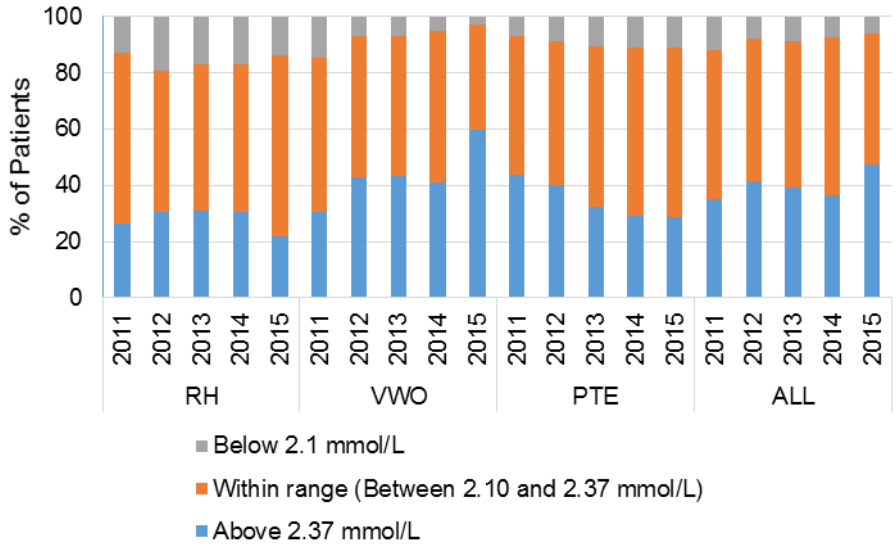
** VWO and PTE patients not presented due to small counts*

5.5.3 Management of Mineral and Bone Disease

5.5.3.1 Calcium

The overall proportion of prevalent HD patients, with corrected serum calcium level between 2.10 and 2.37 mmol/L, was similar in the period from 2011 to 2015, ranging from 46.4% to 56.0%.

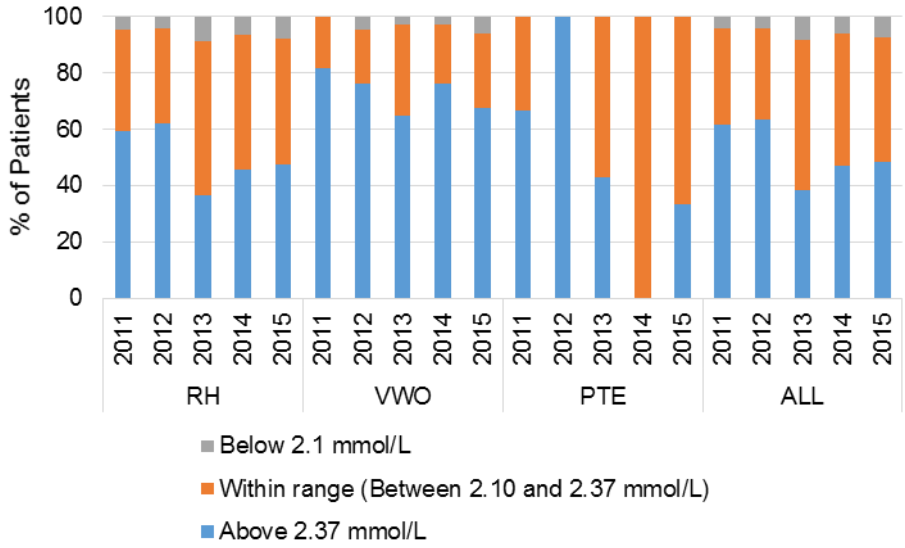
Figure 5.5.3.1.1: Distribution of corrected serum calcium among HD patients



** Only data based on last 5 years are presented due to complexity in the graphic visualisation*

The overall proportion of prevalent PD patients, with corrected serum calcium level between 2.10 and 2.37 mmol/L, ranged from 32.4% to 53.5% in the period from 2011 to 2015.

Figure 5.5.3.1.2: Distribution of corrected serum calcium among PD patients

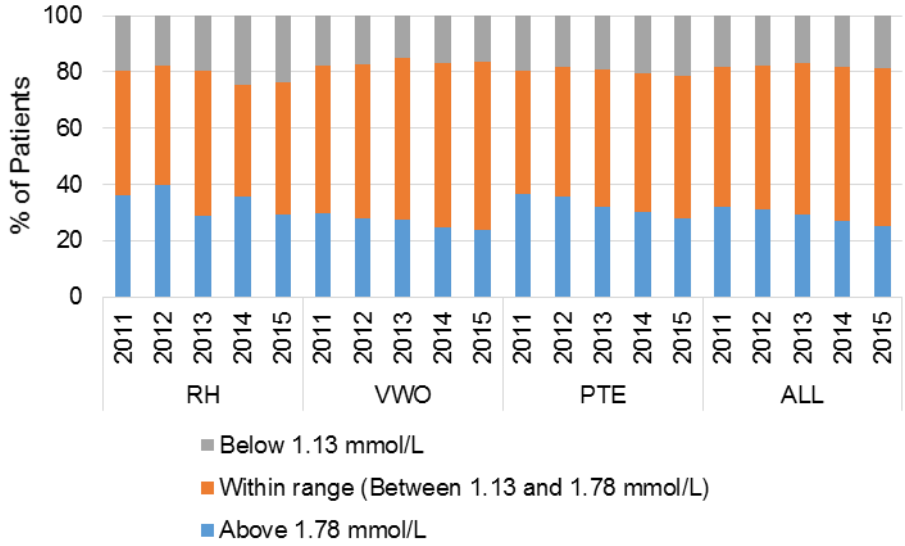


** Only data based on last 5 years are presented due to complexity in the graphic visualisation*

5.5.3.2 Serum Phosphate

The overall proportion of prevalent HD patients with serum phosphate between 1.13 and 1.78 mmol/L was 49.5 – 54.9% in the period from 2011 to 2015. In year 2015, the serum phosphate level was highest among patients in the VWO centres (59.8%), and lowest among patients in the RHs (46.8%).

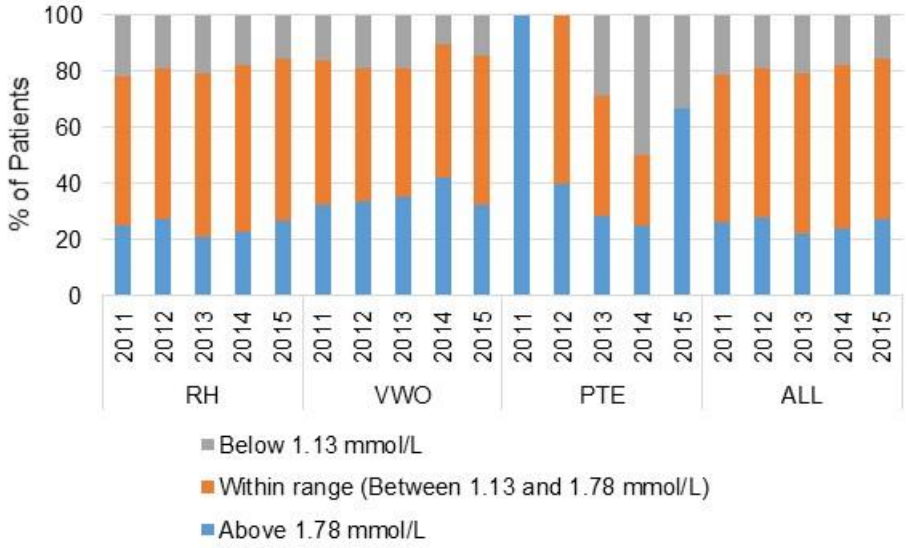
Figure 5.5.3.2.1: Distribution of Serum phosphate among HD Patients



** Only data based on last 5 years are presented due to complexity in the graphic visualisation*

The overall proportion of prevalent PD patients with serum phosphate between 1.13 and 1.78 mmol/L ranged from 52.7% to 58.1% in the period from 2011 to 2015.

Figure 5.5.3.2.2: Distribution of Serum phosphate among PD Patients

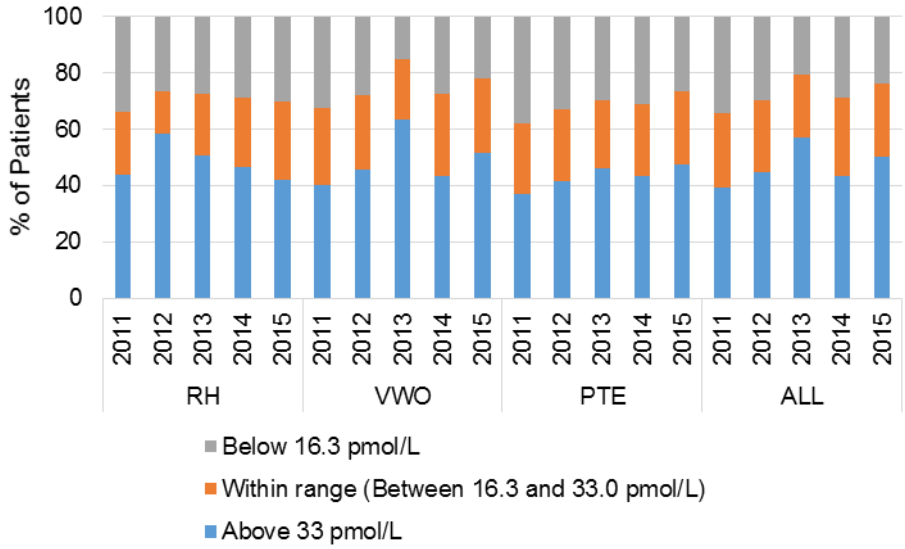


** Only data based on last 5 years are presented due to complexity in the graphic visualisation*

5.5.3.3 Serum Intact Parathyroid Hormone

The overall proportion of prevalent HD patients with serum iPTH level between 16.3 and 33.0 pmol/L ranged from 22.5% to 27.8% in the period from 2011 to 2015. In year 2015, RHs had the highest proportion of patients within this range (27.5%) while both VWOs and private clinics had the lowest proportion (26.1% and 26.3% respectively).

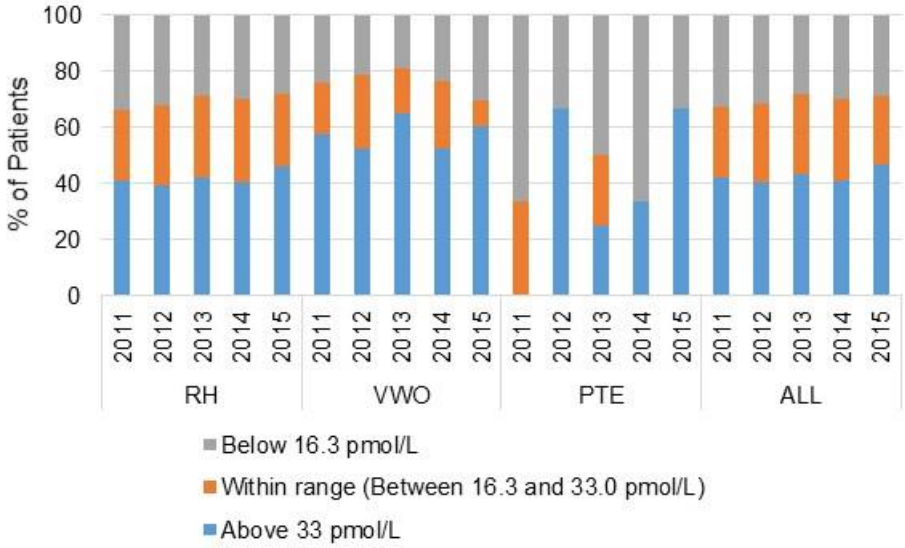
Figure 5.5.3.3.1: Distribution of serum iPTH among HD Patients



** Only data based on last 5 years are presented due to complexity in the graphic visualisation*

The overall proportion of prevalent PD patients with serum iPTH level between 16.3 and 33.0 pmol/L ranged from 25.0% to 29.1% in the period from 2011 to 2015.

Figure 5.5.3.3.2: Distribution of serum iPTH among PD Patients



** Only data based on last 5 years are presented due to complexity in the graphic visualisation*

5.6 Incidence of Kidney Transplantation

The annual number of new kidney transplants increased from 83 in 1999 to 125 in 2006 but dropped to 88 in 2015. The corresponding age-standardised incidence rates increased from 20.4 per million population (pmp) in 1999 to 27.0 pmp in 2006 but dropped to 17.2 pmp in 2015 (Table 5.6.1). The number of incident transplant patients was at its lowest in 2003 for the period from 1999 to 2015. This was likely due to the SARS epidemic in Singapore that disrupted the provision of elective medical services.

Table 5.6.1: Number and Rates of Incident Kidney Transplantation

Year	No.	CR*	ASR*	ASR - 95% C.I.
1999	83	25.7	20.4	19.0-21.8
2000	83	25.4	20.5	19.1-21.9
2001	107	32.2	24.2	22.7-25.7
2002	81	23.9	18.4	17.1-19.8
2003	63	18.7	15.3	14.0-16.5
2004†	103	30.2	22.9	21.5-24.4
2005	117	33.7	26.1	24.6-27.6
2006	125	35.5	27.0	25.5-28.6
2007	112	31.3	24.5	23.0-26.0
2008†	104	28.6	23.0	21.5-24.4
2009	96	25.7	19.6	18.3-20.8
2010	85	22.5	17.7	16.5-19.0
2011	92	24.3	17.7	16.5-18.9
2012	62	16.2	13.4	12.3-14.5
2013	87	22.6	17.4	16.2-18.7
2014	74	19.1	15.4	14.2-16.6
2015	88	22.5	17.2	16.0-18.4

** Crude rates (CR) and age-standardised rates (ASR) are expressed as per 1,000,000 residential populations (DOS) and ASR are standardised to World Population.*

† (a) The Human Organ Transplant Act (HOTA) was passed in 1987 to allow for transplantation of deceased donor kidneys removed from those who died in a hospital as a result of an accident and had chosen not to opt out of donating their organs prior to their deaths.[1]

(b) HOTA was amended in January 2004 to allow (i) transplantation of liver, heart and cornea, (ii) organ donation from donors with non-accidental causes of death and (iii) organ donation from living (both related and unrelated) organ donors.[1]

(c) HOTA was amended in August 2008 to include Muslim organ donors.[2]

(d) HOTA was amended in March 2009 to remove the upper age limit for potential deceased donors.

Note that the numbers include Singapore residents who received kidney transplantation overseas, but not foreigners receiving kidney transplantation in Singapore.

Males constituted a higher percentage of incident kidney transplants for all years (50.0% to 66.4%) except in 2002 and 2004 (Table 5.6.2). The corresponding rates are shown in the same table.

[1] Shum E, Chern A. Amendment of The Human Organ Transplant Act. Ann Acad Med Singapore. 2006; 35 428 - 32
[2] Ministry of Health. 10 February 2009. "Dental Care, HOTA, Infection Control and Cloning".
Website: http://www.moh.gov.sg/mohcorp/speeches.aspx?id=20980. Accessed on: 22 July 2010

Table 5.6.2: Number and Rates of Incident Kidney Transplantation by Gender

	Males				Females			
Year	**No.**	**%**	**CR***	**ASR***	**No.**	**%**	**CR***	**ASR***
1999	44	53.0	27.2	21.5	39	47.0	24.1	18.8
2000	43	51.8	26.3	21.9	40	48.2	24.4	18.8
2001	71	66.4	42.8	32.3	36	33.6	21.6	15.6
2002	39	48.1	23.2	18.1	42	51.9	24.7	18.7
2003	41	65.1	24.5	19.7	22	34.9	13	10.7
2004	51	49.5	30.1	23	52	50.5	30.3	22.8
2005	67	57.3	38.9	29.7	50	42.7	28.6	22
2006	66	52.8	37.8	29.4	59	47.2	33.2	24.8
2007	58	51.8	32.7	25.7	54	48.2	29.9	23
2008	60	57.7	33.3	26.6	44	42.3	23.9	19.4
2009	51	53.1	27.6	20.5	45	46.9	23.8	18.1
2010	43	50.6	23.1	17.3	42	49.4	22	17
2011	53	57.6	28.4	19.8	39	42.4	20.3	15.3
2012	31	50.0	16.5	13.1	31	50.0	16	13.5
2013	50	57.5	26.4	19.9	37	42.5	18.9	14.5
2014	38	51.4	20	14.7	36	48.6	18.3	15.3
2015	49	55.7	25.6	18.9	39	44.3	19.6	15.1

** CR and ASR are expressed as per 1,000,000 residential populations (DOS) and ASR are standardised to World Population.*

Most transplant recipients were Chinese. Malay patients who received transplants was highest in 2008 (19.6%) and was possibly related to the HOTA amendment in that year. The corresponding rates are shown in Table 5.6.3.

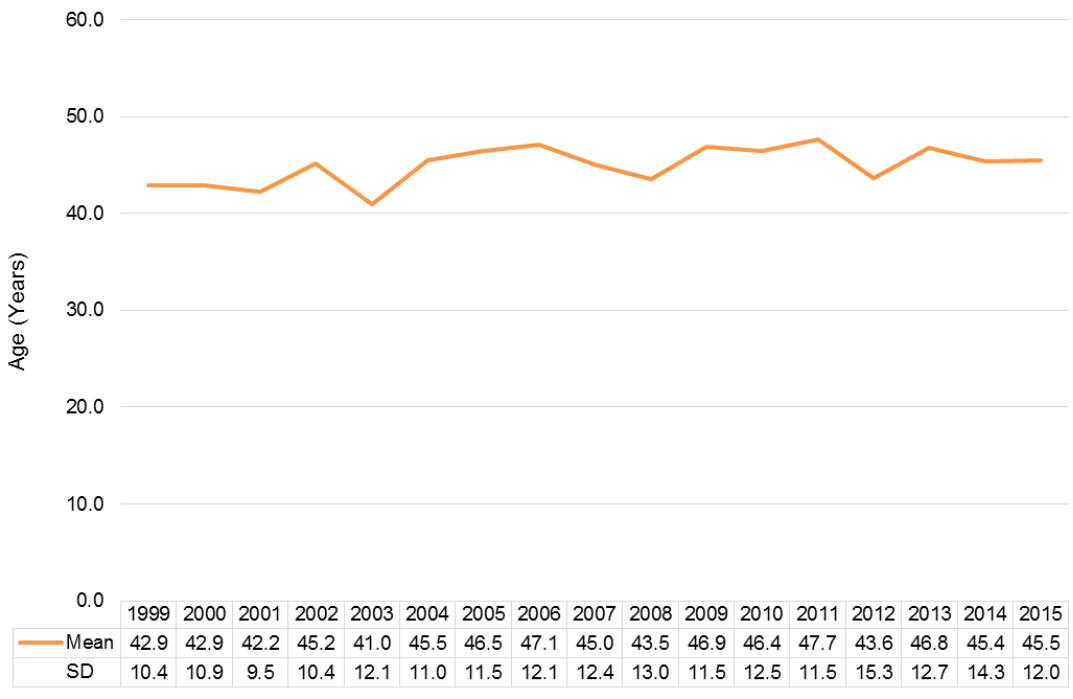
Table 5.6.3: Number and Rates of Incident Kidney Transplantation by Ethnic Group

	Chinese				Malays				Indians			
Year	**No.**	**%**	**CR***	**ASR***	**No.**	**%**	**CR***	**ASR***	**No.**	**%**	**CR***	**ASR***
1999	70	85.4	28.2	21.6	6	7.3	13.3	10.2	6	7.3	23.7	18.8
2000	74	90.2	29.4	22.8	5	6.1	11.0	8.7	3	3.7	11.6	12.4
2001	85	81.0	33.3	24.1	11	10.5	23.8	19.7	9	8.6	34.2	25.6
2002	69	85.2	26.6	19.3	10	12.3	21.4	18.2	2	2.5	7.4	9.3
2003	40	67.8	15.5	11.9	9	15.3	19.2	17.2	10	16.9	37.1	31.5
2004	88	86.3	33.8	25.2	8	7.8	16.8	12.6	6	5.9	21.6	16.8
2005	108	93.1	41.1	30.1	6	5.2	12.5	10.8	2	1.7	6.9	5.0
2006	97	80.2	36.5	27.3	14	11.6	28.8	21.4	10	8.3	33.0	29.9
2007	90	81.8	33.5	24.9	13	11.8	26.5	21.9	7	6.4	22.3	16.7
2008	73	71.6	26.8	20.9	20	19.6	40.4	33.6	9	8.8	27.8	26.0
2009	73	78.5	26.4	19.1	14	15.1	28.0	22.2	6	6.5	17.5	11.6
2010	67	80.7	24.0	17.3	13	15.7	25.8	20.5	3	3.6	8.6	8.1
2011	70	76.9	24.9	17.0	11	12.1	21.7	17.7	10	11.0	28.7	23.2
2012	46	75.4	16.2	13.2	6	9.8	11.8	9.3	9	14.8	25.6	21.0
2013	63	75.0	22.1	16.5	14	16.7	27.3	21.5	7	8.3	19.9	16.1
2014	51	70.8	17.7	12.9	14	19.4	27.1	23.0	7	9.7	19.8	16.5
2015	56	67.5	19.3	13.9	17	20.5	32.6	27.3	10	12.0	28.2	21.1

** CR and ASR are expressed as per 1,000,000 residential populations (DOS) and ASR are standardised to World Population.*

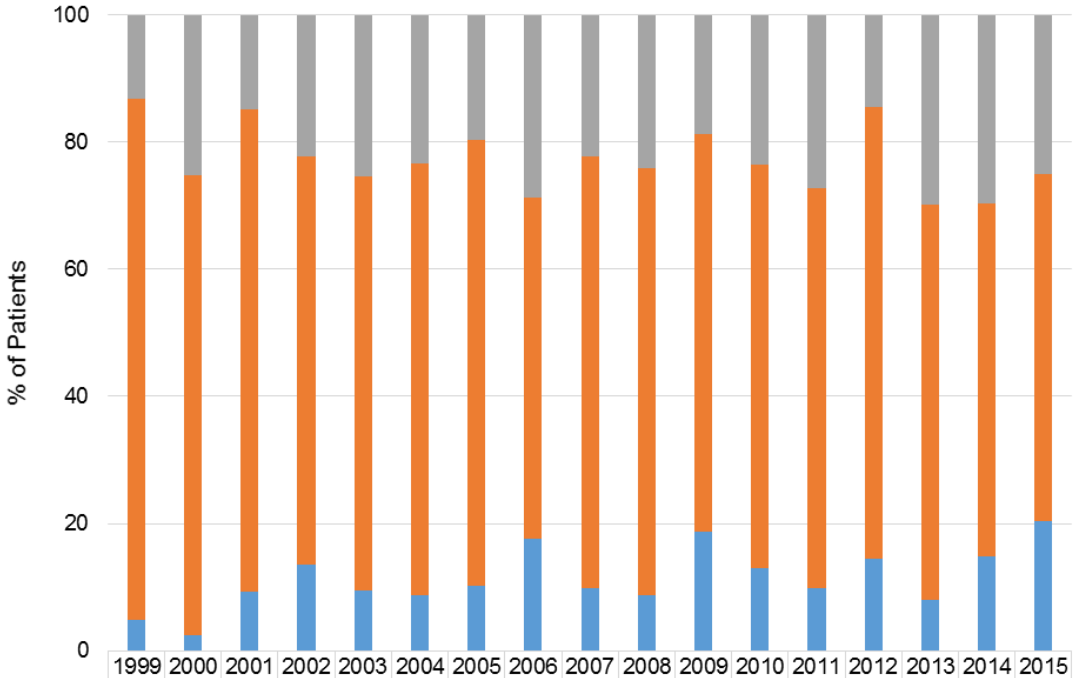
The mean age of transplant patients peaked at 47.7 years in 2011; the mean age of transplanted patients was 45.5 years in 2015 (Figure 5.6.1).

Figure 5.6.1: Average Age of Incident Kidney Transplant Patients



For the period from 1999 to 2015, the percentage of incident transplant patients with DN as the aetiology of renal failure ranged from 2.4% to 20.5% (Figure 5.6.2).

Figure 5.6.2: Percentage of Incident Kidney Transplantation by Etiology



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Others	13.3	25.3	15.0	22.2	25.4	23.3	19.7	28.8	22.3	24.0	18.8	23.5	27.2	14.5	29.9	29.7	25.0
GN	81.9	72.3	75.7	64.2	65.1	68.0	70.1	53.6	67.9	67.3	62.5	63.5	63.0	71.0	62.1	55.4	54.5
DN	4.8	2.4	9.3	13.6	9.5	8.7	10.3	17.6	9.8	8.7	18.8	12.9	9.8	14.5	8.0	14.9	20.5

From Table 5.6.4, new transplants performed overseas ranged from 17.7% to 46.0% in the period from 1999 to 2015. There was an increasing trend in overseas transplants from 1999 to 2003, followed by a decreasing trend since 2004. Cadavaric transplants performed locally ranged from 23.0% to 65.1% in the period 1999 to 2015.

Table 5.6.4: Number and Percentage of Incident Kidney Transplantation by Location and Donor Characteristics

Year	Local TX				Overseas TX		All
	Living-Donor		Deceased-Donor				
	No.	%	No.	%	No.	%	No.
1999	12	14.5	54	65.1	17	20.5	83
2000	10	12.0	44	53.0	29	34.9	83
2001	25	23.4	46	43.0	36	33.6	107
2002	17	21.0	30	37.0	34	42.0	81
2003	16	25.4	18	28.6	29	46.0	63
2004	28	27.2	32	31.1	43	41.7	103
2005	24	20.5	43	36.8	50	42.7	117
2006	30	24.0	56	44.8	39	31.2	125
2007	37	33.0	46	41.1	29	25.9	112
2008	27	26.0	46	44.2	31	29.8	104
2009	28	29.2	41	42.7	27	28.1	96
2010	25	29.4	36	42.4	24	28.2	85
2011	31	33.7	36	39.1	25	27.2	92
2012	28	45.2	23	37.1	11	17.7	62
2013	35	40.2	34	39.1	18	20.7	87
2014	41	55.4	17	23.0	16	21.6	74
2015	40	45.5	32	36.4	16	18.2	88

5.7 Prevalence of Kidney Transplantation

In total, there were 1464 prevalent transplants at the end of 2015. The age-standardised prevalence rates increased from 206.7 pmp in 1999 to 256.8 pmp in 2015 (Table 5.7.1).

Table 5.7.1: Number and Rates of Prevalent Kidney Transplantation

Year	No.	CR*	ASR*	ASR - 95% C.I.
1999	844	261.3	206.7	202.2-211.2
2000	888	271.3	215.3	210.7-219.8
2001	962	289.2	226.8	222.2-231.4
2002	975	288.2	223.3	218.8-227.8
2003	1001	297.3	227.8	223.2-232.3
2004	1051	307.9	233.5	229.0-238.1
2005	1116	321.8	242.4	237.8-247.0
2006	1186	336.4	253	248.3-257.7
2007	1237	345.3	257.4	252.7-262.0
2008	1282	351.9	263.1	258.5-267.8
2009	1330	356.2	264.9	260.3-269.5
2010	1370	363.2	266.5	262.0-271.1
2011	1411	372.4	268.2	263.7-272.7
2012	1411	369.6	262.9	258.5-267.4
2013	1439	374.3	262.3	257.9-266.7
2014	1444	373.1	258.7	254.4-263.1
2015	1464	375.1	256.8	252.6-261.1

* *CR and ASR are expressed as per 1,000,000 residential populations (DOS) and ASR are standardised to World Population.*

Overall, there were more males with transplants (Table 5.7.2).

Table 5.7.2: Number and Rates of Prevalent Kidney Transplantation by Gender

	Males				Females			
Year	**No.**	**%**	**CR***	**ASR***	**No.**	**%**	**CR***	**ASR***
1999	450	53.3	278.7	223.6	394	46.7	243.9	188.1
2000	479	53.9	293.0	234.3	409	46.1	249.6	192.5
2001	530	55.1	319.5	254.1	432	44.9	259.0	198.7
2002	532	54.6	315.8	247.7	443	45.4	260.8	197.4
2003	553	55.2	330.4	255.7	448	44.8	264.6	199.9
2004	578	55.0	340.9	260.4	473	45.0	275.3	206.8
2005	614	55.0	356.8	270.6	502	45.0	287.4	215.2
2006	651	54.9	372.4	283.6	535	45.1	301.0	225.8
2007	672	54.3	378.4	283.0	565	45.7	312.7	232.8
2008	702	54.8	389.4	291.8	580	45.2	315.3	233.5
2009	723	54.4	392.0	289.9	607	45.6	321.3	236.7
2010	740	54.0	397.6	289.0	630	46.0	329.7	239.3
2011	755	53.5	404.1	289.0	656	46.5	341.5	245.2
2012	750	53.2	399.0	280.7	661	46.8	341.1	243.1
2013	761	52.9	402.4	279.8	678	47.1	347.1	243.7
2014	765	53.0	402.1	275.6	679	47.0	345.0	240.8
2015	780	53.3	407.0	274.5	684	46.7	344.4	237.7

* *CR and ASR are expressed as per 1,000,000 residential populations (DOS) and ASR are standardised to World Population.*

Among the three ethnic groups, Chinese comprised the highest proportion of transplant recipients. The proportion of Malay transplant recipients increased slightly over the years (Table 5.7.3).

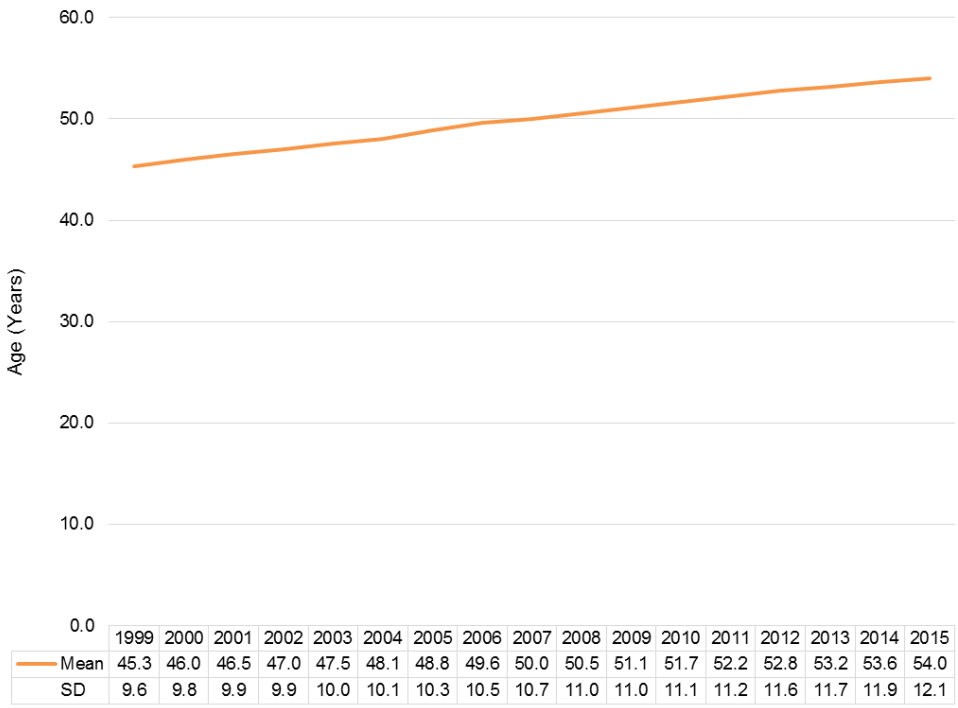
Table 5.7.3: Number and Rates of Prevalent Kidney Transplantation by Ethnic Group

	Chinese				Malays				Indians			
Year	**No.**	**%**	**CR***	**ASR***	**No.**	**%**	**CR***	**ASR***	**No.**	**%**	**CR***	**ASR***
1999	718	85.8	289.2	219.2	73	8.7	162.4	137.8	46	5.5	181.5	152.9
2000	759	86.3	301.9	228.8	75	8.5	164.8	135.7	46	5.2	178.3	153.0
2001	818	85.8	320.5	240.9	82	8.6	177.5	151.1	53	5.6	201.5	172.9
2002	837	86.6	323.2	239.4	83	8.6	177.2	150.2	46	4.8	169.2	145.7
2003	849	85.9	330.0	241.6	85	8.6	181.0	152.3	54	5.5	200.2	170.5
2004	893	86.2	343.5	249.2	85	8.2	178.6	148.0	58	5.6	208.5	173.4
2005	954	86.6	363.2	261.6	89	8.1	185.1	148.7	58	5.3	199.3	165.7
2006	1009	86.3	379.8	273.9	95	8.1	195.5	155.4	65	5.6	214.5	182.4
2007	1045	85.8	389.0	275.9	102	8.4	208.0	166.4	71	5.8	226.6	193.4
2008	1071	84.8	393.5	277.8	114	9.0	230.2	184.8	78	6.2	241.3	213.0
2009	1105	84.5	398.9	277.9	125	9.6	250.0	200.2	77	5.9	224.2	198.3
2010	1135	84.3	406.2	278.0	132	9.8	261.9	204.5	79	5.9	227.1	200.1
2011	1165	84.1	414.8	279.4	136	9.8	268.6	211.0	84	6.1	240.8	207.1
2012	1161	83.9	410.0	273.3	135	9.8	265.0	207.2	88	6.4	250.7	211.9
2013	1177	83.5	412.4	272.0	144	10.2	280.9	217.3	89	6.3	253.2	212.2
2014	1174	83.0	408.4	266.1	148	10.5	286.5	219.8	92	6.5	260.6	215.9
2015	1181	82.6	407.2	261.4	154	10.8	295.6	227.1	94	6.6	264.8	212.9

** CR and ASR are expressed as per 1,000,000 residential populations (DOS) and ASR are standardised to World Population.*

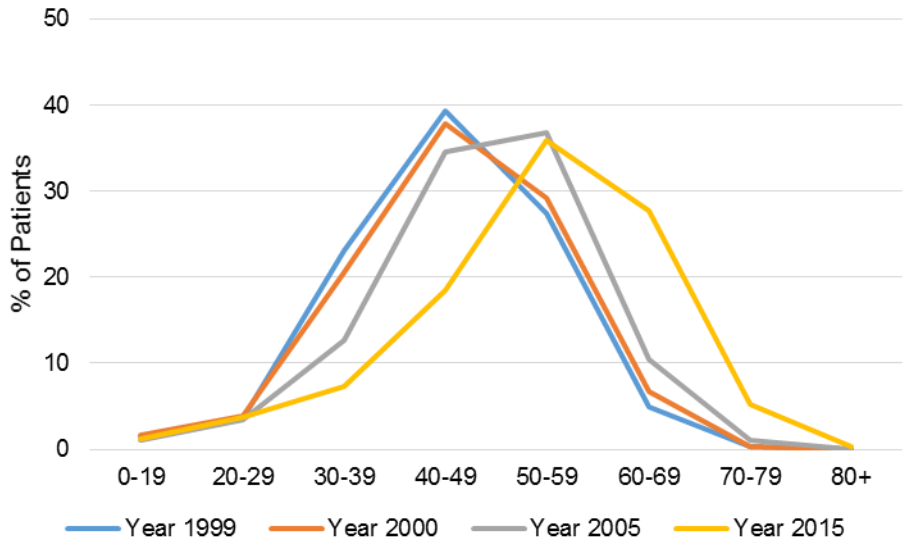
The mean age for prevalent renal transplant patients increased from 45.3 years in 1999 to 54.0 years in 2015 (Figure 5.7.1).

Figure 5.7.1: Average Age of Prevalent Kidney Transplant Patients



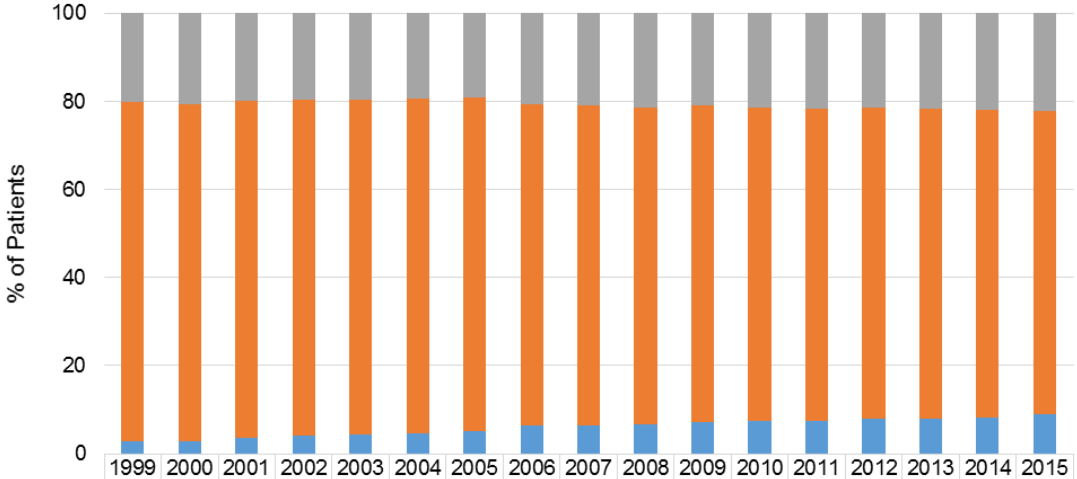
In line with the increase in median age of incident transplant patients, the prevalent transplant patients peaked at an older age in 2015 compared to in 1999 (Figure 5.7.2).

Figure 5.7.2: Percentage of Prevalent Kidney Transplantation by Age Groups



Overall, Primary Glomerulonephritis remained as the single main cause for CKD5 among prevalent kidney transplants (Figure 5.7.3).

Figure 5.7.3: Percentage of Prevalent Kidney Transplantation by Etiology



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Others	20.1	20.7	19.8	19.6	19.6	19.3	19.2	20.7	20.9	21.5	21.0	21.3	21.6	21.3	21.5	22.0	22.1
GN	77.0	76.4	76.6	76.4	76.1	76.1	75.7	72.9	72.7	71.8	71.8	71.2	70.9	70.8	70.5	69.7	68.9
DN	2.8	2.9	3.6	4.0	4.3	4.6	5.1	6.4	6.5	6.8	7.2	7.5	7.5	7.9	7.9	8.3	9.1

Prevalent transplants, which were performed overseas, constituted about 28% of all transplants in 1999-2015. Deceased-donor transplants made up about 45% of the prevalent transplants in the same period (Table 5.7.4).

Table 5.7.4: Number and Percentage of Prevalent Kidney Transplantation by Location and Donor Characteristics

Year	Local TX				Overseas TX		All
	Living-Donor		Deceased-Donor				
	No.	%	No.	%	No.	%	No.
1999	184	21.8	442	52.4	218	25.8	844
2000	189	21.3	467	52.6	232	26.1	888
2001	209	21.7	495	51.5	258	26.8	962
2002	216	22.2	492	50.5	267	27.4	975
2003	230	23.0	487	48.7	284	28.4	1001
2004	248	23.6	496	47.2	307	29.2	1051
2005	264	23.7	510	45.7	342	30.6	1116
2006	282	23.8	539	45.4	365	30.8	1186
2007	310	25.1	556	44.9	371	30.0	1237
2008	327	25.5	568	44.3	387	30.2	1282
2009	348	26.2	583	43.8	399	30.0	1330
2010	361	26.4	592	43.2	417	30.4	1370
2011	386	27.4	602	42.7	423	30.0	1411
2012	402	28.5	589	41.7	420	29.8	1411
2013	427	29.7	591	41.1	421	29.3	1439
2014	453	31.4	571	39.5	420	29.1	1444
2015	477	32.6	571	39.0	416	28.4	1464

5.8 Survival of Kidney Transplantation

The chances of surviving 1 year and 5 years for transplanted patients were 98.2% and 93.2% respectively (Table 5.8.1). The corresponding 1 and 5-year graft survivals were 97.1% and 88.3% respectively. Median survival was not reached for both graft and patient survival. In other words, more than 50% of the patients (grafts) survived by the end of the study period.

Table 5.8.1: Graft and Patient Survival

1999-2015	Graft	Patient
1 year survival (%)	97.1	98.2
5 year survival (%)	88.3	93.2
Median survival (years)	Not reached	Not reached

Graft and patient survival of kidney transplants for the 2 groups (based on types of renal transplant) are shown in Table 5.8.2 and Figure 5.8.1. Only grafts functioning beyond 30 days were included in the analysis. Out of the 1507 transplants, 41 (2.7%) did not survive beyond 30 days. Local living-donor transplants had better 5-year graft survival probability as compared to local deceased-donor transplants (Table 5.8.2).

Table 5.8.2: Graft and Patient Survival Stratified by Type of Kidney Transplantation

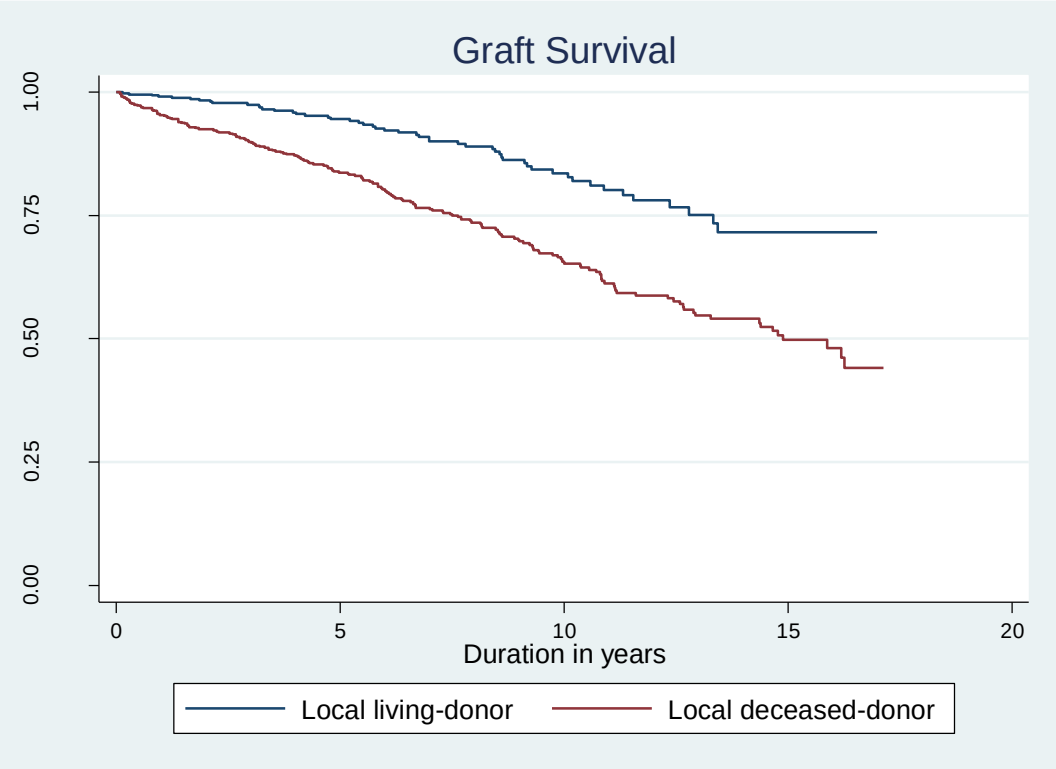
1999-2015 Graft Survival	Local Living-Donor	Local Deceased-Donor
1 year survival (%)	99.1	95.4
5 year survival (%)	94.5	83.7
Median survival (years)	Not reached	14.9

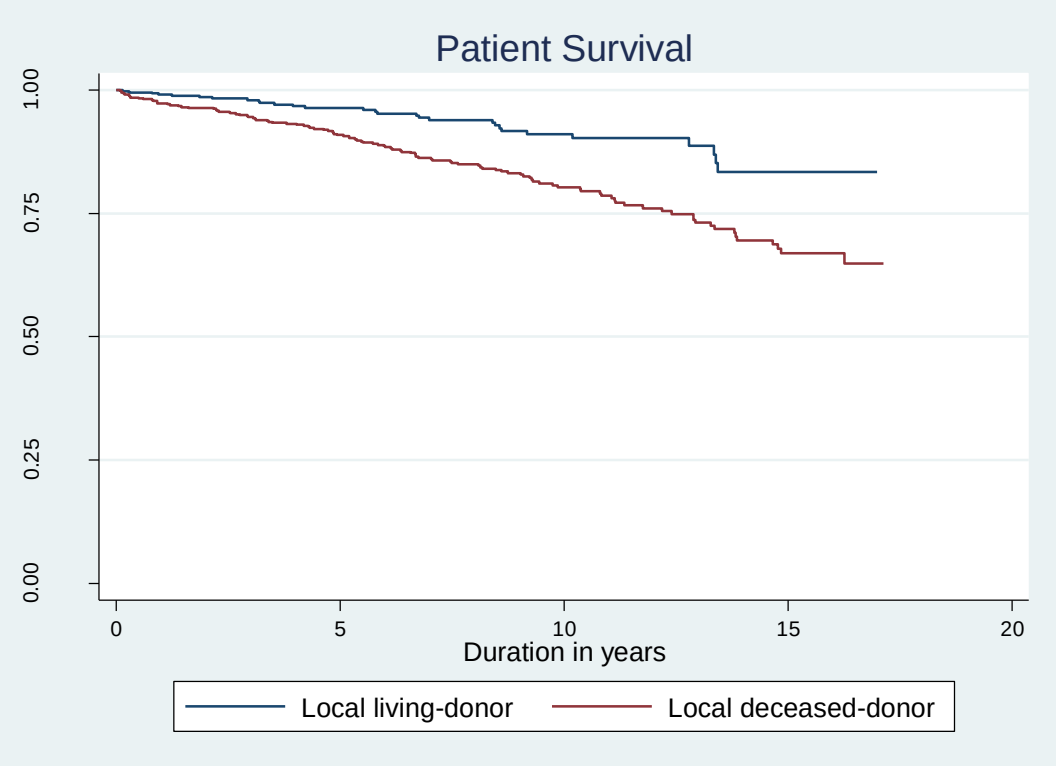
P-value: <0.001

1999-2015 Patient Survival	Local Living-Donor	Local Deceased-Donor
1 year survival (%)	99.1	97.3
5 year survival (%)	96.4	90.9
Median survival (years)	Not reached	Not reached

P-value:< 0.001

Figure 5.8.1: Graft and Patient Survival Stratified by Type of Kidney Transplantation





Tables 5.8.3 to 5.8.6 compare graft and patient survival between diabetic and non-diabetics, gender, ethnicity and age groups. There was no significant difference in

graft survival among the three ethnic groups (p=0.69). Expectedly, patient survival was significantly lower among older recipients. Though there was no significant difference in patient survival in terms of gender and ethnicity, better survival was observed among the non-diabetics, and those aged below 60.

Table 5.8.3: Graft and Patient Survival Stratified by Etiology

1999-2015 Graft Survival	Diabetic Nephropathy	Non-Diabetic Nephropathy
1 year survival (%)	97.5	97.0
5 year survival (%)	81.6	89.1
Median survival (years)	Not reached	Not reached

P-value: 0.06

1999-2015 Patient Survival	Diabetic Nephropathy	Non-Diabetic Nephropathy
1 year survival (%)	98.8	98.1
5 year survival (%)	86.5	94.0
Median survival (years)	Not reached	Not reached

P-value: 0.008

Table 5.8.4: Graft and Patient Survival Stratified by Gender

1999-2015 Graft Survival	Males	Females
1 year survival (%)	96.8	97.4
5 year survival (%)	87.5	89.2
Median survival (years)	Not reached	Not reached

P-value: 0.15

1999-2015 Patient Survival	Males	Females
1 year survival (%)	98.0	98.3
5 year survival (%)	93.6	92.7
Median survival (years)	Not reached	Not reached

P-value: 0.86

Table 5.8.5: Graft and Patient Survival Stratified by Ethnic Group

1999-2015 Graft Survival	Chinese	Malay	Indian
1 year survival (%)	97.3	96.0	97.1
5 year survival (%)	89.6	82.2	81.3
Median survival (years)	Not reached	16.2	Not reached

P-value: 0.001

1999-2015 Patient Survival	Chinese	Malay	Indian
1 year survival (%)	98.4	97.2	98.1
5 year survival (%)	93.6	91.9	90.1
Median survival (years)	Not reached	Not reached	Not reached

P-value: 0.57

Table 5.8.6: Graft and Patient Survival Stratified by Age Groups

1999-2015 Graft Survival	Age < 60	Age ≥ 60
1 year survival (%)	97.3	94.6
5 year survival (%)	88.7	83.0
Median survival (years)	Not reached	13.4

P-value: 0.02

1999-2015 Patient survival	Age < 60	Age ≥ 60
1 year survival (%)	98.4	95.5
5 year survival (%)	93.7	86.9
Median survival (years)	Not reached	13.4

P-value: <0.001

Cox regression model (multivariable analysis) showed that age, diabetes as primary renal disease, ischaemic heart disease, as well as donor type were significant factors affecting time to death for kidney transplant patients (Table 5.8.7).

Table 5.8.7: Factors Associated with Death in Kidney Transplantation

Variables	Multivariable		
	HR	95% CI	p-value
Gender:			
-Male	Reference	-	
-Female	1.06	0.75-1.50	0.76
Ethnicity:			0.99
-Chinese	Reference	-	
-Malay	0.98	0.59-1.61	0.93
-Indian	1.01	0.51-2.01	0.97
Age groups:			
<60	Reference	-	
≥60	3.16	1.33-7.54	0.009
Diabetes as primary disease:			
-Absent	Reference	-	
-Present	2.39	1.18-4.83	0.02
Ischaemic Heart Disease:			
-Absent	Reference	-	
-Present	1.91	1.15-3.18	0.01
Cerebrovascular Disease:			
-Absent	Reference	-	
-Present	1.62	0.57-4.57	0.36
Peripheral Vascular Disease:			
-Absent	Reference	-	
-Present	1.09	0.25-4.75	0.91
Donor Type			
- Local living-donor	Reference	-	
- Local deceased-donor	3.16	1.99-5.03	<0.001

n=1,052

Cox regression model (multivariable analysis) showed that transplant patients (whether recipients from local living donors or local deceased donors) performed better in terms of survival as compared to the patients on dialysis only, after adjusting for age, diabetes as primary renal disease, ischaemic heart disease, cerebrovascular disease, and peripheral vascular disease (Table 5.8.8).

Table 5.8.8: Factors Associated with Death in Kidney Transplantation and Dialysis Patients

Variables	Multivariable		
	HR	95% CI	p-value
Treatment:			
-Dialysis	Reference	-	<0.001
-Local living donor	0.13	0.09-0.19	
-Local deceased donor	0.35	0.29-0.42	
Gender:			
-Male	Reference	-	
-Female	1.03	0.98-1.08	0.31
Ethnicity:			0.37
-Chinese	Reference	-	
-Malay	0.96	0.91-1.02	0.23
-Indian	0.96	0.87-1.05	0.35
Age groups:			
<60	Reference	-	
≥60	1.82	1.73-1.92	<0.001
Diabetes as primary disease:			
-Absent	Reference	-	
-Present	1.58	1.50-1.68	<0.001
Ischaemic Heart Disease:			
-Absent	Reference	-	
-Present	1.48	1.40-1.55	<0.001
Cerebrovascular Disease:			
-Absent	Reference	-	
-Present	1.34	1.27-1.42	<0.001
Peripheral Vascular Disease:			
-Absent	Reference	-	
-Present	1.40	1.31-1.50	<0.001

n=13,088

5.9 Service Providers for Prevalent Dialysis and Kidney Transplant Patients as on 31st December 2015

Majority of the prevalent HD patients were dialysed in centres run by VWOs (60.7%), 37.3% in private dialysis centres and 2.0% in RHs or their affiliated centres (Table 5.9.1).

For PD patients, the majority were cared for by the RHs (94.8%), 4.7% in VWOs and 0.5% in private centres.

Majority of the prevalent renal transplant patients were managed in RHs (90.4%), while 9.6% was managed in private dialysis centres or hospitals.

Table 5.9.1: Service Providers for Prevalent Dialysis and Transplant Patients as of 31st December 2015

Service Provider	HD		PD		TX	
	No.	%	No.	%	No.	%
Restructured Hospitals	112	2.0	693	94.8	1324	90.4
Voluntary Welfare Organisations	3336	60.7	34	4.7	0	0.0
Private Dialysis Centres/Hospitals	2051	37.3	4	0.5	140	9.6
Total	**5499**	**100.0**	**731**	**100.0**	**1464**	**100.0**

** denotes receipt of overseas transplantation in 2015.*

6 CONCLUSION

In its early stages, kidney disease may be asymptomatic, as the kidneys have a large reserve and a significant amount of damage needs to occur before symptoms present themselves. Renal replacement therapy in the form of dialysis or transplant is required when one's kidney function falls below 20% of the required capacity. In the case of dialysis, on top of direct costs incurred due to medical expenses, indirect costs can also arise from lifestyle changes that are required to accommodate the treatments.

It is therefore important for individuals with higher risk of CKD5 to take preventive action. Risk factors include hypertension, diabetes mellitus, and having a family history of kidney disease. Individuals with diabetes are at particularly high risk of developing diabetic nephropathy, currently the most common cause of CKD5 in Singapore and other parts of the world.

As the population of Singapore ages, the burden imposed by CKD5 and other chronic diseases will also increase, resulting in healthcare expenditure that can be avoided through the adoption of appropriate lifestyle modifications that can reduce one's risk of developing said conditions.

One can lower his or her chances of developing CKD5 by maintaining a diet that is low in sodium, fat, and sugar, and high in dietary fibre and whole grains. Exercise, at suitable levels, is also important in maintaining optimum bodily function.

For individuals at higher risk of developing CKD5 and/or its comorbidities, prevention is all the more important, as CKD5 affects not just the patient, but their families and caregivers as well. For individuals who do not have existing medical conditions, health maintenance and screening remains important to avoid the onset of CKD5 and chronic disease.

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