

CHAPTER 4

Nutritional Status on Dialysis

Abdul Halim B Abdul Gafor

Tilakavati Karupaiah

Koh Keng Hee

Fairol Huda binti Ibrahim

Thong Kah Mean

SECTION 4.1: SERUM ALBUMIN LEVELS ON DIALYSIS

The mean serum albumin level in HD patients in the year 2018 was 38.4 ± 4.6 g/L. Between 2009 to 2018, the percentage of patients with serum albumin <30 g/L had increased from 3 to 4% while the percentage of patients with desirable serum albumin of ≥ 40 g/L had dropped significantly from 51 to 41%.

Cumulative distribution trends of serum albumin for HD patients from 2009 to 2018 supported this observation (Figure 4.1.1).

Table 4.1.1: Distribution of serum albumin, HD patients, 2009-2018

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients <30 g/L	% patients 30- <35 g/L	% patients 35- <40 g/L	% patients ≥ 40 g/L
2018	42316	38.4	4.6	39.0	36.0	41.5	4	15	39	41
2017	40879	38.3	5.1	38.8	35.7	41.3	5	15	40	40
2016	36776	38.0	4.9	38.7	35.5	41.0	5	16	42	37
2015	34217	38.2	4.9	38.8	35.7	41.3	5	16	41	38
2014	31318	38.5	4.9	39.0	36.0	41.5	4	15	41	41
2013	27819	38.6	4.9	39.0	36.0	41.5	4	13	42	41
2012	24531	38.8	5.0	39.3	36.3	41.5	4	13	41	43
2011	21375	38.8	4.9	39.3	36.5	41.5	4	12	41	43
2010	18812	38.9	4.9	39.3	36.3	41.8	4	13	40	44
2009	16949	39.4	5.1	40.0	37.0	42.3	3	11	35	51

Figure 4.1.1: Cumulative distribution of serum albumin, HD patients, 2009-2018

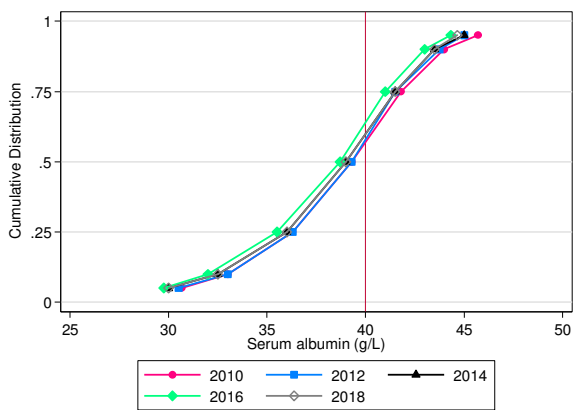
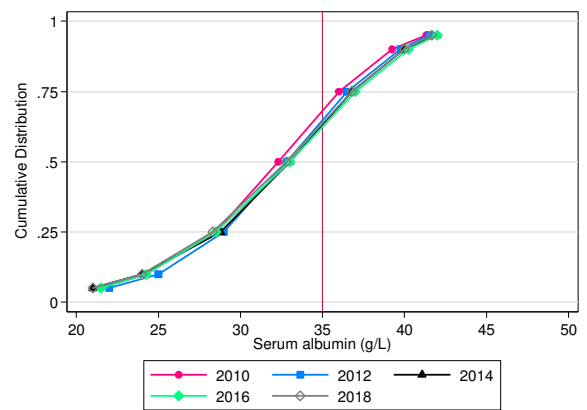


Figure 4.1.2: Cumulative distribution of serum albumin, PD patients, 2009-2018



As we expected the percentage of PD patients with desirable serum albumin levels of ≥ 40 g/L was 11 % which was lower than HD patients. About 33% of PD patients had serum albumin of < 30 g/dL and 31% had serum albumin between 30- <35 g/dL in 2018. Cumulative distribution trends for serum albumin of PD patients from 2009 to 2018 supported this observation (Figure 4.1.2).

Table 4.1.2: Distribution of serum albumin, PD patients, 2009-2018

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients <30 g/L	% patients 30- <35 g/L	% patients 35- <40 g/L	% patients ≥ 40 g/L
2018	5424	32.3	6.4	32.8	28.3	36.8	33	31	26	11
2017	5052	32.8	6.6	33.3	29.0	37.0	29	31	28	11
2016	4566	32.6	6.7	33.0	28.5	37.0	32	29	27	12
2015	4215	32.7	6.4	33.0	28.8	37.0	30	31	28	12
2014	3619	32.6	6.8	33.0	28.8	36.8	30	32	26	11
2013	3172	33.0	6.6	33.3	29.0	37.3	29	31	28	12
2012	2801	32.6	6.5	32.8	29.0	36.5	31	33	27	10
2011	2465	31.9	6.0	32.0	28.3	36.0	35	34	23	8
2010	2305	32.1	6.2	32.3	28.5	36.0	33	35	24	8
2009	2138	32.7	6.4	33.0	29.0	36.8	30	34	25	11

There was a wide variation in serum albumin levels among the 737 HD centres in 2018 (Table 4.1.3). Half of the HD centers with percentage of HD patients with albumin level ≥ 40 g/L had rapidly deteriorated from 52% in 2009 to 43% in 2018.

Table 4.1.3: Variation in proportion of patients with serum albumin ≥ 40 g/L among HD centres 2009-2018

Year	Number of centers	Min	5 th centile	LQ	Median	UQ	95 th centile	Max
2018	737	0	2.0	29.0	43.0	59.0	75.0	95
2017	722	0	2.0	23.0	40.0	56.0	75.0	96
2016	696	0	2.0	21.0	39.0	52.0	74.0	88
2015	675	0	2.0	23.0	38.0	53.0	73.0	90
2014	643	0	3.0	23.0	42.0	57.0	75.0	91
2013	600	0	6.0	24.0	41.0	57.5	72.0	100
2012	546	0	3.0	26.0	42.5	58.0	76.0	96
2011	488	0	6.0	27.0	44.0	58.0	76.0	100
2010	433	0	4.0	26.0	44.0	60.0	80.0	100
2009	389	0	4.0	37.0	52.0	65.0	85.0	100

Figure 4.1.3: Variation in proportion of patients with serum albumin $\geq 40\text{g/L}$, HD centres 2018

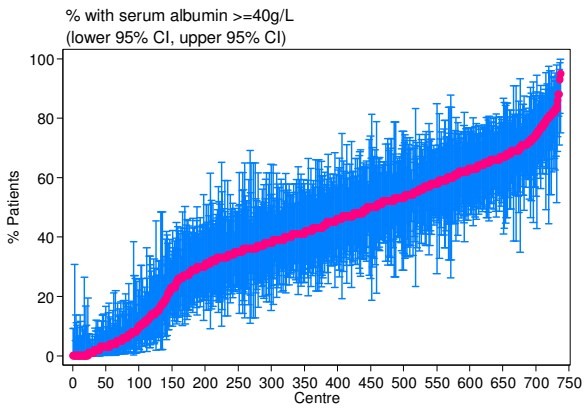
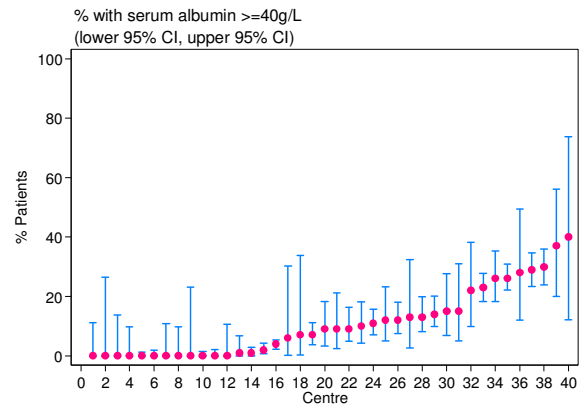


Figure 4.1.4: Variation in proportion of patients with serum albumin $\geq 40\text{g/L}$, PD centres 2018



There were 40 PD centres in the year 2018. Half of the PD centres with percentage of PD patients achieving serum albumin level $\geq 40\text{g/L}$ declined from 14% in 2009 to 9% in 2018 (Table 4.1.4).

Table 4.1.4: Variation in proportion of patients with serum albumin $\geq 40\text{g/L}$ among PD centres 2009-2018

Year	Number of centers	Min	5 th centile	LQ	Median	UQ	95 th centile	Max
2018	40	0	0.0	0.0	9.0	15.0	33.5	40
2017	38	0	0.0	2.0	10.0	17.0	35.0	38
2016	37	0	0.0	2.0	8.0	22.0	35.0	36
2015	35	0	0.0	1.0	11.0	21.0	36.0	42
2014	32	0	0.0	3.5	12.0	20.0	55.0	67
2013	28	0	0.0	2.0	8.0	23.5	31.0	40
2012	28	0	0.0	3.0	10.0	20.5	33.0	37
2011	26	0	0.0	1.0	5.5	21.0	29.0	38
2010	25	0	0.0	2.0	9.0	17.0	29.0	32
2009	23	0	0.0	5.0	14.0	24.0	36.0	37

SECTION 4.2: BODY MASS INDEX (BMI) ON DIALYSIS

The mean BMI for HD patients in 2018 was $24.6 \pm 5.9 \text{ kg/m}^2$. An increasing trend of BMI was observed for HD patients, with the percentage of HD patients with $\text{BMI} \geq 25 \text{ kg/m}^2$ increasing from 35% in 2009 to 42% in 2018. The percentage of patients with $\text{BMI} < 18.5 \text{ kg/m}^2$ reduced from 11% in 2009 to 9% in 2018 (Table 4.2.1). Figure 4.2.1 reflects the increasing BMI trend in HD patients as the curve for 2018 continues moving to the right.

Table 4.2.1: Distribution of BMI, HD patients, 2009-2018

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients <18.5	% patients 18.5-25	% patients ≥ 25
2018	41396	24.6	5.9	24.0	21.1	27.3	9	50	42
2017	40252	24.6	5.6	23.9	21.1	27.2	8	50	41
2016	36078	24.5	5.2	23.9	21.1	27.2	9	51	41
2015	33219	24.5	5.0	23.9	21.0	27.2	8	51	40
2014	30481	24.4	5.0	23.8	21.0	27.1	9	52	40
2013	27348	24.3	5.1	23.7	20.9	27.0	9	52	39
2012	23884	24.2	5.0	23.7	20.9	26.9	9	52	38
2011	20790	24.0	5.0	23.5	20.7	26.7	9	54	37
2010	17992	23.9	4.8	23.4	20.7	26.6	10	54	36
2009	15881	23.7	4.7	23.2	20.5	26.3	11	54	35

Figure 4.2.1: Cumulative distribution of BMI, HD patients, 2009-2018

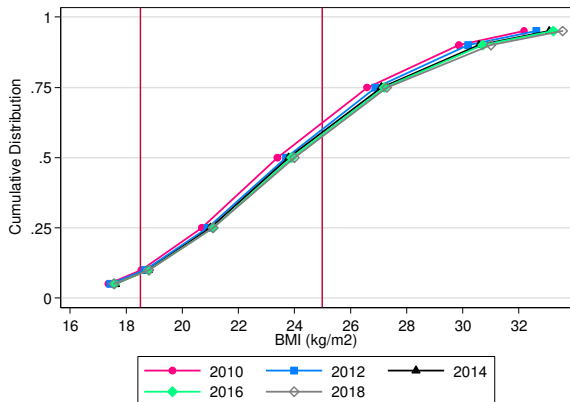
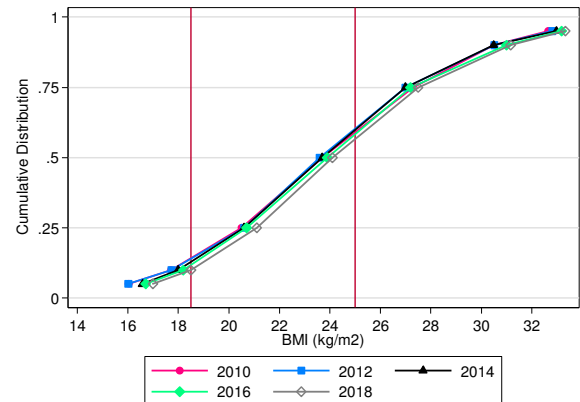


Figure 4.2.2: Cumulative distribution of BMI, PD patients, 2009-2018



The mean BMI for PD patients in 2018 was $24.7 \pm 6.6 \text{ kg/m}^2$. Similar to HD patients, the percentage of PD patients with $\text{BMI} \geq 25 \text{ kg/m}^2$ increased from 39% in 2009 to 42% in 2018. The percentage of patients with $\text{BMI} < 18.5 \text{ kg/m}^2$ reduced from 14% in 2009 to 10% in 2018 (Table 4.2.2). The shifting of the cumulative distribution curve for 2018 was to the right (Figure 4.2.2).

Table 4.2.2: Distribution of BMI, PD patients, 2009-2018

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients <18.5	% patients 18.5-25	% patients >=25
2018	4122	24.7	6.6	24.1	21.1	27.5	10	48	42
2017	3890	24.3	5.1	23.9	20.9	27.3	11	48	41
2016	3724	24.3	5.7	23.9	20.7	27.2	12	48	40
2015	3499	24.3	5.1	24.0	20.8	27.2	11	48	41
2014	2857	24.1	5.2	23.7	20.6	27.0	13	48	39
2013	2376	24.0	5.3	23.6	20.4	27.1	14	46	40
2012	2495	24.0	5.8	23.6	20.6	27.0	13	48	39
2011	2430	24.1	7.1	23.6	20.3	27.2	14	47	39
2010	2252	24.0	5.4	23.7	20.5	27.3	13	46	40
2009	2110	23.7	5.0	23.6	20.5	27.0	14	47	39

The variation in HD centres with proportion of patients achieving the target BMI ≥ 18.5 kg/m² is given in Table 4.2.3. Half of the HD centers had 92% of their patients achieving target BMI ≥ 18.5 kg/m² in 2018 compared to 90% in 2009. Most centres in 2018 showed positive trends in their HD patients achieving the target BMI ≥ 18.5 kg/m² (Figure 4.2.3).

Table 4.2.3: Variation in proportion of patients with BMI ≥ 18.5 kg/m² among HD centres 2009-2018

Year	Number of centers	Min	5 th centile	LQ	Median	UQ	95 th centile	Max
2018	735	8	81	89.0	92.0	96.0	100	100
2017	723	18	81	88.0	92.0	96.0	100	100
2016	694	13	82	88.0	92.0	95.0	100	100
2015	670	69	82	89.0	92.5	96.0	100	100
2014	644	6	79	88.0	92.0	96.0	100	100
2013	607	7	80	88.0	92.0	96.0	100	100
2012	552	29	80	88.0	92.0	95.5	100	100
2011	490	33	78	88.0	92.0	95.0	100	100
2010	436	10	77	87.0	92.0	95.0	100	100
2009	389	20	76	85.0	90.0	94.0	100	100

Figure 4.2.3: Variation in proportion of patients with BMI ≥ 18.5 kg/m² among HD centres 2018

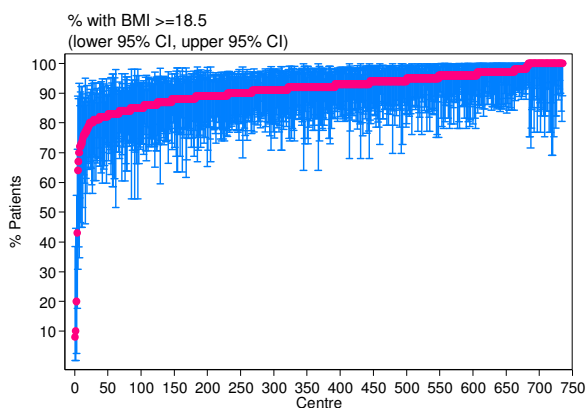
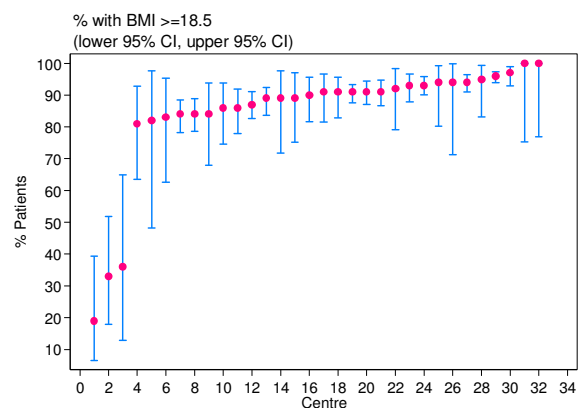


Figure 4.2.4: Variation in proportion of patients with BMI ≥ 18.5 kg/m² among PD centres 2018



Half of the PD centers had 90.5% of their patients achieving target BMI ≥ 18.5 kg/m² in 2018 (Table 4.2.4). The median percentage of PD patients with BMI ≥ 18.5 kg/m² indicated positive trends for most centres in 2018 (Figure 4.2.4).

Table 4.2.4: Variation in proportion of patients with BMI ≥ 18.5 kg/m² among PD centres 2009-2018

Year	Number of centers	Min	5 th centile	LQ	Median	UQ	95 th centile	Max
2018	32	19	33	84.0	90.5	93.5	100	100
2017	29	9	20	82.0	88.0	93.0	95	97
2016	33	14	17	84.0	90.0	94.0	100	100
2015	31	14	18	78.0	88.0	92.0	97	100
2014	28	4	17	83.5	90.0	92.5	95	95
2013	24	9	15	73.5	90.0	94.0	98	100
2012	25	9	13	73.0	86.0	92.0	98	100
2011	25	8	13	78.0	89.0	94.0	99	100
2010	24	9	15	70.0	90.5	92.5	98	100
2009	21	14	15	79.0	89.0	92.0	96	97

Table 4.2.5 indicates nutritional status in patients from 730 HD centres. Half of the centres achieved the combined nutritional status targets (serum albumin ≥ 40 g/dL and BMI ≥ 18.5 kg/m²) in 41% of their patients in 2018 compared to 49% in 2009. The wide variation in nutritional status in most centres was also observed for 2018 (Figure 4.2.5).

Table 4.2.5: Variation in proportion of patients with BMI ≥ 18.5 and serum albumin ≥ 40 g/dL among HD centres 2009-2018

Year	Number of centers	Min	5 th centile	LQ	Median	UQ	95 th centile	Max
2018	730	0	2.0	26.0	41.0	54.0	69.0	87
2017	721	0	2.0	21.0	37.0	51.0	70.0	89
2016	693	0	2.0	19.0	37.0	48.0	67.0	88
2015	672	0	2.0	21.5	35.0	50.0	69.0	91
2014	641	0	3.0	22.0	40.0	53.0	70.0	86
2013	600	0	4.5	23.5	39.0	52.5	69.0	95
2012	539	0	2.0	24.0	40.0	54.0	72.0	87
2011	482	0	3.0	26.0	42.0	53.0	71.0	100
2010	428	0	3.0	22.0	41.0	56.5	72.0	95
2009	379	0	4.0	33.0	49.0	62.0	78.0	98

Figure 4.2.5: Variation in proportion of patients with BMI ≥ 18.5 kg/m² and serum albumin ≥ 40 g/dL among HD centres 2018

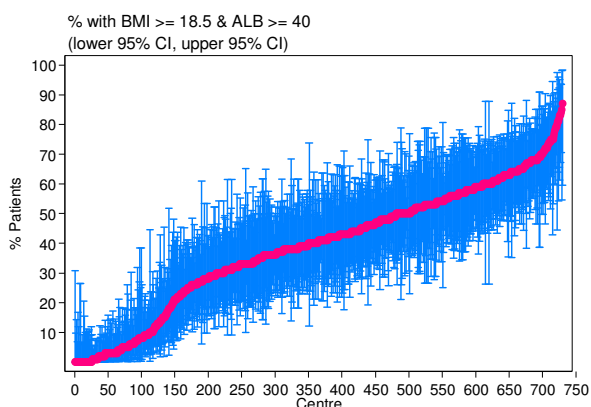


Figure 4.2.6: Variation in proportion of patients with BMI ≥ 18.5 kg/m² and serum albumin ≥ 40 g/dL among PD centres 2018

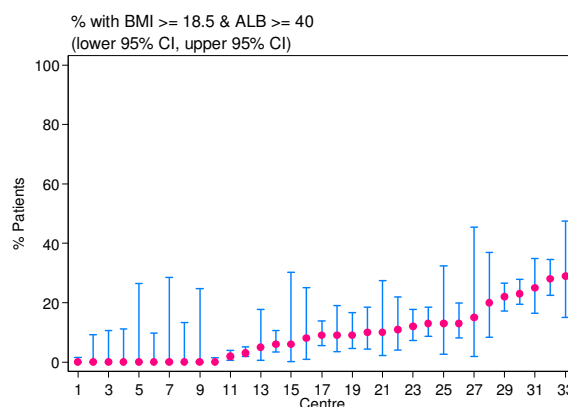


Table 4.2.6 indicates nutritional status of patients in 33 PD centres as assessed by the combined nutritional status targets of BMI ≥ 18.5 kg/m² and serum albumin ≥ 40 g/dL. Half of these centres achieved the combined nutritional status targets in only 9% of their patients in 2018. For 2018, none of the 33 PD centres had 50% of their patients achieving the combined nutritional status targets (Figure 4.2.6).

Table 4.2.6: Variation in proportion of patients with BMI ≥ 18.5 and serum albumin ≥ 40 g/dL among PD centres 2009-2018

Year	Number of centers	Min	5 th centile	LQ	Median	UQ	95 th centile	Max
2018	33	0	0.0	0.0	9.0	13.0	28.0	29
2017	29	0	0.0	4.0	10.0	14.0	23.0	29
2016	34	0	0.0	0.0	7.0	18.0	29.0	30
2015	32	0	0.0	1.0	9.5	16.0	31.0	31
2014	29	0	0.0	0.0	9.0	16.0	55.0	67
2013	25	0	0.0	1.0	7.0	19.0	29.0	39
2012	26	0	0.0	1.0	6.5	15.0	24.0	30
2011	26	0	0.0	0.0	4.5	15.0	29.0	33
2010	25	0	0.0	2.0	7.0	12.0	24.0	24
2009	22	0	0.0	3.0	9.5	19.0	26.0	35

SECTION 4.3: Nutritional parameters

HD patients were older and had better serum albumin compared to PD patients. On the other hand, serum total cholesterol and serum creatinine were significantly higher in PD patients. Both groups were equal in terms of their hemoglobin levels and BMI.

Table 4.3.1: Nutritional parameters between HD and PD patients, 2018

	HD		PD		P-Value
	n= 46153		n= 5740		
	Mean	SD	Mean	SD	
Age	52.73	14.19	48.87	17.04	<0.0001 ^b
Albumin (g/dL)	38.37	4.63	32.26	6.38	<0.0001 ^b
BMI	24.64	5.92	24.64	6.55	0.8977 ^b
Total Cholesterol (mmol/L)	4.30	1.02	4.82	1.25	<0.0001 ^b
Sr Creatinine (µmol/L)	805.53	231.71	848.99	299.47	<0.0001 ^b
Hemoglobin	10.31	1.61	10.31	1.60	0.2967 ^b

a Independent t-test
b Mann Whitney test

In the HD population, the diabetic patients were older with higher BMI compared to the non-diabetic patients. Serum creatinine, total cholesterol, hemoglobin levels and serum albumin were significantly higher in the non-diabetic group.

Table 4.3.2(a): Nutritional parameters between diabetic and non-diabetic HD patients, 2018

	Diabetes		Non-Diabetes		P-Value
	n= 28222		n= 17931		
	Mean	SD	Mean	SD	
Age	56.43	11.38	46.91	16.09	<0.0001 ^b
Albumin (g/dL)	37.89	4.65	39.10	4.49	<0.0001 ^b
BMI	25.45	6.01	23.39	5.55	<0.0001 ^b
Total Cholesterol (mmol/L)	4.25	1.05	4.37	0.97	<0.0001 ^b
Sr Creatinine (µmol/L)	758.48	213.88	878.02	239.31	<0.0001 ^b
Hemoglobin	10.24	1.59	10.40	1.64	<0.0001 ^b

a Independent t-test
b Mann Whitney test

Diabetic PD patients were older and had significantly higher BMI and hemoglobin compared to non-diabetic PD patients. Non-diabetic PD patients had better serum albumin, higher serum creatinine and total cholesterol compared to non-diabetic PD patients.

Table 4.3.2(b): Nutritional parameters between diabetic and non-diabetic PD patients, 2018

	Diabetes		Non-Diabetes		P-Value
	n= 3119		n=2621		
	Mean	SD	Mean	SD	
Age	56.60	11.62	39.68	17.88	<0.0001 ^b
Albumin (g/dL)	30.98	6.46	33.76	5.95	<0.0001 ^b
BMI	25.99	6.76	23.00	5.88	<0.0001 ^b
Total Cholesterol (mmol/L)	4.73	1.29	4.91	1.20	<0.0001 ^b
Sr Creatinine (µmol/L)	766.68	266.77	945.32	306.88	<0.0001 ^b
Hemoglobin	10.42	1.52	10.19	1.69	<0.0001 ^b

a Independent t-test
b Mann Whitney test

In HD patients, the longer they were on treatment, the higher their serum albumin and lower their BMI (Table 4.3.3a).

Table 4.3.3(a): Distribution of serum albumin and BMI by duration of dialysis among HD patients, 2009-2018

Years	<1		1-<5		5-<10		≥10		P-Value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Albumin (g/dL)	35.82	5.27	38.27	3.83	39.43	3.08	40.13	2.84	0.0001 ^d
BMI	24.66	7.94	25.04	5.78	24.72	5.08	23.29	4.26	0.0001 ^d

c ANOVA

d Kruskal Wallis rank test

Similar findings were noted in PD patients. The longer they were on PD treatment, the higher their serum albumin and lower their BMI (Table 7.3.3b) and both these trends were significant.

Table 4.3.3(b): Distribution of serum albumin and BMI by duration of dialysis among PD patients, 2009-2018

Years	<1		1-<5		5-<10		≥10		P-Value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Albumin (g/dL)	31.94	6.80	33.26	5.46	34.38	4.53	35.19	3.67	0.0001 ^d
BMI	25.30	10.01	24.69	5.71	23.31	4.98	21.49	3.92	0.0001 ^d

c ANOVA

d Kruskal Wallis rank test