

CHAPTER 7

Nutritional Status on Dialysis

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SECTION 7.1: SERUM ALBUMIN LEVELS ON DIALYSIS

The mean serum albumin level in HD patients in the year 2015 was 38.2 ± 4.9 g/L. Between 2006 to 2015, the percentage of patients with serum albumin <30g/L had increased from 3 to 5% while the percentage of patients with desirable serum albumin of ≥ 40 g/L had dropped significantly from 54 to 38%. But notably majority of HD patients in 2015 (41%) had serum albumin between 35-40 g/L compared to 2006 (33%).

Cumulative distribution trends of serum albumin for HD patients from 2006 to 2015 supported this observation (Figure 7.1.1).

Table 7.1.1: Distribution of serum albumin, HD patients, 2006-2015

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients <30g/L	% patients 30-<35g/L	% patients 35-<40g/L	% patients ≥40g/L
2006	10927	39.8	5.4	40.3	37.3	42.8	3	10	33	54
2007	12315	39.7	5.3	40.0	37.0	42.5	3	10	35	52
2008	14551	39.4	5.1	40.0	37.0	42.3	3	10	36	50
2009	16948	39.4	5.1	40.0	37.0	42.3	3	11	35	51
2010	18757	38.9	4.9	39.3	36.3	41.8	4	13	40	44
2011	21360	38.8	4.9	39.3	36.5	41.5	4	12	41	43
2012	24531	38.8	5.0	39.3	36.3	41.5	4	13	41	43
2013	27818	38.6	4.9	39.0	36.0	41.5	4	13	42	41
2014	31287	38.5	4.9	39.0	36.0	41.5	4	15	41	41
2015	34081	38.2	4.9	38.8	35.7	41.3	5	16	41	38

Figure 7.1.1: Cumulative distribution of serum albumin, HD patients 2006-2015

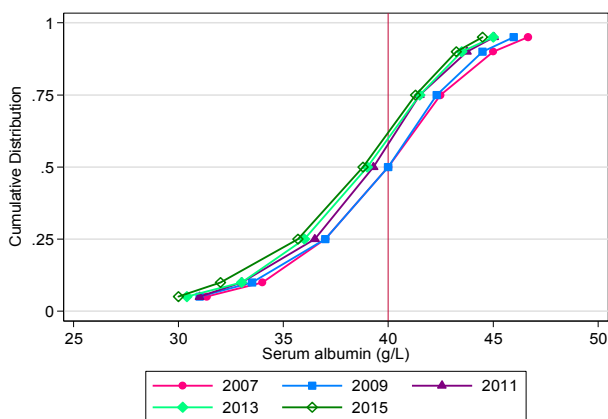
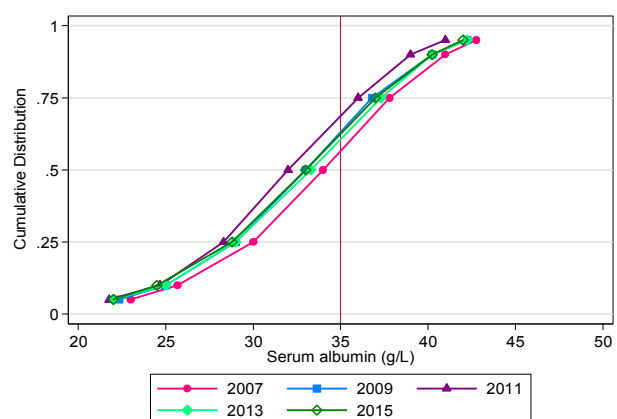


Figure 7.1.2: Cumulative distribution of serum albumin, PD patients 2006-2015



The serum albumin trend in PD patients were consistent since 2012. As we expected the percentage of patients with desirable serum albumin levels of ≥ 40 g/L was 12 % which was lower than HD patients. About one third of PD patients had serum albumin of < 30 g/L and another one third had serum albumin between 30-35 g/L. Cumulative distribution trends for serum albumin of PD patients from 2006 to 2015 supported this observation (Figure 7.1.2).

Table 7.1.2: Distribution of serum albumin, PD patients, 2006-2015

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
2006	1498	33.5	6.1	33.8	30.0	37.0	25	33	30	12
2007	1753	33.6	6.2	34.0	30.0	37.8	25	31	30	14
2008	2021	33.1	6.4	33.3	29.3	37.3	28	32	27	13
2009	2138	32.7	6.4	33.0	29.0	36.8	30	34	25	11
2010	2305	32.1	6.2	32.3	28.5	36.0	33	35	24	8
2011	2465	31.9	6.0	32.0	28.3	36.0	35	34	23	8
2012	2801	32.6	6.5	32.8	29.0	36.5	31	33	27	10
2013	3172	33.0	6.6	33.3	29.0	37.3	29	31	28	12
2014	3619	32.6	6.8	33.0	28.8	36.8	30	32	26	11
2015	4214	32.7	6.4	33	28.8	37	30	31	28	12

As expected, there was a wide variation in serum albumin levels among the 670 HD centres in 2015 (Table 7.1.3). The median percentage of HD patients with albumin level ≥ 40 g/L had rapidly deteriorated from 55% in 2006 to 38% in 2015. For half of the HD centres in 2015, only 38% of their patients achieved albumin level ≥ 40 g/L (Figure 7.1.3)

Table 7.1.3: Variation in proportion of patients with serum albumin ≥ 40 g/L among HD centres 2006-2015

Year	Number of centres	Min	5 th centile	LQ	Median	UQ	95 th centile	Max
2006	274	0	6	36	55	73	89	100
2007	300	0	9.5	36	53	70	88.5	100
2008	346	0	6	33	50	67	84	100
2009	389	0	4	38	52	65	85	100
2010	430	0	4	26	44	60	80	100
2011	488	0	6	27	44	58	76	100
2012	546	0	3	26	42.5	58	76	96
2013	600	0	6	24	41	57.5	72	100
2014	642	0	3	23	42	57	75	91
2015	670	0	2	23	38	53	73	90

Figure 7.1.3: Variation in proportion of patients with serum albumin $\geq 40\text{g/L}$, HD centres 2015

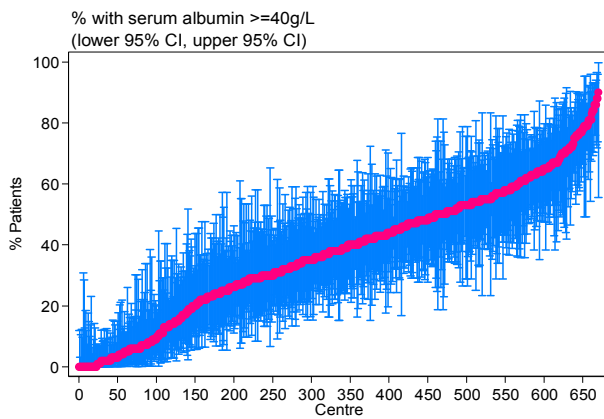
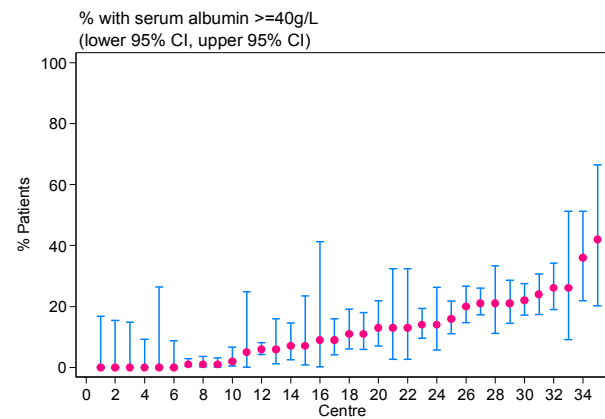


Figure 7.1.4: Variation in proportion of patients with serum albumin $\geq 40\text{g/L}$, PD centres 2015



The median trend for PD patients achieving serum albumin level $\geq 40\text{g/L}$ declined from 13% in 2006 to 11% in 2015 (Table 7.1.4). There were 35 PD centres for the year 2015 and half of these centres had barely 11% of their PD patients achieving serum albumin level $\geq 40\text{g/L}$ (Figure 7.1.4).

Table 7.1.4: Variation in proportion of patients with serum albumin $\geq 40\text{g/L}$ among PD centres 2006-2015

Year	Number of centers	Min	5 th centile	LQ	Median	UQ	95 th centile	Max
2006	24	0	0	5	13	21	33	76
2007	23	0	0	4	15	23	35	64
2008	23	0	0	2	15	25	43	56
2009	23	0	0	5	14	24	36	37
2010	25	0	0	2	9	17	29	32
2011	26	0	0	1	5.5	21	29	38
2012	28	0	0	3	10	20.5	33	37
2013	28	0	0	2	8	23.5	31	40
2014	32	0	0	3.5	12	20	50	67
2015	35	0	0	1	11	21	36	42

SECTION 7.2: BODY MASS INDEX (BMI) ON DIALYSIS

The mean BMI for HD patients in 2015 was $24.4 \pm 5.9 \text{ kg/m}^2$. An increasing trend of BMI was observed for HD patients, with the percentage of HD patients with BMI $\geq 25 \text{ kg/m}^2$ increasing from 29% in 2006 to 39% in 2015. The percentage of patients with BMI $< 18.5 \text{ kg/m}^2$ reduced from 14% in 2006 to 10% in 2015 (Table 7.2.1).

Figure 7.2.1 rejects the increasing BMI trend in HD patients as the curve for 2015 continues moving to the right.

Table 7.2.1: Distribution of BMI, HD patients, 2006-2015

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients <18.5 kg/m ²	% patients 18.5-25 kg/m ²	% patients ≥25 kg/m ²
2006	9783	23.1	5.2	22.6	19.9	25.7	14	56	29
2007	10507	23.2	5.4	22.7	19.9	25.8	14	56	30
2008	12229	23.3	5.1	22.8	20.1	26.0	14	55	31
2009	13747	23.5	5.2	23.0	20.1	26.2	13	54	33
2010	14720	23.7	5.3	23.2	20.3	26.4	12	53	35
2011	16479	23.8	5.7	23.2	20.4	26.5	12	53	35
2012	18355	24.0	5.4	23.4	20.5	26.7	11	52	37
2013	20325	24.1	5.6	23.5	20.6	26.9	11	51	38
2014	22046	24.3	5.9	23.7	20.7	27.0	10	51	39
2015	23594	24.4	5.9	23.7	20.8	27.1	10	51	39

Figure 7.2.1: Cumulative distribution of BMI, HD patients 2006-2015

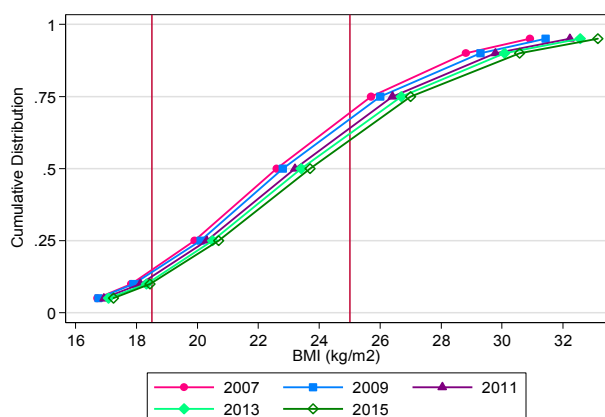
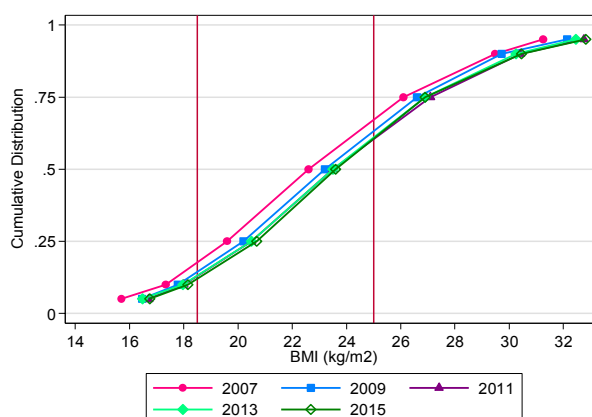


Figure 7.2.2: Cumulative distribution of BMI, PD patients 2006-2015



The mean BMI for PD patients in 2015 was 24.3 ± 5.0 kg/m². Similar to HD patients, the percentage of PD patients with BMI ≥ 25 kg/m² increased from 33% in 2006 to 41% in 2015. The percentage of patients with BMI < 18.5 kg/m² reduced from 16% in 2006 to 11% in 2015 (Table 7.2.2). The shifting of the cumulative distribution curve for 2015 was to the right (Figure 7.2.2).

Table 7.2.2: Distribution of BMI, PD patients 2006-2015

Year	Number of patients	Mean	SD	Median	LQ	UQ	% patients <18.5 kg/m ²	% patients 18.5-25 kg/m ²	% patients ≥25 kg/m ²
2006	1420	23.3	8.3	22.6	19.6	26.1	16	50	33
2007	1617	23.4	5.9	22.9	19.9	26.3	15	51	34
2008	1875	23.7	5.9	23.2	20.2	26.6	14	50	36
2009	1947	24.0	7.1	23.4	20.4	26.8	13	50	37
2010	2052	24.4	8.8	23.5	20.5	27.1	13	49	39
2011	2179	24.1	7.8	23.6	20.3	27.0	13	49	38
2012	2213	24.1	6.8	23.5	20.5	26.9	13	49	38
2013	2025	24.2	7.2	23.6	20.4	27.0	14	47	39
2014	2428	24.2	6.5	23.6	20.7	26.9	12	49	39
2015	3000	24.3	5	24	20.9	27.1	11	49	41

The variation in HD centres with proportion of patients achieving the target BMI ≥ 18.5 kg/m² is given in Table 7.2.3. Half of the HD centers had 91% of their patients achieving target BMI ≥ 18.5 kg/m² in 2015 compared to 86% in 2006. Most centres in 2015 showed positive trends in their HD patients achieving the target BMI ≥ 18.5 kg/m² (Figure 7.2.3).

Table 7.2.3: Variation in proportion of patients with BMI ≥ 18.5 kg/m² among HD centres 2006-2015

Year	Number of centers	Min	5 th centile	LQ	Median	UQ	95 th centile	Max
2006	263	52	70	81	86	92	100	100
2007	284	56	69	82	87	92	100	100
2008	326	60	69	82	88	92	100	100
2009	351	61	72	81	87	93	100	100
2010	383	33	73	84	89	94	100	100
2011	427	46	75	84	90	93	100	100
2012	472	60	76	85.5	90	94	100	100
2013	534	54	76	86	91	94	100	100
2014	571	50	77	86	90	95	100	100
2015	592	64	79	87	91	95	100	100

Figure 7.2.3: Variation in proportion of patients with BMI ≥ 18.5 kg/m² among HD centres 2015

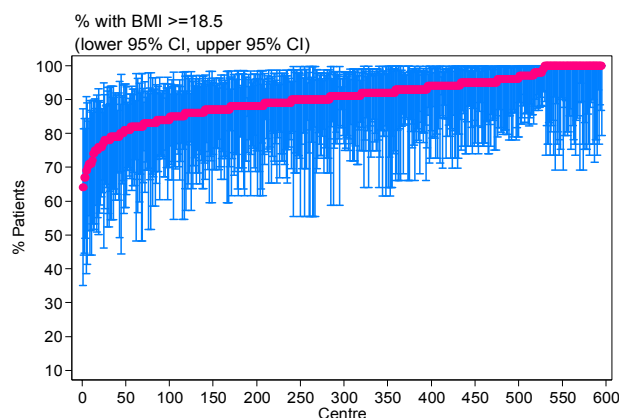
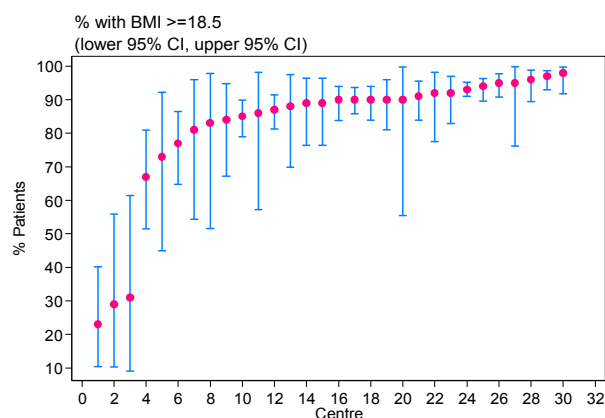


Figure 7.2.4: Variation in proportion of patients with BMI ≥ 18.5 kg/m² among PD centres 2015



The variation in PD centres with proportion of patients with BMI ≥ 18.5 kg/m² showed improving trend from 84% in 2006 to 89.5% for 2015 (Table 7.2.4) with half of the PD centers achieving this target. The median percentage of PD patients with BMI ≥ 18.5 kg/m² indicated positive trends for most centres in 2015 (Figure 7.2.4).

Table 7.2.4: Variation in proportion of patients with BMI ≥ 18.5 kg/m² among PD centres 2006-2015

Year	Number of centers	Min	5 th centile	LQ	Median	UQ	95 th centile	Max
2006	23	22	28	74	84	91	93	96
2007	22	20	23	76	87.5	91	97	100
2008	22	24	33	77	88	91	95	100
2009	21	29	41	80	89	93	95	97
2010	23	37	44	76	89	93	98	98
2011	25	33	35	80	88	93	96	98
2012	25	32	33	79	86	92	97	100
2013	25	18	35	70	90	93	97	100
2014	28	15	36	83.5	89.5	92	94	94
2015	30	23	31	83	89.5	92	97	98

Table 7.2.5 indicates a wide variation in the nutritional status of patients in 589 HD centres. Half of the centres achieved the combined nutritional status targets (serum albumin ≥ 40 g/dL and BMI ≥ 18.5 kg/m²) in 35% of their patients in 2015 compared to 48% in 2006. The continuing trend of lower nutritional status in most centres was also observed for 2015 (Figure 7.2.5).

Table 7.2.5: Variation in proportion of patients with BMI ≥ 18.5 kg/m² and serum albumin ≥ 40 g/L among HD centres 2006-2015

Year	Number of centers	Min	5 th centile	LQ	Median	UQ	95 th centile	Max
2006	251	0	6	33	48	63	80	94
2007	277	0	6	34	48	62	76	93
2008	314	0	4	31	45.5	60	76	88
2009	341	0	4	33	47	62	76	94
2010	378	0	3	23	41	57	73	83
2011	417	0	2	25	40	54	73	100
2012	458	0	1	23	40	56	73	90
2013	519	0	4	23	38	52	70	95
2014	560	0	2.5	20	39	55	72	88
2015	589	0	0	21	35	52	69	94

Figure 7.2.5: Variation in proportion of patients with BMI ≥ 18.5 kg/m² and serum albumin ≥ 40 g/L among HD centres 2015

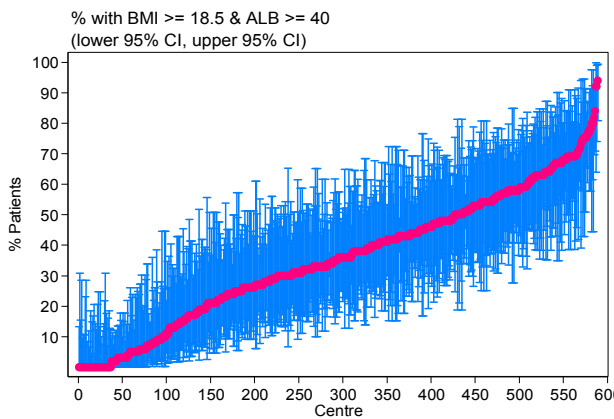


Figure 7.2.6: Variation in proportion of patients with BMI ≥ 18.5 kg/m² and serum albumin ≥ 40 g/L among PD centres 2015

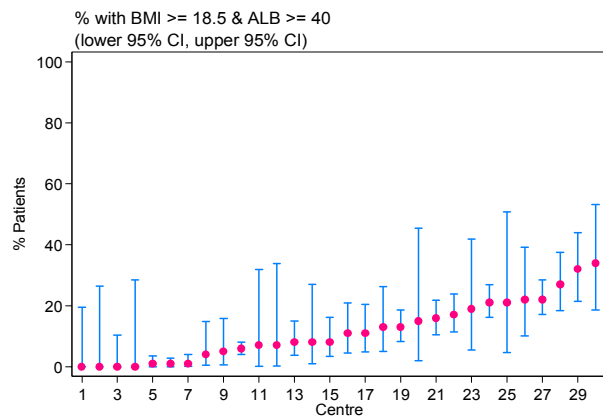


Table 7.2.6 indicates a wide variation in the nutritional status of patients in 30 PD centers as assessed by the combined nutritional status targets of BMI ≥ 18.5 kg/m² and serum albumin ≥ 40 g/L. Half of these centres achieved the combined nutritional status targets in only 9.5% of their patients. For 2015, none of the 25 PD centres had 50% of their patients achieving the combined nutritional status targets (Figure 7.2.6).

Table 7.2.6: Variation in proportion of patients with BMI ≥ 18.5 kg/m² and serum albumin ≥ 40 g/L among PD centres 2006-2015

Year	Number of centers	Min	5 th centile	LQ	Median	UQ	95 th centile	Max
2006	23	0	0	4	11	19	21	55
2007	22	0	1	8	12	19	36	60
2008	22	0	0	3	9.5	19	26	48
2009	21	0	0	4	10	19	28	35
2010	23	0	0	1	8	13	24	25
2011	25	0	0	0	6	17	26	35
2012	25	0	0	2	7	14	26	38
2013	25	0	0	1	8	22	29	38
2014	28	0	0	0	8.5	18	45	64
2015	30	0	0	4	9.5	19	32	34

SECTION 7.3: 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 higher in PD patients. Both groups were equal in terms of their hemoglobin levels and BMI.

Table 7.3.1: Nutritional parameters between HD and PD patients, 2015

	HD		PD		P-Value
	n= 35187		n= 4332		
	Mean	SD	Mean	SD	
Age	56.29	13.60	51.52	16.98	<0.0001 ^b
Albumin (g/dL)	38.15	4.88	32.72	6.45	<0.0001 ^b
BMI	24.37	5.91	24.28	4.97	0.4154 ^b
Total Cholesterol (mmol/L)	4.38	1.06	4.88	1.28	<0.0001 ^b
Sr Creatinine ((μ mol/L)	817.14	237.49	845.63	311.81	<0.0001 ^b
Hemoglobin	10.34	1.57	10.35	1.54	0.6300 ^b

a Independent t-test

b Mann Whitney test

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

Table 7.3.2(a): Nutritional parameters between diabetic and non- diabetic HD patients, 2015

	Diabetes		Non-Diabetes		P-Value
	n= 16196		n= 18990		
	Mean	SD	Mean	SD	
Age	53.15	14.88	59.98	10.82	<0.0001 ^b
Albumin (g/dL)	38.64	4.81	37.58	4.90	<0.0001 ^b
BMI	23.59	5.90	25.26	5.79	<0.0001 ^b
Total Cholesterol (mmol/L)	4.43	1.03	4.32	1.10	<0.0001 ^b
Sr Creatinine ((μmol/L)	866.70	246.85	758.69	211.48	<0.0001 ^b
Hemoglobin	10.37	1.61	10.30	1.53	0.0002 ^b

a Independent t-test
b Mann Whitney test

Diabetic PD patients were younger and had significantly lower BMI compared to non-diabetic PD patients. Diabetic PD patients also had better serum albumin, higher serum creatinine and total cholesterol compared to non-diabetic PD patients. Non-diabetic PD patients had significantly higher haemoglobin levels compared to diabetic patients.

Table 7.3.2(b): Nutritional parameters between diabetic and non-diabetic PD patients, 2015

	Diabetes		Non-Diabetes		P-Value
	n= 1241		n= 3091		
	Mean	SD	Mean	SD	
Age	48.45	17.90	59.14	11.24	<0.0001 ^b
Albumin (g/dL)	33.10	6.40	31.79	6.48	<0.0001 ^b
BMI	23.67	5.00	25.68	4.59	<0.0001 ^b
Total Cholesterol (mmol/L)	4.92	1.27	4.79	1.28	0.0028 ^b
Sr Creatinine ((μmol/L)	886.06	318.61	744.68	268.89	<0.0001 ^b
Hemoglobin	10.30	1.58	10.47	1.45	0.0011 ^b

a Independent t-test
b Mann Whitney test

We noted that in HD patients, the longer they were on treatment, the higher their serum albumin and lower their BMI (Table 7.3.3a). The BMI trend was significant for HD patients.

Table 7.3.3(a): Distribution of serum albumin and BMI by duration of dialysis among HD patients, 2006-2015

Years	<1		1-<5		5-<10		≥10		P-Value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Albumin (g/dL)	35.53	5.70	38.66	4.43	38.77	4.49	38.59	4.53	0.0971 ^d
BMI ≥ 18.5 kg/m ²	24.40	5.72	25.04	6.32	24.04	5.11	22.50	5.46	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 7.3.3(b): Distribution of serum albumin and BMI by duration of dialysis among PD patients, 2006-2015

Years	<1		1-<5		5-<10		≥10		P-Value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Albumin (g/dL)	32.42	6.82	32.88	6.31	32.64	6.20	33.73	5.22	0.0001 ^d
BMI ≥ 18.5 kg/m ²	24.62	5.08	24.50	4.90	22.87	4.65	21.64	4.37	0.0001 ^d

c ANOVA

d Kruskal Wallis rank test