

**CHAPTER - 7**  
**NUTRITIONAL STATUS ON DIALYSIS**

**Winnie Chee Siew Swee**

**Abdul Halim B Abd Gafor**

**Ahmad Fauzi B Abd Rahman**

**Koh Keng Hee**

**Tilakavati Karupaiah**

### SECTION 7.1: SERUM ALBUMIN LEVELS ON DIALYSIS

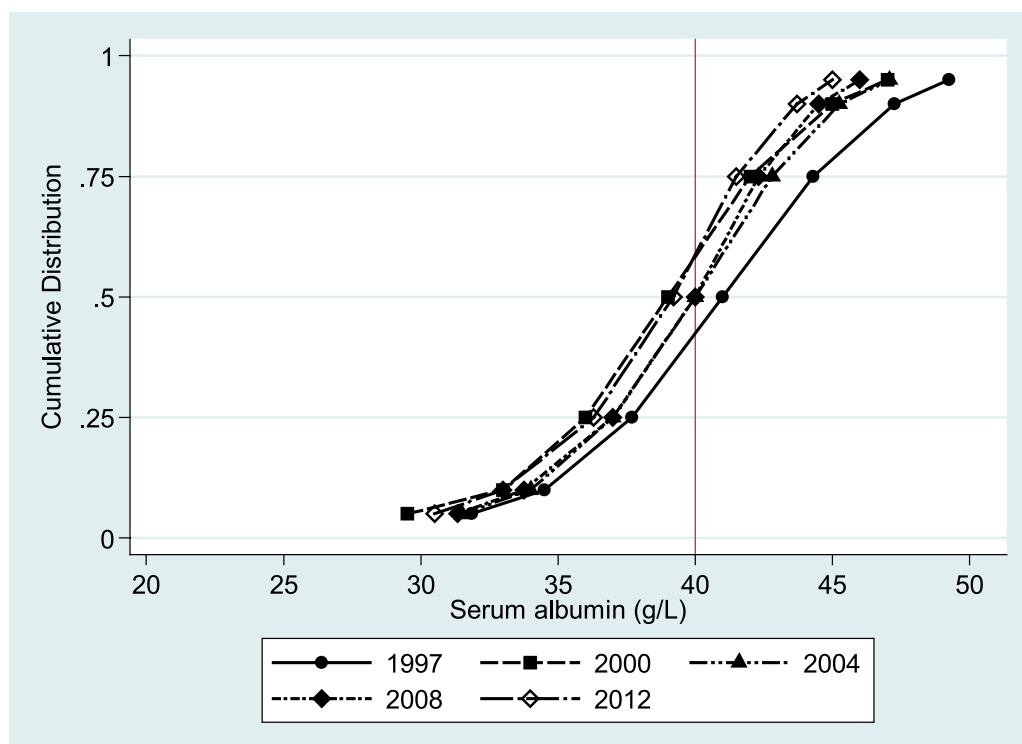
In HD patients, the mean serum albumin level in 2012 was  $38.7 \pm 5.0$  g/L. The percentage of patients with very low serum albumin of  $<30$  g/L and with desirable serum albumin of  $\geq 40$  g/L has remained the same since 2010 (Table 7.1.1). Overall serum albumin trends for HD patients indicates improvements from 2003 to 2005 based on the number of patients with serum albumin levels  $\geq 40$ g/L but has declined from 2007 to 2012 by almost 10 percent points.

Cumulative distribution trends for serum albumin of HD patients between 1997-2012 support this observation (Figure 7.1.1).

**Table 7.1.1:** Distribution of serum albumin, HD patients, 1997-2012

Year	Number of patients	Sr. Albumin (g/L)				Patient Distribution			
		Mean $\pm$ SD	Median	LQ	UQ	% patients $<30$ g/L	% patients $30-<35$ g/L	% patients $35-<40$ g/L	% patients $\geq 40$ g/L
1997	1644	$40.9 \pm 6.2$	41	37.7	44.3	3	8	30	59
1998	2075	$41.2 \pm 6.5$	41	37.5	44.7	3	9	28	59
1999	2755	$39.7 \pm 6.1$	39.7	36.3	43	4	13	35	49
2000	3731	$38.6 \pm 7$	39	36	42	5	11	41	43
2001	4666	$39 \pm 5.6$	38.5	36	41.8	3	15	44	38
2002	5568	$39.2 \pm 5.6$	39	36.5	42	3	12	42	43
2003	6524	$39.9 \pm 5.4$	40	37.3	42.5	3	9	35	52
2004	7581	$39.9 \pm 5.3$	40	37	42.8	3	10	34	53
2005	8706	$40 \pm 5.2$	40.3	37.5	42.8	3	9	33	56
2006	10928	$39.8 \pm 5.4$	40.3	37.3	42.8	3	10	33	54
2007	12315	$39.7 \pm 5.3$	40	37	42.5	3	10	35	52
2008	14548	$39.4 \pm 5.1$	40	37	42.3	3	10	36	50
2009	16940	$39.4 \pm 5.1$	40	37	42.3	3	11	35	51
2010	18757	$38.9 \pm 4.9$	39.3	36.3	41.8	4	13	40	44
2011	21830	$38.7 \pm 5$	39	36.3	41.5	4	13	41	43
2012	24789	$38.7 \pm 5$	39.2	36.3	41.5	4	13	41	43

**Figure 7.1.1:** Cumulative distribution of serum albumin, HD patients 1997-2012



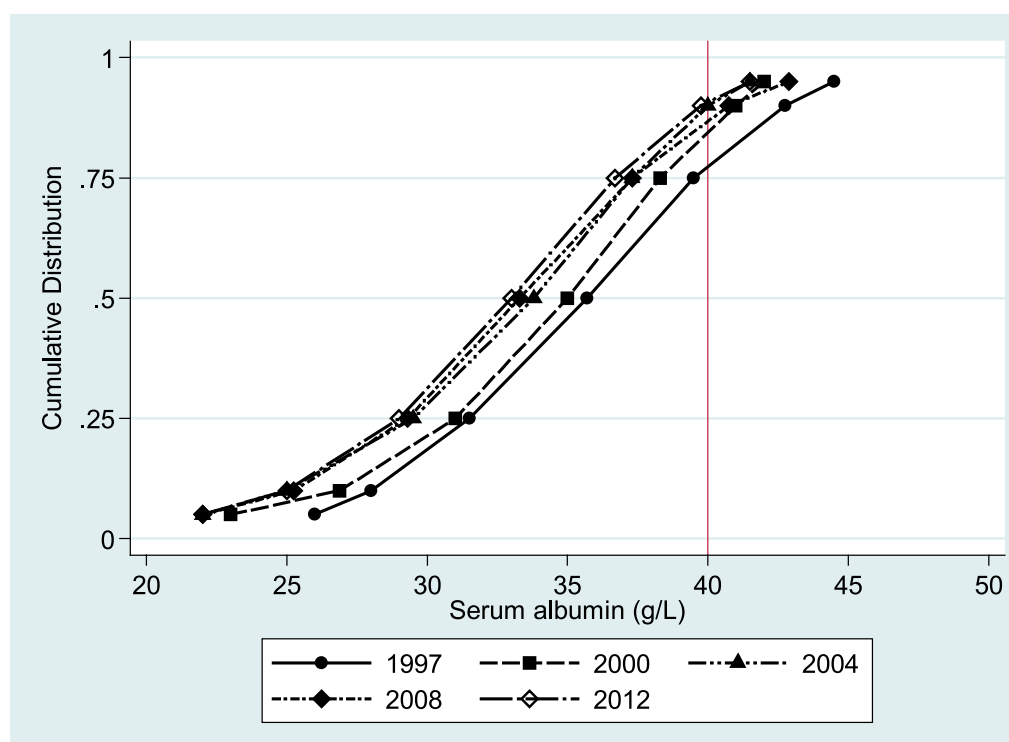
In PD patients, there was an improvement in serum albumin in the year 2012 compared to the decline noted from 2008 as the mean serum albumin of  $32.7 \pm 6.5$ g/L returned to the same levels for 2009 (Table 7.1.2). Percentage of patients with unsatisfactory serum albumin (<30 g/L) were also similar to 2009 whilst the percentage of patients with good serum albumin levels of  $\geq 40$ g/L increased from 8% in 2010-2011 to 10%, closer to 11% in 2009 and 13% in 2008.

Cumulative distribution trends for serum albumin of PD patients between 1997-2012 support the observation that trends for 2012 has declined since 2008 (Figure 7.1.2).

**Table 7.1.2:** Distribution of serum albumin, PD patients, 1997-2012

Year	Number of patients	Sr. Albumin (g/L)					Patient Distribution			
		Mean	SD	Median	LQ	UQ	% patients <30g/L	% patients 30-<35g/L	% patients 35-<40g/L	% patients $\geq 40$ g/L
1997	471	35.7	6.8	35.7	31.5	39.5	16	28	34	22
1998	536	35.8	6.7	36	32	39.7	16	25	35	24
1999	597	34.1	6.6	34	30.8	38	21	33	32	14
2000	640	34.3	6.1	35	31	38.3	20	28	37	14
2001	750	33.3	6.2	33.6	29.3	37	27	33	28	12
2002	862	33.9	5.9	34.3	30.8	37.5	21	35	33	12
2003	1180	33.3	5.8	33.8	29.7	37.3	26	33	30	11
2004	1284	33	6	33.8	29.5	37.3	27	32	30	11
2005	1346	33.2	6.4	33.3	29.5	37	27	33	30	10
2006	1498	33.5	6.1	33.8	30	37	25	33	30	12
2007	1753	33.6	6.2	34	30	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	29	36.8	30	34	25	11
2010	2305	32.1	6.2	32.3	28.5	36	33	35	24	8
2011	2523	31.9	6	32	28.3	36	35	34	23	8
2012	2862	32.7	6.5	33	29	36.7	30	33	27	10

**Figure 7.1.2:** Cumulative distribution of serum albumin, PD patients 1997-2012



As the number of HD centres have increased currently compared to 1997, there was a wide variation in serum albumin  $\geq 40\text{g/L}$  amongst 552 centres in 2012 (Table 7.1.3). Half of the HD centres in 2012 achieved proportion of HD patients  $\geq 42\%$  with albumin level  $\geq 40\text{g/L}$ . The median of percentage of HD patients with albumin level  $\geq 40\text{ g/L}$  has deteriorated gradually from 1997 to 2008 but rather rapidly from 2009 onwards. Similar trends were shown in Figure 7.1.3.

**Table 7.1.3:** Variation in proportion of patients with serum albumin  $\geq 40\text{g/L}$  among HD centres 1997-2012

Year	Number of centers	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
1997	45	0	11	42	61	76	95	98
1998	49	8	11	33	57	82	95	96
1999	67	4	11	20	50	65	91	100
2000	92	0	7	21.5	42	62	81	93
2001	117	0	3	16	38	54	82	100
2002	141	0	10	25	43	62	85	100
2003	170	0	18	39	54.5	70	92	100
2004	205	4	12	36	59	73	88	100
2005	232	4	11	42	56	68	85	97
2006	279	0	12	37	54	72	88	96
2007	313	0	12	36	53	68	85	100
2008	366	0	7	35	50	67	83	100
2009	410	0	9	36	53	66	82	100
2010	446	0	7	26	44	59	79	100
2011	505	0	4	27	43	57	76	95
2012	552	0	5	25	42	58	76	96

**Figure 7.1.3:** Variation in proportion of patients with serum albumin  $\geq 40\text{g/L}$ , HD centres 2012

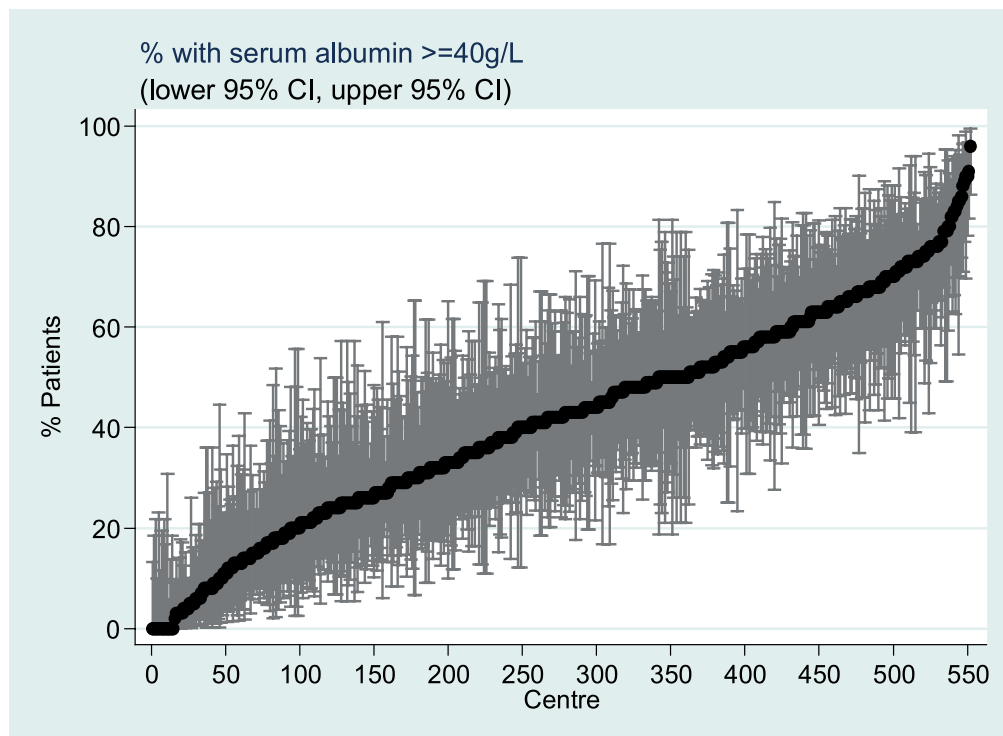
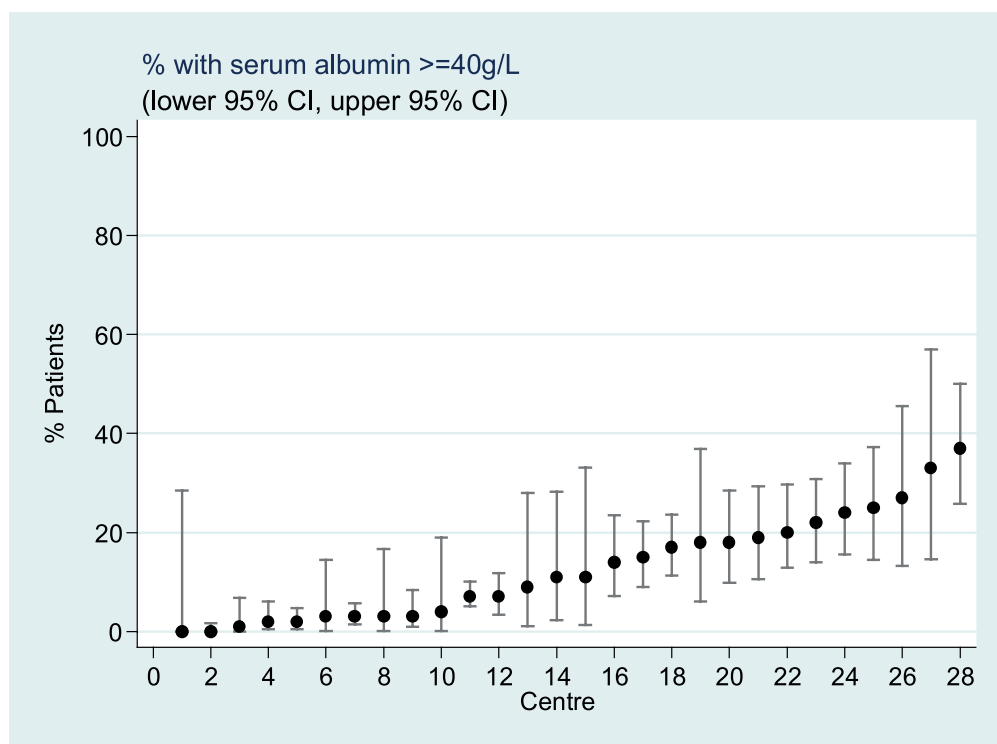


Table 7.1.4 indicates the median number of PD centres in 2012 reported to achieve more than 40g/L in at least half of their patients increased to 11% from 5% in 2011. Nevertheless, we noted that the trend of serum albumin  $\geq 40$ g/L has deteriorated gradually since 1997. Similar trends were shown in Figure 7.1.4.

**Table 7.1.4:** Variation in proportion of patients with serum albumin  $\geq 40$ g/L among PD centres 1997-2012

Year	Number of centers	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
1997	7	5	5	10	28	29	59	59
1998	9	5	5	18	25	34	40	40
1999	10	2	2	8	14.5	19	29	29
2000	11	0	0	5	12	28	43	43
2001	12	1	1	4.5	16	26.5	36	36
2002	15	5	5	6	10	25	36	36
2003	18	1	1	8	14	19	58	58
2004	18	2	2	8	15	22	35	35
2005	19	1	1	7	14	23	29	29
2006	22	1	1	6	13	22	42	70
2007	22	0	1	12	14	21	36	61
2008	24	0	1	4.5	15	23	41	51
2009	25	0	0	6	14	23	35	37
2010	26	0	0	2	10	13	30	33
2011	28	0	0	0.5	5	20	30	38
2012	28	0	0	3	11	19.5	33	37

**Figure 7.1.4:** Variation in proportion of patients with serum albumin  $\geq 40$ g/L, PD centres 2012



### SECTION 7.2: BODY MASS INDEX (BMI) ON DIALYSIS

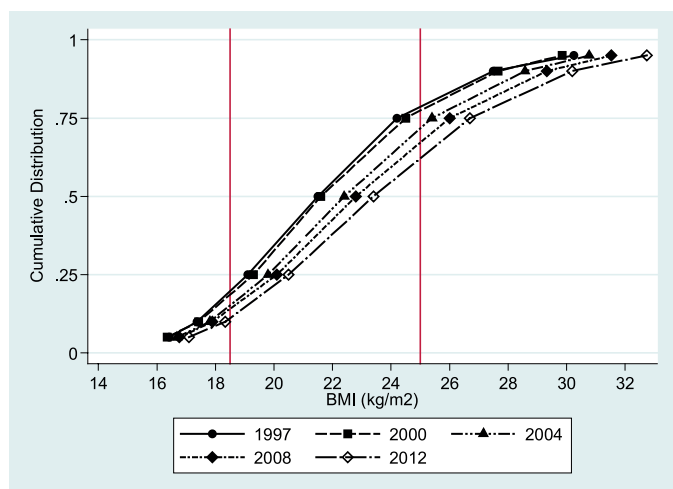
Table 7.2.1 indicates the mean BMI for HD patients from 1997 to 2012. For the year 2012 the mean BMI was  $24.3 \pm 8.4 \text{ kg/m}^2$ . An increasing trend of higher BMI is observed for HD patients, with the percentage of HD patients with BMI  $\geq 25$  increasing from 20% in 1997 to 37% in 2012. The percent number of patients with BMI  $< 18.5$  reduced from 19% in 1997 to 11% in 2012.

Figures 7.2.1(a) and (b) reflect the increasing BMI trends as the curve for 2012 continues in moving right.

**Table 7.2.1:** Distribution of BMI, HD patients, 1997-2012

Year	Number of patients	BMI					Patient Distribution		
		Mean	SD	Median	LQ	UQ	% patients <18.5	% patients 18.5-25	% patients $\geq 25$
1997	1547	23.6	16.2	21.5	19.1	24.2	19	61	20
1998	1981	24.1	18.3	21.6	19.1	24.3	19	60	21
1999	2713	23.5	15.9	21.4	19.2	24.4	18	61	21
2000	3858	22.9	11.7	21.6	19.3	24.5	18	60	22
2001	4552	23	11	21.9	19.3	24.7	18	59	23
2002	5104	23.2	10.6	22	19.5	24.9	16	59	24
2003	5990	23.1	9.7	22.1	19.5	25.1	16	58	26
2004	6776	23.3	9	22.4	19.8	25.4	14	58	28
2005	7837	23.4	9	22.5	19.8	25.6	14	57	29
2006	9793	23.3	7.9	22.6	19.9	25.7	14	56	29
2007	10515	23.4	7.9	22.7	19.9	25.8	14	56	30
2008	12225	23.5	7.5	22.8	20.1	26	13	55	31
2009	13726	23.8	8.2	23	20.1	26.2	13	54	33
2010	14698	24	7.8	23.2	20.3	26.5	12	53	35
2011	16508	24.1	8.6	23.3	20.4	26.5	12	53	35
2012	18188	24.3	8.4	23.4	20.5	26.7	11	52	37

**Figure 7.2.1(a):** Cumulative distribution of BMI, HD patients 1997-2012



**Figure 7.2.1(b):** mean BMI, HD patients 1997-2012

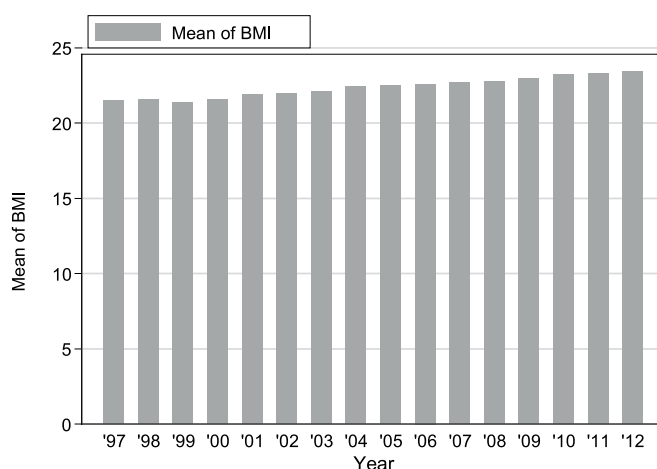
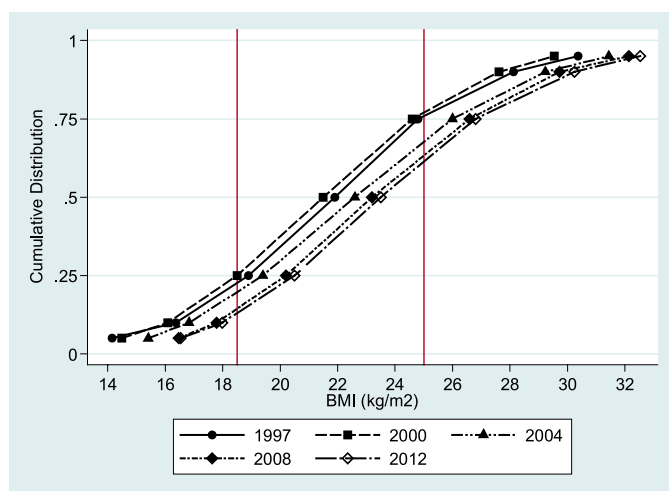


Table 7.2.2. indicates mean BMI for PD patients from 1997 to 2012 is increasing from  $22.5 \pm 12.5$  to  $24.2 \pm 8.2$  kg/m<sup>2</sup>. The percentage of PD patients with BMI  $\geq 25$  increased from 23% in 1997 to 38% in 2012. The shifting of the cumulative distribution curve for 2012 to the right (Figure 7.2.2 (a)) and mean BMI (Figure 7.2.2 (b)) increases for these years both reflect the small increases in BMI compared to the previous years.

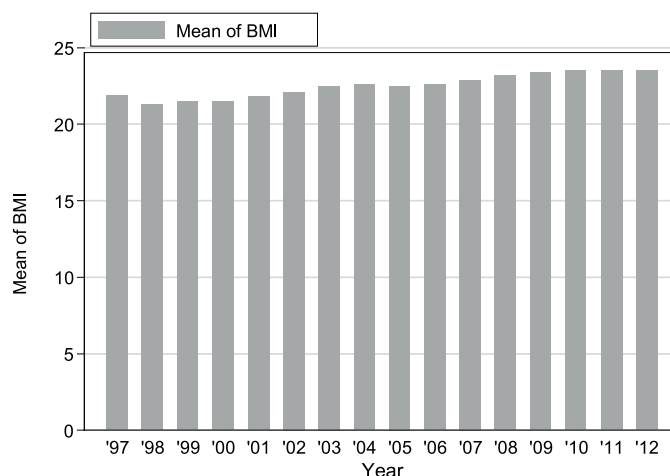
**Table 7.2.2:** Distribution of BMI, PD patients 1997-2012

Year	Number of patients	BMI					Patient Distribution		
		Mean	SD	Median	LQ	UQ	% patients <18.5	% patients 18.5-25	% patients $\geq 25$
1997	420	22.5	12.5	21.9	18.9	24.8	22	55	23
1998	490	22	11.1	21.3	18.6	24	23	57	20
1999	551	21.7	4.5	21.5	18.8	24.5	23	56	22
2000	602	21.6	4.6	21.5	18.5	24.6	25	52	22
2001	664	22	5.1	21.8	18.7	25.3	24	50	27
2002	751	22.2	5.1	22.1	18.7	25.5	24	47	30
2003	1071	22.8	6.9	22.5	19.2	25.8	20	50	30
2004	1175	23.1	7.3	22.6	19.4	26	19	50	31
2005	1223	23	7.2	22.5	19.3	25.8	20	50	30
2006	1420	23.3	8.3	22.6	19.6	26.1	16	50	33
2007	1616	23.4	5.9	22.9	19.9	26.3	15	51	34
2008	1872	23.8	7.7	23.2	20.2	26.6	14	50	36
2009	1944	24.1	8.5	23.4	20.4	26.8	13	50	38
2010	2050	24.5	10.2	23.5	20.5	27.1	13	49	39
2011	2223	24.2	8.8	23.5	20.3	27	13	49	38
2012	2253	24.2	8.2	23.5	20.5	26.8	13	50	38

**Figure 7.2.2(a):** Cumulative distribution of BMI, PD patients 1997-2012



**Figure 7.2.2(b):** mean BMI, PD patients 1997-2012



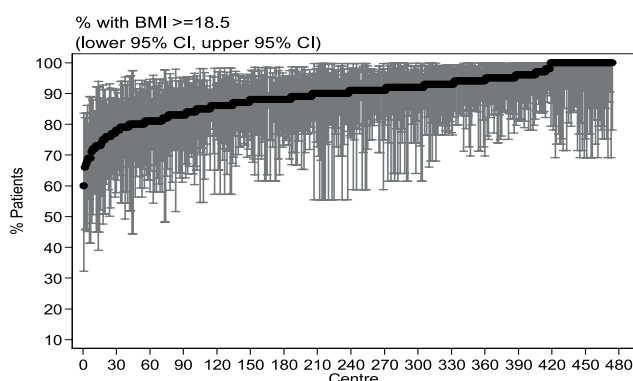
The variation in HD centres with proportion of patients with BMI  $\geq 18.5$  for 2012 is given in Table 7.2.3. Half of HD centers achieving the BMI  $\geq 18.5$  at least 90% of their patients in year 2012 and this positive trend is continuing from the previous years.

**Table 7.2.3:** Variation in proportion of patients with BMI  $\geq 18.5$  among HD centres 1997-2012

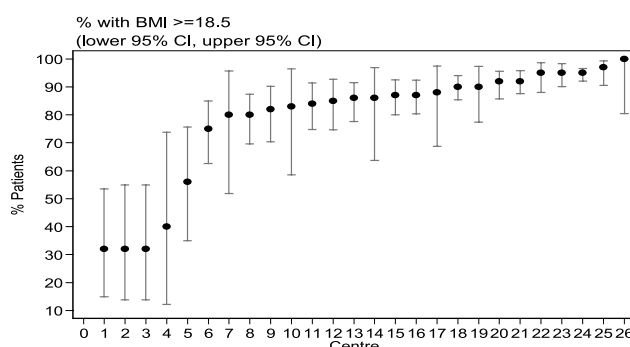
Year	Number of centers	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
1997	44	58	64	75	81.5	89	96	100
1998	47	56	68	75	81	85	92	100
1999	68	53	70	78.5	83.5	90	94	100
2000	91	50	65	78	83	88	96	100
2001	112	59	65	77.5	83	88	93	100
2002	132	55	67	79	85	89	100	100
2003	158	62	69	79	84.5	91	100	100
2004	192	60	69	82	86.5	92	100	100
2005	205	60	70	80	88	92	100	100
2006	258	53	69	80	86	92	100	100
2007	280	62	70	81	87	92	100	100
2008	322	58	71	83	88	93	100	100
2009	360	63	74.5	81	88	93	100	100
2010	384	57	74	84	89	93.5	100	100
2011	422	57	75	84	90	94	100	100
2012	474	60	76	86	90	94	100	100

It was also observed that in 2012, 3 quarter out of 474 HD centres had 94% of their patients achieving BMI  $\geq 18.5$  (Table 7.2.3) while about 60 centres were achieving 100% of this target (Figure 7.2.3).

**Figure 7.2.3:** Variation in proportion of patients with BMI  $\geq 18.5$  among HD centres 2012



**Figure 7.2.4:** Variation in proportion of patients with BMI  $\geq 18.5$  among PD centres 2012



The variation in PD centres with proportion of patients with BMI  $\geq 18.5$  for 2012 is given in Table 7.2.4. Half of PD centers achieving the BMI target in  $\geq 86\%$  of their patients in the year 2012. The trend deteriorated since 2009.

**Table 7.2.4:** Variation in proportion of patients with BMI  $\geq 18.5$  among PD centres 1997-2012

Year	Number of centers	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
1997	7	47	47	74	81	88	93	93
1998	9	0	0	71	80	87	91	91
1999	9	0	0	69	75	83	92	92
2000	11	11	11	61	76	87	90	90
2001	11	15	15	72	77	88	92	92
2002	14	20	20	73	81	85	87	87
2003	18	18	18	74	80.5	88	96	96
2004	18	28	28	72	82	89	94	94
2005	18	17	17	69	83.5	87	91	91
2006	22	14	20	78	84	91	92	92
2007	22	16	18	76	86.5	91	98	100
2008	22	17	27	78	87.5	91	95	100
2009	22	33	35	80	89	93	95	97
2010	24	35	35	81.5	89	94	98	100
2011	26	26	31	80	87	93	96	98
2012	26	32	32	80	86	92	97	100

It was also observed that in 2012, 21 out of 28 PD centres had 75% of their patients achieving BMI  $\geq 18.5$  whilst only one centre was achieving 100% of target (Figure 7.2.4).



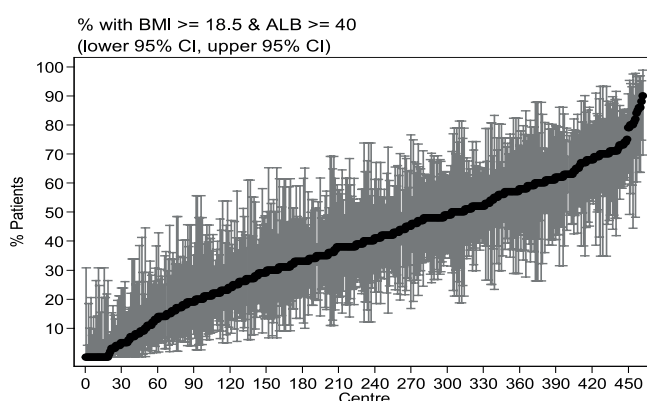
Table 7.2.5 indicates a wide variation in the nutritional status of patients at 462 HD centers. Only half out of 462 centres were achieving the combined nutritional status targets in  $\geq 40\%$  of their patients. A trend of lower nutrition in most centres is observed.

**Table 7.2.5:** Variation in proportion of patients with BMI  $\geq 18.5$  and serum albumin  $\geq 40$  g/dL among HD centres 1997-2012

Year	Number of centers	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
1997	44	0	6	27	48	63	79	91
1998	47	6	8	27	45	65	77	82
1999	62	4	6	23	43.5	60	71	80
2000	82	0	9	21	36.5	50	69	83
2001	105	0	3	11	31	48	67	100
2002	123	0	7	26	36	54	73	100
2003	147	0	18	35	48	62	77	100
2004	184	0	11	35	51	64	80	100
2005	198	3	13	35	50	62	79	90
2006	243	0	11	33	47	63	80	91
2007	271	0	9	32	48	60	74	100
2008	310	0	8	31	46	60	75	100
2009	351	0	7	33	47	61	75	92
2010	371	0	5	25	41	57	73	100
2011	408	0	4	25	40	55	73	93
2012	462	0	3	23	40	56	71	90

It was also observed that in 2012, 162 out of 462 HD centres had 50% of their patients achieving the combined targets (Figure 7.2.5).

**Figure 7.2.5:** Variation in proportion of patients with BMI  $\geq 18.5$  and serum albumin  $\geq 40$  g/dL among HD centres 2012



**Figure 7.2.6:** Variation in proportion of patients with BMI  $\geq 18.5$  and serum albumin  $\geq 40$  g/dL among PD centres 2012

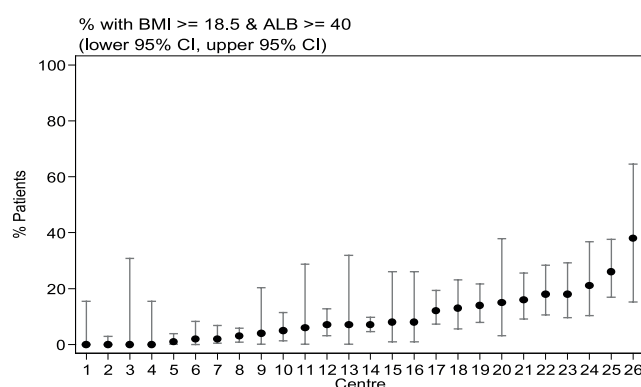


Table 7.2.6 indicates a wide variation in the nutritional status of patients at 26 PD centers as assessed by BMI  $\geq 18.5$  and serum albumin  $\geq 40$  g/dL. A declining trend in nutritional status evident since 2009 is observed with these centres but a marginal improvement by 2% in median has taken place in 2012 compared to 2011.

It was also observed that in 2012, none of the 26 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  $\geq 18.5$  and serum albumin  $\geq 40$  g/dL among PD centres 1997-2012

Year	Number of centers	Min	5 <sup>th</sup> centile	LQ	Median	UQ	95 <sup>th</sup> centile	Max
1997	7	5	5	7	12	22	67	67
1998	9	0	0	6	20	22	32	32
1999	9	0	0	3	8	15	25	25
2000	11	0	0	5	9	21	33	33
2001	11	1	1	5	8	20	26	26
2002	14	0	0	5	10.5	18	36	36
2003	18	0	0	4	10	16	46	46
2004	18	1	1	5	10.5	17	36	36
2005	18	0	0	4	8.5	18	26	26
2006	22	0	0	4	9.5	15	20	52
2007	22	0	1	5	11.5	19	37	56
2008	22	0	1	4	10	19	25	43
2009	22	0	0	5	11.5	18	29	34
2010	24	0	0	2	7.5	13.5	23	24
2011	26	0	0	0	5	17	25	35
2012	26	0	0	2	7	15	26	38

**SECTION 7.3: Nutritional parameters****Table 7.3.1(a):** Nutritional parameters between HD patients, 2012

	Mean	SD
n	25892	
Age	55.6	13.7
Albumin (g/dL)	38.7	5.0
BMI	24.3	8.4
Cholesterol (mmol/L)	4.5	1.1
Sr Creatinine (µmol/L)	817.8	239.6
Hemoglobin	10.4	1.6

**Table 7.3.1(b):** Nutritional parameters between PD patients, 2012

	Mean	SD
n	2938	
Age	50.0	18.0
Albumin (g/dL)	32.7	6.5
BMI	24.2	8.2
Cholesterol (mmol/L)	5.1	1.4
Sr Creatinine (µmol/L)	857.3	324.4
Hemoglobin	10.5	1.6

HD patients were older (~5.6 years) and had better serum albumin (by 6g/dL) compared to PD patients. On the other hand, serum total cholesterol (~0.6mmol/L) was higher in PD patients. Both groups were equal in term of their serum creatinine and hemoglobin levels and BMI.

**Table 7.3.2(a):** Nutritional parameters between diabetic and non- diabetic HD patients, 2012

	Diabetes		Non-Diabetes	
	Mean	SD	Mean	SD
n	11981		13406	
Age	51.9	15.0	59.7	10.6
Albumin (g/dL)	39.2	5.0	38.2	5.0
BMI	23.3	8.2	25.4	8.6
Cholesterol (mmol/L)	4.5	1.0	4.4	1.1
Sr Creatinine (µmol/L)	872.3	247.4	753.1	212.4
Hemoglobin	10.4	1.6	10.3	1.6

In the HD population, the diabetic patients were younger (by 8 years) with lower BMI (by 2.1) compared to the non- diabetic patients. Serum creatinine was higher in the diabetic group (by 120µmol/L).

**Table 7.3.2(b):** Nutritional parameters between diabetic and non-diabetic PD patients, 2012

	Diabetes		Non-Diabetes	
	Mean	SD	Mean	SD
n	900		1976	
Age	45.7	18.9	59.4	11.1
Albumin (g/dL)	33.3	6.4	31.0	6.5
BMI	23.3	6.2	26.1	11.4
Cholesterol (mmol/L)	5.2	1.4	5.0	1.3
Sr Creatinine (µmol/L)	904.3	331.2	739.9	273.5
Hemoglobin	10.4	1.6	10.6	1.4

Diabetic patients were younger (by ~14 years) and had lower BMI (~2.8) compared to non diabetic PD patients. Diabetic patients also had better serum albumin (~2.3g/dL) and higher serum creatinine (by ~165µmol/L) levels.

**Table 7.3.3(a):** Distribution of serum albumin and BMI by duration of dialysis among HD patients, 1997-2012

Years	<1		1-<5		5-<10		≥10	
n	4454		12658		5742		2437	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Albumin (g/dL)	36.2	5.6	39.0	3.9	40.2	3.3	40.5	3.0
BMI	24.4	7.7	24.7	8.4	24.1	7.6	22.8	10.0

In HD patients, the longer they were on treatment, the higher their serum albumin and lower their BMI.

**Table 7.3.3(b):** Distribution of serum albumin and BMI by duration of dialysis among PD patients, 1997-2012

Years	<1		1-<5		5-<10		≥10	
n	879		1557		373		58	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Albumin (g/dL)	32.0	6.7	33.1	5.2	34.5	4.2	34.9	3.5
BMI	24.2	7.2	24.6	10.7	23.4	4.6	21.6	3.5

The longer the patients on PD treatment, the higher their serum albumin and lower their BMI.