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Correlations between anthropometric measurements, biochemical indicators, dietary intake and Dialysis Malnutrition Score among haemodialysis patients in Sibu, Sarawak

Lina Ho Ling Ling[1] & Chan Yoke Mun[1, 2*]

[1]*Department of Nutrition and Dietetics, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia*; [2]*National Research Institute on Aging, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia*

ABSTRACT

Introduction: Malnutrition is a common problem associated with increased risk of morbidity and mortality among haemodialysis (HD) patients. **Methods:** This study determined the correlation between anthropometric measurements, biochemical indicators, dietary intake and dialysis malnutrition score among HD patients in Sibu, Sarawak. A total of 55 patients were recruited by purposive sampling and their biochemical parameters were retrieved from dialysis records. Anthropometric measurements and dietary intake were determined using standardised protocols while Dialysis Malnutrition Score (DMS) was computed to determine patients' nutritional status. **Results:** Mean age of the patients was 53.0±12.2 years. Mean DMS was low, indicating low tendency of malnutrition among the patients. Approximately one-third of the patients had high interdialytic weight gain (IDWG), indicating a poor adherence on fluid recommendation. Mean intakes of dietary energy (DEI) and protein (DPI) were low, with only approximately 15% achieving the recommendations according to Kidney Disease Outcomes Quality Initiative (K/DOQI). Increase in age (r=0.337, p=0.012) and dialysis vintage (r=0.403, p=0.002) were associated with poorer nutritional status while higher BMI, MUAC, and serum albumin were associated with better nutritional status. **Conclusion:** This study revealed a high proportion of the HD patients with poor adherence on fluid intake, and the prevalence of inadequate DEI and DPI, indicating the importance of regular dietary counselling for HD patients. In view of their non-invasive nature and close relationship with nutritional status, body mass index, mid-upper arm circumference, and serum albumin should be included as part of the comprehensive periodic nutrition assessment of HD patients.

Keywords: Haemodialysis, Dialysis Malnutrition Score, dietary intakes, anthropometric parameters

INTRODUCTION

Chronic kidney disease (CKD) is defined as the progressive loss of kidney functions and performance of nephrons over a period of at least three months and leading to permanent damage to the kidneys (Kidney Disease: Improving Global Outcomes, 2012). When the glomerular

*Corresponding author: Dr Chan Yoke Mun
Department of Nutrition and Dietetics, Faculty of Medicines and Health Sciences, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
Tel: +603 8947 2433; E-mail: cym@upm.edu.my

filtration pressure and hyperfiltration keep increasing due to fewer functional nephrons, hyperfiltration will accelerate the evolution of CKD to end stage renal disease (ESRD) (McPhee & Ganong, 2006). ESRD is defined as total and permanent loss of kidney function at which renal replacement therapy is required to sustain life.

Haemodialysis (HD) is a long term renal replacement therapy, which replaces the renal functions partially. It requires a fistula created via surgery access the bloodstream by connecting an artery and a vein. During the HD process, waste products and electrolytes will be removed by diffusion, ultrafiltration, and osmosis from the blood to the dialysate (Mahan, Escott-Stump & Raymond, 2012). Globally, by the end of 2014, HD remains as the most common treatment modality among the dialysis population compared to peritoneal dialysis, with around 88% of all incident ESRD cases began the renal replacement therapy with HD (Saran *et al.*, 2017). A similar situation prevails in Malaysia where more than 90% of dialysis patients were on HD treatment between 2005 and 2014 (Goh *et al.*, 2015). Nonetheless, the survival rate of HD patients decreased with prolonged dialysis vintage (Wong & Ong, 2015). Together with lower survival rate, protein energy wasting (PEW) is very common among HD patients. Malnutrition is common among HD patients, varying widely from 29-91%, depending on the population studied (Chan, Kelly, Batterham & Tapsell, 2012; Janardhan *et al.*, 2011; Mohammed, Farhood & AtheemWtwt, 2014). Harvinder *et al.* (2016) reported majority of HD patients were malnourished, regardless of the nutritional status assessment tools used.

Assessment of nutritional status is an integral part of care for CKD patients to provide early nutrition intervention to those who are at risk of malnutrition. The Dialysis Malnutrition Score (DMS), a modified Subjective Global Assessment (SGA) tool to detect the presence of malnutrition, was recommended by European Best Practice Guidelines (EBPG) on Nutrition (Fouque *et al.*, 2007) and Kidney Disease Outcomes Quality Initiative (K/DOQI) (2000) as a predictor tool of malnutrition in HD patients. DMS has also been suggested to be a more practical tool in Malaysia dialysis settings due to its relatively quick, easy, inexpensive to perform, more objective than SGA, and requires no laboratory markers (Harvinder *et al.*, 2016; K/DOQI, 2000). Several studies among Asian dialysis population have reported DMS as a useful and reliable index to detect malnutrition (Harvinder *et al.*, 2016; Janardhan *et al.*, 2011).

While available data indicates a continual increase in the dialysis treatment rate in Sarawak, Malaysia (Goh *et al.*, 2015), studies on nutritional status among HD patients in Sibu, Sarawak are scarce. This study was carried out to determine the nutritional status of HD patients by using the DMS and its correlation with anthropometric measurements, biochemical indicators, and dietary intake.

MATERIALS AND METHODS

This was a cross-sectional study that employed purposive sampling based on pre-determined inclusion criteria for the selection of HD patients. A total of 55 HD patients with informed consent were recruited from SJAM-KPS Haemodialysis Centre 8 (Sibu) Sarawak in Jan-Feb, 2014. All recruited patients met the inclusion criteria of: (1) above 21 years old; (2) undergone HD treatment thrice weekly for at least three months; (3) ability to communicate in Malay, English or Mandarin language. Patients were excluded if they presented with psychological problems such as dementia and mental illness; hospitalised in the past one month prior to study enrolment; and had hepatitis previously. Ethical approval was obtained from the Ethics Committee for Research Involving Human Subjects, Universiti Putra Malaysia (project identification: UPM/TNCPI/RMC/1.4.18.1 (JKEUPM)/F2). Subject anonymity and confidentially were maintained.

A pre-tested questionnaire was administered to obtain information on socio-demographic background of the patients, clinical history such as dialysis vintage, presence of co-morbidity, and accessibility with dietitians. Patients' body weight and height were measured using Detecto 6868 Bariatric Flip Seat Scale and Stand-alone Stadiometer (SECA 214, Germany), respectively. Body mass index (BMI) of patients was computed using Weight (kg)/(Height x Height) (m^2) formula based on dry weight. Presence of PEW was ascertained when BMI was less than 18.5 kg m^{-2} (Kanazawa *et al.*, 2017). This cut-off is adopted after taken into consideration the recommendation from the International Society of Renal Nutrition and Metabolism (ISRNM), as well as the adjustment made for diagnostic criterion for PEW for Southeast Asian HD patients (Kanazawa *et al.*, 2017).

As an indicator of fluid compliance, interdialytic weight gain (IDWG) was calculated by subtracting post-dialysis weight of the previous dialysis session from the pre-dialysis weight (Bots *et al.*, 2004). This was then compared to the recommendation by EBPG on Nutrition (Fouque *et al.*, 2007), with an IDWG of 4 to 4.5% is considered as acceptable range. Mid-upper arm circumference (MUAC) of the non-fistula arm was measured using a flexible, non-stretchable measuring tape at the midpoint of the upper arm, between acromion and olecranon process, after completion of dialysis session. A MUAC of ≥23 cm is desired as MUAC of <23 cm was strongly associated with BMI <18.5 kg m^{-2} and with increased risk of malnutrition as well as mortality (Tang *et al.*, 2013). Serum albumin and total cholesterol for the last three measurements were obtained retrospectively from medical record as secondary data. The desirable serum albumin levels and total cholesterol were ≥40 g/L and 3.9-5.2 mmol/L, respectively, based on K/DOQI guidelines (2000).

Dietary intake on non-dialysis day of the patients was obtained through 24-hour dietary recall. The quantity of food consumed by the patients was estimated using household measurement tools. Standard calibrated household measuring cups, glasses, spoons and bowls were used during the interview session to help the patients to estimate food portions. Consumed foods and drinks were converted into grams before nutrient analysis using Nutritionist Pro™ Diet Analysis software: Version 2.4.1 (Axxya, USA), with USDA Food Database and Malaysian Food Composition Tables (Tee *et al.*, 1997) as the food databases. Food labels were used whenever possible. Adequacy of dietary intakes (total energy, protein, fluid, sodium, potassium, phosphorus, and calcium) were compared with K/DOQI Recommendations for Nutritional Management (2000) and EBPG (2007).

The nutritional status of the patients was assessed using a fully quantitative scoring system (DMS) developed by Kalantar-Zadeh *et al.* (1999). It comprised five components of medical history (weight change, dietary intake, gastrointestinal symptoms, functional capacity, and co-morbidity) and two components of physical assessments (loss of subcutaneous fat and signs of muscle wasting). The scoring scheme used is described below:

- For 'Weight change' component, the overall change in the post-dialysis dry weight in the past six months was considered as follow. Score of 1 was given if there was no weight change or if the patient had gained weight. Minor weight loss (<5%), weight loss of 5-10%, weight loss of 10-15%, or any weight loss over 15% during the last six months was given a score of 2 to 5, respectively.

- For 'Dietary intake' component, 1 score was given if it was a regular solid intake with no recent changes in the amount of meals, a score of 2 for sub-optimal solid diet, 3 for full liquid diet or moderate overall decrease, 4 for hypo-caloric liquid and 5 for starvation.
- For 'Gastrointestinal symptoms' component, patients were given a score of 1 if there were no symptoms, 2 for nausea, 3 for vomiting or moderate gastrointestinal symptoms, 4 for diarrhoea and 5 for severe anorexia.
- For 'Functional capacity' component, a score of 1 if patients had normal functional capacity or any improvement in the level of previous functional impairment, 2 for difficulty with ambulation, 3 for difficulty with normal activity, 4 for restricted to solely light activity and 5 for persistent bed/ chair-ridden with no or little activity.
- Patients who had been dialysed for less than one year or healthy otherwise will be given a score of 1 for 'Co-morbidity' component. This was followed by a score of 2 if the subject had been dialysed for 1 to 2 years or if there was any mild co-morbidity, 3 if the subject had been dialysed for 2 to 4 years or if there was moderate co-morbidity or if the patient aged more than 75 years old, 4 if the subject had been dialysed for more than 4 years or if there was severe co-morbidity, and 5 if there were very severe and multiple co-morbidities.

The second part of the DMS comprised physical examination. 'Body fat stores or subcutaneous fat' was determined by assessing the fat deposition below the eyes, triceps, biceps and in the chest area. Sign of muscle wasting was determined by examining temple, clavicle, scapula, ribs, quadriceps, knee and interosseous muscles. Both components under physical examination were given a score of 1-5 to represent normal to very severe changes. Each component had a score of 1 (normal) to 5 (severe). Summation of the scores of the seven components provides a continuous score with possible range of 7 (normal) to 35 (severely malnourished), with higher score indicates higher risk of PEW (Kalantar-Zadeh *et al.*, 1999), and reflects a more severe degree of PEW. The approval of DMS use in this study was obtained from the author.

Statistical analysis

The results were analysed using IBM SPSS Statistics for Windows, Version 21.0 (IBM Corp., USA). Pearson product-moment correlation coefficient analysis was carried out for parametric data while Spearman's rank correlation coefficient was performed for non-parametric data to determine correlations between DMS of patients and anthropometric measurements, biochemical indicators, and dietary intake. Independent-samples *t*-test was performed to compare the mean of two groups. Statistical significant was set at p-value<0.05. Based on calculation according to Cole (1997), with a total of 55 patients, this study achieved study power of 80% and sensitivity and specificity of 90% for the correlation between DMS and related variables.

RESULTS

A total of 55 patients comprising 74.5% men was included in the study (Table

1). Their mean age was 53.0±12.2 years, ranging from 28 to 78 years. Majority were Chinese (58.2%), followed by *Bumiputera* (34.5%) and Malay (7.3%). More than 80% of them were married. Approximately 62% had moderate to high educational levels while 12.7% had no formal schooling.

Close to 90% of the patients were unemployed, while the rest were employed or working in family business. The working patients had monthly income of less than Ringgit Malaysia (RM) 2,300. Approximately 70% of the patients had household monthly income less than RM2,300 while the rest earned between RM2,300 to RM5,599. These income levels are respectively classified as low income and middle-income households based on the Tenth Malaysia Plan. Many of the patients were economically dependent on government subsidies, charity organisations, Social Security Organisation (SOCSO), and support from family members and relatives.

Majority of the patients (81.8%) suffered from co-morbidities along with kidney failure with 40.0% of them presented with more than one co-morbidities. Hypertension was most prevalent (76.4%), followed by diabetes mellitus (40.0%). Mean dialysis vintage was 2.67±0.64 years with a range of 3 months to 14 years. Approximately three quarters of them had at least a previous encounter with dietitians, indicating relatively high accessibility of the patients to dietitians.

Low mean DMS (11.85±2.26) indicated that the patients had a low risk of malnutrition. The DMS of women (12.64±2.59) was approximately 1.1 units higher than men (11.59±2.10), suggesting that women had a higher risk of malnutrition. Similarly, DMS in older patients (12.79±2.58) was higher than their younger counterparts (11.54±2.08), suggesting a poorer nutritional status among the older patients. However, the mean differences of DMS were not significant between sex and age groups.

Mean BMI and MUAC of the patients were 23.8±4.1 kg m^{-2} and 27.2±3.4 cm, respectively (Table 2). One-third of them exceeded the recommended IDWG of 4.5%, whereby more men and younger patients with IDWG greater than 4.5%. There was no sex-specific difference after adjustment for dry weight. In general, mean serum albumin and cholesterol levels of the patients were within the desirable range, with no significant differences between sex and the age groups. Nonetheless, approximately 10% and 30% patients had hypoalbuminemia and hypocholesterolemia, respectively.

Mean DEI and DPI of the patients were inadequate (Table 3), with only 14.5% and 16.4% achieved the recommendations, respectively (Table 4). Mean fluid intake was 922±384 ml/day, ranged widely from 600 to 3250 ml/day. Approximately 40% of the patients had excessive sodium intake according to K/DOQI (2000) and EBPG (2007) recommendations, with significantly higher sodium intake in men. Primary food sources of sodium included hawker foods, processed foods, and frequent use of condiments. Mean potassium intake was below the recommended level of 1950 to 2730 mg/day. Mean phosphate intake was low (543.5±210.5 mg/day) with significant higher intake among men (t=3.383, p=0.002). While mean dietary calcium intake (187.9±76.5 mg/day) was well below the recommended level of 500 mg/day, 61.8% of the patients reported excess calcium intake, mainly from supplements.

Pearson product-moment correlation coefficient analysis (Table 5) showed medium but significant positive correlation between age and DMS (r=0.337, p=0.012), independent of the presence of co-morbidities, suggesting

Table 1. Distribution of patients by socio-demographic and clinical backgrounds (*n*=55)

Variables	*Number, n (%)*	*Mean±SD*	*Range*
Sex			
Male	41 (74.5)		
Female	14 (25.5)		
Ethnicity			
Chinese	32 (58.2)		
Bumiputera[†]	19 (34.5)		
Malay	4 (7.3)		
Age group (years)		53.0±12.2	28-78
<60	41 (74.5)		
≥60	14 (25.5)		
Marital status			
Single	8 (14.6)		
Married	46 (83.6)		
Widow/ Widower	1 (1.8)		
Educational level			
No formal education	7 (12.7)		
Primary school	14 (25.5)		
Secondary school	29 (52.7)		
Tertiary	5 (9.1)		
Working status			
Unemployed	49 (89.0)		
Part time	3 (5.5)		
Full time	3 (5.5)		
Personal monthly income[‡]			
<RM 2300	55 (100.0)		
RM 2300-RM 5599	0 (0.0)		
≥RM 5600	0 (0.0)		
Household monthly income[‡]			
<RM 2300	39 (70.9)		
RM 2300-RM 5599	16 (29.1)		
≥RM 5600	0 (0.0)		
Presence of co-morbidity			
Yes	45 (81.8)		
No	10 (18.2)		
Number of co-morbidity			
0	10 (18.2)		
1	23 (41.8)		
≥2	22 (40.0)		
Co-morbidities[§]			
Hypertension	42 (76.4)		
Diabetes mellitus	22 (40.0)		
Dyslipidaemia	9 (16.4)		
Cardiovascular disease	2 (3.6)		
Anaemia	1 (1.8)		
Gout	1 (1.8)		
Dialysis vintage		2.67±0.64 years	3 months-14 years
Encounters with dietitians			
Yes	40 (72.7)		
No	15 (27.3)		

[†]Natives of Sarawak
[‡]Classified according to 10th Malaysia Plan, US$1.00=RM3.90
[§]Multiple responses

Table 2. Anthropometric measurements, biochemical indicators and Dialysis Malnutrition Score of patients according to sex and age (years) (n=55)

Measurements	*Age<60 (n=41)*	*Age≥60 (n=14)*	*Male (n=41)*	*Female (n=14)*	*Total*	*Range*
Height (cm)	161.8±0.1	157.2±0.1	162.1±0.1	156.2±0.1	160.6±1.0	149-179
Dry weight (kg)	63.6±14.9	56.4±10.7	64.5±15.0	53.9±7.6	61.8±14.3	37.0-100.5
Body Mass Index (BMI) (kg m^{-2})	24.1±4.3	22.7±3.5	24.4±4.5	22.0±2.1*	23.8±4.1	15.0-32.4
<18.5	4 (9.8)	2 (14.3)	5 (12.2)	1 (7.1)	6 (10.9)	
≥18.5	37 (90.2)	12 (85.7)	36 (87.8)	13 (92.9)	49 (89.1)	
Interdialytic Weight Gain (IDWG) (kg)	2.8±1.1	2.2±0.6*	2.8±1.0	2.1±1.0*	2.6±1.0	0.4-6.3
Interdialytic Weight Gain (IDWG) (%)	4.4±1.6	3.9±0.9	4.4±1.4	3.9±1.6	4.3±1.4	0.7-7.9
<4	16 (39.0)	6 (42.9)	16 (39.0)	6 (42.8)	22 (40.0)	
4-4.5	8 (19.5)	6 (42.9)	10 (24.4)	4 (28.6)	14 (25.5)	
>4.5	17 (41.5)	2 (14.2)	15 (36.6)	4 (28.6)	19 (34.5)	
Mid-Upper Arm Circumference (MUAC) (cm)	27.6±3.7	26.2±2.3	27.5±3.6	26.4±2.8	27.2±3.4	19.6-35.4
<23	6 (14.6)	1 (7.1)	5 (12.2)	2 (14.3)	7 (12.7)	
≥23	35 (85.4)	13 (92.9)	36 (87.8)	12 (85.7)	48 (87.3)	
Serum albumin (g/L)	43.1±2.6	42.2±2.8	42.9±2.9	42.5±1.9	42.8±2.7	35.0-48.0
<40	5 (12.2)	2 (14.3)	7 (17.1)	0 (0.0)	7 (12.7)	
≥40	36 (87.8)	12 (85.7)	34 (82.9)	14 (100.0)	48 (87.3)	
Total cholesterol (mmol/L)	4.3±1.0	4.1±0.6	4.1±0.8	4.6±1.0	4.2±0.9	2.4-6.5
<3.9	14 (34.1)	5 (35.7)	14 (34.1)	5 (35.7)	19 (34.5)	
3.9-5.2	20 (48.8)	8 (57.2)	23 (56.1)	5 (35.7)	28 (50.9)	
≥5.2	7 (17.1)	1 (7.1)	4 (9.8)	4 (28.6)	8 (14.6)	
Dialysis Malnutrition Score (DMS)	11.54±2.08	12.79±2.58	11.59±2.10	12.64±2.59	11.85±2.26	9-18

Data were presented as mean±SD or n (%).
*Independent t-test is significant at $p<0.05$.

Table 3. Mean daily dietary intake among patients according to sex and age (years) (n=55)

Nutrients	*Mean±SD*				*Mean±SD (Range)*
	Male (n=41)	*Female (n=14)*	*Age<60 (n=41)*	*Age≥60 (n=14)*	*Total*
Energy (kcal/kg/day)	21±9	19±5	21±8	20±8	21±8 (6-44)
Protein (g/kg/day)	0.82±0.43	0.64±0.23	0.82±0.43	0.65±0.27	0.77±0.39 (0.13-2.08)
Fluid (ml/day)	979±428	756±85	891±224	1014±667	922±384 (600-3250)
Sodium (mg/day)	2398.7±942.3	1715.1±656.4*	2234.4±882.5	2196.3±1067.8	2224.7±922.9 (1054-4533)
Potassium (mg/day)	1118.3±502.9	926.1±428.2	1129.6±461.4	893.2±539.7	1069.4±488.5 (245-2529)
Phosphate (mg/day)	583.1±222.0	427.4±113.3*	564.0±204.6	483.4±223.7	543.5±210.5 (128-951)
Calcium (mg/day)	1937.8±726.1	1820.4±603.7	2085.8±584.1	1387.1±746*	1907.9±693.5 (64-3408)
Diet	201.2±77.6	148.9±60.0*	198.0±76.5	158.6±71.3	187.9±76.5 (53-371)
Supplement	1763.6±716.2	1671.4±585.0	1887.8±583.2	1228.6±727*	1720.0±680.5 (0-3200)

*Independent-samples t-test is significant at p<0.05.

Table 4. Adequacy of dietary intake among patients according to sex and age (years) (n=55)

Nutrients	*Recommendations*	*Number of patients achieved recommendations, n (%)*				
		Age<60 (n=41)	*Age≥60 (n=14)*	*Male (n=41)*	*Female (n=14)*	*Total (n=55)*
Energy (kcal/kg/day)	35 for age<60† 30-35 for age≥60†	3 (7.3)	1 (7.1)	7 (17.1)	1 (7.1)	8 (14.5)
Protein (g/kg/day)	≥1.1‡	9 (22.0)	0 (0.0)	8 (19.5)	1 (7.1)	9 (16.4)
Fluid (ml/day)	500-750‡	16 (39.0)	5 (35.7)	12 (29.3)	9 (64.3)	21 (38.2)
Sodium (mg/day)	2000-2300‡	4 (9.8)	0 (0.0)	3 (7.3)	1 (7.1)	4 (7.3)
Potassium (mg/day)	1950-2730‡	1 (2.4)	1 (7.1)	2 (4.9)	0 (0.0)	2 (3.6)
Phosphate (mg/day)	800-1000†,‡	3 (7.3)	3 (21.4)	6 (14.6)	0 (0.0)	6 (10.9)
Elemental calcium (mg/day)	<2000†,‡	20 (48.8)	11 (78.6)	22 (53.7)	9 (64.3)	31 (56.4)
Diet	<500	41 (100.0)	14 (100.0)	41 (100.0)	14 (100.0)	55 (100.0)
Supplement	<1500	12 (29.3)	9 (64.3)	17 (41.5)	4 (28.6)	21 (38.2)

†K/DOQI (2000)
‡EBPG (2007)

Table 5. Correlation of Dialysis Malnutrition Score with socio-demographic and clinical backgrounds, anthropometric measurements, biochemical indicators, and dietary intake

Variables	*DMS*	
	r	*P*
Socio-demographic and clinical backgrounds		
Age	0.337	0.012*
Sex	0.189	0.167
Ethnic group	-0.039	0.779
Marital status	0.003	0.980
Educational level	-0.223	0.102
Occupation	-0.007	0.958
Household income	-0.166	0.232
Presence of co-morbidity	0.039	0.777
Number of co-morbidity	-0.041	0.764
Dialysis vintage	0.403	0.002**
Encounter with dietitian	-0.100	0.466
Anthropometric measurements		
Mean BMI	-0.459	0.000**
Mean IDWG (%)	0.037	0.788
Mean MUAC	-0.520	0.000**
Biochemical indicators		
Mean serum albumin	-0.284	0.036*
Mean total cholesterol	-0.127	0.356
Dietary intake		
Dietary energy intake	-0.095	0.491
Dietary protein intake	-0.082	0.552
Fluid intake	-0.103	0.455
Sodium intake	-0.100	0.469
Potassium intake	-0.093	0.499
Calcium intake	-0.187	0.172
Phosphate intake	-0.091	0.509

*Correlation is significant at $p<0.05$.
**Correlation is significant at $p<0.01$.

older age was associated with poorer nutritional status. Longer dialysis vintage had a significant positive moderate impact on DMS (r=0.403, p=0.002). BMI (r=-0.459, $p<0.01$), MUAC (r=-0.520, $p<0.01$) and serum albumin (r=-0.284, p=0.036) were negatively correlated with DMS. There were no significant correlations between DMS and other variables including education level, household family income or dietary intakes.

DISCUSSION

Malnutrition is often associated with mortality risk (Mohammed *et al.*, 2014). Mean DMS of the current study was relatively lower than that reported by other studies (Janardhan *et al.*, 2011; Mohammed *et al.*, 2014), but was comparable with studies in Malaysia (Harvinder *et al.*, 2016; Sahathevan *et al.*, 2015). Mean BMI of the patients was comparable to the national data among dialysis patients as reported in the 22nd National Renal Registry of Malaysia (Abdul Halim *et al.*, 2015). While morbid obesity should be avoided, higher BMI should be maintained among dialysis population, attributed to the "obesity paradox" or "reverse epidemiology", whereby higher BMI is paradoxically associated with better survival in patients with ESRD. This survival advantage of large BMI has been consistently reported for HD patients across regional differences (Cabezas-Rodriguez *et al.*, 2013; Wong & Ong, 2015), including Malaysia (Abdul Halim *et al.*, 2015). The current finding of approximately one in ten of the patients were underweight is similar to that in the national data among dialysis patients (Abdul Halim *et al.*, 2015). Despite BMI being not a sensitive marker, a low BMI is associated with higher mortality risk (Abdul Halim *et al.*, 2015) and PEW (Kanazawa *et al.*, 2017), thus patients with BMI below the desirable range should receive close monitoring. Significant mean BMI differences between sex was expected due to the differences in the body composition (Tang *et al.*, 2013). The findings of this study suggested the needs of nutritional intervention such as comprehensive dietary counselling and renal nutritional supplement to improve the body weight status and muscle mass of the HD patients.

Interdialytic weight gain is a common used index in assessing fluid and dietary compliance among HD population, with increased of IDWG often associated with hypertension, acute pulmonary edema, and congestive heart failure (Bots *et al.*, 2004). This study showed comparable proportions of patients with excessive IDWG, fluid and dietary sodium intakes. These findings are not unexpected as excessive dietary sodium intake will increase thirst, leads to higher fluid intake and excessive IDWG eventually (Fouque *et al.*, 2007). Men and younger patients had poorer fluid compliance, which may be attributed to lower health awareness (Chan, Zalilah & Hii, 2012; Park *et al.*, 2008).

Despite its limitations, serum albumin is commonly used as an objective data to identify malnutrition due to low cost and widely available (Friedman & Fadem, 2010). Mean serum albumin of the patients in this study was higher than the national mean reading (Abdul Halim *et al.*, 2015) indicating lower risk of malnutrition among the patients.

Mean total cholesterol of the patients was relatively low, with approximately one in three patients with hypocholesterolemia, compared to the national data among dialysis patients (Abdul Halim *et al.*, 2015). The lower mean cholesterol level and the high proportion of hypocholesterolemia in this study warrant further investigation.

Mean DPI of the studied patients was far lower when compared to other studies and recommended intake of 1.1 to 1.2 g/kg/day (Cupisti *et al.*, 2010; Fouque *et al.*, 2007; K/DOQI, 2000). Inadequate protein intake was associated with increased mortality (Jadeja & Kher, 2012). Reduced food intake could be affected by loss of appetite (Sahathevan *et al.*, 2015) or nausea when toxins removal by dialysis was inadequate (Cupisti *et al.*, 2010) and dietary restrictions (Fouque *et al.*, 2007).

Lower dietary phosphorus intake may be attributed by the low protein intake as food sources high in protein are generally good sources of phosphorus (Fouque *et al.*, 2007). Low dietary calcium intake among the patients may be due to omission of milk or dairy products, with the intention to control serum phosphorus levels (Cupisti *et al.*, 2010). On the other hand, more than half of the patients had excessive calcium intake from supplements. Various dietary restrictions amongst HD patients aimed at keeping IDWG, serum phosphorus and potassium levels within desirable range may have resulted in limited food choices.

Our findings are in concordance with Chan *et al.* (2012) who found that DMS was positively correlated with age and dialysis vintage. Longer HD treatment was associated with poorer nutritional status as dialysis treatment is a catabolic process. On the other hand, BMI, MUAC, and serum albumin were negatively correlated with DMS, which were in congruence with Kalantar-Zadeh *et al.* (1999), Janardhan *et al.* (2011) and Harvinder *et al.* (2016). However, as BMI does not discriminate between muscle mass and fat mass, we are not able to delineate whether muscle mass or body fat confers the nutritional status advantage in our study.

Studies should investigate further the association between energy or protein intake with DMS. Despite the strong biological plausibility of nutritional interventions to improve health, empirical evidence on their effectiveness or significant correlations with nutrition status in cross sectional studies is lacking (Chen *et al.*, 2013). Possible attributions include day-to-day variations in dietary intake and lack of objective measures of food intakes. The use of one-day food recall in the current study may have also contributed to the lack of significant correlation between DMS and dietary intake in this study.

CONCLUSION

This study revealed overall unsatisfactory dietary intake among the haemodialysis patients, indicating the need for regular individual dietetic counselling and assessment of anthropometric and biochemical status.

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Authors' contributions
Lina Ho LL conceptualized and designed the study, conducted the data collection, analysis and interpretation, and prepared the draft of the manuscript; Chan YM advised on study conceptualization, data analysis and interpretation, and reviewed the manuscript.

Conflict of interest
The authors declare that they have no competing interest.

Glossary of abbreviations
HD – Haemodialysis
SJAM-KPS – St. John Ambulance of Malaysia Kawasan Pantai Selangor
DMS – Dialysis Malnutrition Score
BMI – Body mass index
MUAC – Mid-upper arm circumference
IDWG – Interdialytic weight gain
CKD – Chronic kidney disease
ESRD – End-stage renal disease
PEW – Protein energy wasting
SGA – Subjective Global Assessment
K/DOQI – Kidney Disease Outcomes Quality Initiative
EBPG – European Best Practice Guidelines
ISRNM – International Society of Renal Nutrition and Metabolism
DEI – Dietary energy intake
DPI – Dietary protein intake

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