

EVALUATION OF DIETARY PROTEIN AND PHOSPHATE INTAKE AMONG THE HEMODIALYSIS PATIENTS WITH HYPERPHOSPHATEMIA IN PENANG, MALAYSIA

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ABSTRACT

Objective: High serum phosphate level and malnutrition are among the key factors that elevate the risk of mortality among hemodialysis patients. The objective of this study was to evaluate the total dietary protein and phosphate intake by hemodialysis patients with hyperphosphatemia in Penang state, Malaysia. **Methods:** This was a cross sectional study conducted between September to November 2015 which involved hemodialysis patients from eight dialysis centers in Penang. The inclusion criteria were hemodialysis patients aged more than 18 years old with serum phosphate more than 1.8 mmol/L. Patients' two days' unscheduled diet recall that included one weekday and one weekend diet intake were recorded. **Results:** A total of 117 eligible hemodialysis patients were approached and 98 patients agreed to participate in this study. The mean age of the patients was 52.6±14.1 years. The patients' mean serum phosphate and albumin level were 2.18±0.24 mmol/L and 38.28±3.94 g/L respectively. The mean total dietary calorie intake was 1411.2±248.3 kcal/day. Whereas, the mean dietary protein intake was 43.7±7.6 g/day and phosphate intake were 940.2±150.8 mg/day. **Conclusion:** The dietary calories and protein intake for the hemodialysis patients were relatively low, indicating that the patients were at risk of malnutrition and mortality. The patients' dietary phosphate intake was within the recommended range, but the target serum phosphate level was not achieved.

Keywords: Hemodialysis, Hyperphosphatemia, Dietary protein, Phosphate

INTRODUCTION

The number of hemodialysis patients in Malaysia had increased by more than eleven folds over the past 20 years (Goh *et al.*, 2014). Among these hemodialysis patients, only 15% of them achieved the targeted serum phosphate level of 0.8 - 1.3 mmol/L as recommended by KDIGO guideline (KDIGO CKD-MBD Work Group, 2009). There was only a slight improvement seen in the serum phosphate level of Malaysian hemodialysis patients with the mean of 1.8±0.5 mmol/L in 2005 as compared to 1.7±0.5 mmol/L in 2014 (Goh & Ong, 2015). Generally, high phosphate level which is known as hyperphosphatemia, can lead to high risks of morbidity and mortality among the hemodialysis patients (Hruska *et al.*, 2008). A previous study showed an increase of 6% of mortality rate with only 0.32 mmol/L increase in serum phosphate (Block, 1998).

Besides the phosphate removal from dialysis and the use of phosphate binders, restriction of dietary phosphate also plays a crucial role to control the serum phosphate level among the hemodialysis patients. However, a previous study revealed that dietary restriction of phosphate may lead to poor nutritional status and survival among hemodialysis patients (Arenas *et al.*, 2010). This is because dietary phosphate is usually origins from high protein diet. Hence, hemodialysis patients with restricted dietary phosphate consumption might have insufficient protein intake to prevent malnutrition.

Generally, the hemodialysis patients are recommended to consume dietary protein of 1.2 g/kg body weight/day, which is higher than general population. This poses a major challenge for the successful rate in achieving the target serum phosphate level. In fact, a previous study

conducted showed over half of hemodialysis patients had inadequate dietary protein intake of less than 1.0 g/kg/day (Shinaberger *et al.*, 2006). Despite the low protein intake, many hemodialysis patients had poorly controlled serum phosphate level. Poor adherence to phosphate binders (Chironda & Bhengu, 2016) and hidden phosphate additives in diets (Benini *et al.*, 2011) which were often overlooked by most of the medical practitioners became the challenges in maintaining the hemodialysis patients' target serum phosphate level.

The serum albumin level is an indicator to determine adequate dietary protein intake. According to the 22nd Report of the Malaysian Dialysis and Transplant Registry 2014, the percentage of hemodialysis patients who achieved desirable albumin level of more than 40 g/L had reduced gradually from 56% to 41% between 2005 to 2014 (Goh & Ong, 2015). This finding suggested that the Malaysian hemodialysis patients might have inadequate dietary protein intake. A previous study also showed a strong influence of protein intake with the serum albumin level (Sridhar & Josyula, 2013). Despite having protein intake as an important indicator influencing the serum albumin level, inflammation is another factor contributing to hypoalbuminemia in hemodialysis patients. According to a study conducted by HEMO study group, sustained low serum albumin levels in hemodialysis patients was due to chronic inflammation in the patients (Kaysen *et al.*, 2000).

There was a lack of Malaysian data evaluating the total dietary protein and phosphate intake among hemodialysis patients with hyperphosphatemia. Hence, this study was to evaluate the total dietary protein and phosphate intake by Malaysian hemodialysis patients. This study will gain better insights of the main causes of hyperphosphatemia among the hemodialysis patients and the potential interventions to control their serum phosphate level.

METHODOLOGY

This was a cross sectional study involving hemodialysis patients from eight dialysis centers in Penang state, Malaysia. Permissions to conduct the study was obtained from the Head of Department from Hospital Pulau Pinang, Hospital Seberang Jaya, Hospital Bukit Mertajam, Hospital Balik Pulau, Lion-NKF Dialysis Center, Buddhist Tzu Chi Merit Dialysis Center, Foyi-NKF Hemodialysis Center and Foyi-NKF Unit 2

Hemodialysis Unit. The study was carried out from September 2015 to November 2015.

This study included end stage kidney disease patients age more than 18 years old undergoing routine hemodialysis treatment for at least 4 months prior to this study. The patients must have hyperphosphatemia with serum phosphate level more than 1.8 mmol/L. Patients with major acute disease or psychological disorders were excluded from this study as they might have a significant lower dietary intake which will impact the total protein and phosphate intake.

All data collections were performed by the principal investigator who is a dietitian (the first author). Demographic information including age, gender, ethnicity, date started on dialysis, education level, weight, height, body mass index (BMI), serum phosphate level, and albumin level were collected on the first visit. The patients' two days' unscheduled 24 hours diet recall that included one weekday and one weekend were collected on the second and third visits. As a quick and convenient diet assessment instrument commonly used for research, 24 hours diet recall is a structured interview to capture the foods and beverages consumed by respondents in the past 24 hours, from midnight to midnight, on the day prior to the interview (Ma *et al.*, 2009). The diet recall must be conducted on one weekday and one weekend because studies showed that the intakes were usually higher on weekends than weekdays (Lee & Nieman, 2007).

The principal investigator personally collected face to face diet recall from each patient. Besides the description of the cooking methods, the time and venue of the reported food consumed by each patient were recorded in the recall. The details of snacks in between meals were also collected. The portion size was estimated with the help of visual aids (common household containers such as one bowl, one cup, one tablespoon and one teaspoon) during the diet recall interview. The patients were also asked during the recall if they had consumed their usual diet or retracted diet on the reported recalled day. The purpose of the 24-hour dietary data collection in this study was to estimate the total dietary protein and phosphate intake by the patients.

The data compilation and statistical analysis was performed by SPSS 18.0 for Window (SPSS Inc. Chicago, USA) statistical software package. All the

continuous variable data was presented as percentage, mean and standard deviation. The total dietary protein and phosphate of the foods were calculated using the Nutrient Composition of Malaysia Food Book, 4th Edition (Tee, 1997) by the principle investigator.

The study was approved by the Medical Research & Ethics Committee (MREC), Ministry of Health Malaysia (ethics approval number: NMRR-15-782-25554) in September 2015. Considering ethical issues, verbal agreement to interview participant were done and a written consent form was signed by each participant prior to data collection.

RESULTS

A total of 384 hemodialysis patients were screened from eight dialysis centers. There were 117 hemodialysis patients who fulfilled the inclusion criteria of the study. However, only 98 patients from the 117 eligible hemodialysis patients agreed to participate and were enrolled in the study. There were 40 patients from government hospital dialysis centers and 58 patients from NGO dialysis centers. Majority of the patients had their hemodialysis done in Hospital Pulau Pinang (20.4%) and Foyi-NKF Unit 2 Hemodialysis Unit (20.4%) respectively. A significant number (19.4%) of hemodialysis patients went to Buddhist Tzu Chi Merit Dialysis Center (Table 1).

Table 1: Distribution of hemodialysis patients from the dialysis centers

No.	Dialysis centers	N (%)
Hospital Dialysis Center		
1.	Hospital Pulau Pinang	20 (20.4)
2.	Hospital Seberang Jaya	11 (11.2)
3.	Hospital Bukit Mertajam	5 (5.1)
4.	Hospital Balik Pulau	4 (4.1)
NGO Dialysis Center		
1.	Foyi-NKF Unit 2 Hemodialysis Unit	20 (20.4)
2.	Buddhist Tzu Chi Merit Dialysis Center	19 (19.4)
3.	Foyi-NKF Hemodialysis Center	12 (12.2)
4.	Lion-NKF Dialysis Center	7 (7.1)
	Total	98 (100.0)

The hemodialysis patients were mostly male (68.4%) and were Chinese (70.4%). Monday, Wednesday and

Friday were the most commonly visited dialysis days for the hemodialysis patients (53.1%). Most patients (62.2%) had been on hemodialysis for more than 5 years. A total of 59.2% of the patients had their education up to secondary school level while 60.2% of the patients were unemployed. The patients involved in this study had the mean age of 52.6 ± 14.1 years. The means weight and height of the patients were 60.7 ± 10.8 kg and 1.6 ± 9.0 meter, respectively. Even though the mean body mass index (BMI) was 23.1 ± 3.5 kg/m², minority of the patients were under weight (10.2%); whereas 43.9% and 45.9% respectively of patients were in normal weight and overweight (Table 2).

Table 2: Patients' demographic characteristics

Characteristics	N (%)
Gender	
Male	67 (68.4)
Female	31 (31.6)
Ethnic	
Malay	25 (25.5)
Chinese	69 (70.4)
Others	4 (4.1)
Dialysis Day	
Monday/Wednesday/ Friday	52 (53.1)
Tuesday/Thursday/ Saturday	46 (46.9)
Years of dialysis ^a	
1 to 5 years	37 (37.8)
More than 5 years	61 (62.2)
Education level	
Primary	27 (27.6)
Secondary	58 (59.2)
Diploma or higher	13 (13.2)
Employment status	
Yes	39 (39.8)
No	59 (60.2)
Body Mass Index, BMI (kg/m²)^b	
< 18.5	10 (10.2)
18.5 – 22.9	43 (43.9)
23.0 – 27.4	45 (45.9)

^aThe Mean ± SD for years of dialysis is 6.9 ± 4.2 years

^bThe Mean ± SD for BMI is 23.1 ± 3.5 kg/m²

Considering the biochemical measures, 43.9% of the patients had serum phosphate level more than 2.2 mmol/L. A total of 57.2% patients had serum albumin level less than 40.0 g/L (Table 3).

Table 3 Biochemical measures of the patients

Blood test	N (%)
Serum Phosphate (mmol/L)^a	
1.8 – 2.2	55 (56.1)
≥ 2.2	43 (43.9)
Total	98 (100.0)
Serum Albumin (g/L)^b	
< 30.0	1 (1.0)
30.0 - 34.9	18 (18.4)
35.0 - 39.9	37 (37.8)
≥ 40.0	42 (42.9)
Total	98 (100.0)

^aThe mean ± SD for phosphate level is 2.18 ± 0.24 mmol/L

^bThe mean ± SD for albumin level is 38.28 ± 3.94 g/L

The mean protein intake of the patients was 0.75±0.19 g/kg body weight/day (43.7±7.6 g/day) while the total dietary phosphate intake was 940.2±150.8 mg/day. The mean total calories intake was 24.0± 5.8 kcal/kg body weight/day (1411.2±248.3 kcal/day).

The intake of high phosphate food by the hemodialysis patients during the past one year is illustrated in Table 4.

Table 4: Frequency of patients' high phosphate food intake

Food Item	Number of patients, N (%)					
	2-3 times per day	Once per day	2-4 times per week	2-4 times per month	Few months once	Never
Dairy product	2 (2.0)	6 (6.1)	15 (15.3)	15 (15.3)	40 (40.8)	20 (20.4)
Processed meat	0 (0.0)	0 (0.0)	9 (9.2)	18 (18.4)	39 (39.8)	32 (32.7)
Convenient food	0 (0.0)	5 (5.1)	24 (24.5)	23 (23.5)	35 (35.7)	11 (11.2)
Carbonated soft drinks	0 (0.0)	0 (0.0)	13 (13.3)	17 (17.3)	23 (23.5)	45 (45.9)
Seafood	0 (0.0)	1 (1.0)	15 (15.3)	32 (32.7)	30 (30.6)	20 (20.4)
Ready to bake dough	0 (0.0)	1 (1.0)	23 (23.5)	40 (40.8)	24 (24.5)	10 (10.2)
Biscuits	1 (1.0)	11 (11.2)	54 (55.1)	11 (11.2)	15 (15.3)	6 (6.1)
Breads	5 (5.1)	23 (23.5)	33 (33.7)	22 (22.4)	11 (11.2)	4 (4.1)

From the eight groups of high phosphate foods, the biscuits and breads were mostly consumed by the

patients. A total of 67.3% of the patients consumed biscuits and 62.3% consumed breads for at least 2 to 4 times per week. Besides, dairy products were also commonly consumed by 23.4% of the patients for at least 2 to 4 times weekly. However, there were also several food groups that were never being consumed by most of the hemodialysis patients. A total of 45.9% patients never took carbonated soft drinks such as Coca-Cola® and Pepsi®. This was followed by 32.7% of the patients not consuming processed meats such as hotdog, burger, ham and nugget at all. About 20% of the patients did not consume both dairy products and seafood respectively while approximately 11% of the patients had never consumed convenient food such as instant noodles and premix 3-in-1 coffee powder throughout the past one year.

DISCUSSION

The hemodialysis patients in this study were found to have calorie and protein intake lower than the recommended intakes. The present study finding was consistent with a previous study conducted among 72 hemodialysis patients in Brazil on their nutritional status which also found low mean calories intake of 28±10 kcal/kg/day and protein of 0.9 g/kg/day (Pinto *et al.*, 2009). The lack of sufficient protein and calorie intake among hemodialysis patients will cause malnutrition, eventually leading to higher morbidity and mortality rates (Ikizler & Hakim, 1996). From the diet recall, the average calorie intake of the patients was only 24 kcal/kg of body weight daily. It was relatively low as compared to the recommended intakes by the K/DOQI guideline (35 kcal/kg body weight/day) (National Kidney Foundation, 2000). The same situation happened in the protein intake as well. All patients were found only consuming 0.74 g/kg body weight/day of protein instead of a recommendation of 1.2 g/kg body weight/day (National Kidney Foundation, 2000). Several studies have shown that low protein consumption below 0.9 g/kg body weight/day will impair the survival of the hemodialysis patients. Instead, the highest survival for patients would be if the protein intake is between 1.0 and 1.4 g/kg body weight/day (Fouque *et al.*, 2011).

The hemodialysis patients in this study consumed about 940 mg of dietary phosphate daily which was consistent with a previous Brazilian study reporting the patients'

phosphate intake of 958 ± 374 mg/day (Fouque *et al.*, 2011). The dietary phosphate intake in the present study was within the range as recommended by the K/DOQI guideline, which should be between 800 – 1000 mg/day (adjusted for dietary protein needs) when the serum phosphorus levels are elevated more than 1.78 mmol/L in hemodialysis patients (National Kidney Foundation, 2000). There had been various inconclusive debate about the dietary phosphate restriction or high protein diet would help in reducing the mortality rate in hemodialysis patients (Denomme & Cui, 2013; Karavetian *et al.*, 2014; Karkar, 2012; Waheed *et al.*, 2013). Prescribing low dietary phosphate intake to the patients was learnt not bringing any survival benefit but in fact it might be harmful in long term period (Lynch *et al.*, 2011). Instead, the phosphate restriction may cause protein malnutrition and inadequate caloric intake.

Ordinarily, the serum albumin level acts as one of the predictors for mortality rate in end-stage kidney disease patients that reflects the poor nutrition or malnutrition (Phelan *et al.*, 2008). The mean albumin level of the patients in this study was 38.28 g/dL which indicated poor nutrition. This finding was consistent to the mean serum albumin level that was reported in 22nd Report of the Malaysian Dialysis and Transplant Registry which showed 38.5 g/L among the Malaysian hemodialysis patients in year 2014. Only 41% of the hemodialysis patients in Malaysia achieved the normal albumin level (> 40.0 g/L). The percentage had dropped from 56% to 41% since 2005, showing that the issue of malnutrition is getting worse in Malaysian dialysis patients (Goh & Ong, 2015). Hence, the issue of malnutrition should be addressed promptly as previous studies have shown that serum albumin level less than 40.0 g/L would contrarily and increasingly raise the mortality rate in hemodialysis patients (Lowrie & Lew, 1990; Owen *et al.*, 1993).

As hyperphosphatemia is a common complication faced by hemodialysis patients, restriction of dietary phosphate plays a crucial role in the management of hyperphosphatemia (Cannata-Andia & Rodriguez-Garcia, 2002). Nevertheless, dietary restriction of phosphorus remained as a challenge to provide sufficient protein for malnutrition prevention because foods high in phosphorus are generally high in protein (Fouque *et al.*, 2011). In fact, both hemodialysis treatment and phosphate binders were unable to remove all the dietary phosphate when the patients meet the

requirement for calories and protein intake (González-Parra *et al.*, 2012). Examples of foods or beverages that contain high amounts of phosphorus include meats, dairy products, dried beans, nuts, colas, peanut butter, and beer. Hemodialysis patients require a higher protein intake (1.2 g/kg/day) (National Kidney Foundation, 2000), making restriction of phosphorus even more challenging. Most patients in this study rarely consumed fast food, carbonated soft drink, and processed meats like hotdog, burger, ham or nuggets. However, the high phosphate food that were most frequently consumed by the hemodialysis patients were biscuits, breads, and convenient foods such as canned food, instant noodles and premix 3-in-1 coffee powder (contains coffee powder, creamer and sugar). Hemodialysis patients are more prone to consume convenient foods as these foods were easily accessible and cheaper than fresh and unprocessed healthy foods.

Currently, processed foods available in the market were often underestimated of their phosphate contents due to the addition of phosphate additive during the food processing. A previous study involving advanced kidney disease patients suggested that food additive found in most processed meat products might lead to higher serum phosphate level (Moe *et al.*, 2011). The identification of the food additives remained as a challenge as the manufacturers did not require to list down the types and amount of phosphate salt used on the food label (Gutiérrez & Wolf, 2010). For instance, similar cream crackers might have different types and amount of phosphate additive added depending on the formulating processes by the manufacturers. Product food labels with small prints containing an initial “E” followed by a number which serves as a code to distinguish food additives are often unnoticed by consumers. The E-Numbers are used to identify the phosphate substances found in specific food additives used by the food industry. The maximum permitted level of phosphates is ranged from 1000 mg to 50,000 mg/kg in foods (European Food Safety Authority, 2013). Besides, some phosphate additives were only declared as “natural flavors” or “preservative” on the food label without identifying the additives. Therefore, these phosphate additives consumed by the patients could prevent them from achieving the target phosphate level even with less protein intake.

Generally, the phosphate additive in food has the highest

bioavailability (80% - 100%) as compared to naturally present phosphate in the animal protein (40 - 60%) and plant protein (20 - 40%) rich food which is present in organic form. Organic phosphate in animal protein like poultry, fish, meat, and dairy products need to be hydrolyzed in the intestinal to transform into readily absorbable inorganic phosphate, leading to only 40-60% of the phosphate is absorbed by the intestinal (Noori *et al.*, 2010). Meanwhile, plant proteins like grains, seeds, nuts, and legumes are mostly in the form of phytic acid or phytate. It is hardly split in the intestinal due to the lack of phytate enzyme in human body (Kalantar-Zadeh *et al.*, 2010). Thus, despite the actual phosphate contents is high in plant protein, the lower rate of absorption has resulted less likely high phosphate burden compare to animal protein. A previous study revealed that taking more grain vegetarian diet gave better protein intake without affecting the phosphate level compared to meat diet (Moe *et al.*, 2011).

The issue of hyperphosphatemia among hemodialysis patients can be controlled by several approaches. One of the crucial ways is to avoid consuming the processed foods that contain high phosphate (Moe *et al.*, 2011). Instead, more grains vegetarian diet should be consumed to aid increase protein intake without adversely affecting the phosphate level. Besides, nutritional supplements which is high in calories and protein but low in phosphate should be recommended to the dialysis patients for achieving better nutritional status (Wolfson, 1999). Another strategy is to provide patient education on understanding the food labels to identify the content of phosphate additives. Additionally, manufacturers also play a vital role in implementing proper food labelling on phosphate additives.

CONCLUSION

The dietary calories and protein intake for the hemodialysis patients were relatively low as compared to recommended intakes. This insufficiency might pose higher risk of malnutrition and mortality among the patients. Even though the dietary phosphate intake among the hemodialysis patients was within the recommended range, the serum phosphate level was uncontrolled. Clinicians and other clinical team members should be aware of the nutritional care provision for hemodialysis patients to improve their health outcomes.

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