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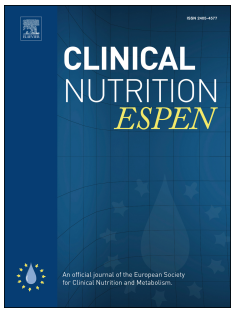

Phosphorus nutritional knowledge among dialysis health care providers and patients: a multicenter observational study

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Phosphorus nutritional knowledge among dialysis health care providers and patients: a multicenter observational study

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ABSTRACT

Background - Aims: Phosphorus nutritional knowledge level of hemodialysis patients and renal nurses has been found to be low, while respective knowledge of nephrologists has not been studied yet. There are equivocal results regarding the association of phosphorus nutritional knowledge level and serum phosphorus values. The aim of this study was to assess phosphorus nutritional knowledge of hemodialysis patients, nephrologists and renal nurses and seek potential interventions to improve patients' adherence to phosphorus and overall nutritional guidelines.

Methods:

This cross-sectional observational study was conducted on sixty eight hemodialysis patients, 19 renal nurses and 11 nephrologists who were recruited from 3 hemodialysis units in Greece. Phosphorus nutritional knowledge of the participants was assessed by a 25-item item questionnaire (CKDKAT–N) which included 15 questions on phosphorus and 10 questions on protein, sodium, and potassium knowledge.

Results: Nephrologists had higher CKDKAT–N total (19.1 ± 3.6 vs 14.1 ± 2.8 and 13.2± 2.8, $P<0.01$) and phosphorus knowledge scores (10.6 ± 2.7 vs 7.6 ± 2.2 and 7.3 ± 2.0, $P<0.01$) compared to renal nurses and patients respectively. There were no differences in total and phosphorus knowledge scores between nurses and patients. Patients and nurses answered correctly significantly less questions regarding phosphorus compared with the rest of the questions ($P<0.01$) while no such difference was found in nephrologists. Serum phosphorus was positively correlated with phosphorus knowledge score ($r=0.31$, $P=0.02$), and negatively correlated with patient age ($r=-0.34$, $P<0.05$). None of the

patients, 11% of the nurses and 27% of the nephrologists answered correctly all three questions regarding P, K and Na dietary recommendations (P<0.01).

Conclusions: The study confirms that hemodialysis patients have low renal nutrition knowledge while higher nutritional phosphorus knowledge does not lead to lower serum phosphorus values. Alarmingly, renal nurses have been found to have a similar level of knowledge with hemodialysis patients, something that needs to be taken into account when training the new dialysis staff. Nephrologists have superior knowledge; however they are still lacking essential nutritional knowledge that could affect patients' and nurses' overall understanding. Continuing education on nutrition of nephrologists and renal nurses could improve nutrition care of hemodialysis patients.

Key words: phosphorus knowledge, hemodialysis, nephrologists, renal nutrition

INTRODUCTION

Hyperphosphatemia is a significant and frequent problem in hemodialysis patients (1, 2). In this population, increased phosphorus levels are considered an important risk factor for cardiovascular disease (3, 4) and one of the major components of chronic kidney disease, mineral and bone disorder (5).

Even though, during a typical hemodialysis session, 600 - 1200 mg phosphorus can be removed (6) and phosphate binding medication is able to bind approximately 200–300 mg of phosphorus per day (7), hemodialysis patients need to monitor and control their dietary phosphorus intake in order to achieve target serum phosphorus levels (8). Dietary phosphorus intake has been shown to range from 1000 - 1800 mg depending on diet, cooking methods and the consumption of foods with additives or not (9-11).

Apart from phosphorus, hemodialysis patients are asked to conform to multiple dietary restrictions regarding energy, protein, fluid, sodium, potassium and calcium (12, 13). Due to the complexity of dietary advice the majority of the patients are having difficulties in understanding, applying and adhering in the long term (14, 15).

In studies investigating hemodialysis patients' nutritional knowledge, it has been found that patients can not easily identify foods that are high and low in phosphorus (16-18), and that knowledge of phosphorus is the lowest compared to knowledge of other nutrients important for the management of end stage renal disease (sodium, potassium and fluid) (16, 19, 20).

Nephrologists and renal dietitians (where available) are the main sources of dietary information for dialysis patients. Apart from them, renal nurses are the ones closest to the patients and can provide appropriate suggestions, advice, or recommendations (20) while

106 their role is deemed essential to identify and reinforce each component of optimal care
107 (13). Nutritional knowledge of renal nurses has been found to be superior to that of the
108 patients', but phosphorus knowledge is poor (20). Nephrologists' dietary phosphorus
109 knowledge level has not been yet assessed and reported.
110 The purpose of the current study was to assess nutritional knowledge, with a special focus
111 in phosphorus, of hemodialysis patients, nephrologists and renal nurses.
112

113 **MATERIALS AND METHODS**

114 **Participants**

115 Data were collected from 3 hemodialysis units in Greece (2 university hospitals and 1
116 general hospital). The study included patients receiving hemodialysis 3 times a week for
117 more than 3 months (46 male, 22 female), hemodialysis unit renal nurses (working in the
118 hemodialysis units for more than 6 months), and unit nephrologists. Serum phosphorus,
119 calcium data and albumin data were obtained from patients' last 3 recorded analyses
120 closer to the day of the study. A 3 month average value of serum phosphorus and calcium
121 was calculated for each patient. Nutritional status of the patients was assessed using
122 Subjective Global Assessment (21).
123 All patients had received general guidelines regarding diet in dialysis by the unit
124 nephrologists. None of the units was regularly covered by a renal dietitian. The study was
125 approved by all of the three hospitals ethics committees.
126

127 **Nutritional knowledge level evaluation**

Nutritional knowledge was evaluated using a previously published 25 item multiple - choice questionnaire, which includes 15 questions concerning phosphorus and 10 questions concerning protein, sodium, and potassium (CKDKAT–N) (19). Each correct answer was worth one point. Apart from total score, knowledge scores for phosphorus and the other nutrients were calculated.

The questionnaire was administrated by interview by a qualified clinical dietitian (ZP). In 3 questions which included foods not usually consumed in Greece, items were replaced with Greek foods with the same nutrient profile using Greek food composition tables (22) as suggested by the clinical dietitian.

STATISTICAL ANALYSIS

One way analysis of variance (ANOVA) was used to compare differences of the independent variables among groups. Tukey HSD test was used for post hoc analysis. The Pearson correlation coefficient was used to assess the relationship between the examined variables. Data are presented as mean ± standard deviation and the significance was set at $p \leq 0.05$. Data was analyzed using the SPSS Statistical Package version 22.

RESULTS

Eighty eight patients, 32 nurses and 24 nephrologists initially agreed to be interviewed, however, complete data was obtained only from 68 patients (77.3%), 19 renal nurses (59.4%) and 11 nephrologists (45.8%) due to availability reasons.

Patient characteristics are shown in Table 1. According to SGA, 72.1% of the patients were classified as well nourished (SGA-A), 26.5% as moderately malnourished (SGA-B) and 1.5% (1 patient) as severely malnourished (SGA-C).

Patient, nurse and nephrologists' total, phosphorus, and the sum of sodium, potassium and protein (rest section) CKDKAT–N knowledge scores are shown in Table 2. Patients and nurses answered correctly a greater percentage of questions related to sodium, potassium and protein than those referred to phosphorus ($P<0.01$ for both groups) (Figure 1). There were no differences between the percentage of correct answers to phosphorus and the rest section of CKDKAT-N for the unit nephrologists (73 ±16%, 75±18% respectively). Correlation coefficients for total and phosphorus knowledge scores in all three groups of participants (patients, nurses and doctors) are shown in Table 3.

In patients, total knowledge score (max 25) and phosphorus knowledge score (max 15) ranged from 6 (N=1) to 18 (N=1) and 2 (N=1) to 12 (N=1) respectively. Sixty nine percent (69%) of the patients answered correctly more than half of all the questions, whereas no patient had a total score >20. In renal nurses, total and phosphorus knowledge scores ranged from 6 (N=1) to 17 (N=4) and 1 (N=1) to12 (N=1) respectively. Seventy four percent (74%) of the nurses answered correctly more than half of the CKDKAT–N questions, whereas no one had a total score >20. In nephrologists, total and phosphorus knowledge scores ranged from 12 (N=1) to 25 (N=1) and 7 (N–1) to 15 (N=1) respectively, and 36% of the doctors had a total CKDKAT–N score >20.

In patients there were no differences in any of the measured or calculated variables between sexes, and the only significant difference in knowledge scores between different hemodialysis units was that Unit 3 patients had significantly higher CKDKAT–N

phosphorus knowledge scores compared with Unit 1 and 2 patients (8.2 ± 1.5 vs 6.7 ± 2.1, respectively, P<0.02).

Patient age ranged from 18.8 to 79.9 yrs, and hemodialysis duration ranged from 0.3 to 27 yrs. When patients were categorized according to age (<40 yrs, 40–60 yrs and ≥60 yrs), the ones in the middle category (40–60 yrs) had significant higher total knowledge scores compared with patients ≥ 60 yrs (P<0.05), and higher phosphorus knowledge scores compared with both the other groups (P<0.05). Total knowledge scores were: 14.2 ± 2.1, 15.0 ± 2.7, 12.7 ± 3.0, and phosphorus scores: 7.6 ± 1.4, 7.8±1.9 and 6.3 ±2.1 for patients < 40, 40–60 and ≥ 60 yrs respectively. There were no significant correlations between duration of dialysis and total or phosphorus knowledge scores.

Thirty nine percent of the patients for whom serum phosphorus values were available had levels above 5.5 mg/dL.

Serum phosphorus was positively correlated with phosphorus knowledge score (r = 0.31, P = 0.02), and negatively correlated with patient age (r=−0.34, P<0.05). Patients with serum phosphorus >5.5 mg/dL tended to have higher phosphorus CKDKAT–N knowledge scores compared to those with serum phosphorus ≤ 5.5 mg/dL (8.1 ± 1.3 vs 7.0 ± 2.2 mg/dL, P=0.61).

Even though none of the patients had a serum albumin value below 3.6 mg/dL, there was a significant difference in serum albumin values between patient age groups (P<0.05), with patients aged ≥60 yrs having significantly lower serum albumin compared to the patients aged 40–60 yrs (4.1 ± 0.3 mg/dL vs 4.3 ± 0.25 mg/dL respectively, P<0.05).

There were no significant correlations between SGA nutritional status classification and albumin, and serum phosphorus and SGA or albumin.

DISCUSSION

This is the first study to assess renal nutrition knowledge among hemodialysis patients, nephrologists and renal nurses. The findings of the current study reveal that for the current cohort of participants, hemodialysis patients' renal nutritional knowledge level is low, while phosphorus knowledge is much lower compared to sodium, potassium and protein knowledge overall. This was also the case for renal nurses, whose total and phosphorus knowledge scores did not differ from the respective patients' scores. Nephrologists, as expected, had superior nutritional knowledge compared to both patients and nurses, but they had a wide range of total and phosphorus knowledge scores, and most of them could not accurately identify the dietary recommendations for hemodialysis patients regarding sodium, potassium and phosphorus (5).

Our results for the hemodialysis patients' phosphorus nutritional knowledge are in agreement with the results from the two previous studies that used the CKDKAT-N questionnaire (Figure 1) (19, 20). Similarly, other studies in which other questionnaires were used in order to evaluate nutritional knowledge, have also confirmed that hemodialysis patients' phosphorus nutritional knowledge is low. In one study, 74% of the patients failed to identify foods rich in phosphorus (16), whereas in the study of Durose et al, the mean patient score for knowledge of phosphorus dietary restrictions and medical complications of noncompliance with dietary guidelines was found to be low (53.4%) (18).

Renal nurses' total and phosphorus scores were similar, albeit a little lower with the ones found by previous studies (20).

Based to the findings of the current study, it seems that the phosphorus-related knowledge score is lower that the respective score related to potassium, sodium and protein. This may be due to the fact that phosphorus is widely spread in nature and foods, and is ingested both as a natural component and as a food additive (7, 11, 23, 24). In addition, the recommendations for higher protein intake are often difficult to dissociate from recommendations for low phosphorus intake, since dietary phosphate restriction has the potential to compromise adequate intake of protein (25-27).

In our study the positive correlation between phosphorus nutritional knowledge and serum phosphorus levels adds to the argument that dietary knowledge seems to help to affect serum phosphorus levels only when patients are ready to make nutrition changes and to follow dietary advice (23). Similarly to our results, other studies have reported that better knowledge does not always translate to better adherence to dietary advice and recommended serum phosphate levels (20, 24). Moreover, other studies have found that the hemodialysis patients with higher level of phosphorus food content knowledge and those who exhibit high serum phosphorus complications are the ones with the poorest compliance (18, 24).

Another argument for the disagreement of phosphorus nutritional knowledge and serum phosphorus levels might arise from the fact that our results, and that of others, show that older patients seem to have lower serum phosphorus despite worse phosphorus nutritional knowledge (17, 24). However, since serum phosphorus levels have been found to be highly correlated with dietary protein intake (26, 27), low serum phosphorus in older patients might not be affected so much by phosphorus knowledge as from lower protein intake. Our results showing that patients in the older age group had significantly lower

albumin compared to younger patient add to that argument, since albumin has been found to be one of the determinants of serum albumin in hemodialysis patients (28).

However, as shown by a number of studies, educating hemodialysis patients about phosphorus can lead to a decrement in serum phosphorus levels (16, 23, 29-36). In a review and meta-analysis of studies using different educational strategies to reduce serum phosphorus in dialysis patients it is concluded that any educational intervention results in a 0.72 mg/dL reduction in serum phosphorus; and that the reduction increases to 1.07 mg/dL when educational interventions last over 4 months (35). This could be of significant importance for patients, since it has been found that 1 mg/dL increase in serum phosphorus increases mortality by 5-8% in this patient population (37, 38).

A closer look to the individual CKDKAT-N answers revealed that the weakest point in nephrologists nutritional knowledge was phosphorus food content, since less than 50% of nephrologists answered correctly 5 from the 9 questions regarding foods high and low in phosphorus (range of correct answers 18 – 45% in these 5 questions). Renal dietitians are the most qualified health care professionals to provide nutritional education for hemodialysis patients, however in Europe, renal dietitians' presence is not compulsory in hemodialysis units (39). The burden and responsibility of patient nutritional education falls to nephrologists, even though renal nurses could play an important role due to their proximity to the patients. It is important to point out that clinical nutrition modules are not part of every medical or nursing school curricula, and when they are available they are frequently described as inadequate (40). We have recently reported that from the 7 medical schools in Greece only one includes a nutrition course as compulsory, 3 as elective and the rest do not include a nutrition course in their undergraduate curricula

(41). Data from the U.S.A. have also reported that even though the majority of nephrology trainees perceive nutrition training as somewhat or very important, more than 50% of them perceive their nutrition training as inadequate (42).

As far as Greek nursing schools are concerned, 20% do not include a nutrition course, 40% include it as elective and only 40% as a compulsory course in their undergraduate curricula (41). Also, in Greece there is no specialization in renal nursing and in order to be considered a specialized renal nurse one has to have practical training in hemodialysis units for at least 6 months whereas no theoretical courses are required. This could change in the following years since a postgraduate course in renal patient care led by one of the researchers of the study which is mainly addressed to nurses has recently commenced.

This was the first study to assess nephrologists' along with renal nurses' and hemodialysis patients' renal nutrition knowledge. Our results are limited by the small number of participants and would require larger scale studies to be further confirmed. We could not perform correlation analysis between patient and nephrologists' knowledge scores due to the small number of nephrologists completing the CKDKAT-N questionnaire, however the better phosphorus knowledge scores of the patients of Unit 3 could be partially attributed to the higher total and phosphorus knowledge scores of the nephrologists of the same unit compared with Unit 1 counterparts (21.4 and 12.4 vs 17 and 8.8 respectively).

Low level of phosphorus knowledge among hemodialysis health care staff, could negative affect patients adherence to phosphorus guidelines and jeopardize their overall health. Renal dietitians should be a part of every hemodialysis unit or at least routinely visit units for nutritional assessments and patient training. Along with dietitians,

nephrologists and nurses should take part in continuing education programs on nutrition in order to better care for patients dealing with one of the most deliberating diseases.

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Statement of Authorship

ZP acquired data, did data analysis, drafted the first version and finalized the final version. MM designed the study, facilitated data collection, did data analysis, reviewed various drafts and finalized the final draft; CDG designed the study, acquired data, did data analysis, reviewed and finalized the final version. CK designed the study, supervised ZP for data analysis, reviewed various versions and finalized the final version. VL facilitated data collection, participated in data analysis, reviewed various versions and finalized the final version. TE facilitated data collection, participated in data analysis, reviewed various versions and finalized the final draft. IS designed the study, acquired ethical approval, supervised data analysis and finalized the final draft; GKS designed the study, supervised ZP for data analysis, reviewed the various versions and finalized the final version

The manuscript has been read and its submission has been approved by all co –authors

Conflict of Interest

The authors declare to have no conflicts of interest related to this manuscript.

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309

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435

436 **FIGURE LEGENDS**

437 **Figure 1**. Percentage of correct answers to questions regarding the knowledge of
438 phosphorus and other nutrients for hemodialysis patients and renal nurses in all tree
439 studies using CKDKAT-N questionnaire (Data from Pollock and Jaffery (2007) and
440 Cupisti et al (2012) extrapolated from text and graphs. No standard deviations are
441 provided in the Pollock and Jaffery (2007) study regarding phosphorus and sodium,
442 potassium and protein knowledge scores.

443

444 **Table 1. Patient characteristics**

	Unit 1	Unit 2	Unit 3	Total
Age, yrs (N=68)	54.8 ± 13.2	55.4 ± 13.8	48.3 ± 15.4	52.5 ± 14.4
Dry weight, kg (N=68)	68.0 ± 12.1	73.0 ± 11.5	69.2 ± 12.0	69.9 ± 11.9
BMI (N=68)	24.4 ± 4.1	24.3 ± 4.1	24.3 ± 4.2	24.4 ± 4.1
Years in hemodialysis, yrs (N=68)	7.9 ± 6.8**	3.5 ± 2.5	6.6 ± 6.1*	6.2 ± 5.8
Serum albumin, g/dL (N=68)	4.1 ± 0.3**	4.1 ± 0.3*	4.4 ± 0.2	4.2 ± 0.3
Serum phosphorus, mg/dL, (N= 49)	5.2. ± 1.5	–	5.6. ± 1.4	5.4. ± 1.5
Ca x P, mg^2/dL^2, (N= 49)	49.2 ± 14.6	–	50.1 ± 12.2	49.7 ± 13.2

445 * P<0.05, ** P<0.01

446 Data are presented as mean ± SD.

447 Abbreviations: BMI: Body mass index, Ca x P: Calcium x phosphorus product.

448

449 **Table 2. Nutrition knowledge scores according to CKDKAT–N**

	Patients	Renal nurses	Nephrologists
N	68	19	11
Total score (max=25)	13.2 ± 2.8 **	14.1 ± 2.8**	19.1 ± 3.6
Phosphorus score (max=15)	7.3 ± 2.0**	7.6 ± 2.2**	10.6 ± 2.7
Rest score (max=10)	6.0 ± 1.4**	6.4 ± 1.5**	8.5 ± 1.6
Sodium questions score (max=6)	4.2 ± 1.0**	4.3 ± 0.9 *	5.3 ± 0.9
Protein questions score (max= 2)	0.7 ± 0.5**†	1.2 ± 0.8*	1.7 ± 0.5
Potassium questions score (max=2)	1.1 ± 0.6	0.9 ± 0.7	1.5 ± 0.7
% correct answers in dietary K recommendations question	31%	42%	55%
% correct answers in dietary Na recommendations question	25%**	47%	73%
% of correct answers in dietary P recommendations question	31%*	37%	73%
% of correct answers in all three K, Na and P dietary recommendations questions	0%**	11%**	27%
% of false answers in all three dietary K, Na, and P recommendations questions	28%**	26%**	0%
% of correct answers in desired serum phosphorus level question	72%	63%	100%

450 * P<0.05 from Nephrologists, **P<0.01 from Nephrologists, † P<0.01 from Renal nurses

451 Data are presented as mean ± SD.

452

453 **Table 3. Pearson correlation coefficients for total, phosphorus and rest nutritional knowledge scores in hemodialysis patients,**

454 **renal nurses and nephrologists**

	N	Total vs Phosphorus	Phosphorus vs Rest
Patients	68	0.868*	0.33*
Renal nurses	19	0.86*	non significant
Nephrologists	11	0.97*	0.85*
All	98	0.91*	0.49*

455 *P<0.01

456 Data are presented as mean ± SD.

Statement of Authorship

ZP acquired data, did data analysis, drafted the first version and finalized the final version. MM designed the study, facilitated data collection, did data analysis, reviewed various drafts and finalized the final draft. CDG designed the study, acquired data, did data analysis, reviewed and finalized the final version. CK designed the study, supervised ZP for data analysis, reviewed various versions and finalized the final version. VL facilitated data collection, participated in data analysis, reviewed various versions and finalized the final version. TE facilitated data collection, participated in data analysis, reviewed various versions and finalized the final draft. IS designed the study, acquired ethical approval, supervised data analysis and finalized the final draft. GKS designed the study, supervised ZP for data analysis, reviewed the various versions and finalized the final version.

The manuscript has been read and its submission has been approved by all co – authors