Factors Associated with Phosphate Binder Adherence among Patients Undergoing Hemodialysis in China*

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Abstract

Purpose: To study factors associated with phosphate binder adherence among patients undergoing hemodialysis in China.

Design: Correlational predictive study.

Methods: A total of 158 participants receiving hemodialysis at two hemodialysis centers under a university in China were recruited via convenience sampling. Data were collected using Chinese version of modified Medication Adherence Report Scale (MARS), modified Beliefs about Medicines Questionnaire (BMQ), modified Health Care Climate (HCC) Scale, and Phosphate Binder Knowledge Test (PBKT). Descriptive statistics, Mann-Whitney U test, Chi-square test, and binary logistic regression were applied for statistical analysis. Main findings: Results indicated that 54.4% of the participants did not adhere to phosphate binders. In binary logistic regression, participants with higher knowledge about phosphate binder (OR = 10.73, 95%CI = 3.84, 29.97), higher beliefs about necessity of phosphate binders (OR = 1.23, 95%CI = 1.09, 1.39), and lower concerns about phosphate binders (OR = .88, 95%CI = .79, .98) had better phosphate binder adherence.

Conclusion and recommendations: Phosphate binder adherence was poor in patients undergoing hemodialysis in China. Knowledge and beliefs about phosphate binders are crucial in improving patients' phosphate binder adherence. Health care providers should provide efficient interventions enhancing knowledge and positive beliefs about phosphate binders in hemodialysis patients.

Keywords: China, knowledge, medication adherence, phosphates, renal dialysis

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ปัจจัยที่เกี่ยวข้องกับความร่วมมือในการรับประทานยาจับฟอสเฟตในผู้ป่วยที่ได้รับการฟอกเลือดด้วยเครื่องไตเทียมในประเทศจีน*

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บทคัดย่อ

วัตถุประสงค์: เพื่อศึกษาปัจจัยที่เกี่ยวข้องกับความร่วมมือในการรับประทานยาจับฟอสเฟตในผู้ป่วยที่ได้รับการฟอกเลือดด้วยเครื่องไตเทียมในประเทศจีน

รูปแบบการวิจัย: การศึกษาความสัมพันธ์เชิงทำนาย

วิธีดำเนินการวิจัย: กลุ่มตัวอย่างจำนวน 158 ราย ที่ได้รับการฟอกเลือดที่ศูนย์ฟอกเลือดด้วยเครื่องไตเทียม 2 แห่ง ภายใต้มหาวิทยาลัยแห่งหนึ่งในประเทศจีน เข้าร่วมการวิจัยโดยวิธีการคัดเลือกกลุ่มตัวอย่างแบบสะดวก เก็บรวบรวมข้อมูลโดยใช้แบบสอบถามฉบับภาษาจีน ได้แก่ 1) แบบสอบถามความร่วมมือในการรับประทานยา 2) แบบสอบถามความเชื่อเกี่ยวกับการรับประทานยา 3) แบบสอบถามบรรยากาศการดูแลสุขภาพ ฉบับปรับปรุง และ 4) แบบสอบถามความรู้เกี่ยวกับยาจับฟอสเฟต วิเคราะห์ข้อมูลโดยใช้สถิติพรรณนา สถิติทดสอบแมน-วิทนีย์ ยู ไคสแควร์ และการวิเคราะห์ถดถอยโลจิสติกแบบไบนารี

ผลการวิจัย: กลุ่มตัวอย่างร้อยละ 54.4 ขาดความร่วมมือในการรับประทานยาจับฟอสเฟต ผลการวิเคราะห์ถดถอยโลจิสติก พบว่ากลุ่มตัวอย่างที่มีความรู้เกี่ยวกับยาจับฟอสเฟตดี (OR = 10.73, 95%CI = 3.84, 29.97) มีความเชื่อเกี่ยวกับความจำเป็นในการรับประทานยาสูง (OR = 1.23, 95%CI = 1.09, 1.39) และมีความกังวลเกี่ยวกับการรับประทานยาน้อย (OR = .88, 95%CI = .79, .98) มีความร่วมมือในการรับประทานยาจับฟอสเฟตดี

สรุปและข้อเสนอแนะ: ผู้ป่วยที่ได้รับการฟอกเลือดด้วยเครื่องไตเทียมในประเทศจีนมีความร่วมมือในการรับประทานยาจับฟอสเฟตน้อย ความรู้และความเชื่อเกี่ยวกับยาจับฟอสเฟตมีความสำคัญในการส่งเสริมความร่วมมือในการรับประทานยาของผู้ป่วย บุคลากรสุขภาพควรเพิ่มความรู้และส่งเสริมความเชื่อทางบวกเกี่ยวกับยาจับฟอสเฟตด้วยวิธีที่มีประสิทธิภาพแก่ผู้ป่วยที่ฟอกเลือดด้วยเครื่องไตเทียม

คำสำคัญ: ประเทศจีน ความรู้ ความร่วมมือในการรับประทานยา ฟอสเฟต การฟอกเลือด

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Background and Significance

Hyperphosphatemia is the most prevalent condition in patients with late stage of chronic kidney disease and is associated with increased risk of vascular, valvular, and other soft tissue calcification, leading to cardiovascular diseases and increased death rate.[1] Hyperphosphatemia in kidney failure patients can be relieved by hemodialysis (HD) and dietary phosphate restriction; however, HD is not sufficient to eliminate phosphorus intake from dietary,[2] and dietary phosphate restriction limiting the intake of protein, results in malnutrition. Therefore, phosphate binders, which combine phosphate in the gastrointestinal tract to prevent absorption, are regularly prescribed to control hyperphosphatemia in HD patients.[1] Although phosphate binders are critical for controlling serum phosphate levels, poor adherence to phosphate binders has been commonly found among HD patients.[3-6] In China, 65% of HD patients reported nonadherence to phosphate binders.[7]

HD patients are usually confronting complex treatment regimens and unique intake pattern (during meals) of phosphate binders. World Health Organization (WHO)[8] thus investigated a variety of associated factors and developed the Multidimensional Adherence Model (MAM) to further understand medication adherence, categorizing factors into five dimensions: social and economic factors, therapy-related factors, patient-related factors, condition-factors, and health care team- and health system-related factors.[8]

Social and economic factors include socio-demographic factors and other factors, such as medication cost. According to a systematic review, medication cost was one of the barriers of medication adherence in HD patients.[3] In China, 12.2% of Chinese HD patients concerned about the cost of phosphate binder.[7] Cost-related factors, such as drug coverage by insurance[3] and medication insurance,[9] were also reported to affect phosphate binder adherence. However, few studies have focused on investigating the direct influence of medication cost of phosphate binder on phosphate binder adherence in HD patients.

Therapy-related factors consist of such factors as the duration, failure, or changes of treatment. The influence of duration of hemodialysis on phosphate binder adherence was found rather controversial in previous research. It was found that longer duration of hemodialysis was related to poorer medication adherence,[6-10] while some studies reported better phosphate binder adherence.[11-12] Even other studies reported no association between duration of hemodialysis and phosphate binder adherence.[3-4]

Patient-related factors refer to patients' resources, knowledge, attitudes, beliefs, perceptions and expectations of their diseases. Insufficient knowledge about indications, effects and side effects of medications could have negatively association

with medication adherence in patients with chronic kidney disease.[13] However, knowledge about phosphate binders was reported to be inconsistently correlated with phosphate binder adherence in systematic reviews.[3-4,6] Although 60% of HD patients in China were revealed lacking knowledge about phosphate binders,[14] no study has been found to assess their association in the Chinese context. Furthermore, adherence behaviors are suggested to be affected by beliefs about necessity of a medicine for improving or maintaining one's health, as well as concerns about the potential consequences of a medication.[15] Beliefs about phosphate binders, including necessity and concerns, have been reported association with phosphate binder adherence in various studies.[4,6,15-18] Higher level of beliefs about necessity of phosphate binders were related to adherence to phosphate binders, while concerns were associated with nonadherence. However, those studies were not conducted in the Chinese context, where medication beliefs could be different due to a distinctive culture.

Condition-related factors, such as comorbidity, could influence adherence by shaping patients' perception of risk, treatment importance, and adherence priority. Comorbidity is a condition with paradoxical research findings about its correlation with phosphate binder adherence. A significant correlation with self-reported adherence to phosphate binders was reported,[3] while two other studies revealed noncorrelation.[11-19] In addition, little is known about their relation in Chinese patients undergoing HD.

Health care team and system-related factors include health service, health insurance, and support from health care providers. Perceived autonomy support from health care providers refers to HD patients' perception regarding health care providers' support in deciding phosphate binder use. Patients with chronic kidney diseases expressed autonomy in medication intake rather than delegate medication decisions.[13] A systematic review found a significant relationship between support from health care providers and medication adherence.[3] However, only one study directly addressed autonomy support from health care providers and reported positive association with phosphate binder adherence.[20]

To fulfill the gap of knowledge and to develop effective interventions, further research is therefore expected to understand the factors associated with adherence to phosphate binders among population in China. Informed by the MAM, the purpose of this study was then to examine the relations between phosphate binder adherence and selected factors in each dimension of the model, including medication cost, comorbidity, duration of hemodialysis, knowledge about phosphate binders, beliefs about phosphate binders (necessity and concerns), and perceived autonomy support from health care providers.

Objectives

To examine whether such factors as medication cost, comorbidity, duration of hemodialysis, knowledge about phosphate binders, beliefs about phosphate binders (necessity and concerns), and perceived autonomy support from health care providers are associated with phosphate binder adherence among patients undergoing HD in China.

Methodology

This study was a correlational predictive study, which is used to identify the direction and magnitude of the predictive relationship between predictors and the outcome variable.

Population and Sample

This study was conducted with convenience sampling method to recruit Chinese patients, both male and female, undergoing HD and taking phosphate binders for at least three months. Eligible participants were those who were 18 years old and above and came to receive HD at the two HD centers from two tertiary hospitals under a medical university in Changchun, China. However, those patients with severe conditions such as heart failure functional class IV, diagnosed with mental illness, and aged over 60 years old with cognitive impairment were excluded. Cognitive impairment was screened by using the General Practitioner Assessment of Cognition (GPCOG)-Chinese version. The sample size in this study was calculated by using G-Power 3.1.9.2,[20] with an odds ratio of 1.95 derived from a previous study[19] indicating the predictive power of beliefs about phosphate binders on adherence to phosphate binders, two tails, probability (Y = 1; X = 1), H_0 = .2, α = .05, and power = .90. The required sample size was 158.

Research Instruments

Research instruments in this study consisted of the Modified Medication Adherence Report Scale (MARS),[15] the Modified Beliefs about Medicines Questionnaire (BMQ),[15] the Modified Health Care Climate (HCC) Scale,[21] and the Phosphate Binder Knowledge Test (PBKT),[19] as well as a personal information form. All scales were translated into Chinese by using back translation method.[22]

Phosphate binder adherence was measured by the MARS, originally developed with five items[23] to measure medication adherence and then modified by adding two items relevant to phosphate binders.[15] The response options of modified MARS ranged from “always” (1) to “never” (5). The summed scores ranged between 7 and 35, and a score more than 28 was classified as adherence to phosphate binder.[15] The modified 7-item MARS had a Cronbach’s alpha coefficient of .83.[15]

The modified BMQ scale measures beliefs about phosphate binders including necessity and concerns.[15] It consists of 11 questions for assessing beliefs about necessity of phosphate binders and 9 questions for concerns.[15] It is a 5-point Likert scale from

"strongly disagree" (1) to "strongly agree" (5). The summed scores for necessity and concerns are 11-55 and 9-45 respectively, with higher scores indicating stronger beliefs about necessity or concerns. The scale had a Cronbach's alpha coefficient of .80 for necessity and .87 for concerns.[15]

The modified HCC scale assesses perceived autonomy support form health care providers.[21] It consists of 6 items and uses a 7-point Likert scale that ranges from "not true at all" (1) to "very true" (7). The higher the average summed scores, the higher perceived autonomy support levels from health care providers in the dialysis center. The Cronbach's alpha coefficient of the modified HCC scale was .90.[21]

The PBKT was used to test patients' knowledge about phosphate binders, consisting of 10 multiple choice questions.[19] One score was assigned to a correct answer, with a summed score ranging from 0 to 10. In the current study, a score equal or less than 7 was considered as low level of knowledge about phosphate binders and a score between 8-10 as high level.[24]

The personal information form was developed by the researcher and used to collect demographic and clinical characteristics of the participants included age, gender, education level, married status, employment, income, living status, ethnic group, insurance type, phosphate binder type, phosphate binder intake duration, comorbidity, and serum phosphate level. Comorbidity data were identified from HD patients' medical records and was calculated with scores by applying Charlson Comorbidity Index (CCI).[25] A score between 0-2 was considered as mild, 3-4 as moderate, and 5 or more as severe.

Validity and Reliability of the Instruments

The modified MARS,[15] BMQ,[15] HCC,[21] and CCI[25] were well developed and used in HD patients. However, the PBKT had never been validated, and its Chinese version was then validated by three clinical validators, two Chinese nephrologists and one Chinese dialysis nurse. The tested content validity index (CVI) is 1.0 in the study. The reliability of the instruments was assessed with a separate sample of 30 participants who were similar to the sample in the study. Cronbach's alpha coefficients were .73 for the modified MARS, .77 for the modified BMQ necessity, .84 for concerns, and .81 for the modified 6-item HCC scale.

Ethical Considerations

This project was approved by the Institutional Review Board, Faculty of Nursing, Mahidol University, Bangkok, Thailand (COA No.IRB-NS2017/419.2112).

Data Collection

Registered nurses from the two dialysis centers screened the potential participants who met the inclusion criteria. The principal investigator informed the potential participants regarding the study objectives and the rights to refuse to participate in

the study. Participants signed written consent voluntarily and took approximately 30 minutes to complete the questionnaires during their dialysis period. Potential participants aged over 60 years old were also screened for the cognitive impairment by using the GPCOG questionnaire. They were included if they had no cognitive impairment.

Data Analysis

Data were analyzed with the Statistical Product and Service Solutions (SPSS) statistical package version 18.0 (SPSS Inc., Chicago, IL, USA). Variables were presented with descriptive statistics including frequency, percentage, mean and standard deviation. Comparison of categorical and continuous variables between adherence and nonadherence to phosphate binders was carried out by Chi-square test and Mann-Whitney U test due to violation of assumptions.[26] Binary logistic regression with passed assumptions was used to identify factors associated with phosphate binder adherence.

Findings

As illustrated in Table 1, the average age of participants was 49.16 years (SD = 14.10) with a range of 20-79. The majority of participants were male, married, and living with others. All the participants received an education, but just over half of them were employed, with most of them having an income less than 5,000 Chinese Yuan (approximate 727 US dollars). A predominant number of the participants were Han nationality; and nearly all of them had medical insurances. Calcium carbonate was most common prescribed to the participants for controlling serum phosphate level.

Table 1: Characteristics of the participants (N = 158)

Characteristics	n (%)
Age (year) ($\bar{X}$ = 49.16, SD = 14.10)	
Gender	
Male	100 (63.3)
Female	58 (36.7)
Education level	
Primary school	16 (10.1)
Middle school	48 (30.4)
High school	49 (31)
College/university graduate	45 (28.5)
Marital status	
Married	103 (65.2)
Unmarried (single, divorced/separated, widow)	55 (34.8)

Table 1: (Cont.)

Characteristics	n (%)
Employment	
Employed	84 (53.2)
Unemployed	74 (46.8)
Income	
No income	21 (13.3)
≤5,000	101 (63.9)
5,001-10,000	33 (20.9)
>10,000	3 (1.9)
Living status	
Living with others (spouse, children, relatives, or friends)	140 (88.6)
Living alone	18 (11.4)
Ethnic group	
Han	152 (96.2)
Non-Han	6 (3.8)
Insurance type	
Urban Employees Basic Medical Insurance	103 (65.2)
New Rural Cooperative Medical Scheme	34 (21.5)
Urban Residents Basic Medical Insurance	20 (12.7)
Self-pay	1 (0.6)
Phosphate binder type	
Calcium carbonate	68 (43.1)
Calcium acetate	46 (29.1)
Lanthanum carbonate	22 (13.9)
Sevelamer carbonate	21 (13.3)
Cuttlebone sepium (80% of calcium carbonate)	1 (0.6)
Phosphate binder intake duration (year) ($\bar{X}$ = 3.72, SD = 3.10)	
Serum phosphate level (mmol/L) ($\bar{X}$ = 1.79, SD = 0.48)	

As shown in Table 2, 72 out of 158 participants (45.6%) were considered as adherence to phosphate binders. Chi-square test was applied for the association between phosphate binder adherence and categorical variables including medication cost, knowledge about phosphate binders, and comorbidity, while Mann-Whitney U test was performed for the association between phosphate binder adherence and such variables as beliefs about phosphate binders, perceived autonomy support from health care providers, and duration of hemodialysis. The results showed significant differences between adherence and nonadherence to phosphate binders in beliefs about necessity of phosphate binders ($p < .001$) and knowledge about phosphate binders ($p < .001$).

Table 2: Association between the studied variables and phosphate binder adherence (N = 158)

Variables	All participants N = 158 n (%)	Adherence N = 72 n (%)	Nonadherence N = 86 n (%)	p-value
Medication cost[a] (Yuan/month)				.295
≤500	123 (77.8)	52 (72)	71 (82.6)	
500-1000	23 (14.6)	13 (18.1)	10 (11.6)	
>1000	12 (7.6)	7 (9.7)	5 (5.8)	
Knowledge about phosphate binders[a]				< .001
Low level	115 (72.8)	36 (50)	79 (91.9)	
High level	43 (27.2)	36 (50)	7 (8.1)	
Comorbidity[a]				.994
Mild	11 (7)	6 (7)	5 (6.9)	
Moderate and Severe	147 (93)	80 (93)	67 (93.1)	
	$\bar{X} \pm SD$	$\bar{X} \pm SD$	$\bar{X} \pm SD$	
Beliefs about phosphate binders[b]				
Necessity	38.39 ± 4.16	40.10 ± 3.77	36.95 ± 3.94	< .001
Concerns	22.06 ± 4.07	21.46 ± 3.47	22.57 ± 4.47	.224
Perceived autonomy support from health care providers[b]	5.54 ± 0.81	5.63 ± 0.70	5.45 ± 0.89	.756
Duration of hemodialysis[b] (year)	4.91 ± 3.60	5.41 ± 3.83	4.49 ± 3.36	.143

[a] Chi-square test, [b] Mann-Whitney U test

In the binary logistic regression analysis (Table 3), knowledge about phosphate binders was found strongly significantly associated with phosphate binder adherence (OR = 10.73, 95%CI = 3.84, 29.97). Participants with high level of knowledge about phosphate binders were more likely to adhere to phosphate binders. Both beliefs about necessity of phosphate binders (OR = 1.23, 95%CI = 1.09, 1.39) and concerns about phosphate binders (OR = .88, 95%CI = .79, .98) were significantly associated with phosphate binder adherence. Beliefs about necessity of phosphate binders encouraged participants to adhere to phosphate binders, while concerns about phosphate binders made them less likely to adhere.

Table 3: Results of binary logistic regression on phosphate binder adherence

Variables	OR	95%CI		p-value
		Lower	Upper	
Medication cost (Yuan/month)				
≤500	Ref.			
500-1000	1.61	.54	4.86	.394
>1000	1.82	.44	7.51	.406
Knowledge about phosphate binders				
Low level	Ref.			
High level	10.73	3.84	29.97	< .001
Comorbidity				
Mild	Ref.			
Moderate & Severe	2.24	.52	9.69	.279
Beliefs about phosphate binders				
Necessity	1.23	1.09	1.39	.001
Concerns	.88	.79	.98	.018
Perceived autonomy support from health care providers	.94	.55	1.62	.829
Duration of hemodialysis (year)	1.06	.95	1.19	.313

Cox & Snell R square = .31, Nagelkerke R square = .42, Hosmer and Lemeshow test p = .45

Discussion

In the current study, the percentage of participants adherent to phosphate binders was only 45.6%. This result is consistent with three previous systematic reviews.[3-5] Participants may simply forget or intentionally miss doses of prescribed phosphate binders, since they needed to self-control their own medication intake without assistance from health care providers. In the current study, two factors selected from patient-related factors of MAM were significantly associated with phosphate binder adherence: knowledge about phosphate binders and beliefs about phosphate binders.

Knowledge about phosphate binders was found to be the most significant factor associated with phosphate binder adherence among HD patients in China. Patients with high level of knowledge about phosphate binder were more likely to adhere to phosphate binders (OR = 10.73, 95%CI = 3.84, 29.97). This is in line with previous studies.[3-4,6,10] High level of knowledge about phosphate binders can empower HD patients to properly manage their phosphate binders when they better understand the functions and precautions of taking phosphate binders. Conversely, lacking an understanding of medications prescribed was reported as a barrier to medication adherence.[13]

Furthermore, beliefs of necessity about phosphate binder were positively associated with phosphate binder adherence (OR = 1.23, 95%CI = 1.09, 1.39), while concerns had a negative association (OR = .88, 95%CI = .79, .98). These findings were consistent with previous studies.[3-4,6,15-16] Even though the Chinese patients have a culture environment different from the western countries, beliefs of patients with HD in China regarding taking phosphate binders were not different from the western cultures.

By contrast, factors selected from other dimensions were found no significant association with phosphate binder adherence. Medication cost of phosphate binders from the social and economic factors was not significantly associated with phosphate binder adherence. This is inconsistent with the systematic review,[3] which found that medication cost was a barrier to adherence with medication regimen in HD patients. The cost of medication is a common reason given by patients with HD to explain their nonadherence experience.[3] In the current study, however, the cost of different types of phosphate binders varied widely from a low of 15 to a high of 1,800 Chinese Yuan per month (from 2.38 to 286.17 US dollars per month). Most participants earned an income and nearly all participants had health insurance coverage. Thus, medication cost of phosphate binders might not affect phosphate binder adherence in the participants.

Duration of hemodialysis from therapy-related factors had no association with phosphate binder adherence in the study. This is congruent with two systematic reviews[3-4] but inconsistent with other

studies.[6,10-12] Participants in this study had quite shorter duration of hemodialysis ($\overline{X}$ = 4.91 years), which is different from the previous studies.[6] In addition, during the study, the participants in the same dialysis treatment room were found sharing with each other their attitude and knowledge about their disease conditions as well as phosphate binders during the HD therapy. Therefore, it is possible that the participants, though experiencing different duration of hemodialysis, shared similar attitude and knowledge about taking phosphate binders and thus showed similar phosphate binder adherence behaviors, when they simultaneously had their HD treatment in the same dialysis room.

Comorbidity from condition-related factors was not associated with phosphate binder adherence in the study. Indeed, there was no significant difference in phosphate binder adherence with all levels of comorbidities. This is in line with previous studies.[11,19] However, the result is different from that of the systematic review[3] which found that having a comorbid disease, i.e. diabetes and hypertension, affected medication adherence in HD patients. This may be due to difference in term of measurement. In this current study, the CCI was applied to assign the scores from all concomitant diseases of each participant, not only diabetes and hypertension. It is evident that all participants in the current study were commonly accompanied by comorbidities; and most of them were in moderate to severe levels. Accordingly, they were more willing to take prescribed medications when they were in more complex situations under comorbidities.

In addition, perceived autonomy support from health care providers, one of health care team- and system-related factors, was not a significant associated factor in the study. This result is different from previous studies.[3,21] It has been reported that some patients may wish to be involved in the decisions concerning phosphate binder taking instead of fully relying on medical professionals' decisions on their behalf.[13] However, patients in China could have been influenced by its culture, which does not emphasize the importance of autonomy in daily lives.[7] When Chinese people become ill, they tend to look for help from health professionals and mainly rely on their family members or relatives to take care of their daily lives.[7] Thus, autonomy support may not have significant effects on adherence behaviors in Chinese patients with HD.

Conclusion and Recommendations

Although phosphate binders are commonly prescribed to control hyperphosphatemia in HD patients, poor adherence to this medication has been reported. The result of this study conducted in China also revealed that phosphate binder adherence in HD population is problematic. Additionally, knowledge about phosphate binders,

followed by beliefs about phosphate binders were found to be the powerful predictors in this study. Participants with higher knowledge about phosphate binders, higher beliefs about necessity of phosphate binders, and lower concerns about phosphate binders had better phosphate binder adherence.

Future research of other factors from the MAM and of phosphate binder adherence intervention is warranted. Interventions to improve phosphate binder adherence among HD patients in China are suggested to improve their knowledge and positive beliefs about phosphate binders.

Certain limitations should be acknowledged in this study. First, phosphate binder adherence was measured by using self-report method with a potential risk of biased responses from surveyed subjects, despite the use of standardized questionnaires with back translation into Chinese to avoid biased responses. Also, a cross-sectional design is limited to prove causality relationship between the factors and phosphate binder adherence. In addition, due to the use of convenience sampling with all participants recruited from two tertiary hospitals in Northeastern region of China, generalization might be caution to apply the research findings to HD patients with different characteristics.

References

1. Kidney Disease: Improving Global Outcomes (KDIGO) CKD-MBD Update Work Group. KDIGO 2017 Clinical practice guideline update for the diagnosis, evaluation, prevention, and treatment of chronic kidney disease-mineral and bone disorder (CKD-MBD). Kidney Int Suppl (2011). 2017;7(1):1-59. doi: 10.1016/j.kisu.2017.04.001.
2. Shaman AM, Kowalski SR. Hyperphosphatemia management in patients with chronic kidney disease. Saudi Pharm J. 2016;24(4):494-505. doi: 10.1016/j.jsps.2015.01.009.
3. Ghimire S, Castelino RL, Lioufas NM, Peterson GM, Zaidi ST. Nonadherence to medication therapy in haemodialysis patients: a systematic review. PLoS One. 2015;10(12):e0144119. doi: 10.1371/journal.pone.0144119.
4. Karamanidou C, Clatworthy J, Weinman J, Horne R. A systematic review of the prevalence and determinants of nonadherence to phosphate binding medication in patients with end-stage renal disease. BMC Nephrol. 2008;9:2. doi: 10.1186/1471-2369-9-2.
5. Schmid H, Hartmann B, Schiffl H. Adherence to prescribed oral medication in adult patients undergoing chronic hemodialysis: a critical review of the literature. Eur J Med Res. 2009;14(5):185-90. doi: 10.1186/2047-783x-14-5-185.

6. Umeukeje EM, Mixon AS, Cavanaugh KL. Phosphate-control adherence in hemodialysis patients: current perspectives. Patient Prefer Adherence. 2018;12:1175-91. doi: 10.2147/PPA.S145648.
7. Shi YX, Liu JD, Zhao Y. Effects of a nurse-led intensive education program on chronic renal failure patients with hyperphosphatemia. Zhonghua Hu Li Za Zhi. 2011;46(3):250-3. doi: 10.3761/j.issn.0254-1769.2011.03.011.
8. World Health Organization. Adherence to long-term therapies: evidence for action. Geneva: World Health Organization; 2003. 196 p.
9. Park H, Rascati KL, Lawson KA, Barner JC, Richards KM, Malone DC. Adherence and persistence to prescribed medication therapy among Medicare part D beneficiaries on dialysis: comparisons of benefit type and benefit phase. J Manag Care Spec Pharm. 2014;20(8):862-76. doi: 10.18553/jmcp.2014.20.8.862.
10. Chan YM, Zalilah MS, Hii SZ. Determinants of compliance behaviours among patients undergoing hemodialysis in Malaysia. PLoS One. 2012;7(8):e41362. doi: 10.1371/journal.pone.0041362.
11. Martins MT, Silva LF, Kraychete A, Reis D, Dias L, Schnitman G, et al. Potentially modifiable factors associated with non-adherence to phosphate binder use in patients on hemodialysis. BMC Nephrol. 2013;14(1):208. doi: 10.1186/1471-2369-14-208.
12. Neri L, Martini A, Andreucci VE, Gallieni M, Rey LA, Brancaccio D, et al. Regimen complexity and prescription adherence in dialysis patients. Am J Nephrol. 2011;34(1):71-6. doi: 10.1159/000328391.
13. Mechta Nielsen T, Frojk Juhl M, Feldt-Rasmussen B, Thomsen T. Adherence to medication in patients with chronic kidney disease: a systematic review of qualitative research. Clin Kidney J. 2018;11(4):513-27. doi: 10.1093/ckj/sfx140.
14. Wang Y, Liu Q. Survey of the use of phosphate binders in maintaining hemodialysis patients. Clinical Focus. 2009;3(24):234-5.
15. Chater AM, Parham R, Riley S, Hutchison AJ, Horne R. Profiling patient attitudes to phosphate binding medication: a route to personalising treatment and adherence support. Psychol Health. 2014;29(12):1407-20. doi: 10.1080/08870446.2014.942663.
16. Jamous RM, Sweileh WM, El-Deen Abu Taha AS, Zyoud SH. Beliefs about medicines and self-reported adherence among patients with chronic illness: a study in Palestine. J Family Med Prim Care. 2014;3(3):224-9. doi: 10.4103/2249-4863.141615.
17. Wileman V, Chilcot J, Norton S, Hughes L, Wellsted D, Farrington K. Choosing not to take phosphate binders: the role of dialysis patients' medication beliefs. Nephron Clin Pract. 2011;119(3):c205-13. doi: 10.1159/000329106.

18. Wileman V, Farrington K, Wellsted D, Almond M, Davenport A, Chilcot J. Medication beliefs are associated with phosphate binder non-adherence in hyperphosphatemic haemodialysis patients. Br J Health Psychol. 2015;20(3):563-78. doi: 10.1111/bjhp.12116.
19. Van Camp YP, Vrijens B, Abraham I, Van Rompaey B, Elseviers MM. Adherence to phosphate binders in hemodialysis patients: prevalence and determinants. J Nephrol. 2014;27(6):673-9. doi: 10.1007/s40620-014-0062-3.
20. Faul F, Erdfelder E, Buchner A, Lang A-GJBrm. Statistical power analyses using G* Power 3.1: tests for correlation and regression analyses. 2009;41(4):1149-60.
21. Umeukeje EM, Merighi JR, Browne T, Wild M, Alsmaan H, Umanath K, et al. Health care providers' support of patients' autonomy, phosphate medication adherence, race and gender in end stage renal disease. J Behav Med. 2016;39(6):1104-14. doi: 10.1007/s10865-016-9745-7.
22. Brislin RW. Back-translation for cross-cultural research. 1970;1(3):185-216. doi: 10.1177/135910457000100301.
23. Horne R. The nature, determinants and effects of medication beliefs in chronic illness [dissertation]. London: University of London; 1997. 290 p.
24. Jankowska-Polanska B, Uchmanowicz I, Dudek K, Mazur G. Relationship between patients' knowledge and medication adherence among patients with hypertension. Patient Prefer Adherence. 2016;10:2437-47. doi: 10.2147/PPA.S117269.
25. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis. 1987;40(5):373-83. doi: 10.1016/0021-9681(87)90171-8.
26. Field A. Discovering statistics using SPSS. 3rd ed. London: Sage Publications; 2009. 856 p.