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Effects of a nutrition education program on self-care behavior and kidney functions in pre-dialysis chronic kidney disease patients

Kasama Wongprachum
Faculty of Public Health, Mahasarakham University, Thailand *and* Public Health and Environmental Policy in Southeast Asia Research Cluster (PHEP-SEA), Mahasarakham University, Thailand

Duanggai Sopa
Department of Nutrition, Nakhon Pathom Hospital, Thailand

Palisa Pondod
Faculty of Public Health, Mahasarakham University, Thailand

Chutima Phasuknit
Faculty of Public Health, Mahasarakham University, Thailand

Rattanaporn Prathumsai
Faculty of Public Health, Mahasarakham University, Thailand

Charunthon Kherukhe
Faculty of Public Health, Mahasarakham University, Thailand

Chaloemporn Namyota
Faculty of Public Health, Mahasarakham University, Thailand *and* Public Health and Environmental Policy in Southeast Asia Research Cluster (PHEP-SEA), Mahasarakham University, Thailand

Tarinee Nilkamheang
Faculty of Public Health, Mahasarakham University, Thailand *and* Public Health and Environmental Policy in Southeast Asia Research Cluster (PHEP-SEA), Mahasarakham University, Thailand

Kukiat Tudpor
Faculty of Public Health, Mahasarakham University, Thailand *and* Public Health and Environmental Policy in Southeast Asia Research Cluster (PHEP-SEA), Mahasarakham University, Thailand
Corresponding author email: kukiat.t@msu.ac.th

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***Abstract*---**The kidneys play a vital role in eliminating wastes and maintaining electrolyte and acid balance in the human body. Chronic kidney disease (CKD) is a condition in which the kidney functions irreversibly decline and eventually requires hemodialysis or renal transplantation. This present study aimed to investigate the effects of an 8-week nutrition education program on self-care behavior and kidney functions in pre-dialysis CKD patients. Twenty-one patients diagnosed with pre-dialysis CKD in the CKD Clinic were appointed to the 8-week nutrition education program on basic kidney functions, CKD etiology, CKD delaying strategies, and dietary counseling. Primary outcomes were the knowledge, attitude, and behavior scores on pre-dialysis self-care. Secondary outcomes were the estimated glomerular filtration rate (eGFR), blood urea nitrogen (BUN), serum creatinine (sCr), sodium, potassium, and phosphorus. Baseline and post-intervention scores of all outcomes were measured. Results show that most of the participants were female and aged ≥ 60. The nutrition education program significantly improved post-intervention knowledge, attitude, and behavior scores. Moreover, laboratory results of BUN, sCr, eGFR, and serum sodium levels were stable. Even though the mean potassium and phosphorus levels increased, there were improvements in the post-intervention measurements. In conclusion, the 8-week nutrition education program was able to improve self-care behavior and delay kidney function impairment in pre-dialysis CKD patients.

***Keywords*---**chronic kidney disease, self-care behavior, nutrition education, kidney function.

Introduction

The kidneys play important roles in the excretion of waste products (urea, creatinine, and uric acid), controlling of body fluid and electrolyte balance, and synthesis of hormones (1,25 dihydroxy vitamin D, erythropoietin, and renin) (Gounden et al., 2018). Chronic kidney disease (CKD) is a state of progressive loss of kidney function, which eventually requires renal replacement therapy (RRT; dialysis or transplantation) (Vaidya & Aeddula, 2021). CKD is defined as “abnormalities of kidney structure or function, present for >3 months, with implications for health” (Outcomes & Group, 2013). CKD globally influences >10% of the population, summing to >800 million people (Kovesdy, 2022). The RRT is a costly measure and probably unaffordable, particularly in low- and middle-income countries (Tonelli & Dickinson, 2020). Therefore, to delay the process of RRT, early diagnosis, monitoring, treatment, and therapeutic measures must be promptly implemented.

Essentially, kidney function can be measured by laboratory testing of an estimated glomerular filtration rate (eGFR), blood urea nitrogen (BUN), serum creatinine (sCr), and albumin-to-creatinine ratio (ACR) (Gounden et al., 2018). The eGFR is characterized as the amount of plasma filtered by the kidneys in one minute and has been mainly used for determining the presence of CKD (Kovesdy, 2022). Based on eGFR values (in the unit of ml/min/1.73 m^2), CKD is categorized into six stages – G1 (>90), G2 (60-89), G3a (45-59), G3b (30-44), G4 (15-29), and G5 (<15). The CKD patients with the eGFR between 10-45 ml/min/1.73 m^2 can be classified as a pre-dialysis group (Janmaat et al., 2018). The kidney functions of pre-dialysis CKD patients intensely decline during the pre-dialysis period (O'Hare et al., 2012). The patients with a more extreme rate of eGFR decline were more prone to hospitalization with CKD complications. Therefore, pre-dialysis care should be provided to decelerate the kidney function decline and to prepare patients for pre-emptive RRT (Janmaat et al., 2018). Various pre-dialysis care interventions have been employed including medication, exercises, lifestyle modifications, and nutrition therapy (van Berlo-van de Laar et al., 2020). Malnutrition-related conditions such as obesity, hypertension, and diabetes mellitus have been found to exaggerate CKD (Anderson & Nguyen, 2018). Nutrition education warrants an optimal nutritional status and maintains renal function in CKD patients (Kurniawan et al., 2021). However, it has been not known whether a nutrition education program improves renal function through self-care behavior adaptation. This present study aimed to investigate the effects of nutrition education program on knowledge, attitude, behavior, and laboratory test results in pre-dialysis patients.

Materials and Methods

Study design

In this present study, we used a one-group pretest-posttest quasi-experimental design. The project has been approved by the Ethical Review Committee for Human Research, Faculty of Public Health, Mahasarakham University (PH041/2562). The study was conducted at Nakhon Pathom Hospital, Nakhon Pathom, Thailand. All data were encrypted and only the authorized staff were allowed to have an access. Written informed consent forms were obtained from all patients.

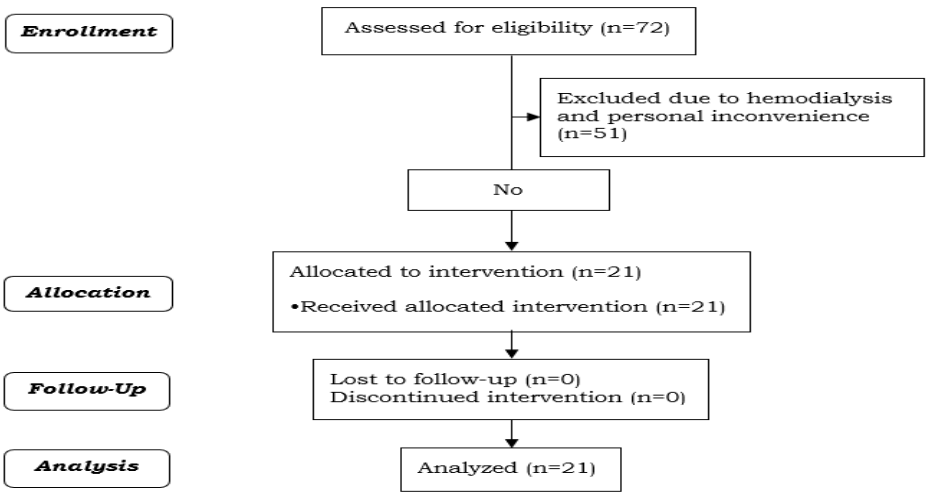

Figure 1 CONSORT flowchart for a single-arm, open-label clinical trial with a nutrition education program in pre-dialysis CKD patients.

Participants and baseline assessments

Seventy-two pre-dialysis CKD patients were recruited from the CKD Clinic of Nakhon Pathom Hospital and were assessed for eligibility (Fig. 1). Inclusion criteria were 1) being the patients diagnosed with the pre-dialysis CKD corresponding to the criteria from the KDIGO 2012 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease for at least 6 months, 2) being the patients of the CKD outpatient department, 3) being able to communicate and self-care, and 4) being informed consent. Exclusion criteria were 1) having RRT and 2) having severe physical complications and being hospitalized. After recruitment, the participants were evaluated for baselines of knowledge, attitude, behavior, laboratory test results, and other demographic data. Twenty-one patients were included in the study and all of them were extant until the project had finished.

Intervention

The participants were enrolled in the 8-week nutrition education program designed by nutritionists in the Department of Nutrition, Nakhon Pathom Hospital. The contents in the program consisted of basic kidney functions, etiology of CKD, CKD progression delaying methods (control of blood pressure ≤ 130/80 mmHg, blood glucose ≤ 110 mg/dL, HbA_1c < 6.5%, uric acid, steroid drug avoidance, low-density lipoprotein (LDL) < 100 mg/dL, body weight, and smoke cessation), graded walking exercise 5-30 min/day x 3 days/week, dietary counseling (tailored made amounts of daily total energy requirements, macronutrients, micronutrients, and water according to the Thailand Dietetic Association). Food models were used for the counseling sessions (Fig. 1).

Figure 1 Representatives of food models for a nutrition education program in pre-dialysis CKD patients.

Outcomes

The primary outcomes were the knowledge, attitude, and behavior on pre-dialysis CKD self-care scores. The questionnaires' validity was determined by submitting it to a panel of three experts for evaluation and the reliability has been verified with Cronbach's alpha value of 0.70. Before the interventions, the participants were screened for baseline scores. Three questionnaires consisted of knowledge (10 items, modified from Sangchaiwut (Saenchaiwut, 2015), attitude (10 items), and behavior (12 items), which take 5-10 min to complete (Tables 1-3). Post-intervention knowledge, attitude, and behavior were measured again after 8 weeks. The scores of the negative questions were reversed before summation. Secondary outcomes were laboratory blood test results (BUN, creatinine, eGFR, sodium, potassium, and phosphorus. All entries were obtained at baseline and 8-week posttest from the hospital's database and were checked for accuracy by nutritionists.

Table 1 Questionnaire on knowledge for pre-dialysis CKD patients

Item	Knowledge
1	The kidneys secrete waste out of the human body.
2	Diabetes mellitus and hypertension can cause chronic kidney disease.
3	Dietary control can delay chronic kidney disease progression.
4	Fish and white eggs are high in protein and are good for chronic kidney disease patients.
5	Soy products are high in phosphorus and are not good for chronic kidney disease patients.
6	Colored vegetables like dark green, yellow, and red are high in vitamins and are good for chronic kidney disease patients.*
7	Bananas, ripe mangos, and tomatoes are high in potassium and are not good for chronic kidney disease patients.
8	Drinking milk is good for chronic kidney disease patients.*
9	Low sodium intake can reduce edema in chronic kidney disease patients.
10	Consumption of five food groups and getting enough sleep are good for chronic kidney disease patients.

*False answer choices

Table 2 Questionnaire on attitude for pre-dialysis CKD patients

Item	Attitude
1	Consumption of five food groups can delay kidney damage.
2	Chronic kidney disease patients can eat dark green vegetables like kales and broccoli.*
3	Chronic kidney disease patients should not eat protein-rich food like white eggs and fish fillet.*
4	Consumption of spicy food like salty food accelerates kidney damage.
5	Chronic kidney disease patients should not eat packed food from markets.
6	Chronic kidney disease patients should eat good fat-containing food like olive and rice bran oil.
7	Cooking with proper proportion of food ingredients can delay kidney

	damage.
8	Chronic kidney disease patients should not exercise.*
9	Chronic kidney disease patients should exercise 3-5 times/week.
10	Chronic kidney disease patients should not buy medicines but see their doctors.

*Negative question.

Table 3 Questionnaire on behavior for pre-dialysis CKD patients

Item	Behavior
1	I have more than 3 meals a day.*
2	I only eat white eggs, not yolks.
3	I eat dairy products.*
4	I choose flour-based food, not milk-containing food.
5	I eat fatty meats like chicken skins, pork legs, and pork belly.*
6	I eat dark green vegetables like wild betels, broccoli, and kales.*
7	I drink a glass of milk or soy milk daily.*
8	I drink coffee, cocoa, soda, and energy beverages.*
9	I drink less water and take less salt when my body swells.
10	I eat fermented food like pickled vegetables/fruits and fermented fish.*
11	I avoid eating ready meals.
12	I cook for myself to control amount of salt suggested by a nutritionist.

*Negative question.

Statistical analysis

The data are expressed as mean±SD and number (%). Continuous data of pretest and posttest were compared with paired t-test. Categorical variables of pretest and posttest were expressed as number (percentage). The level of statistical significance was $p < 0.05$. All data were analyzed by SPSS version 18.0.

Results

Fifty-one participants were excluded from the program due to being referred to RRT and personal inconvenience. Twenty-one participants were allocated and completed the program. Most of the participants were female (66.7%) and aged ≥ 60 (71.4%). All other socio-demographic data are shown in Table 4. A paired samples t-test was conducted to determine the effect of nutrition education program on knowledge, attitude, and behavior scores. The results indicated a significant difference between the knowledge scores before the program (M=8.61; SD=1.02) and after the program (M=9.23; SD=0.88); [t(20) = -3.08, P <.00]; the attitude scores before the program (M=17.23; SD=2.71) and after the program (M=18.09; SD=1.72); [t(20) = -2.25, P = .03]; and the behavior scores before the program (M=25.57; SD=5.24) and after the program (M=30.42; SD=3.18); [t(20) = -4.64, P <.00]. We, therefore, reject the null hypothesis that there is no difference between the means and conclude that there are positive effects of the nutrition education program on the knowledge, attitude, and behavior scores (Table 5). Results of laboratory tests in pre-dialysis CKD patients at baseline and post-intervention of nutrition education program depicted that BUN, sCr, eGFR, and serum sodium levels were not changed, whereas potassium and phosphorus levels increased. Details are shown in Table 6. Subsequently, the laboratory results were categorized into “improved” and “not improved”. It showed that BUN, sCr, and eGFR were respectively improved in 23.81, 14.29, and 28.57% of the participants. Meanwhile, the serum sodium, potassium, and phosphorus were respectively improved in 66.67, 66.67, and 71.43% of the participants (Table 7).

Table 4 Socio-demographic characteristics of participants (N = 21)

Characteristics	Category	n (%)
Gender	Male	7 (33.3)
	Female	14 (66.7)
Age	< 60	6 (28.6)
	≥ 60	15 (71.4)
Educational level	Higher than primary school	9 (42.9)
	Primary school	12 (57.1)
Occupational status	Wageworker	14 (66.7)
	Others	7 (33.3)
Income (baht)	< 10,000	5 (23.8)
	≥ 10,000	16 (76.2)

Table 5 Mean scores of knowledge, attitude, and behavior at baselines (pretest) and post-intervention (posttest) of nutrition education program

Variable	Mean	SD	Mean difference	SD	95% CI of the difference		t	df	P-value
					Lower	Upper			
Knowledge pretest	8.61	1.02	0.62	0.92	-1.03	-0.19	-3.08	20	0.00
Knowledge posttest	9.23	0.88							
Attitude pretest	17.23	2.71	0.86	1.74	-1.64	-0.06	-2.25	20	0.03
Attitude posttest	18.09	1.72							
Behavior pretest	25.57	5.24	4.85	4.78	-7.03	-2.67	-4.64	20	0.00
Behavior posttest	30.42	3.18							

Table 6 Laboratory test results in pre-dialysis CKD patients at baseline and post-intervention of nutrition education program

Laboratory value (normal range)	Baseline	Post-intervention
BUN (8-20 mg/dL)	47.86±25.26	49.43±31.04
Creatinine (0.72-1.18 mg/dL)	4.90±3.94	5.19±4.01
eGFR (>90 ml/min/1.73 m^2)	14.91±12.51	14.61±13.25
Sodium (136-146 mg/dL)	139.70±2.85	139.20±2.56

Potassium (3.5-5.1 mg/dL)	4.14±0.74	4.54±0.93*
Phosphorus (2.5-4.5 ma/dL)	3.79±1.01	4.32±1.48*

*, $P < 0.05$

Table 7 Category of laboratory test results in pre-dialysis CKD patients at baseline and post-intervention of nutrition education program

Laboratory value (normal range)	Improved	Not improved
BUN (8-20 mg/dL)	5 (23.81)	16 (76.19)
Creatinine (0.72-1.18 mg/dL)	3 (14.29)	18 (85.71)
eGFR (>90 ml/min/1.73 m^2)	6 (28.57)	15 (71.43)
Sodium (136-146 mg/dL)	14 (66.67)	7 (33.33)
Potassium (3.5-5.1 mg/dL)	14 (66.67)	7 (33.33)
Phosphorus (2.5-4.5 ma/dL)	15 (71.43)	6 (28.57)

Discussion

This present study showed that the 8-week nutrition education program was able to improve knowledge, attitude, and behavior of the pre-dialysis patients as well as delayed the progression of the CKD. This statement was based on our following findings. First, knowledge, attitude, and behavior scores were significantly increased upon the post-intervention re-assessments. Secondly, the post-intervention eGFR was preserved.

The kidney function regression is associated with anxiety and cognitive impairment in the CKD patients (Renczes et al., 2019; Zammit et al., 2016). These mental disorders are obvious in the pre-dialysis stage and most prominent in the dialysis stage (Renczes et al., 2019). Cognitive impairment is interrelated with the poor behavior (Ismail et al., 2021). Therefore, behavior change is one of the keys to delay the progression of kidney function decline. So far, adaptation of five behaviors have been found to improve kidney functions – dietary control, physical activity, smoking cessation, alcohol refrain, and body weight control (Schrauben et al., 2022). Behavior change techniques can be divided into sixteen domains – antecedents, comparison of behavior, feedback and monitoring, goals and planning, identity, natural consequences social support, shaping knowledge, associations, repetition and substitution, comparison of outcomes, reward and threat, regulation, scheduled consequences, and self-belief and covert learning (Evangelidis et al., 2019). In the present study, we employed the nutrition education to shape knowledge (and attitude) for changing behavior in the pre-dialysis patients. Previous study by Flesher and colleagues, it has been reported that self-management by adaptation of cooking style and exercise improved eFGR and other outcomes in 6 months (Flesher et al., 2011). Limitation of our study is the relatively short-time experimentation. Therefore, successful preservation of the kidney function was not solely from nutrition education as other factors such as exercise, smoking, and alcohol drinking were not incorporated into the analysis. A further extended version of the cohort study would be useful to unravel the effectiveness of the intervention.

In general, annual declines of eGFR of 0 to 1, 1 to 4, and >4 ml/min per year are considered mild, moderate, and severe progression of CKD, respectively (Al-Aly et al., 2010). In the present study, the eGFR decline was 0.3 ml/min in two months i.e., 1.8 ml/min per year and thus being considered as the moderate decline. The kidney function decline has been found to be associated with age, black race, diabetes mellitus, hypertension, and peripheral artery disease (PAD) (Al-Aly et al., 2010). The pre-dialysis patients in the present study were Asian people with modifiable comorbidity such as diabetes mellitus and hypertension, which should have been more tightly controlled. While the laboratory outcomes of BUN and sCr were not very satisfied, serum sodium, potassium, and phosphorus levels were improved in higher proportion. These findings were speculated to be due to effective dietary counseling. Salt limitation is a well-known method to reduce the blood sodium level, while the restriction of certain types of fruits and vegetables were beneficial to lower potassium and phosphorus levels (Duayer et al., 2021; Nagasawa, 2021; Yamada & Inaba, 2021). Larger scale study in this group of patients is needed to unravel mechanistic details the program. For example, a 12-month project can be planned with 3-month interval data collection and re-assessment of the outcomes.

Conclusion

In conclusion, our present study demonstrates that that the 8-week nutrition education program was able to improve knowledge, attitude, and behavior of the pre-dialysis patients. Moreover, the program was feasible to delay the decline of kidney function. Long-term investigation of this program will be beneficial for further clinical implication and decision for implementation.

Conflict of Interest

The authors have no conflicts of interest to declare.

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