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Care Interventions on the Health Indicators of Patients with Early-Stage Chronic Kidney Disease

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Abstract

This study evaluated the effectiveness of a health care intervention program on the health indicators of patients with early-stage chronic kidney disease (CKD).The study participants consisted of outpatients from a regional hospital in Southern Taiwan, and cases included CKD patients and those suffering from Stage 1, Stage 2, and Stage 3a of the disease, with cases from the nephrology department forming the experimental group, and cases from other departments forming the control group.After 3 times individualized health education interventions for patients with early-stage CKD can significantly improve patients' health-related indicators.

Keywords: Early-stage chronic kidney disease, health indicators, quasi-experimental design, individualized health education

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1 Introduction

According to statistics from the 2012 United States Renal Data System,Taiwan is ranked among the top 3 countries in incidence and prevalence of end-stage kidney disease, with 361 cases per million persons in incidence, and 2,584 cases per million persons in prevalence [1]. Because the symptoms of early-stage kidney disease are easy to overlook, most patients are already in Stage 3 when the disease is finally diagnosed. According to results from cohort studies of the National Health Research Institute (NHRI) of Taiwan, 2.03 million people suffer from CKD, with Stage 1 to Stage 3 patients amounting for 1.97 million. However, only 3.5% of these patients were aware that they had CKD [2]. This study calculated the mortality rate of CKD in Taiwan to be 10.3%.

The rising prevalence of CKD has received increased focus worldwide. Studies conducted in Taiwan and other countries have reported a global prevalence of CKD of approximately 10%. In Taiwanese territories, a cohort study by the NHRI, which involved 462,000 persons above the age of 20, showed that the prevalence of Stage 1 was 1.0%, Stage 2 was 3.8%, Stage 3 was 6.8%, Stage 4 was 0.2%, and Stage 5 was 0.1% [2]. The results from a community screening of residents above the age of 40 undertaken by 35 hospitals and clinics in Taoyuan County, Taiwan between 2004 and 2006 showed that the prevalence of patients of different gender was 15.2% for Stage 3, 0.7% for Stage 4, and 0.2% for Stage 5. In this screening, the CKD prevalence for male and female patients was 18.8% and 14.0%, respectively. Studies have shown that the prevalence increases with age. This is particularly applicable after age 60, when each yearly increase in age brings a higher probability of CKD than each yearly increase does before the age of 60 [3].

The NHI introduced pre-end-stage renal disease (Pre-ESRD) preventive programs and patient education programs specifically for Stage 3b, 4, and 5 CKD patients. The Taiwan Society of Nephrology has demonstrated that case management programs are effective in delaying kidney function deterioration. According to the Taiwan Renal Data System, the prevalence of CKD has dropped from 424 cases per million persons to 347 cases per million. Chen et al investigated Stage 3 to Stage 5 cases referred from medical institutes and regional hospitals serving as the study population. After a tracking period from 2001 to 2006, cases that had undergone CKD treatment through referrals exhibited a slowdown, wherein their glomerular filtration rate had decreased annually [4]. Wei et al indicated that, in addition to CKD referrals, the quality of nursing care improved, the usage rate for medical services lowered, and medical expenses were reduced [5]. A comparative study between early and late referred cases showed a higher mortality rate (relative risk = 1.99) and a higher mortality rate and hospitalization rate for late referred cases compared with early referred cases [6]. St. Peter et al discovered that CKD health care intervention that involved using a diverse set of medical services helped to improve complications caused by CKD [7]. After investigating 726 cases consisting of Stage 3 to Stage 5 patients, another study found that a referral for CKD treatment mitigated the course of the disease and improved survivability [8]. In recent years, Taiwan has actively promoted programs for preventing kidney disease. These programs have been effective in delaying the deterioration of kidney function, thereby lowering the incidence and prevalence of ESRD. To reduce the incidence of dialysis cases, disease management for early CKD cases (namely Stage 1, 2, and 3a patients) is also actively promoted. This study investigated whether health care intervention for early-stage chronic disease effectively improves various health indicators, thereby improving and delaying the occurrence of deteriorating renal function in CKD patients.

2 Methods

This study used a quasi-experimental design. The data were collected through the Institutional Review Board and with the permission of people suffering from the early-stage CKD. Each independent instance of health education served as an intervention measure for the patients, and their health indicators were compared to contrast. We invited outpatients from a regional hospital in Southern Taiwan to serve as the participants. Among them, those in the early stages of CKD were invited between March 2011 and March 2012. Participants invited by the nephrology department, totaling 127 patients, formed the experimental group, and those invited by other departments, totaling 121 patients, formed the control group.

Early-stage CKD used, as reference, the current internationally recognized the MDRD equation for the glomerular filtration rate, which is expressed as $186 \times SCr^{-1.154} \times Age^{-0.203} \times 0.742$ (female), and the value for this filtration rate served as the periodic record of CKD. Proteinuria was defined as urine protein and creatinine ratio（UPCR）≧150 mg/gm. The reference value for creatinine in the bloodstream is 0.5–1.3 mg/dL. Any increase is considered an abnormality.

After a doctor attended to the control group of this study, health care personnel in the outpatient department distributed kidney health care brochures and booklets, an act referred to as “common outpatient practice”. For the experimental group, in addition to the common outpatient practice, the patients participated in 3 independent 1-to-1 health care coaching sessions in a specially prepared room for the duration of the intervention. The first session, referred to as “intervention commencement,” included content such as “Knowing the structure and functions of kidneys,” “Introduction to the common symptoms of kidney diseases and diagnosis,” and “Daily care and preventive measures for kidney disease.” These topics facilitated evaluating patient conditions, provided them with individual care, and served as motivation for learning. The second session, which was conducted 3 months after the onset of intervention, included content such as the “Importance of periodic tracking,” “Items of attention during drug administration,” and “Kidney biopsy and referral to nephrology specialists.” In this phase, the test results were discussed with the case patients, test records were provided according to need, and misconceptions were clarified. The third session, which was conducted 6 months after the onset of intervention, included content such as “Understanding the relationship among high blood cholesterol, high blood pressure, diabetes, and kidney diseases” and “Controlling blood pressure, blood sugar, weight, and the body mass index (BMI)”. During this phase, appropriate care was provided according to the attributes of the patient’s diagnosis, the self-monitoring capabilities of the patient, and the level of cooperation from the patient’s family, to reduce the patient’s difficulty in self-care.

Based on the NHI Administration funding proposal for early-stage CKD, a pretest was conducted before each new case was accepted. An initial posttest was administered 3 months after the case was accepted and a second posttest was administered after 9 months. The test items involved physiological and biological examinations, health knowledge, and behavior.

The study instruments consisted of questionnaires and results from physical tests. The questionnaire entailed basic information, physical checks, and blood and urine tests, which are described as follows:

Blood tests: The mandatory test items for the blood tests addressed creatinine, low-density lipoprotein cholesterol (LDL-C), and glycated hemoglobin (HbA1c). A fasting period of 8 hours was required for items that prohibited food intake. The amount of blood drawn was 4 ml, with 3 ml in vacutainers and 1 ml of EDTA whole blood. The Hitachi 7170 bioanalyzer and CLC385 glycohemoglobin analyzer were used for the blood analysis.

Urine test: To prevent any contamination by materials secreted at the end of the urinary tract, midstream urine was collected as a test specimen. After collection that involved using clean specimen cups, at least 8 ml of the specimen was poured into a urine centrifuge tube.

3 Main Results

The basic characteristics data from various physical examinations of the participants from the experimental and control groups were not statistically significantly different (Table 1). After individualized health education intervention, statistically significant differences emerged between the experimental and control groups in their physiological and biochemical indicators (Table 2) such as systolic blood pressure, the glomerular filtration rate, and triglyceride levels. The values for the experimental and control groups were 130.63 vs 141.95 ($P < .001$), 63.59 vs 59.25 ($P < .05$), and 132.66 vs 181.53 ($P < .001$), respectively. The experimental group showed significant improvement. In addition, independent sample t-testing for the posttest and pretest differences showed statistically significant differences between the 2 groups in systolic blood pressure, diastolic blood pressure, body weight, BMI, creatinine, the glomerular filtration rate, blood sugar, glycosylated hemoglobin, triglyceride levels, and total urine protein . The experimental group showed obvious improvement in the post-intervention physiological and biochemical indicators, whereas these indicators worsened in the control group.

Paired sample t-test analyses were used for the pre-intervention and post-intervention differences of physiological and biochemical indicators for both groups (Table 2). The results showed statistically significant improvements in the experimental group in systolic blood pressure, diastolic blood pressure, body weight, BMI, creatinine, blood sugar, glycated hemoglobin, triglyceride levels, and urine total protein. Other indicators indicated a trend toward improvement after intervention, although the improvements were not statistically significant. The control group without individualized health education intervention exhibited statistically significant pre- and post-intervention differences in diastolic blood pressure, body weight, BMI, creatinine, the glomerular filtration rate, blood sugar, and glycosylated hemoglobin levels.

Table 3 shows the effects of group and intervention time points on physiology and biochemistry. The results indicate main group effects for systolic blood pressure, diastolic blood pressure, body weight, BMI, the glomerular filtration rate, and triglyceride levels, and a main intervention time point effect for systolic blood pressure. Group and intervention time point interactions were observed for systolic blood pressure, diastolic blood pressure, and triglyceride and blood sugar levels; therefore, simple main-effect tests were necessary. Table 4 shows these results.

Systolic blood pressure: (1) The simple group-effect test showed no statistically significant group difference in the measurement before the intervention, but the group difference was statistically significantly different after intervention ($P < .001$), with the mean values of 130.63 vs 141.95. (2) The simple group-effect of the intervention time point showed a statistically significant difference for the experimental group between preand post-intervention systolic blood pressure measurements ($P < .001$). The mean systolic blood pressure for the experimental group was 142.87 before intervention and 130.63 after intervention. Therefore, we observed a significant improvement in average systolic blood pressure for the experimental group after individualized health education intervention, but no statistically significant difference in systolic blood pressure for the control group between the pre- and post-intervention time points.

Diastolic blood pressure: (1) The simple group-effect test showed a significant difference in diastolic blood pressure between the 2 groups in the pre-intervention test with a mean value of 85.37 vs 77.79, but no group difference in the post-intervention diastolic blood pressure measurement. (2) The simple group-effect of the intervention time point showed a statistically significant difference for the experimental group ($P < .001$), with an average diastolic blood pressure of 85.37 and 77.98 for the pre- and post-intervention measurements. Therefore, we observed significant improvement in average diastolic blood pressure for the experimental group after individualized health education intervention, but no statistically significant difference in diastolic blood pressure for the control group between the pre- and post-intervention time points.

Triglyceride levels: (1) The simple group-effect test showed no significant group difference in triglyceride levels for the pre-intervention measurement. The post-test and follow-up test showed statistically significant group differences in triglyceride values ($P < .001$), with average values of 134.14 vs 182.01, and 132.66 vs 181.53. The results showed that in the follow-up test, the experimental group showed statistically and significantly enhanced triglyceride control compared with the control group. (2) The simple group-effect of the intervention time point showed that the experimental group demonstrated significantly different triglyceride levels at different intervention time points ($P = .016$), with an average triglyceride value of 159.90 before intervention and 132.66 after intervention. Therefore, we observed significant improvement in average triglyceride value for the experimental group after the individualized health education intervention, but no statistically significant difference in triglyceride levels for the control group between the pre- and post-intervention time points.

Blood sugar: (1) The simple group-effect test showed a significant group difference in blood sugar for the pre-intervention measurement ($P = .006$), with average values of 155.36 vs 127.60; however, no significant group difference of blood sugar was observed for the post-intervention measurement. (2) The simple group-effect of intervention time point showed a borderline significant difference in blood sugar value for the 2 groups ($P = .056$). For the experimental group, the average blood sugar value was 155.36 before intervention and 130.97 after intervention. We observed no statistically significant difference in blood sugar for the control group between the pre- and post-intervention measurements.

4 Labels of Figures and Tables

Table 1: Attributes and physical examination data analysis of the experimental group and the control group (N=248)

Variables	Experimental group (N＝127) N (％)/Mean±SD	Control group (N＝121) N(％)/Mean±SD	χ^2 /t	P-Value
Age	64.33±12.24	67.07±11.90	-1.783	**.076**
Age			2.589	**.274**
< 40	3(2.4)	3(2.5)		
40-60	41(32.3)	28(23.1)		
>60	83(65.3)	90(74.4)		
Gender			0.029	**.865**
Male	79(62.2)	74(61.2)		
Female	48(37.8)	47(38.8)		
Education Level			4.169	**.124**
Illiterate	48(37.8)	59(48.8)		
Elementary/ Junior High	52(40.9)	46(38.0)		
Senior High/ Vocation Education and above	27(21.3)	16(13.2)		
Occupation			0.377	**.539**
No	76(59.8)	77(63.6)		
Yes	51(40.2)	44(36.4)		
Smoking			0.084	**.772**
No	101(79.5)	98(81.0)		
Yes	26(20.5)	23(19.0)		
Drinking			0.755	**.385**
No	104(81.9)	104(86.0)		
Yes	23(18.1)	17(14.0)		
Betel Nut consumption			0.010	**.920**
No	119(93.7)	113(93.4)		
Yes	8(6.3)	8(6.6)		
History of urinary tract Infection			0.448	**.503**
No	89(70.1)	80(66.1)		
Yes	38(29.9)	41(33.9)		
BMI			0.268	**.605**
＜27	63(49.6)	64(52.9)		
≧27	64(50.4)	57(47.1)		
Blood Pressure			2.087	**.149**
Normal	22(17.3)	30(24.8)		
Abnormal	105(82.7)	91(75.2)		
Triglyceride			0.510	**.475**
Normal	72(56.7)	74(61.2)		
Abnormal	55(43.3)	47(38.8)		
Cholesterol			2.039	**.153**
Normal	92(72.4)	97(80.2)		
Abnormal	35(27.6)	24(19.8)		
LDL Cholesterol			0.152	**.697**
Normal	96(75.6)	94(77.7)		
Abnormal	31(24.4)	27(22.3)		
Creatinine			0.000	**.982**

Normal	88(69.3)	84(69.4)		
Abnormal	39(30.7)	37(30.6)		
Glomerular filtration rate			0.388	**.824**
≧90	10(7.9)	9(7.5)		
60-89.9	41(32.3)	35(28.9)		
45-59.9	76(59.8)	77(63.6)		

1. Chi-square (χ^2) test is applied, significance level α=.05 (Two-tailed Test)
2. Independent-sample t test is applied, significance level α=.05 (Two-tailed Test)

Table 2: Comparison of physiological and biochemical indicators between experimental and control groups before and after intervention (N=127)

Variables	Pre-test Mean±SD	Post-test Mean±SD	Follow-up test Mean±SD	Follow-up test – Pre-test Mean±SD	t^a
Systolic blood pressure					
Experimental group	142.87±18.25	134.97±18.08	130.63±16.19	-12.24±16.51	**-8.357***
Control group	139.35±20.55	138.76±19.29	141.95±18.90	2.60±17.50	**1.648**
t^b	**1.43**	**-1.598**	**-5.074***	**-6.874***	
Diastolic blood pressure					
Experimental group	85.37±12.72	80.68±12.80	77.98±10.92	-7.39±13.45	**-6.195***
Control group	77.79±11.28	78.58±11.76	80.43±10.11	2.64±10.58	**2.748**
t^b	**4.961***	**1.343**	**-1.834**	**-6.547***	
Body weight					
Experimental group	71.71±13.46	71.57±13.54	71.13±13.46	-0.57±1.12	**-5.766***
Control group	68.99±12.33	69.09±12.33	69.30±12.27	0.31±1.33	**2.570*
t^b	**1.658**	**1.512**	**1.121**	**-5.677***	
BMI					
Experimental group	27.50±4.51	27.44±4.50	27.27±4.48	-0.24±0.45	**-6.000***
Control group	26.67±4.00	26.71±3.99	26.80±3.96	0.13±0.54	**2.558*
t^b	**1.540**	**1.361**	**0.876**	**-5.784***	
Creatinine					
Experimental group	1.20±0.29	1.16±0.27	1.17±0.27	-0.03±0.17	**-2.062*
Control group	1.19±0.26	1.22±0.27	1.23±0.28	0.04±0.17	**2.369*
t^b	**0.307**	**-1.880**	**-1.646**	**-3.312**	
Glomerular filtration rate					
Experimental group	62.34±17.71	64.59±16.68	63.59±15.30	1.25±10.33	**1.364**
Control group	61.00±14.69	59.10±13.88	59.25±14.77	-1.76±9.43	**-2.049*
t^b	**0.646**	**2.281**	**2.273*	**2.390*	

Blood sugar					
Experimental group	155.36±92.51	137.72±79.19	130.97±77.73	-24.39±59.52	**-4.619*****
Control group	127.60±60.69	136.45±67.46	137.34±70.13	9.74±53.95	**1.987**
t^b	**2.807****	**0.136**	**-0.677**	**-4.736*****	
Glycated hemoglobin					
Experimental group	6.53±3.60	6.10±3.23	6.08±3.23	-0.50±1.21	**-4.612*****
Control group	6.42±2.72	6.55±2.78	6.61±2.82	0.19±0.89	**2.370***
t^b	**0.267**	**-1.180**	**-1.371**	**-5.114*****	
Cholesterol					
Experimental group	180.40±38.73	174.85±38.70	174.72±42.91	-5.68±44.80	**-1.438**
Control group	169.34±38.54	175.96±41.29	170.45±35.89	1.12±30.44	**0.403**
t^b	**2.254***	**-0.218**	**0.848**	**-1.409**	
Triglyceride					
Experimental group	159.90±97.98	134.14±78.03	132.66±74.57	-27.24±80.23	**-3.826*****
Control group	163.77±13.81	182.01±109.46	181.53±111.06	17.76±107.10	**1.824**
t^b	**-0.287**	**-3.949*****	**-4.048*****	**-3.756*****	
Low-density lipoprotein cholesterol					
Experimental group	107.93±35.72	108.98±37.07	106.87±36.51	-1.06±40.95	**-0.293**
Control group	104.75±33.85	102.88±33.32	101.81±32.86	-2.94±28.90	**-1.120**
t^b	**0.718**	**1.359**	**1.145**	**0.416**	
Urine total protein					
Experimental group	1231±2019.09	1005.96±1708.59	781.06±1370.18	450.44±1502.09	**-3.379****
Control group	769.78±1688.19	807.93±2446.48	912.71±2692.50	142.93±1845.33	**0.852**
t^b	**1.540**	**1.361**	**0.876**	**-5.784*****	

Note: t^a Paired-sample t test (follow-up and pre-test), t^b Independent sample t-test, significant criteria α=.05(two-tailed test). *p<.05, **p<.01, ***p<.001

Table 3: Comparison of physiological and biochemical tests between two groups for pre-, post-, and follow-up tests

Source of variance	*SS*	*df*	*MS*	*F*	*P*
Systolic blood pressure					
Group effect	2365.23	1	2365.23	6.776	**.009**
Time point of intervention effect	2806.48	2	1403.24	4.020	**.018**
Interaction between group and time point	7672.28	2	3836.14	10.990	**.001**
Diastolic blood pressure					
Group effect	1079.74	1	1079.74	7.957	**.005**
Time point of intervention effect	794.82	2	397.41	2.929	**.054**
Interaction between group and time point	3130.99	2	1565.50	11.54	**.001**
Body weight					
Group effect	1025.71	1	1025.71	6.139	**.013**
Time point of intervention effect	2.58	2	1.29	.008	**.992**
Interaction between group and time point	26.09	2	13.04	.078	**.925**
BMI					
Group effect	86.15	1	86.15	4.762	**.029**
Time point of intervention effect	.43	2	0.22	.012	**.988**
Interaction between group and time point	4.38	2	2.19	.121	**.886**
Creatinine					
Group effect	.26	1	.26	3.420	**.065**
Time point of intervention effect	.01	2	.003	.044	**.957**
Interaction between group and time point	.21	2	.11	1.435	**.239**
Glomerular filtration rate					
Group effect	2576.71	1	2576.71	10.607	**.001**
Time point of intervention effect	23.02	2	11.51	.047	**.954**
Interaction between group and time point	569.09	2	284.55	1.171	**.311**
Cholesterol					
Group effect	4179.06	1	4179.06	2.689	**.101**
Time point of intervention effect	1108.06	2	554.03	.356	**.700**
Interaction between group and time point	4610.12	2	2305.06	1.483	**.228**
Triglyceride					
Group effect	209052.45	1	209052.45	21.579	**.001**
Time point of intervention effect	3100.80	2	1550.40	.160	**.852**
Interaction between group and time point	81818.99	2	40909.50	4.223	**.015**
Low-density lipoprotein cholesterol					
Group effect	4238.65	1	4238.65	3.467	**.063**
Time point of intervention effect	554.70	2	277.35	.227	**.797**
Interaction between group and time point	270.61	2	135.30	.111	**.895**
Blood sugar					
Group effect	10611.88	1	1061.88	1.861	**.173**
Time point of intervention effect	6736.57	2	3368.28	.591	**.554**
Interaction between group and time point	39777.58	2	19888.79	3.488	**.031**
Glycated hemoglobin					
Group effect	15.76	1	15.76	1.655	**.199**
Time point of intervention effect	3.10	2	1.55	.163	**.850**
Interaction between group and time point	14.98	2	7.49	.786	**.456**
Urine total protein					
Group effect	5760657.69	1	5760657.69	1.395	**.238**
Time point of intervention effect	2976412.84	2	1488206.42	.360	**.698**
Interaction between group and time point	1.095E7	2	5476744.28	1.326	**.266**

Note: Use Two-Factor ANOVA (mixed design), significance criteriaα=.05 (two-tailed test)

Table 4: Main effect tests for physiological and biochemical tests between two groups for pre-, post-, and follow-up tests

Source of variance	*SS*	*df*	*MS*	*F*	*P*
Systolic blood pressure					
Group (Factor A)					
Pre-test	1205.74	1	1205.74	3.095	**.080**
Post-test	890.91	1	890.91	2.553	**.111**
Follow-up test	7940.87	1	7940.87	25.741	**<.001**
Time point of intervention (Factor B)					
Experimental group	9789.09	2	4894.54	15.924	**<.001**
Control group	904.62	2	452.31	1.151	**.317**
Diastolic blood pressure					
Group (Factor A)					
Pre-test	3564.87	1	3564.87	24.609	**<.001**
Post-test	272.91	1	272.91	1.803	**.181**
Follow-up test	373.96	1	372.96	3.364	**.068**
Time point of intervention (Factor B)					
Experimental group	3555.34	2	1777.67	11.995	**<.001**
Control group	445.71	2	222.85	1.818	**.164**
Triglyceride					
Group (Factor A)					
Pre-test	928.48	1	928.48	.083	**.774**
Post-test	141971.56	1	141971.56	15.840	**<.001**
Follow-up test	147971.41	1	147971.41	16.692	**<.001**
Time point of intervention (Factor B)					
Experimental group	59578.65	2	29789.33	4.206	**.016**
Control group	26149.90	2	13074.95	1.053	**.350**
Blood sugar					
Group (Factor A)					
Pre-test	47774.97	1	47774.97	7.731	**.006**
Post-test	99.92	1	99.92	.018	**.892**
Follow-up test	2514.56	1	2514.56	.458	**.499**
Time point of intervention (Factor B)					
Experimental group	40292.30	2	20146.15	2.896	**.056**
Control group	7026.65	2	3513.33	.801	**.449**

Note: use Two-Factor ANOVA for the tests of simple main effects, significant criteria α=.05 (two-tailed test)

5 Discussion

In this study, the experimental group showed significant improvement in blood pressure after 9 months of individualized health education intervention. The systolic and diastolic blood pressures were 142.87 vs 130.63 and 85.37 vs 77.98. Related studies have found that patients with a glomerular filtration rate lower than 60 showed significant improvements in blood pressure after 1 year of care intervention, and both diastolic and average blood pressures significantly differed [9]. Another study found altered diastolic blood pressure for the experimental group after 9 months of healthy lifestyle intervention.

The median change in diastolic blood pressure was -7 mmHg and 2 mmHg (*P* = .001) for the experimental and the control group, respectively [10]. Other studies have shown significantly reduced systolic blood pressure from 155 mmHg to 149 mmHg for 726 patients after 1 year of referral care [8]. Balagopal, Kamalamma, Patel, and Misra (2012) observed reduced systolic and diastolic blood pressure of 8 mmHg and 4 mmHg, respectively, after 6 months of intervention care for 1638 patients [11].

Body weight and BMI showed statistically significant reductions of 0.57 kg and 0.24 kg/m^2 ($P < .001$) after intervention. One study showed significantly improved body weight after 4 individualized management care sessions during 1 year of intervention [12]. Another study showed a 0.4 kg/m^2 reduction in BMI after 1 year of knowledge intervention, with no statistical difference in body weight [13]. Other studies have shown significantly reduced body weight in the experimental group receiving health education intervention with a self-monitoring diary and recording daily diet and exercise for 12 weeks. The body weight reductions were -5.7 kg vs -2.1kg for the experimental and control groups, respectively [14]. These results were similar to our findings.

In this study, the experimental group showed improved creatinine and glomerular filtration rate after intervention, whereas the control group not receiving health education intervention exhibited significantly lower performance in these variables. This result is consistent with previous findings that renal functions significantly improved after care intervention [4,8,9,13]; another study showed that the creatinine and glomerular filtration rate change for patients who participated in routine follow-up care in the CKD health education plan could be effectively delayed [15].

The blood sugar and glycated hemoglobin in the experimental group showed significant improvement over the control group, consistent with previous studies [9,10,12,16]. The experimental group in other studies have shown a 0.9% [17], 0.68% [18], and 0.29% [19] decrease in glycated hemoglobin after 6 and 24 months of intervention.

Additionally, the experimental group in this study showed statistically significant improvement in triglyceride levels. Although improved cholesterol and low-density lipoprotein cholesterol was not statistically significant, we observed an improved trend after intervention. Kuo et al (2005) and Chen et al (2010) have shown statistically significant differences in cholesterol, low-density lipoprotein cholesterol, and triglyceride levels after 1 year of case-management care intervention. Our results are not identical to theirs, probably because of the different timing of the intervention effectiveness assessment. The ratio of total protein in urine for the experimental group showed statistically significant improvement after intervention. These results indicate that effective management of blood pressure, blood sugar, and blood lipids effectively improves proteinuria and delays deteriorating renal function [20,21,22].

We used a mixed-design 2-way ANOVA to simultaneously consider the effects of group and intervention time points for the physiological and biochemical test values. Our results showed statistically significant group effects for systolic and diastolic blood pressure, body weight, BMI, glomerular filtration rate and triglyceride levels and a significant difference in systolic blood pressure between pre- and post-intervention tests. These values could differ according to the groups or time-points of intervention. The significant interactions between the groups and time-points of intervention for systolic blood pressure, diastolic blood pressure, and triglyceride and blood sugar levels required conducting simple effect tests. Table 4 shows that the average values of systolic blood pressure, diastolic blood pressure, and triglyceride statistically and significantly improved after intervention for the experimental group receiving individualized health education interventions. These results are similar to the findings of Hao et al (2007), Chen et al (2010), and Anderson et al (2009). Related studies have shown that the instructions regarding an understanding of the importance of a healthy lifestyle assisted patients in significantly reducing their body weight, waist circumference, and BMI, thereby reducing the incidence of metabolic syndrome [23,24], and subsequently reducing the incidence of CKD.

The early symptoms of kidney disease are not obvious. An early diagnosis of kidney disease, with early treatment and individualized health care instruction, can help patients adjust their lifestyle and delay the progression of disease processes [25,26]. Our results confirm that individualized health care intervention measures improve the physiological and biochemical indicators in patients with early-stage chronic kidney disease and retard the deterioration of renal functions.

This study has some limitations. Because the participants were outpatients of a regional hospital in Southern Taiwan, a selection bias might have been present; thus, the study findings cannot be generalized to all early stages of CKD patients. Because of limited manpower, time, and funding, the time spent gathering cases lasted only 9 months, which was insufficient for extending the investigation toward improving the effectiveness of the intervention measures.

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