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Original Article

Multidisciplinary Care Associated with Quality of Life in Older Chronic Kidney Disease Patients: A Cross-Sectional Analysis

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SUMMARY

Background: Chronic kidney disease (CKD) is prevalent in older adults and associated with reduced quality of life (QOL). The Taiwan nationwide multidisciplinary care (MDC) program for non-dialysis CKD patients (mainly stage 3b–5) was proven to improve patient outcomes, but its association with intrinsic capacity (IC), activities of daily living (ADL) and QOL remains underexplored. This study aimed to examine the associations between MDC laboratory parameters with QOL, and possible mediation effect.
Methods: A cross-sectional, observational study was conducted in a tertiary hospital in Taiwan. Outpatients enrolled in the MDC program was recruited and underwent assessments of IC (ICOPES-TW), basic ADL, instrumental ADL, frailty, and QOL (WHOQOL-AGE). Routinely monitored laboratory parameters (electrolytes, albumin, hemoglobin) served as MDC effectiveness indicators. Structural equation modeling (SEM) was employed to explore direct and mediating relationships.
Results: The 322 participants were older (mean age 74.1 years) with 81.6% of advanced CKD. Limited mobility (40%) was the most common IC deficit, while the others ranged from 7% to 11%. In linear regressions, IADL was most associated with QOL ($p < 0.001$); cognition was most associated with IADL ($p < 0.001$). Levels of phosphate, albumin, and hemoglobin were correlated significantly with QOL in Spearman's correlation analyses. SEM showed the composite of laboratory parameters were associated with QOL, partially (20.6%) through mediation of instrumental ADL.
Conclusion: Effectiveness of MDC, as monitored by specific laboratory parameters, correlated with the QOL of older, non-dialysis CKD patients, partially through the mediation of IADL. Cognition and mobility also associated with IADL but not our MDC parameters.

1. Introduction

Chronic kidney disease (CKD) is a prevalent global health issue affecting approximately 10–13% of the population, with a notably high prevalence among older adults.[1] In Taiwan, while transitioning into super-aged society, 37.2% of adults over 65 years are affected by CKD.[2] The condition significantly impacts activities of daily living (ADL),[3] quality of life (QOL),[4] and mortality,[5] particularly among older individuals. Consequently, QOL has emerged as a critical focus in CKD care, emphasizing patient-centered outcomes beyond mere survival.

Taiwan's nationwide multidisciplinary CKD care (MDC) program targets non-dialysis CKD stages 3b to 5 (See Supplement A). Previous studies demonstrated its effectiveness in improving renal outcomes,[6] survival rates,[7] and reducing medical costs.[8] This program aims to maintain critical laboratory parameters (electrolytes, hemoglobin, nutrition indicators) within normal ranges through patient education and lifestyle modifications. Yet, their direct association with QOL and functional status remains underexplored, especially among older patients.[9]

Intrinsic capacity (IC)[10] provides a comprehensive approach to assessing older adults' health and is widely implemented through the ICOPE framework, including in Taiwan.[11] IC usually includes cognition, locomotion, nutrition, vision, hearing, and psychological status,[11,12] all of which are highly relevant to common health issues observed in patients with CKD.[13,14] IC is known to predict functional decline,[15,16] frailty,[17] and reduced QOL;[18] however, research exploring IC's relationship with QOL within the CKD population is limited.

Our study aimed to investigate the associations among MDC effectiveness (measured by routine laboratory data), IC, functional outcomes (ADL and frailty), and QOL in older, community-dwelling, non-dialysis CKD outpatients, a population facing risks of functional decline. We hypothesized that effective CKD management through the MDC program, reflected in routinely monitored laboratory para-

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meters, would correlate with improved IC, functional status, frailty, and ultimately mediated to better QOL. Our primary conceptual model is illustrated in Figure 1, depicting the potential relationships among these variables.

2. Materials and methods

2.1. Study design

This study was a cross-sectional observational study, conducted at National Cheng Kung University Hospital (NCKUH), a tertiary hospital in Tainan, Taiwan, and approved by the Institutional Review Board (A-ER-101-089), and obtained individual informed consent before clinical assessments. This study was conducted in three steps. First, we examined the associations among the IC domains, frailty, functional status (BADL/IADL), and QOL. Second, we used the regularly monitored laboratory data under the MDC program (see Section 2.4) as parameters of CKD care quality and determined their associations with IC domains, frailty, BADL, IADL, and QOL. Third, we employed structural equation modeling (SEM) to assess the latent "effective MDC" concept and its association with QOL.

2.2. Study participants, MDC program, and MDC program associated laboratory parameters

Community-dwelling, non-dialysis CKD patients over 60 years[10,19] who participated in the MDC program were recruited from the nephrology outpatient department between July 1, 2022, and June 30, 2024. The MDC program enrollment criteria were advanced CKD (eGFR < 45 ml/min/1.73 m^2) or heavy proteinuria (urine protein-creatinine ratio > 1000 mg/g). The program provides health education, dietary education, and medication management.[7]

Laboratory data were routinely collected every three months. We selected six key markers — sodium (Na), potassium (K), calcium (Ca), phosphate (P), albumin (Alb), and hemoglobin (Hb) — as "MDC parameters" to evaluate program effectiveness objectively. These parameters reflect major MDC interventions, including dietary control (Na, K, P), nutritional status (Alb, P, Hb), mineral bone disorder (Ca, P), and renal anemia (Hb) (Table 1, and Supplement Table B1).

Our MDC parameters didn't include blood urea nitrogen and creatinine, as they primarily reflect CKD severity rather than care quality. Instead, CKD stage was included as a confounding factor in the regression models, given its strong association with patient baseline, underlying disease etiology, care complexity, ADL, and QOL.

2.3. Assessment of intrinsic capacity, functional status, frailty, and QOL

The ICOPES-TW integrated with the Geriatric 4Ms model,[20] and

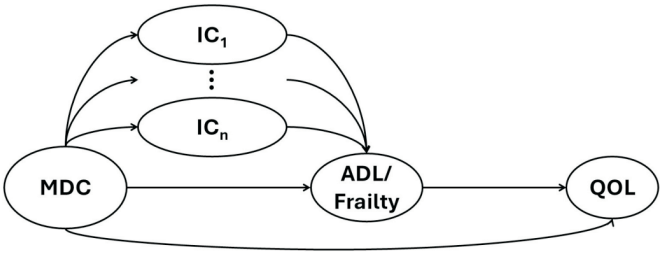

Figure 1. Primary conceptual model for the relationship between effective MDC, IC domains, ADL, and QOL: effective MDC (measured by laboratory parameters) may be associated with QOL, through mediation of IC and ADL. Abbreviations: ADL, activities of daily living; IC, intrinsic capacity; MDC, multidisciplinary care; QOL, quality of life.

Table 1

(A) Patient characteristics.

Total	322 (100%)
Age (year)	74.1 ± 6.9
60–69	99 (30.75%)
70–79	143 (44.41%)
80–89	75 (23.29%)
≥ 90	5 (1.55%)
Sex (female)	177 (54.97%)
Education (year)	
≤ 6	156 (48.6%)
7–12	111 (34.58%)
> 12	54 (16.82%)
Alcohol	
Quit	34 (10.56%)
Using	10 (3.11%)
Smoking	
Quit	22 (6.83%)
Using	5 (1.55%)
MDC program enrollment duration (year)	4.71 [1.90, 11.31]
Hypertension	263 (81.68%)
Diabetes mellitus	230 (71.43%)
Cancer	9 (2.8%)
Chronic kidney disease	
Stage ≤ 2	28 (8.81%)
Stage 3a	27 (8.49%)
Stage 3b	75 (23.58%)
Stage 4	104 (32.7%)
Stage 5	84 (26.42%)

Data are presented as n (%), mean ± SD, median [Q1, Q3].

(B) Patient measurements.

Parameters for CKD care	
Abnormal potassium	33 (10.38%)
< 3.5 (mmol/l)	9 (2.83%)
> 5.0 (mmol/l)	24 (7.55%)
Abnormal sodium	20 (6.31%)
< 135 (mmol/l)	18 (5.68%)
> 145 (mmol/l)	2 (0.63%)
Abnormal calcium	42 (13.29%)
< 8.6 (mg/dl)	20 (6.33%)
> 10.0 (mg/dl)	22 (6.96%)
Abnormal phosphate	60 (19.05%)
< 2.5 (mg/dl)	5 (1.59%)
> 4.5 (mg/dl)	55 (17.46%)
Abnormal albumin (< 3.5 g/dl)	12 (3.83%)
Anemia[a]	224 (70.22%)
ICOPE intrinsic capacities	
A. Cognitive impairment	24 (7.45%)
B. Limited mobility	122 (40%)
C. Malnutrition	32 (10.49%)
D. Visual impairment	26 (8.52%)
E. Hearing loss	29 (9.51%)
F. Depressive symptoms	27 (8.85%)
Functional and QOL measures	
CFS	2.5 ± 0.98
	2.0 [2.0,3.0]
BADL	95.8 ± 12.10
	100.0 [100.0,100.0]
IADL disability	1.2 ± 2.31
	0.0 [0.0,1.0]
WHOQOL-AGE	33.5 ± 5.09
	34.0 [30.0,38.0]

[a] Hemoglobin level < 12.0 g/dl in female and < 13.0 g/dl in male are labelled as anemia.

Data are presented as n (%), mean ± SD, median [Q1, Q3].

Abbreviations: BADL, basic activity of daily living; CFS, clinical frailty scale; IADL, instrumental activity of daily living; ICOPE, integrated care for older people; Q1, first quantile; Q3, third quantile; SD, standard deviation; WHOQOL-AGE, World Health Organization Quality of Life Instrument – Older Adults Module.

had been validated with satisfactory psychometric properties in Taiwanese older adults.[10,21] The six typical IC domains (cognition, locomotion, nutrition, vision, audition, psychology) comprised a total of 10 items, measured by either self-report or interviewer-conducted assessments. BADL was measured by the Barthel Index (BI). IADL was measured by the Lawton Instrumental Activities of Daily Life Scale (Lawton IADLS). The psychometric properties of BI and Lawton IADLS have been validated among older Taiwanese.[22,23] Frailty was measured by the Clinical Frailty Scale (CFS),[24] which was translated and validated among older Taiwanese people.[25] QOL was measured using the Taiwan version of the WHOQOL-AGE questionnaire.[26] The Taiwan version of WHOQOL-AGE, and had been translated and validated[26] (see Supplementary B for detail).

2.6. Statistical analysis

Descriptive statistics were used to summarize participant characteristics, presented as frequency (percentage) for categorical variables, and as mean (standard deviation, SD) or median (interquartile range, IQR). Linear regression and Spearman's correlation coefficient was used to assess correlations between variables. We constructed two proposed structural equation models (SEM) based on our primary conceptual model (Figure 1). For both models, we constructed a continuous latent variable "effective MDC" from the binary MDC parameters (see Section 2.3), where higher indicates more effective MDC in maintaining normal laboratory data. The first (Figure 2) was simplified, containing only effective MDC and QOL to test their direct association. The second proposed model (Figure 3) resembled the primary conceptual model, which included IC domains, frailty, or ADL (BADL, IADL, or both) as potential mediators. We utilized the findings of the linear regression models to decide whether each potential mediator would be included in the model. The model was estimated using the diagonally weighted least squares (DWLS) method to account for categorical data used in the SEM. We controlled for confounding factors of age, sex, education, alcohol consumption, smoking, hypertension, DM, cancer, and CKD stage. A chi-squared test examined the discrepancy between the observed data and the model's predicted covariance structure. Model fit was assessed using the comparative fit index (CFI), Tucker-Lewis index (TLI), root mean square error of approximation (RMSEA), and standardized root mean squared residual (SRMR). Acceptable fit thresholds were set at CFI and TLI > 0.90, RMSEA < 0.07, and SRMR < 0.08. The mediation effect was analyzed using the Sobel test, considering an indirect effect significant at a p-value < 0.05.[27] SEM was conducted using the lavaan package in R (version 0.6-11), while SPSS 20 (IBM, Armonk, NY) was used for other statistical analyses. All tests were two-tailed, with significance set at $p < 0.05$ and marginal significance set at p between 0.05 and 0.10.

3. Result

3.1. Characteristics and prevalence of disability

322 patients were recruited. The mean age was 74.1 ± 6.9 years. Most (82.7%) patients had advanced CKD (stages 3b to 5) (Table 1 (A)). Anemia (70.2%) was the most common abnormality, followed by hyperphosphatemia (17.46%) and hyperkalemia (7.55%) (Table 1 (B)). The median time interval from laboratory data collection to recruitment was 4 days (IQR: 3.0, 7.0).

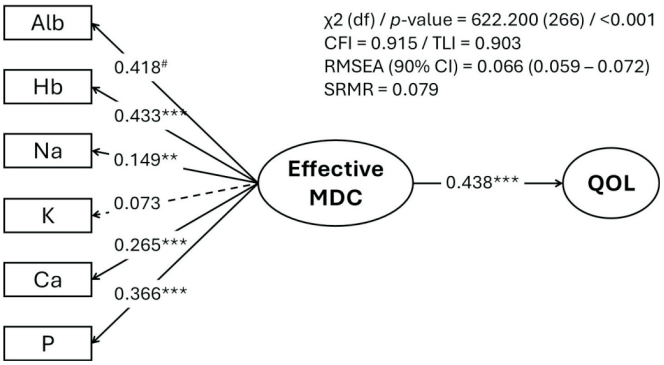

Figure 2. Structural equation model for effective MDC and QOL: Effective MDC was positively associated with better QOL. Abbreviations: CFI, comparative fit index; CI, confidence interval; df, degrees of freedom; effective MDC, effective multidisciplinary care by laboratory data-derived parameters; QOL, quality of life; RMSEA, root mean square error of approximation; SRMR, standardized root mean squared residual; TLI, Tucker-Lewis Index. # Factor loading constraint, * p < 0.05, ** p < 0.01, *** p < 0.001.

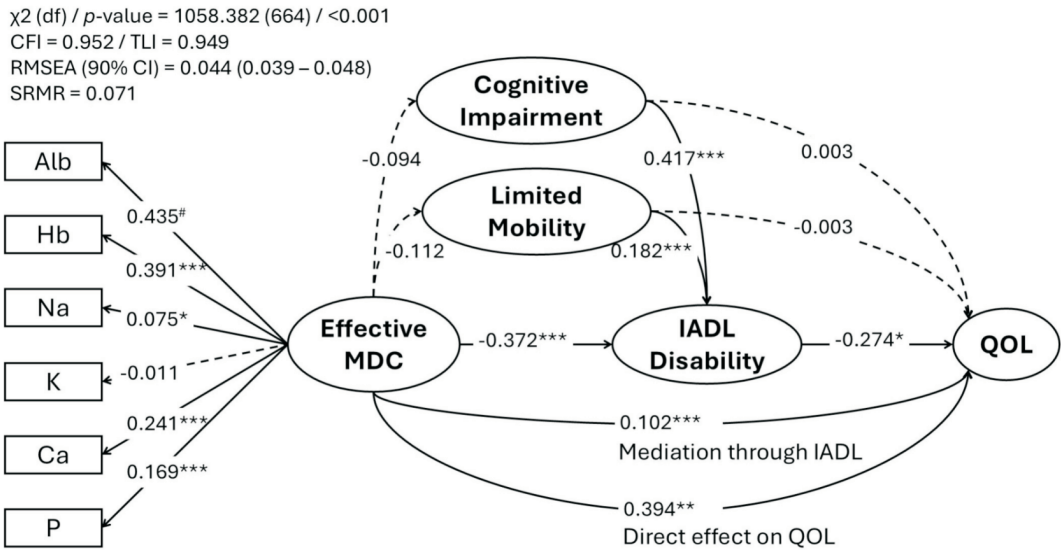

Figure 3. Structural equation model for effective MDC, IC domains, IADL, and QOL: Effective MDC was associated with better QOL, with both direct and indirect effects. Indirect effect was through the mediation of IADL, but not less cognitive impairment or limited mobility. Abbreviations: CFI, comparative fit index; CI, confidence interval; df, degrees of freedom; IADL, instrumental activities of daily living; effective MDC, effective multidisciplinary care by laboratory dataderived parameters; QOL, quality of life; RMSEA, root mean square error of approximation; SRMR, standardized root mean squared residual; TLI, Tucker-Lewis Index. # Factor loading constraint, * p < 0.05, ** p < 0.01, *** p < 0.001.

Limited mobility (40.0%) was the most common disability; the prevalence of the other disability ranged from 7% to 11%. Most patients (82.5%) were fully independent in BADL. In the CFS, 65.8% of patients were classified as fit or better, and only 6.52% were moderately frail or worse. 28.8% showed disability in at least one aspect of instrumental ADL. The mean score of WHOQOL-AGE was 33.5 ± 5.1 (Table 1 (B)).

3.2. Associations between IC, functional status, and QOL (step 1)

In step 1, we identified which domains of IC or functional status were most strongly associated with QOL, and the multivariate regression analyses showed only IADL remained a significant predictor of QOL (standardized coefficient β = -0.117, p = 0.036). We then explored which IC components contributed to IADL limitations. Cognitive impairment was significantly associated with IADL disability (β = 0.258, p < 0.001), while limited mobility showed weaker borderline significance (β = 0.080, p = 0.103).

3.3. Associations between MDC parameters, and functional and QOL measures or IC domains (step 2)

Among MDC laboratory parameters, albumin and hemoglobin were most consistently associated with BADL, IADL, and QOL, reflecting their association in nutritional and anemia-related status. When focusing on IC domains, only a few weak associations were found — such as low albumin or calcium with malnutrition, and sodium or albumin with visual impairment. Notably, no significant correlations were observed between MDC parameters and core capacities shown in step 1, like cognition or mobility, suggesting a possible gap between biomedical monitoring and functional aging indicators (Table 3).

3.4. Association and mediators between effective MDC and QOL in proposed SEM models (step 3)

The results of the first proposed SEM model (Figure 2) was simplified from the primary conceptual model (Figure 1) and shows that effective MDC was positively associated with better QOL (β = 0.438, p < 0.001). The model showed a good fit (χ^2 test p < 0.001; CFI = 0.915, TLI = 0.903, RMSEA = 0.066, and SRMR = 0.079). In addition, Figure 3 is the results of the second (full) proposed SEM model and shows that effective MDC was associated with better QOL partially through the mediation of IADL but not cognitive function or mobility. This model incorporated potential mediation by two IC domains (cognitive impairment and limited mobility), and IADL; frailty, BADL, and other IC domains were excluded based on the results of linear regressions. The model showed a good fit (χ^2 test p < 0.001; CFI = 0.952, TLI = 0.949, RMSEA = 0.044, and SRMR = 0.071). The individual factor loadings for each MDC parameter were shown in supplement Table B3.

Table 2
Regression analyses of QOL and IADL on IC domains, ADL, and IADL.

	Association with QOL		Association with IADL [a]	
	Univariate regression	Multivariate regression [b]	Univariate regression	Multivariate regression [b]
Intrinsic capacity domains [c]				
A. Cognitive impairment				
Unstandardized coefficient (95% CI)	*-2.095 (-4.302, 0.113)*	0.601 (-1.572, 2.774)	**2.855 (1.898, 3.812)**	**2.361 (1.449, 3.274)**
p value	*0.063*	0.587	**< 0.001**	**< 0.001**
B. Limited mobility				
Unstandardized coefficient (95% CI)	**-1.203 (-2.326, -0.081)**	-0.274 (-1.333, 0.785)	**0.721 (0.214, 1.228)**	0.371 (-0.075, 0.818)
p value	**0.036**	0.611	**0.005**	0.103
C. Malnutrition				
Unstandardized coefficient (95% CI)	-0.448 (-2.319, 1.423)		-0.384 (-1.232, 0.464)	
p value	0.638		0.374	
D. Visual impairment				
Unstandardized coefficient (95% CI)	-1.21 (-3.261, 0.841)		0.372 (-0.56, 1.303)	
p value	0.247		0.433	
E. Hearing loss				
Unstandardized coefficient (95% CI)	-1.001 (-2.954, 0.952)		**1.076 (0.197, 1.956)**	0.203 (-0.601, 1.008)
p value	0.314		**0.017**	0.619
F. Depressive symptoms				
Unstandardized coefficient (95% CI)	-1.27 (-3.285, 0.745)		0.191 (-0.726, 1.108)	
p value	0.216		0.682	
Functional measures				
BADL/100 [d]				
Unstandardized coefficient (95% CI)	**15.695 (11.4, 19.989)**	4.893 (-1.551, 11.337)		
p value	**< 0.001**	0.136		
IADL disability				
Unstandardized coefficient (95% CI)	**-0.954 (-1.172, -0.735)**	**-0.670 (-1.021, -0.319)**		
p value	**< 0.001**	**< 0.001**		
CFS				
Unstandardized coefficient (95% CI)	-0.302 (-0.866, 0.262)			
p value	0.293			

[a] Regression models between IC and IADL were constructed after IADL was identified as the only factor significantly associated with QOL in multivariable regression. [b] Age, sex, education, alcohol consumption, smoking, HTN, DM, cancer, and CKD stage were controlled in multivariate regression. [c] IC domains are binary, where 0 indicates normal, and 1 indicates disability. [d] ADL (Barthel Index) is divided by 100 to align its scale with other variables and improve model stability and interpretability.
Significant correlation (p < 0.05) is shown in **bold**, marginal significance (0.05 ≤ p < 0.10) is shown in *italic*.
Abbreviations: BADL, basic activity of daily living; IADL, instrumental activity of daily living; QOL, quality of life.

Table 3
Spearman's correlation between MDC parameters and IC, ADL and QOL.

MDC parameters [a]	Potassium	Sodium	Calcium	Phosphate	Albumin	Hemoglobin
Functional and QOL measures						
BADL/100 [b]						
r	-0.067	0.049	**0.140**	0.009	**0.254**	**0.150**
p value	0.234	0.381	**0.012**	0.876	**0.000**	**0.007**
IADL disability						
r	0.049	-0.085	-0.090	0.027	**-0.208**	**-0.163**
p value	0.378	0.130	0.106	0.632	**0.000**	**0.003**
Frailty						
r	-0.003	-0.025	0.010	0.007	0.024	0.014
p value	0.954	0.661	0.864	0.907	0.670	0.807
WHOQOL-AGE						
r	0.021	0.038	*0.107*	**0.170**	**0.199**	**0.216**
p value	0.704	0.497	*0.056*	**0.002**	**0.000**	**0.000**
Intrinsic capacity domains						
A. Cognitive impairment						
r	-0.018	-0.059	-0.025	-0.073	-0.078	-0.013
p value	0.745	0.288	0.656	0.189	0.162	0.813
B. Limited mobility						
r	0.019	0.042	0.013	0.076	-0.024	-0.041
p value	0.733	0.453	0.821	0.174	0.671	0.459
C. Malnutrition						
r	0.022	0.019	**-0.123**	-0.034	**-0.165**	-0.033
p value	0.694	0.737	**0.027**	0.540	**0.003**	0.558
D. Visual impairment						
r	-0.036	**-0.170**	-0.036	0.012	**-0.153**	-0.042
p value	0.518	**0.002**	0.520	0.837	**0.006**	0.455
E. Hearing loss						
r	0.045	0.010	0.040	-0.026	-0.049	-0.037
p value	0.418	0.855	0.471	0.644	0.384	0.508
F. Depressive symptoms						
r	0.074	-0.038	0.001	0.045	-0.011	*-0.097*
p value	0.186	0.499	0.989	0.424	0.846	*0.081*

[a] For all CKD care parameters, normal was set to 1 and abnormal was set to 0. [b] ADL (Barthel Index) is divided by 100 to align its scale with other variables and improve model stability and interpretability.
Significant correlation ($p < 0.05$) is shown in **bold**, marginal significance ($0.05 \leq p < 0.10$) is shown in *italic*.
Abbreviations: BADL, basic activity of daily living; IADL, instrumental activity of daily living; QOL, quality of life; WHOQOL-AGE, World Health Organization Quality of Life Instrument – Older Adults Module.

In Figure 3, effective MDC was negatively associated with IADL disability (β = -0.372, p < 0.001), suggesting that better MDC might reduce IADL limitations. IADL was further associated with QOL (β = -0.274, p = 0.011). Notably, effective MDC maintained a significantly direct association with QOL (β = 0.394, p = 0.002), along with a significantly indirect association mediated through IADL (β = 0.102, p < 0.001), accounting for 20.6% of the total effect. These findings suggest that improving patients' abilities in IADL may partly mediate the beneficial impact of MDC on QOL. Cognitive impairment (β = -0.417, p < 0.001) and limited mobility (β = 0.182, p < 0.001) were also significantly related to IADL disability, and mediated to QOL. However, effective MDC was not significantly associated with cognitive impairment or limited mobility.

4. Discussion

This study focused on the interactions between the composite of MDC parameters (referred to as "effective MDC"), IC, ADL, frailty, and QOL in older, community-dwelling, non-dialysis CKD patients. The results demonstrated that MDC, cognitive impairment, and limited mobility were significantly associated with QOL of CKD patients and were mediated by IADL disability. However, the associations between MDC parameters and IADL or QOL were not mediated through cognitive impairment or limited mobility, indicating potential room for improvement in the current MDC program.

To our knowledge, this is the first study to investigate the association of IC with QOL, specifically in the CKD population. The study cohort was predominantly composed of older adults with moderate to severe CKD, representing a critical group in CKD care given their higher risk for adverse outcomes. Our findings are compatible with studies in other community-dwelling older adults, showing the well-known interrelationship among cognition, mobility, IADL, and QOL.[16,19,28,29] The ceiling effect of BI[19,30] was also noticed in our study.

This is also the first study to explore the association between the MDC program and the QOL of CKD patients. Our findings support the use of routinely monitored laboratory data within the MDC program as meaningful indicators, and we found maintaining these parameters within normal ranges was associated with better IADL performance and QOL. To further explore the potential implication, we additionally constructed an alternative SEM model (Figure S1) that replaced laboratory parameters with behavioral markers (medication adherence, physical activity, and enrollment duration in the MDC program). The results were consistent with the original model. In another way, these results supported our hypothesis that laboratory parameters serve as proxies for medical adherence.

These laboratory data have long been recognized as being associated with disease status and complications of CKD.[31–35] In our study, no significant association was found between MDC parameters and either cognitive or locomotor function. However, previ-

ous studies have highlighted that hyponatremia,[36] hypoalbuminemia,[37] and anemia[38] impact cognitive and physical functions. This may be due to the relatively mild severity or short duration of laboratory abnormalities in our cohort, which consisted of well-functioning, community-dwelling older adults capable of attending outpatient visits. For example, no patients had serum sodium levels below 120 mmol/L, a threshold typically associated with cognitive impairment; severe abnormalities such as anemia were likely corrected promptly through standard care. As a result, IC could not adequately explain the mechanism linking MDC parameters to IADL.

Additionally, cognition and mobility were assessed using brief ICOPE-based tools, which may lack sensitivity to detect trivial impairments — especially in a relatively healthy population. These functions are also influenced by factors beyond the scope of MDC, such as dementia, stroke, and osteoarthritis, which were not fully assessed or adjusted for in our models.

These findings reveal a potential gap in the current MDC program, which lacks structured tools and targeted interventions to assess and manage declines in cognition and mobility — critical determinants of IADL and overall QOL in older patients with CKD. Although nurse educators routinely offer general advice on physical activity and provide basic lower-limb exercise instructions, no standardized cognitive assessments are conducted, and further evaluations or referrals are left to the discretion of individual nephrologists.

To address these shortcomings, routine frailty assessments and comprehensive cognitive evaluations should be incorporated beyond brief screening tools. Screening instruments such as ICOPES-TW followed by secondary evaluation could be helpful in guiding intervention.[39] Additionally, timely referral to neurology, psychiatry, or rehabilitation medicine specialists can significantly augment the current MDC model. Integrating interdisciplinary professionals — such as physical therapists, occupational therapists, and geriatric specialists — into MDC teams would strengthen patient-centered care by ensuring that cognitive and physical functioning are systematically addressed.

Despite its strengths, this study has several limitations. First, although CKD stage was included as a confounder, the rate of eGFR decline — important indicator for CKD care — was not analyzed. Given that eGFR trajectory is strongly influenced by underlying renal disease and that this study employed a cross-sectional design, its exclusion is considered acceptable. Proteinuria was also not included due to substantial missing data, as the current MDC program mandates only annual testing. Moreover, its potential impact on QOL may be partially captured by serum albumin levels. Second, while better MDC quality is theoretically linked to improved QOL, the cross-sectional nature of this study could not definitively concludes causality. Third, the direct impact of MDC education on health behaviors was not assessed. However, our supplementary SEM model (Figure S1), which incorporated behavioral indicators, yielded results consistent with the main model (Figure 3); in addition, separate analysis showed that enrollment duration of MDC program exceeding two years associated with better QOL (Supplementary Table B4). These results suggest that effective MDC is related to medical adherence and health behaviors. Fourth, we lacked data on socioeconomic status and social support, both of which may influence the impact of MDC on QOL. Future studies incorporating these variables may provide additional insight into patient outcomes. Fifth, the assessment of IC using the ICOPES-TW was relatively simple and limited in scope. While more comprehensive tools may provide a fuller understanding, our study was still able to identify cognition and mobility as key IC domains in older adults with CKD.

For future research, given that our study found MDC quality to be associated with IADL and QOL beyond the influence of IC (Figure 3), further investigation is needed to elucidate the underlying mechanisms of this relationship. Since cognition and mobility within the IC domains were also linked to QOL through IADL, future studies should include more comprehensive assessments of these domains. For example, the ICOPES-TW currently assesses cognition using only a short-term memory test; however, visuospatial and executive functions may also play critical roles in functional independence and quality of life and should be incorporated into future evaluations. A longitudinal study design would also be valuable to examine temporal and sustained changes in laboratory values, ADL, and QOL at the individual level. By addressing these gaps, the multidisciplinary CKD care program can be further developed to better meet the complex needs of this vulnerable population.

5. Conclusion

In conclusion, this study highlighted the relationships between laboratory data-derived MDC parameters, IC domains, functional status, and QOL in older, non-dialysis CKD patients. While the findings underscore the associations among routinely monitored laboratory data, IADL, and QOL, they also reveal the independence of cognitive and physical functions from these parameters. These results challenge the current multidisciplinary CKD care framework and emphasize the possible need for a more holistic approach that integrates assessments and interventions targeting cognitive and physical functions in older patients.

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Declaration of any potential conflict of interest

The authors declare that the research was conducted in the absence of any commercial, financial, or non-financial relationships that could be construed as a potential conflict of interest.

Supplementary materials

Supplementary materials for this article can be found at

http://www.sgecm.org.tw/ijge/journal/view.asp?id=36.

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