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Interprofessional Differences in Multidimensional Self-Efficacy Associated With Professional Performance in Nephrology During Case-Based Learning

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Introduction: Postgraduate medical education assumes rising importance in the rapidly advancing field of medicine. Case-based learning (CBL), a learner-centered pedagogy employing clinical cases to improve decision-making, is widely embraced in postgraduate medical education, including nephrology. Studies suggest that learning self-efficacy (SE) was closely associated with learning motivation and academic performance; however, very few studies examined this association in postgraduate nephrology education. None evaluated whether there were interprofessional differences concerning such association.

Methods: In 2022, we prospectively enrolled physicians and nurses participating in chronic kidney disease (CKD) care from institutions around Taiwan. They completed the Professional Medical Learning Self-efficacy (PMLS) questionnaire after attending >1 CBL session involving CKD care. We undertook confirmatory factor analysis (CFA), followed by structural equation modeling (SEM) to evaluate associations between 5 dimensions of learning SE (conceptual understanding [CU], higher-order cognitive skills [HC], practical work [PW], everyday application [EA], and medical science communication [MSC]) and their professional SE in nephrology according to participants' medical professions.

Results: A total of 513 healthcare providers were surveyed. The convergent and construct validity of our questionnaire were satisfied after analyses. We found that better perceived professional performance in the form of higher professional SE in nephrology was significantly associated with all 5 dimensions of learning SE among physicians and nurses. Only CU and PW were significantly associated with physicians' professional performance; whereas among nurses, only HC and MSC were significantly associated.

Conclusion: We showed that learning SE was an important determinant of nephrology professional performance. Different medical professions posed influences on major SE dimensions.

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Health science assumes increasing importance in modern society, and the effective dissemination and safe implementation of healthcare relies upon medical professionals demonstrating competence, clinical excellence, and professionalism, all contributing to trust-earning.[1] The orchestration of these fine plays in healthcare requires postgraduate medical education, which encompasses the complex interactions between discipline-specific knowledge, meticulous skill sets, and professional attitude.[2] Carefully preparing postgraduate trainees for independent practice eases their clinical burdens and enhances their responsibility for

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patient care.[3] Although postgraduate health science learning is often achieved through apprenticeship,[4] this model draws criticism because clinical teachers usually do not have an education background and their approaches do not always meet trainees' needs.[2] This situation necessitates a more effective format, such as CBL, an educational pedagogy employing real-world cases to help trainees improve decision-making. CBL has been used in postgraduate education for decades, enhancing subject matter relevance.[5] The definitions and spectrum of CBL evolves, and previous studies demonstrated its effectiveness in facilitating long-term knowledge retention and improving learning outcomes compared to other pedagogies.[5,6] CBL further improves trainees' satisfaction and cultivates their problem-solving ability and can be part of an integrative curricular module for teaching medical science subjects.[6,7] CBL is particularly instrumental in nephrology (e.g., electrolytes and CKD), which entails mounting data and complex decision-making algorithms. Existing reports adapt the CBL format to enhance trainees' point-of-case practices through various platforms[8,9] with fair results.

SE, proposed by Bandura in 1977, was defined as individuals' belief in their ability to complete a task successfully.[10] Four kinds of SE sources were outlined, including mastery experiences, vicarious experiences, verbal persuasion, and physiological or affective states.[11] Higher SE has been associated with greater motivation for learning, self-regulation, and achievement[12] SE can be strengthened through encouragement, careful observation of successful peers, and mastering of specific tasks; and can be damaged by adverse psychological experiences.[13] Various context-specific SE has been described, including generalized SE, teacher SE, learning SE, research SE, professional SE, etc., each with its uniqueness.[13,14] Three dimensions of SE estimation are outlined, from magnitude and strength to generality, focusing on one's belief, confidence in task completion, and the applicability of certain tasks to others, respectively.[11] As task complexity grows, the dimensions and influences of SE expand from SE sources to other personal or environmental factors.[15] Multidimensional SE is increasingly utilized to gauge the learners' beliefs, especially learning SE.[16] Medical students' learning SE was shown to correlate with their academic performance.[12] Learning SE is particularly important for postgraduate learners because discipline-specific knowledge retention and clinical skill acquisition during this period are more complex, thereby making decision-making difficult.[17] Learning SE can be instrumental in enhancing the professional performance of undergraduate medical students.[18] Moreover, previous studies in nursing science,[19] singing artists,[20] and mental health therapists[17] all showed that professional SE was a valid surrogate of discipline-specific clinical performance. However, the existing literature rarely addresses how to assess learning SE from a multidimensional perspective among postgraduate learners, especially in nephrology.

In this study, we hypothesized that results from a multidimensional learning SE questionnaire were closely linked to nephrology care team members' professional performance, and investigated whether there was an interprofessional difference in such association. We used professional self-efficacy (PSE) in nephrology as a measurement of nephrology workers' global confidence in handling their daily practice smoothly. We aimed to contribute to a better understanding of the factors that influenced nephrology workers' clinical practice.

METHODS

Ethical Statement

The protocol of this study has been approved by the institutional review board of National Taiwan University Hospital (NO. 202108085RINA). All study participants agreed to the study procedures and provided verbal informed consent. The conduct of this study adhered to the Declaration of Helsinki.

Participant Enrollment and Study Procedure

Healthcare personnel who practiced nephrology or participated in the care of patients with CKD, including physicians and nurses (including case managers) with varied lengths of working experiences from different institutions around Taiwan, were invited to participate in the year 2022. All participants first provided information about their demographic data, the lengths of working experiences, and their clinical roles. Then they were instructed to complete a PMLS questionnaire, including a multidimensional learning SE questionnaire and a PSE in nephrology questionnaire (as the outcome) after they completed at least 1 CBL session focusing on CKD patients' care.

In Taiwan, multidisciplinary care for patients with advanced CKD has been shown to successfully decelerate their kidney function decline and reduce mortality.[21,22] It is now established as a standardized care process for patients with at least stage 3b CKD or those with massive proteinuria (>1 g protein in urine daily). Within the multidisciplinary care protocol, members with different specialties, nurses, and case managers jointly provide advice on lifestyle adjustment, optimal pharmacologic treatments, comorbidity management, and dietary education according to patients' kidney function.[23] Team members meet regularly for therapy

individualization, in the format of CBL sessions, aiming to foster a "learning healthcare system."[24]

A typical CBL session, in this study, is facilitated by attending nephrologist(s) as chairperson(s). Each session covers the entire spectrum of personalized CKD care for real clinical patients, including the investigation of CKD origin, the trajectories of kidney function, the appropriateness of current pharmacologic and dietary interventions, the screening and management of CKD complications, patient preferences, and/or dialysis preparation. A CBL session can be conducted in small or large groups, with experienced facilitators presenting clinical details followed by discussions about issues for care strategy optimization. CBL session participants can articulate their own knowledge and experiences about similar cases, with input from others and a review of the literature. Facilitators can instruct or advise participants to reflect on their CKD care quality. The frequency of CBL sessions is usually weekly or monthly, accommodating clinical schedules and case numbers, with a duration of less than 1 to several hours. A final summary and feedback period is reserved for CBL participants. In this study, facilitators distributed the questionnaire described above to participants after at least 1 CBL session.

The Exposure: Assessment of Professional Medical Learning SE

In this study, SE was measured in a task-specific manner from a multidimensional perspective.[10,25,26] Multidimensional SE measurements can better accommodate the diverse spectrum of requirements learners face.[11,25,27] We adapted a preexisting questionnaire to achieve our purpose.[28] Lin *et al*.[28] validated their science learning SE instrument previously, consisting of 5 dimensions (CU, HC, PW, EA, and science communication) among a large group of learners. This questionnaire has also been validated previously among Taiwanese students[29,30] and for application in nephrology learners. We rephrased the science communication dimension as MSC in a medical context. Each dimension contained 5 CU, 6 HC, 7 PW, 8 EA, and 6 MSC items. We rated participants' responses on a 5-point Likert-type scale (e.g., strongly disagree; disagree; neutral; agree; and strongly agree), whose results were coded using 1 to 5. We further introduced elements of CKD care and case discussion into all items to accommodate our study aim, constituting the nephrology-specific learning SE instrument. The adapted version was read and approved by at least 3 expert nephrologists with >10 years of experience in providing CKD care and conferencing. Disagreement between experts concerning item details was resolved by consensus. Wordings were also optimized for clarification.

The Outcome: Professional Performance of Participants

The professional performance of participants was evaluated using the sixth dimension of our PMLS questionnaire, PSE in nephrology, derived from the academic SE subscale of the Motivated Strategies Learning Questionnaire.[31] The original subscale contained 9 items assessing respondents' perception and measured students' confidence to optimize one's own academic performance within a given scientific discipline. Factorial analysis in the original study showed a Cronbach α of 0.89, and the scale results correlated significantly with various types of task performance.[31] We harnessed its results as the outcome variable of this study as a surrogate of future professional performance involving CKD care. The wordings of the questionnaire were tailored to the nephrology practice content, with particular emphasis on processes related to CKD care.

Statistical Analysis

The statistical software Statistical Package for the Social Sciences (SPSS; IBM Corp, Armonk, NY) 25.0 was used to analyze the gathered data, and we used SPSS AMOS 24.0 for CFA and SEM analysis. We divided the analytical strategies into 3 parts; first, we undertook the CFA to evaluate the construct validity of our PMLS instrument based on physicians' and nurses' responses, separately; and to clarify the structure of our measurements (learning SE and PSE in nephrology) with our hypothetic model (Figure 1). Validation tests were also done to examine the result validity. According to previous studies,[32-34] fit scales, including goodness of fit index, incremental fit index, Tucker-Lewis index, comparative fit index, root mean square error of approximation, and standardized root mean square residual, could be used to determine whether the model validity was satisfactorily

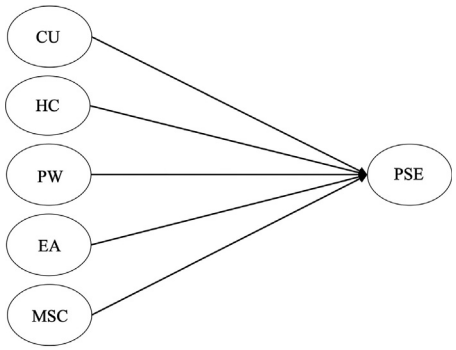

Figure 1. The hypothetical model in this study. CU, conceptual understanding; EA, everyday application; HC, higher order cognitive skill; MSC, medical science communication; PSE, professional self-efficacy in nephrology; PW, practical work.

Table 1. Clinical features of study participants

Features	Results ($N = 513$)
Demographics	
Age, yr	40.8 ± 8.5
Gender (male)	19.9%
Occupation	
Physicians	27.5%
Renal nurses	72.5%
Geographic distribution	
Northern	67.1%
Central	13.6%
Southern	19.3%
Institute level	
Medical center	9.0%
Regional hospital	73.9%
Private clinic	17.1%
Work experience	
≥10 years	48.5%
5–10 years	24.0%
<5 years	27.5%

fit. The SEM followed to evaluate the associations between the dimensions of learning SE (CU, HC, PW, EA, and MSC) and the PSE in nephrology for the physicians' and nurses' responses. We used the measurement model for analyses, because its results displayed the predictions between latent variables and indicators. Finally, we performed SEM in each clinical role for result comparison. We provided the standardized path coefficients and omitted paths without statistical significance from the figures. In all analyses, a P value <0.05 was deemed statistically significant.

RESULTS

Participants' Characteristics

In 2022, total of 513 healthcare providers were surveyed after participating in CBL sessions involving CKD care (Table 1), among whom 102 (19.9%) were male. Their mean age were 40.8 ± 8.5 years. One-fourth ($n = 141$; 27.5%) of participants were physicians whereas the others (72.5%) were nurses. Approximately half ($n = 249$; 48.5%) had >10 years of practice in nephrology including CKD care, whereas 123 (24.0%) and 141 (27.5%) had 5 to 10 years and <5 years of experience, respectively. Participants came from all geographic areas of Taiwan (67.1% northern, 13.6% central, and 19.3% southern part), with 9.0%, 73.9%, and 17.1% from medical centers, regional hospitals, and private clinics, respectively.

Validity and Reliability of the PMLS Instrument

We then performed CFA to evaluate the construct validity of the PMLS instrument (learning SE and the PSE in nephrology) in a single model, including factor loadings, Cronbach's alpha values, average variance extracted, composite reliability, and descriptive statistics (Table 2). Among all 6 dimensions, 3, 5, 4, 4, 3, and 6 items exhibited significant factor loadings of the dimensions, including CU, HC, PW, EA, and MSC, and PSE in nephrology, respectively. The loading values of each item in all dimensions among physicians or nurses were higher than 0.70 (Table 2). Cronbach's alpha values of the 6 dimensions of PMLS among physicians and nurses were 0.90–0.94 and 0.85–0.92, respectively. For convergent validity, the construct reliability values for the PMLS instrument among physicians and nurses were 0.80–0.95 and 0.87–0.92, respectively (Table 2). The average variance extracted values of the 6 dimensions among physicians and nurses ranged between 0.71 and 0.85 and between 0.58 and 0.98, respectively (Table 2). Regarding the goodness of fit for the model construct, we found that for the physician, the $\chi 2$ per degree of freedom was 1.74, the goodness of fit index was 0.81, the incremental fit index was 0.95, the Tucker-Lewis index was 0.94, the comparative fit index was 0.95, the root mean square error of approximation was 0.072, and the standardized root mean square residual was 0.049; whereas for the nurse, the χ^2 per degree of freedom was 2.40, goodness of fit index was 0.88, incremental fit index was 0.95, Tucker-Lewis index was 0.94, comparative fit index was 0.95, root mean square error of approximation was 0.061, and standardized root mean square residual was 0.044. These findings support the validity of our assessment tools.

Effect Size Estimation Among Physicians' and Nurses' Learning SE and PSE in Nephrology Results After CBL Sessions

Next, we examined the scores of the 6 dimensions and compared differences between results from physicians and nurses (Table 3). Physicians had higher item rating scores of all 6 dimensions of the PMLS instrument than nurses ($P < 0.001$ for all). We found that the Cohen's d values were large (>0.8) for comparisons of HC, PW, and MSC and moderate for CU, EA, and PSE (Table 3), suggesting that the standardized effect size was significantly higher among physicians.[35]

Correlation Between Dimensions of Learning SE, PSE in Nephrology Results, and Demographic Characteristics

We subsequently performed correlation analyses between each dimension of learning SE and age and the length of working experiences (Table 4). Higher age and longer working experiences were positively associated with greater confidence in CU, HC, EA, and MSC among physicians and nurses. However, higher age and longer experiences did not correlate with PW among nurses (Table 4). Interestingly, we observed that better

Table 2. Confirmatory factor analysis and validation values (alpha, AVE, and CR) for the healthcare providers of the 6 dimensions of the professional medical learning self-efficacy instrument

	Factor 1: Conceptual understanding		Factor 2: Higher order cognitive skills		Factor 3: Practical work		Factor 4: Everyday application		Factor 5: Medical science communication		Factor 6: Professional self-efficacy	
Items	P	N	P	N	P	N	P	N	P	N	P	N
Factor 1: Conceptual understanding (CU), Physician: Cronbach's alpha = 0.94, AVE = 0.85, CR = 0.95; Nurse: Cronbach's alpha = 0.91, AVE = 0.98, CR = 0.91.												
CU 1	0.94	0.92										
CU 2	0.91	0.92										
CU 3	0.92	0.80										
Factor 2: Higher order cognitive skills (HC), Physician: Cronbach's alpha = 0.94, AVE = 0.77, CR = 0.94; Nurse: Cronbach's alpha = 0.87, AVE = 0.58, CR = 0.87.												
HC 1			0.86	0.74								
HC 2			0.85	0.75								
HC 3			0.90	0.82								
HC 4			0.89	0.78								
HC 5			0.88	0.72								
Factor 3: Practical work (PW), Physician: Cronbach's alpha = 0.91, AVE = 0.80, CR = 0.80; Nurse: Cronbach's alpha = 0.85, AVE = 0.67, CR = 0.89.												
PW 1					0.84	0.81						
PW 2					0.88	0.84						
PW 3					0.87	0.79						
PW 4					0.83	0.84						
Factor 4: Everyday application (EA), Physician: Cronbach's alpha = 0.93, AVE = 0.78, CR = 0.94; Nurse: Cronbach's alpha = 0.89, AVE = 0.67, CR = 0.89.												
EA 1							0.89	0.81				
EA 2							0.91	0.84				
EA 3							0.84	0.79				
EA 4							0.90	0.84				
Factor 5: Medical science communication (MSC), Physician: Cronbach's alpha = 0.90, AVE = 0.77, CR = 0.91; Nurse: Cronbach's alpha = 0.87, AVE = 0.69, CR = 0.87.												
MSC 1									0.85	0.82		
MSC 2									0.89	0.85		
MSC 3									0.89	0.83		
Factor 6: Professional self-efficacy, (PSE), Physician: Cronbach's alpha = 0.93, AVE = 0.71, CR = 0.94; Nurse: Cronbach's alpha = 0.92, AVE = 0.67, CR = 0.92.												
PSE 1											0.81	0.76
PSE 2											0.83	0.82
PSE 3											0.87	0.86
PSE 4											0.87	0.86
PSE 5											0.83	0.82
PSE 6											0.84	0.77

alpha, Cronbach's alpha; AVE, average variance extracted; CR, composite reliability; N, nurses; P, physicians.

professional performance in higher PSE in nephrology was significantly associated with all 5 dimensions of learning SE among physicians and nurses (Table 4).

Structural Relationships Between Dimensions of Learning SE and PSE in Nephrology Among Participants of CBL Sessions

Finally, we used SEM to evaluate the relationship between each dimension of learning SE and PSE in nephrology. The SEM result showed that the model in this study adequately explained the instrument data by the fit indices.[36] We showed that among physicians, only CU (path coefficient = −0.44, $P < 0.05$) and PW (path coefficient = 0.52, $P < 0.01$) were significantly associated with their professional performance, whereas HC exhibited borderline positive association (path coefficient = 0.34, $P = 0.083$) (Figure 2). Among nurses, only HC (path coefficient = 0.2, $P < 0.05$) and MSC (path coefficient = 0.58, $P < 0.001$) were significantly associated (Figure 3). Only better HC was positively associated with improved performance in both professions. Interprofessional differences existed

Table 3. The scores of the dimensions of the Professional Medical Learning Self-efficacy for the healthcare providers

Profession	CU	HC	PW	EA	MSC	PSE
Physicians ($n = 141$)	4.43 (0.60)	4.36 (0.59)	4.47 (0.54)	4.39 (0.62)	4.38 (0.60)	4.15 (0.61)
Nurses ($n = 372$)	4.05 (0.46)	3.91 (0.46)	3.85 (0.51)	3.97 (0.46)	3.92 (0.52)	3.71 (0.54)
t-test	6.88[a]	8.34[a]	11.63[a]	7.42[a]	8.03[a]	7.69[a]
Cohen's *d*	0.71	0.85	1.18	0.77	0.82	0.76

CU, conceptual understanding; HC, higher order cognitive skills; PW, practical work; EA, everyday application; MSC, medical science communication; PSE, professional self-efficacy.
[a]$P < 0.001$.

Table 4. The correlations between the health care providers' age, working experience, and each dimension of the medical professional learning self-efficacy

	CU		HC		PW		EA		MSC		PSE	
Clinical variables	P	N	P	N	P	N	P	N	P	N	P	N
Age	0.41 ([c])	0.25 ([c])	0.42 ([c])	0.21 ([c])	0.52 ([c])	0.07	0.38 ([c])	0.16 ([b])	0.45 ([c])	0.22 ([c])	0.47 ([c])	0.14 ([b])
Working experience	0.53 ([c])	0.26 ([c])	0.53 ([c])	0.26 ([c])	0.50 ([c])	0.07	0.49 ([c])	0.16 ([b])	0.48 ([c])	0.23 ([c])	0.48 ([c])	0.13 ([a])
PSE	0.70 ([c])	0.56 ([c])	0.74 ([c])	0.62 ([c])	0.78 ([c])	0.58 ([c])	0.74 ([c])	0.67 ([c])	0.79 ([c])	0.72 ([c])	——	——

CU, conceptual understanding; HC, higher order cognitive skills; PW, practical work; EA, everyday application; MSC, medical science communication; PSE, professional self-efficacy; N, nurses; P, physicians.
[a]$P < 0.05$;
[b]$P < 0.01$;
[c]$P < 0.001$.

regarding contributors to professional performance in nephrology; PW was more instrumental for physicians, whereas MSC was vital for nurses.

DISCUSSION

In this study, we conducted a nationwide survey recruiting renal physicians and nurses participating in CBL sessions focusing on CKD care, then evaluated the relationship between their learning SE and professional performance. We used a CKD-adapted learning SE instrument and a professional SE in nephrology questionnaire, whose validity and reliability were reassured through CFA. We found that physicians rated higher in all learning-related aspects than their nurse colleagues. Interestingly, physicians and nurses had distinct dimensions of learning SE that correlated with their professional performance; the former placed more emphasis on CU and PW, whereas the latter focused on HC and MSC.

Potential Importance of Professional SE in Postgraduate Medical Education

The existing literature favors that assessing and promoting PSE helps professionals to maintain self-control, increase motivation, and improve resilience during adverse conditions.[37] Better PSE can be conducive to greater work performance and satisfaction, a higher chance of gaining control of the challenging environment, and goal achievement.[38] On the other hand, professionals with lower PSE may experience greater stress, burnout, and potentially poorer performance.[39] Determinants of PSE highly depend on details of the index profession and individual features. For example, emotional labor was shown to negatively correlate with artists' PSE.[20] Cultural context, suboptimal supervision, as well as aversive working experiences, all exhibited a certain degree of association with clinical trainees' PSE.[40] Importantly, PSE, as an important predictor of performance among healthcare professionals,[41] can be modifiable through participation in discipline-specific courses or sessions.[42] This is particularly important during postgraduate medical education because trainees and staff spend more time on patient care relative to participating in education sessions. In light of our findings, a CBL type session can serve as an underappreciated opportunity to enhance PSE in renal physicians and nurses. A small-scale study demonstrated that a CBL-type web conference focusing

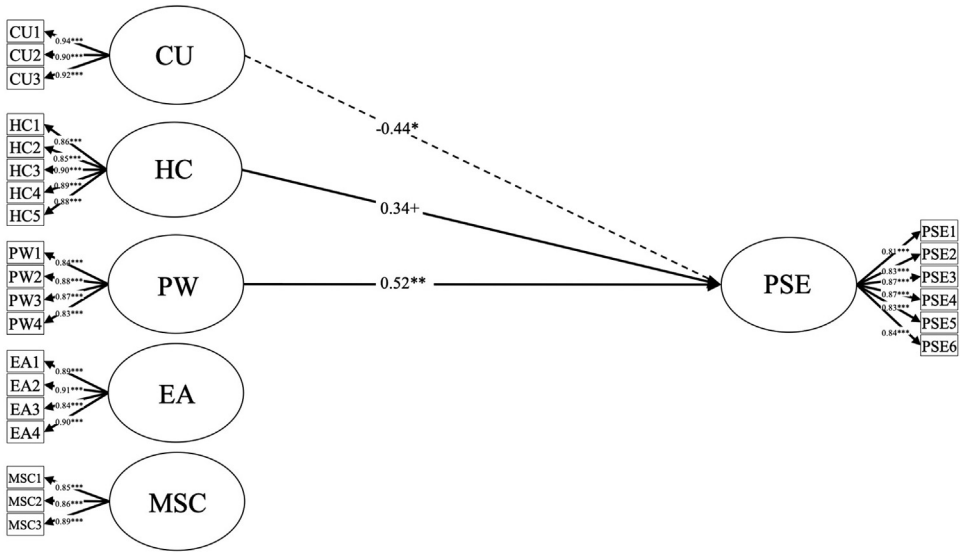

Figure 2. The structural model of the professional self-efficacy survey variables for the physicians. [†]$P < 0.1$; *$P < 0.05$; **$P < 0.01$.

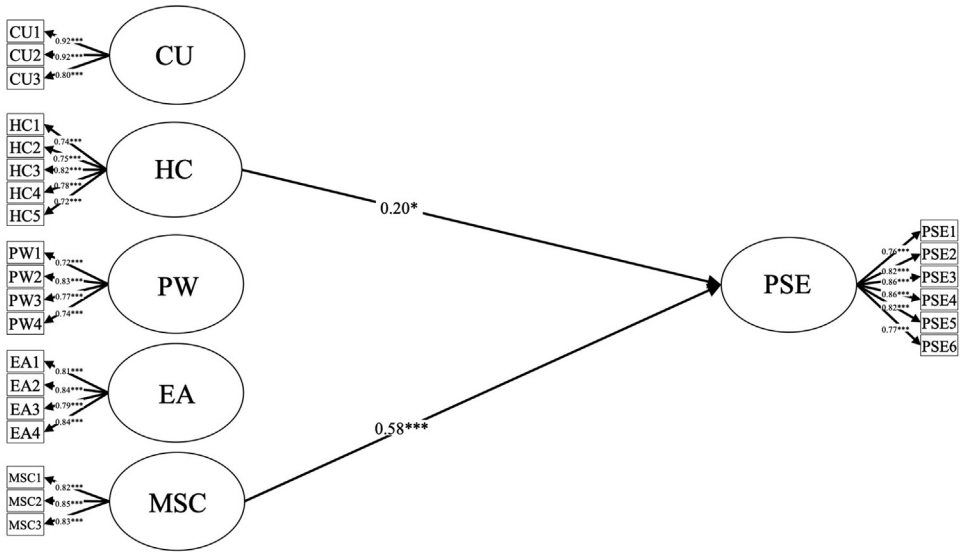

Figure 3. The structural model of the professional self-efficacy survey variables for the nurses. *$P < 0.05$; ***$P < 0.001$.

on cancer risk prediction could potentially enhance participants' PSE,[43] supporting this claim.

Interprofessional Differences in Learning SE Dimensions Associated With PSE: Plausible Explanations

We further showed that renal physicians and nurses differed with regard to dimensions of learning SE contributing to PSE in nephrology. Similar interprofessional differences in task-specific SE have been observed before[44] but rarely involved renal physicians. Several studies pinpointed significant dimensions that nurses rated as most influential for cultivating their professional knowledge and skills; Hosseinzadeh *et al.*[45] reported that medical professional interaction and communication was an instrumental ability for achieving nursing competency and frequently coexisted with insufficient PSE. Better communication skills confer greater PSE among nurses, likely resulting from increased confidence in providing care and constructing positive interpersonal relationships with patients.[46] We similarly observed that MSC contributed to PSE in nephrology among renal nurses (Figure 3) but not among renal physicians. On the other hand, among renal physicians, CU and PW significantly contributed to PSE instead of renal nurses. A previous study investigating genetic counseling-related declarative and procedural knowledge among a group of multidisciplinary members revealed that physicians had higher work understanding and required skills compared to advanced practice nurses.[47] With a greater proficiency in discipline-specific details, renal physicians might value CU and PW, which assessed interpretative thinking and clinical reasoning process more suitable for a scenario involving CKD than renal nurses. On the contrary, nursing education more commonly emphasizes patient rapport establishment and communication. This is further supported by a recent local study, reporting that nursing students had better long-term PSE if they received mentoring support focusing on good rapport with patients.[48] Alternatively, the lack of association between certain learning SE dimensions and profession-specific PSE might result from the lack of interest, familiarity, or experiences involving the dimension of interest. Others have reported that the process of CU in nursing sciences might not be so straightforward and requires interdisciplinary collaboration for clarification and affirmation.[49] Based on our findings, interprofessional differences in learning SE dimensions determining PSE truly exist. It would be prudent to address these differences during the subsequent design of profession-specific continued medical education to improve participants' professional performance and potentially reduce burnout risk. Interprofessional education should also incorporate these differences into consideration for optimizing learning outcomes.

Associations Between Age, Working Experiences, Learning SE, and PSE in Nephrology

In Table 4, we present significant associations between older age or longer working experiences, learning SE dimensions, and PSE in nephrology. Part of the association between the dimensions of learning SE and PSE in nephrology might be attributed to the influences of age or working experiences. Indeed, a previous study among nursing aides showed that a longer working experience significantly correlated with positive changes in learning attitudes.[50] Being employed also

correlated with having higher SE.[51] On the other hand, better SE was also associated with work engagement and potentially longer duration at work.[52] Increasing age might strengthen the association between SE and subjective work ability.[53] However, another study showed that the association between medical professional performance and the duration of employment might be attenuated by work atmosphere, satisfaction, and job burnout among healthcare personnel.[54] Therefore, we suspect that the association between learning SE dimension and professional performance could not be solely explained by that between age, the duration of employment, and professional performance. Moreover, differences in associations between age, working experiences, and certain learning SE dimensions according to professions may result from clinical rotation schedules.

Implications of Study Findings

Our findings are expected to significantly improve profession-specific and interprofessional education. Previous studies addressing postgraduate education in nephrology frequently focused on reducing a hierarchical atmosphere, the design of a cozier workplace, and promoting interprofessional collaboration,[55] with minimal reference to the importance of the clinical role. Based on our findings, it is recommended to design different strategies for enhancing physician-specific and nurse-specific SE dimensions so as to promote professional performance. For renal physicians, they can be reminded periodically of details regarding updated CKD care protocols and recent technological advancements in laboratory and pharmaceutics through arranging dedicated continuous education sessions. These designs are shown to promote learners' PW capacity.[56] On the other hand, renal nurses can be trained for critical thinking and deductive and inductive reasoning during case investigation, coupled with reflective learning after case presentation and metacognitive skill sharpening between each CBL session to polish their HC capacity. Some of this training may be achieved through multimedia and e-learning, as reported by others.[57] Blended learning modules are also found to be beneficial for improving nurses' communication skills,[58] promoting their SE and MSC capacity at the same time.

The Importance of Identifying Contributors to Better Professional Performance: Reducing Burnout and Workforce Loss

The decreasing nephrology workforce and a rising prevalence of burnout among active workers has been a lurking concern. A dedicated task force from the professional nephrology society has outlined several strategies to tackle this problem.[59] Less mentoring, knowledge intensiveness, suboptimal training experiences, dissatisfaction with practice fields, work-life imbalance, etc., have all been suggested as contributors to this trend[60]; however, poor PSE in nephrology has not been addressed before as a potential driver for insufficient resilience, poor wellbeing, and shrinking nephrology workforce, though similar phenomenon has been identified in other professions or disciplines.[61,62] Better learning SE, if intentionally promoted during postgraduate education, has the potential of upholding professional performance and improving staff morale and motivation while reducing the probability of developing burnout. Our findings further shed light on how to improve postgraduate education courses to maintain and even expand the current pool of nephrology workforce.

Strengths and Limitations

Our study has its strengths and limitations. This study is the first to focus on CBL sessions in postgraduate medical education for nephrology, with broad clinical implications. The study context was CBL, a practical and interactive form of learning that may enhance the applicability of findings to real-world clinical practice. We included a diverse range of healthcare providers in terms of sex, geographic distribution, institute level, and work experience, supporting the applicability of our findings. We surveyed many healthcare providers ($n = 513$), which increased the statistical power and result reliability. Our robust statistical analyses, including CFA and SEM, increased the result validity. However, limitations do exist. First, this study was cross-sectional; therefore, we could not establish the causality between learning SE in a CBL-fashioned course and professional performance among nephrology practitioners. Longitudinal studies would be required to evaluate such a relationship. Second, we relied on self-report data for analysis, which might be subject to social desirability or recall bias. Participants might overestimate or underestimate their abilities, potentially affecting study findings. Third, cultural context, healthcare systems, and health policies could vary between Taiwan and other countries, and the generalizability of our results to nephrologists or nurses in other countries remains unknown. Fourth, our assessment of professional performance was subjective in nature. However, objective measurements of such feature in postgraduate education may not have a standard definition and fail to exhibit sufficient associations with learning motivation. Fifth, we did not record the exact number of CBL sessions in this study because of the pandemic issue, and we were unable to predict whether more

CBL sessions strengthened the associations we observed. Finally, other unmeasured variables might affect study findings, such as the quality of CBL sessions, participants' prior knowledge or training, or their motivation levels. Our findings need to be verified in a larger cohort with an international nephrology workforce.

Conclusion

In this study, we successfully surveyed a diverse group of healthcare providers, including physicians and nurses, from various geographic areas and institutions in Taiwan, with different levels of work experience. We used the PMLS instrument among participants to assess an individual's belief and confidence in learning CKD-related care and their potential professional performance. Our instrument was valid and reliable for assessing healthcare providers' SE in CKD-related care. We discovered that physicians generally had higher scores for all dimensions of learning SE and PSE in nephrology than nurses. Importantly, different dimensions contributed to professional performance in nephrology for physicians and nurses. SEM revealed that among physicians, CU and PW were significantly associated with better professional performance; whereas among nurses, HC and MSC were significantly associated with better professional performance. These findings are expected to show how to optimize nephrology education in different medical professions.

DISCLOSURE

All the authors declared no competing interests.

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DATA AVAILABILITY STATEMENT

The raw data for conducting this analysis are available upon reasonable request to the corresponding author.

AUTHOR CONTRIBUTIONS

Study design was done by CTC and JCL. Data analysis was by CTC, MYW, and JCL. Article drafting was done by CTC, MYW, KYH, MSW, and JCL. All authors approved the final version of the manuscript.

SUPPLEMENTARY MATERIAL

Supplementary File (PDF)

STROBE statement

REFERENCES

1. Frenk J, Chen L, Bhutta ZA, et al. Health professionals for a new century: transforming education to strengthen health systems in an interdependent world. *Lancet*. 2010;37:1923–1958. https://doi.org/10.1016/S0140-6736(10)61854-5
2. McInerney P, Green-Thompson LP. Theories of learning and teaching methods used in postgraduate education in the health sciences: a scoping review. *JBI Evid Synth*. 2020;18:1–29. https://doi.org/10.11124/JBISRIR-D-18-00022
3. Kadmon M, Ten Cate O, Harendza S, Berberat P. Postgraduate Medical Education - an increasingly important focus of study and innovation. *GMS J Med Educ*. 2017;34:Doc70. https://doi.org/10.3205/zma001147
4. Rodriguez-Paz JM, Kennedy M, Salas E, et al. Beyond "see one, do one, teach one": toward a different training paradigm. *Postgrad Med J*. 2009;85:244–249. https://doi.org/10.1136/qshc.2007.023903
5. Thistlethwaite JE, Davies D, Ekeocha S, et al. The effectiveness of case-based learning in health professional education. A BEME systematic review: BEME Guide No. 23. *Med Teach*. 2012;34:e421–e444. https://doi.org/10.3109/0142159X.2012.680939
6. Bi M, Zhao Z, Yang J, Wang Y. Comparison of case-based learning and traditional method in teaching postgraduate students of medical oncology. *Med Teach*. 2019;41:1124–1128. https://doi.org/10.1080/0142159X.2019.1617414
7. Chao CT. Literacy for frailty among undergraduate medical education: an under-recognized opportunity to improve geriatric care. *Aging Dis*. Published online October 3, 2023. https://doi.org/10.14336/AD.2023.0925
8. William JH, Huang GC. How we make nephrology easier to learn: computer-based modules at the point-of-care. *Med Teach*. 2014;36:13–18. https://doi.org/10.3109/0142159X.2013.847912
9. Berkoben M, Roberts JK. The treatment of metabolic acidosis: an interactive case-based learning activity. *MedEdportal*. 2019;15:10835. https://doi.org/10.15766/mep_2374-8265.10835
10. Bandura A. Self-efficacy: toward a unifying theory of behavioral change. *Psychol Rev*. 1977;84:191–215. https://doi.org/10.1037//0033-295x.84.2.191
11. Bandura A, Freeman WH, Lightsey R. Self-efficacy: the exercise of control. *J Cogn Psychother*. 1997;13:158–166. https://doi.org/10.1891/0889-8391.13.2.158
12. Morton J, Anderson L, Frame F, Moyes J, Cameron H. Back to the future: teaching medical students clinical procedures. *Med Teach*. 2006;28:723–728. https://doi.org/10.1080/01421590601110025
13. Yokoyama S. Academic self-efficacy and academic performance in online learning: a mini review. *Front Psychol*. 2019;9:2794. https://doi.org/10.3389/fpsyg.2018.02794
14. Pfitzner-Eden F, Why Do I. Why do i feel more confident? Bandura's sources predict preservice teachers' latent changes in teacher self-efficacy. *Front Psychol*. 2016;7:1486. https://doi.org/10.3389/fpsyg.2016.01486

15. van der Bijl JJ, Shortridge-Baggett LM. The theory and measurement of the self-efficacy construct. *Sch Inq Nurs Pract*. 2001;15:189–207.
16. Meera KP, Jumana M. Self-efficacy and academic performance in English. *Res Pedagog*. 2015;5:25–30. https://doi.org/10.17810/2015.13
17. Gori A, Topino E, Brugnera A, Compare A. Assessment of professional self-efficacy in psychological interventions and psychotherapy sessions: development of the Therapist Self-Efficacy Scale (T-SES) and its application for eTherapy. *J Clin Psychol*. 2022;78:2122–2144. https://doi.org/10.1002/jclp.23391
18. Kang YN, Chang CH, Kao CC, Chen CY, Wu CC. Development of a short and universal learning self-efficacy scale for clinical skills. *PLoS One*. 2019;14:e0209155. https://doi.org/10.1371/journal.pone.0209155
19. Caruso R, Pittella F, Zaghini F, Fida R, Sili A. Development and validation of the Nursing Profession self-efficacy Scale. *Int Nurs Rev*. 2016;63:455–464. https://doi.org/10.1111/inr.12291
20. Liu Z. Correlation analysis between emotion control and professional self-efficacy of singing artists based on multidimensional environment. *J Environ Public Health*. 2022;2022:2876474. https://doi.org/10.1155/2022/2876474
21. Chen YR, Yang Y, Wang SC, et al. Effectiveness of multidisciplinary care for chronic kidney disease in Taiwan: a 3-year prospective cohort study. *Nephrol Dial Transplant*. 2013;28:671–682. https://doi.org/10.1093/ndt/gfs469
22. Wang SM, Hsiao LC, Ting IW, et al. Multidisciplinary care in patients with chronic kidney disease: a systematic review and meta-analysis. *Eur J Intern Med*. 2015;26:640–645. https://doi.org/10.1016/j.ejim.2015.07.002
23. Chao CT, Chang CI, Wang PC, et al. Impact of a kidney-specific disease-specific care certification program on the institutional performance indicators of hospitals caring for patients with chronic kidney disease: a national data analysis. *Nephrology (Carlton)*. 2021;26:669–675. https://doi.org/10.1111/nep.13901
24. Wu MY, Wu MS. Taiwan renal care system: a learning healthcare system. *Nephrology (Carlton)*. 2018;23(suppl 4):112–115. https://doi.org/10.1111/nep.13460
25. Zimmerman BJ. Self-efficacy: an essential motive to learn. *Contemp Educ Psychol*. 2000;25:82–91. https://doi.org/10.1006/ceps.1999.1016
26. Lin TJ, Tsai CC. A multi-dimensional instrument for evaluating Taiwanese high school students' science learning self-efficacy in relation to their approaches to learning science. *Int J Sci Math Educ*. 2013;11:1275–1301. https://doi.org/10.1007/s10763-012-9376-6
27. Baldwin JA, Ebert-May D, Burns DJ. The development of a college biology self-efficacy instrument for nonmajors. *Sci Educ*. 1999;83:397–408. https://doi.org/10.1002/(SICI)1098-237X(199907)83:4<397::AID-SCE1>3.0.CO;2-#
28. Lin TJ, Tan AL, Tsai CC. A cross-cultural comparison of Singaporean and Taiwanese eighth graders' science learning self-efficacy from a multi-dimensional perspective. *Int J Sci Educ*. 2013;35:1083–1109. https://doi.org/10.1080/09500693.2013.776193
29. Lin TC, Liang JC, Tsai CC. Conceptions of memorizing and understanding in learning, and self-efficacy held by university biology majors. *Int J Sci Educ*. 2015;37:446–468. https://doi.org/10.1080/09500693.2014.992057
30. Lin T-J, Tsai C-C. An investigation of Taiwanese high school students' science learning self-efficacy in relation to their conceptions of learning science. *Res Sci Technol Educ*. 2013;31:308–323. https://doi.org/10.1080/02635143.2013.841673
31. Pintrich PR, De Groot EV. Motivational and self-regulated learning components of classroom academic performance. *J Educ Psychol*. 1990;82:33–40. https://doi.org/10.1037/0022-0663.82.1.33
32. Hu Lt, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Struct Equ Model*. 1999;6:1–55. https://doi.org/10.1080/10705519909540118
33. MacCallum RC, Browne MW, Sugawara HM. Power analysis and determination of sample size for covariance structure modeling. *Psychol Method*. 1996;1:130–149. https://doi.org/10.1037/1082-989X.1.2.130
34. Salama IEE. The impact of knowledge management capability, organizational learning, and supply chain management practices on organizational performance. *Bus Manag Rev*. 2017;8:37–51.
35. Cohen J. *Statistical Power Analysis for the Behavioral Sciences*. Academic press; 2013.
36. Jöreskog KG, Sörbom D. *Lisrel 8: Structural Equation Modeling With the SIMPLIS Command Language*. Scientific software international; 1993.
37. Su X, Jiang X, Lin W, Xu A, Zheng Q. Organizational innovative climate and employees' improvisational behavior: the mediating role of psychological safety and the moderating role of creative self-efficacy. 12. SAGE Open; 2022:21582440221132526. https://doi.org/10.1177/21582440221132526
38. Schunk D, DiBenedetto M. *Advances in Motivation Science*. Vol. 8. Elsevier Academic Press; 2021.
39. Simonetti V, Durante A, Ambrosca R, et al. Anxiety, sleep disorders and self-efficacy among nurses during COVID-19 pandemic: a large cross-sectional study. *J Clin Nurs*. 2021;30:1360–1371. https://doi.org/10.1111/jocn.15685
40. Pugh E, Robinson A, Montgomery V, Calamia M. Trainee perceptions of multicultural climate and supervision in neuropsychology. *J Clin Exp Neuropsychol*. 2022;44:386–397. https://doi.org/10.1080/13803395.2022.2107185
41. Bernales-Turpo D, Quispe-Velasquez R, Flores-Ticona D, et al. Burnout, professional self-efficacy, and life satisfaction as predictors of job performance in health care workers: the mediating role of work engagement. *J Prim Care Community Health*. 2022;13:21501319221101845. https://doi.org/10.1177/21501319221101845
42. Buchan J, Clanchy KM. Changes in professional self-efficacy and competency knowledge following participation in a student-led exercise clinic. *Educ Health (Abingdon)*. 2021;34:128–129. https://doi.org/10.4103/efh.efh_21_21
43. Blazer KR, Christie C, Uman G, Weitzel JN. Impact of web-based case conferencing on cancer genetics training outcomes for community-based clinicians. *J Cancer Educ*. 2012;27:217–225. https://doi.org/10.1007/s13187-012-0313-8

44. Kottorp A, Peterson E. Comparing self-efficacy in interprofessional collaborative practice among health care professions students. *Am J Occup Ther*. 2018;72(suppl 1): 7211510205p1-7211510205p1. https://doi.org/10.5014/ajot.2018.72S1-PO7022

45. Hosseinzadeh T, Tabrizi KN, Fallahi-Khoshknab M, Khankeh H, Shokooh F. Barriers to the development of clinical reasoning skills among coronary care nurses: a qualitative study. *Iran J Nurs Midwif Res*. 2022;27:567–574. https://doi.org/10.4103/ijnmr.ijnmr_164_21

46. Leal-Costa C, Tirado González S, Ramos-Morcillo AJ, Ruzafa-Martínez M, Díaz Agea JL, van-der Hofstadt Román CJ. Communication skills and professional practice: does it increase self-efficacy in nurses? *Front Psychol*. 2020;11:1169. https://doi.org/10.3389/fpsyg.2020.01169

47. Blazer KR, Macdonald DJ, Culver JO, et al. Personalized cancer genetics training for personalized medicine: improving community-based healthcare through a genetically literate workforce. *Genet Med*. 2011;13:832–840. https://doi.org/10.1097/GIM.0b013e31821882b7

48. Kung PC, Huang HL, Che HL, Chou YF, Chi SF, Tseng SM. Effectiveness of clinical mentorship program for students of long-term aged care: a mixed-methods study. *Nurse Educ Today*. 2023;125:105781. https://doi.org/10.1016/j.nedt.2023.105781

49. Bonis SA. Concept analysis: method to enhance interdisciplinary conceptual understanding. *ANS Adv Nurs Sci*. 2013;36:80–93. https://doi.org/10.1097/ANS.0b013e318290d86e

50. Hsu YM, Chang TS, Chu CL, et al. Effectiveness of multimedia-based learning on the improvement of knowledge, attitude, and behavior intention toward COVID-19 prevention among nurse aides in Taiwan: a arallel-interventional study. *Healthcare*. 2022;10:1206. https://doi.org/10.3390/healthcare10071206

51. Bonsaksen T, Lerdal A, Heir T, et al. General self-efficacy in the Norwegian population: differences and similarities between sociodemographic groups. *Scand J Public Health*. 2019;47:695–704. https://doi.org/10.1177/1403494818756701

52. Tian G, Wang J, Zhang Z, Wen Y. Self-efficacy and work performance: the role of work engagement. *Soc Behav Pers*. 2019;47:1–7. https://doi.org/10.2224/sbp.8528

53. Weber J, Tzivian L, Muller A, Angerer P. Country-specific differences of age stereotypes towards older hospital staff and their association with self-efficacy, work ability and mental well-being. *J Adv Nurs*. 2020;76:1614–1626. https://doi.org/10.1111/jan.14380

54. Dinc MS, Kuzey C, Steta N. Nurses' job satisfaction as a mediator of the relationship between organizational commitment components and job performance. *J Workplace Behav Health*. 2017;33:75–95. https://doi.org/10.1080/15555240.2018.1464930

55. Hamoen EC, van Blankenstein FM, de Jong PGM, Ray A, Reinders MEJ. Development of a clinical teaching unit in internal medicine to promote interprofessional and multidisciplinary learning: a practical intervention. *Teach Learn Med*. 2021;33:78–88. https://doi.org/10.1080/10401334.2020.1792309

56. Gott R, Duggan S. Practical work: its role in the understanding of evidence in science. *Int J Sci Educ*. 1996;18:791–806. https://doi.org/10.1080/0950069960180705

57. Kwangmuang P, Jarutkamolpong S, Sangboonraung W, Daungtod S. The development of learning innovation to enhance high order thinking skills for students in Thailand junior high schools. *Heliyon*. 2021;7:e07309. https://doi.org/10.1016/j.heliyon.2021.e07309

58. Chung JYS, Li WHC, Cheung AT, Ho LLK, Chung JOK. Efficacy of a blended learning programme in enhancing the communication skill competence and self-efficac of nusring students in conducting clinical handovers: a randomized controlled trial. *BMC Med Educ*. 2022;22:275. https://doi.org/10.1186/s12909-022-03361-3

59. Rosenberg ME, Anderson S, Farouk SS, et al. Reimagining nephrology fellowship education to meet the future needs of nephrology: a report of the American Society of Nephrology task force on the future of nephrology. *Clin J Am Soc Nephrol*. 2023;18:816–825. https://doi.org/10.2215/CJN.0000000000000133

60. Moura-Neto JA. "To Be, or Not to Be" a nephrologist: students' dilemma and a strategy for the field. *Blood Purif*. 2021;50:696–701. https://doi.org/10.1159/000513155

61. Ventura M, Salanova M, Llorens S. Professional self-efficacy as a predictor of burnout and engagement: the role of challenge and hindrance demands. *J Psychol*. 2015;149:277–302. https://doi.org/10.1080/00223980.2013.876380

62. Maffoni M, Sommovigo V, Giardini A, Velutti L, Setti I. Well-being and professional efficacy among health care professionals: the role of resilience through the mediation of ethical vision of Patient Care and the moderation of managerial support. *Eval Health Prof*. 2022;45:381–396. https://doi.org/10.1177/01632787211042660