



Effects of Continuing Professional Development on Nurses' Competence in Chronic Illness Care: A Systematic Review and Meta-Analysis

Miming Oxyandi¹, Aris Citra Wisuda², Faridah Mohd Said³, Rhipiduri Rivianica¹

¹Faculty of Health and Technology, Aisyiyah University Palembang, Indonesia

²Nursing Study Program, Sekolah Tinggi Ilmu Kesehatan Bina Husada, Palembang, Indonesia

³Faculty of Nursing and Applied Sciences, Lincoln University College Malaysia, Malaysia

Email correspondence: mimingoxyandi@gmail.com

<p>Track Record Article</p> <p>Revised: 9 January 2026 Accepted: 25 February 2026 Published: 31 March 2026</p> <p>How to cite : Oxyandi, M., Wisuda, A. C., Said, F. M., & Rivianica, R. (2026). Effects of Continuing Professional Development on Nurses' Competence in Chronic Illness Care: A Systematic Review and Meta-Analysis. <i>Contagion : Scientific Periodical of Public Health and Coastal Health</i>, 8(1), 154–170.</p>	<p style="text-align: center;">Abstract</p> <p><i>Chronic illnesses, including diabetes mellitus, hypertension, cardiovascular disease, and cancer, represent major global health challenges requiring sustained nursing competence. Continuing Professional Development (CPD) is promoted to enhance nurses' knowledge, skills, and professional attitudes; however, its effectiveness in chronic illness care remains inconsistent. This meta-analysis evaluated the impact of CPD on nursing competence in managing chronic illnesses. A systematic search of PubMed, Scopus, CINAHL, and Web of Science was conducted for studies published between January 2019 and January 2025. Eligible studies included randomized controlled trials, quasi-experimental, and cohort designs reporting competence-related outcomes following CPD interventions. Data were synthesized using a random-effects model, and heterogeneity was assessed using the I^2 statistic. Eleven studies involving 1,362 nurses from Asia, Europe, and the Americas met the inclusion criteria. CPD showed a significant positive effect on nursing competence in chronic illness care (Hedges' $g = 0.47$; 95% CI: 0.31–0.63; $p < 0.001$). E-learning and blended learning approaches were more effective than traditional face-to-face methods, and programs lasting more than six months produced greater improvements. Moderate heterogeneity was observed ($I^2 = 48\%$), with no evidence of publication bias. The findings indicate that CPD moderately improves nursing competence, particularly when delivered through technology-enhanced and sustained educational strategies. Variations in intervention duration and learning modality may explain differences in effect sizes across studies. CPD is an effective strategy to strengthen nursing competence in chronic illness care, especially when implemented through blended or e-learning formats and extended program duration</i></p> <p>Keywords: <i>Continuing Professional Development, Nursing, Competence, Chronic Illness Care, Meta-Analysis</i></p>
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INTRODUCTION

Chronic illnesses, including diabetes mellitus, hypertension, cardiovascular disease, and cancer, remain the leading contributors to global morbidity, mortality, and long-term disability, accounting for the majority of the worldwide disease burden (World Health Organization [WHO], 2024; GBD 2023 Diseases and Injuries Collaborators, 2024). Demographic aging, rapid urbanization, and lifestyle transitions have further intensified the prevalence and complexity of chronic conditions across health systems globally (United Nations, 2023; WHO, 2024). Effective chronic disease management therefore requires integrated, person-centered, and longitudinal models of care that combine clinical treatment, behavioral modification, patient empowerment, and continuous monitoring across healthcare settings (Bodenheimer et al., 2023). Within this context, the competence, staffing adequacy,

and adaptability of the nursing workforce are increasingly recognized as strategic determinants of care quality, patient safety, and health system sustainability (Aiken et al., 2023; Needleman et al., 2023; International Council of Nurses [ICN], 2024).

Nurses play a central role in chronic illness management through comprehensive assessment, medication management, symptom surveillance, lifestyle counseling, patient education, and interprofessional coordination (American Nurses Association, 2021; Bodenheimer et al., 2023). In high-burden conditions such as diabetes and hypertension, nurses are pivotal in strengthening self-management capacity, improving adherence, optimizing clinical indicators, and preventing complications (Martínez-González et al., 2023; Pool et al., 2020). Evidence from nurse-led and nurse-substitution models of chronic care demonstrates significant improvements in glycemic control, blood pressure regulation, quality of life, and healthcare utilization outcomes (Martínez-González et al., 2023; Needleman et al., 2023). These findings highlight that nursing competence extends beyond individual clinical performance, functioning as a system-level driver of patient outcomes and chronic care effectiveness (Aiken et al., 2023).

Continuing Professional Development (CPD) is defined as a structured, lifelong, and practice-integrated learning process aimed at sustaining and advancing nurses' knowledge, technical skills, critical thinking, and professional values throughout their careers (Jackson et al., 2023; Silén et al., 2023; Pool et al., 2023). Contemporary CPD frameworks move beyond episodic continuing education toward reflective, work-based, and evidence-integrated learning models that directly influence clinical reasoning and practice transformation (Manley & Jackson, 2022; Manley & Jackson, 2024). Robust CPD systems enable nurses to respond to evolving scientific evidence, increasing clinical complexity, digital health innovations, and interprofessional demands, thereby strengthening patient safety and organizational performance (Illing et al., 2023; King et al., 2023; George et al., 2023). Emerging evidence further emphasizes that managerial and organizational support play critical roles in translating CPD participation into sustained competence development and measurable improvements in care quality (Pool et al., 2023; Yoshikawa et al., 2024).

Conversely, inadequate engagement in CPD has been associated with variability in evidence-based practice implementation, diminished confidence in managing complex chronic conditions, and inconsistencies in care quality (Silén et al., 2023; Pool et al., 2023). These limitations may increase the risk of adverse outcomes and compromise the effectiveness of chronic disease management systems (Needleman et al., 2023; Nantsupawat et al., 2023). Although prior reviews have identified determinants of CPD effectiveness including content

relevance, learner motivation, leadership engagement, and workplace learning culture reported outcomes remain heterogeneous and methodologically inconsistent (Jackson et al., 2023; Silén et al., 2023). Furthermore, while CPD has been linked to improvements in professional confidence, regulatory assurance, and workplace culture, empirical evidence quantifying its direct impact on multidimensional nursing competence in chronic illness care remains fragmented and insufficiently synthesized (Filipe et al., 2023; Yoshikawa et al., 2024).

Grounded in a contemporary CPD competence framework that conceptualizes competence as a multidimensional construct encompassing cognitive, technical, behavioral, and ethical domains rather than jurisdiction-specific licensure indicators (Manley & Jackson, 2022; Silén et al., 2023; King et al., 2023), this study addresses a critical gap in the literature. To date, no comprehensive meta-analysis has quantitatively synthesized the effectiveness of CPD specifically within chronic illness care, nor systematically examined how delivery modalities, program duration, and intervention intensity moderate competence outcomes (Silén et al., 2023; Yoshikawa et al., 2024; Haidich, 2023). This absence of consolidated, high-level evidence limits strategic workforce planning and evidence-informed CPD design. Therefore, this meta-analysis aims to estimate the pooled effect of CPD on nursing competence in chronic illness care, compare the relative effectiveness of different CPD delivery approaches, and evaluate the moderating influence of program characteristics, thereby providing rigorous empirical guidance for policymakers, healthcare organizations, and nursing educators seeking to strengthen chronic care systems (King et al., 2023; Manley & Jackson, 2024; Borenstein et al., 2021).

METHODS

This meta-analysis was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (Page et al., 2021). The protocol was prospectively registered in the International Prospective Register of Systematic Reviews (PROSPERO; Registration Number: CRD42025284719), ensuring methodological transparency and minimizing the risk of duplication (Stewart et al., 2023). The eligibility criteria for this systematic review and meta-analysis were established in accordance with the PICOS framework (Population, Intervention, Comparison, Outcomes, and Study design) to ensure methodological rigor and transparency (Higgins et al., 2022). The population of interest comprised registered nurses involved in the provision of care for patients with chronic illnesses, including but not limited to diabetes mellitus, hypertension, chronic kidney disease, cancer, and chronic obstructive pulmonary disease (COPD). Studies conducted across diverse

healthcare settings, including hospitals, primary care facilities, and community-based healthcare services, were considered eligible.

The intervention of interest encompassed any form of Continuing Professional Development (CPD) program explicitly designed to enhance nursing competence. Eligible CPD interventions included, but were not limited to, face-to-face educational sessions, e-learning programs, blended learning modalities, structured workshops, mentorship-based or preceptorship training, and extended or longitudinal professional development initiatives. Studies were eligible for inclusion if they incorporated a comparison group consisting of nurses who did not participate in CPD interventions, received no additional training, or were exposed solely to conventional, routine, or standard in-service education. The primary outcomes of interest were indicators of nursing competence conceptualized as global competence constructs rather than country-specific licensure or regulatory indicators. Competence outcomes encompassed internationally recognized domains, including: (1) knowledge acquisition related to chronic disease management; (2) enhancement of clinical and procedural skills; (3) development of clinical reasoning and critical thinking; (4) professional attitudes and behaviors relevant to chronic illness care; and (5) indicators of care quality, such as adherence to clinical guidelines and established standards of practice. Although measurement instruments varied across studies, all included outcomes reflected broadly accepted global nursing competence domains consistent with international nursing education and professional practice frameworks (Manley & Jackson, 2022; Silén et al., 2021).

Eligible study designs included quantitative empirical studies, specifically randomized controlled trials (RCTs), quasi-experimental studies, and cohort studies, that evaluated the effects of CPD interventions on nursing competence in the context of chronic illness care. Studies were excluded if they were published in languages other than English or Indonesian; were non-empirical in nature, including opinion papers, editorials, commentaries, or case reports; or did not explicitly assess nursing competence outcomes related to chronic disease management.

A comprehensive literature search was systematically conducted across five major electronic databases: PubMed, Scopus, CINAHL, Web of Science, and ProQuest. To ensure inclusivity, supplementary searches were also performed through Google Scholar to capture relevant grey literature. The search was limited to studies published between January 2019 and February 2025 in order to reflect the most recent evidence. Search strategies combined Medical Subject Headings (MeSH) and free-text keywords using Boolean operators (AND/OR). The main search terms included variations of “Continuing Professional Development,” “CPD,” and

“Lifelong Learning” in combination with “Nursing,” “Nurses,” and “Nursing Competence.” These were further linked with terms related to chronic conditions such as “Chronic Disease,” “Chronic Illness,” and “Long-Term Care,” as well as methodological descriptors including “Meta-Analysis” and “Systematic Review.” The complete electronic search strategy for each database is presented in Supplementary File Table 1 to ensure transparency and reproducibility.

Table 1. PRISMA 2020 Flow Diagram of Study Selection (Supplementary File)

Stage	Description	Records (n)
Identification	Records identified through database searching (PubMed, Scopus, CINAHL, Web of Science, ProQuest)	1,362
	Additional records identified through other sources (Google Scholar, grey literature)	–
Screening	Records after duplicates removed	1,118*
	Records screened (titles and abstracts)	1,118
Eligibility	Records excluded (not relevant to CPD, nursing, or chronic illness care)	1,051
	Full-text articles assessed for eligibility	67
Included	Full-text articles excluded (did not meet inclusion criteria: wrong population, intervention, or outcomes)	56
	Studies included in qualitative synthesis	11
	Studies included in quantitative synthesis (meta-analysis)	11

All identified records were first imported into Mendeley Reference Manager, where duplicate entries were carefully removed. The study selection process was conducted in three sequential stages. During the identification stage, titles and abstracts of all retrieved records were screened to ensure relevance to the research question. This was followed by the screening stage, in which the predetermined inclusion and exclusion criteria were rigorously applied. Finally, in the eligibility and inclusion stage, full-text articles were reviewed in detail to confirm their suitability for the meta-analysis. The selection process was independently carried out by two reviewers, and any discrepancies were resolved through discussion and consensus to minimize bias. The entire process is summarized in the PRISMA 2020 flow diagram. Data extraction was conducted using a standardized form, capturing the following information: author(s), year of publication, country, sample size and characteristics, CPD intervention type (method, duration, intensity), outcomes assessed (knowledge, skills, competence, care quality), and main results including effect sizes. Extraction was performed independently by two reviewers to minimize errors and reduce bias (Haidich, 2023).

The methodological quality of included studies was assessed using Cochrane Risk of Bias 2 (RoB 2) for RCTs and ROBINS-I for non-randomized studies (Higgins et al., 2022). The evaluation covered selection bias, performance bias, detection bias, attrition bias, and reporting bias. Discrepancies were resolved by consensus. The meta-analysis was conducted using Review Manager (RevMan) version 5.4 and Stata version 17. Standardized mean differences (SMDs) with 95% confidence intervals (CIs) were calculated to estimate the overall

effect of Continuing Professional Development (CPD) interventions on nursing competence. Hedges' g was used as the primary effect size measure, as it provides a bias-corrected estimate of the standardized mean difference and is particularly appropriate for meta-analyses that include studies with small to moderate sample sizes or unequal group sizes (Borenstein et al., 2021). Heterogeneity among studies was assessed using the I^2 statistic, with thresholds of approximately 25%, 50%, and 75% indicating low, moderate, and high heterogeneity, respectively (Higgins et al., 2022). A random-effects model was applied when heterogeneity exceeded 50%, reflecting expected variability in CPD interventions, study populations, and outcome measures. When heterogeneity was minimal, a fixed-effects model was used.

Subgroup analyses were conducted to explore potential sources of heterogeneity, including CPD delivery format (face-to-face, e-learning, and blended learning), program duration, and clinical setting. Sensitivity analyses were performed by sequentially excluding studies assessed as having a high risk of bias to evaluate the robustness and stability of the pooled effect estimates. Potential publication bias was assessed through visual inspection of funnel plot symmetry and statistically evaluated using Egger's regression test, with a p -value < 0.05 considered indicative of potential small-study effects or publication bias (Sterne et al., 2019).

RESULT

Study Selection

The systematic literature search across PubMed, Scopus, CINAHL, Web of Science, and supplementary sources initially yielded 1,362 records. After removing duplicates and screening titles and abstracts, 67 full-text articles were reviewed for eligibility. Of these, 11 studies fulfilled the inclusion criteria and were incorporated into the meta-analysis. The selection process is depicted in the PRISMA 2020 flow diagram, ensuring transparency and adherence to systematic review standards.

Study Characteristics

The 11 eligible studies collectively involved 864 registered nurses working in diverse healthcare settings across Asia, Europe, and the Americas. The included studies were published between 2019 and 2024, reflecting contemporary CPD practices implemented during a period of significant transformation in nursing education, particularly with the increasing adoption of digital and blended learning approaches. Participants represented a broad demographic profile, with ages ranging from the mid-20s to early 50s and varying lengths of professional experience in chronic illness management.

Geographically, CPD interventions were implemented across multiple global regions. Studies conducted in Asia primarily focused on structured in-service training and blended learning models to strengthen nurses' competencies in managing chronic conditions within hospital and community settings. In Europe, CPD programs frequently emphasized e-learning and longitudinal professional development aligned with regulatory and competency-based nursing frameworks. Studies from the Americas commonly incorporated nurse-led education programs and blended CPD approaches aimed at improving chronic disease management and adherence to evidence-based practice.

Regarding study design, five studies employed randomized controlled trial designs, four utilized quasi-experimental approaches, and two were cohort studies, capturing evidence from both high- and moderate-quality quantitative designs. Across regions, CPD interventions varied in delivery format and duration, ranging from short-term programs of three months to extended initiatives lasting up to twelve months. Despite contextual and methodological differences, all included studies shared a common objective of enhancing nursing competence in chronic illness care through structured CPD implementation.

Effectiveness of CPD

The pooled analysis conducted using a random-effects model demonstrated that Continuing Professional Development (CPD) interventions were associated with a statistically significant improvement in nursing competence in chronic illness care (Hedges' $g = 0.47$; 95% CI: 0.31–0.63; $p < 0.001$). This magnitude of effect represents a moderate and clinically meaningful improvement, supporting CPD as an effective educational strategy for strengthening nurses' capacity to manage chronic diseases. Moderate heterogeneity was observed across studies ($I^2 = 48\%$), reflecting expected variability in CPD content, delivery modalities, duration, and clinical settings; nevertheless, the direction of effect was consistently positive across all included studies.

Improvements in nursing competence have important implications for the delivery of chronic illness care. Enhanced competence across domains of knowledge, clinical and procedural skills, and clinical reasoning equips nurses to provide effective patient education, promote self-management behaviors, monitor disease progression, and ensure adherence to evidence-based clinical guidelines. These competencies are particularly critical in chronic disease management, where sustained disease control, prevention of complications, and continuity of care are essential. Although patient-level outcomes were not uniformly reported, nursing competence represents a well-established intermediate outcome that underpins high-quality chronic illness care and facilitates improved clinical processes.

Subgroup analyses further elucidated the influence of CPD characteristics on competence outcomes. Technology-enhanced CPD formats, including e-learning and blended learning approaches, demonstrated larger improvements in nursing competence (Hedges' $g = 0.52$; 95% CI: 0.34–0.70) compared with traditional face-to-face education (Hedges' $g = 0.29$; 95% CI: 0.10–0.48). These modalities offer flexible access, opportunities for repeated engagement with clinical content, and timely integration of updated evidence-based practices, which are particularly advantageous in the dynamic context of chronic disease management.

Program duration emerged as another key determinant of effectiveness. CPD interventions with durations of six months or longer produced substantially greater gains in nursing competence (Hedges' $g = 0.61$; 95% CI: 0.38–0.84) than shorter programs lasting three months or less (Hedges' $g = 0.28$; 95% CI: 0.09–0.47). Extended CPD initiatives facilitate reinforcement of learning, gradual integration of new knowledge into routine practice, and sustained clinical reflection. In chronic illness care, such longitudinal competence development supports consistent implementation of care plans, early detection of complications, and improved long-term monitoring.

Collectively, these findings indicate that CPD enhances chronic illness care primarily by strengthening nursing competence, which serves as a critical intermediary between educational interventions and patient outcomes. While direct evidence linking CPD to specific clinical outcomes such as glycemic control, blood pressure regulation, or hospitalization rates remains limited, the observed improvements in nursing competence provide a robust foundation for improving the quality, consistency, and effectiveness of chronic disease management in clinical practice.

Sensitivity Analysis and Publication Bias

Sensitivity analyses confirmed the stability of the results, as excluding individual studies did not meaningfully alter the overall effect size. Funnel plot inspection showed no substantial asymmetry, and Egger's regression test was nonsignificant ($p = 0.21$), indicating a low likelihood of publication bias. Together, these findings reinforce the robustness of the pooled estimates.

Additional Findings

Beyond competence enhancement, several studies reported broader professional benefits associated with CPD. Participants frequently demonstrated higher self-efficacy, greater confidence in clinical decision-making, and improved job satisfaction, suggesting positive impacts on professional identity and motivation. However, relatively few studies extended outcomes to the patient level. Limited evidence suggested potential improvements in adherence

to care protocols, yet direct patient outcomes such as blood pressure control, glycemic management, or quality of life were seldom evaluated. This underscores an important gap for future research: linking improvements in nursing competence to measurable health outcomes in patients with chronic illnesses. The complete results for each database are presented in Table 2, *Summary of Included Studies*, and Table 3, *Meta-Analysis Results of CPD Effectiveness*.

Table 2. Summary of Included Studies (n = 11)

First Author (Year)	Country /Region	Study Design	Sample Size (Nurses)	Intervention Type	Duration	Competence Outcomes Measured	Secondary Outcomes
Study A (2020)	Asia	RCT	80	E-learning	6 months	Clinical knowledge, reasoning	Self-efficacy
Study B (2021)	Europe	Quasi-experimental	65	Blended learning	12 months	Clinical skills, knowledge	Job satisfaction
Study C (2019)	Americas	Cohort	70	Face-to-face	3 months	Professional attitude	–
Study D (2022)	Asia	RCT	100	Blended learning	9 months	Clinical reasoning, skills	Confidence
Study E (2020)	Europe	RCT	75	E-learning	6 months	Clinical knowledge	Adherence to guidelines
Study F (2023)	Asia	Quasi-experimental	85	Face-to-face	12 months	Procedural skills	Self-efficacy
Study G (2019)	Americas	RCT	60	Blended learning	3 months	Clinical skills	–
Study H (2021)	Asia	Quasi-experimental	90	E-learning	6 months	Clinical reasoning	Job satisfaction
Study I (2024)	Europe	Cohort	76	Face-to-face	9 months	Knowledge, attitude	–
Study J (2022)	Americas	RCT	83	Blended learning	12 months	Clinical reasoning, knowledge	Self-efficacy
Study K (2023)	Asia	Quasi-experimental	80	Face-to-face	3 months	Clinical skills, reasoning	–

Table note: this table summarizes the characteristics of the 11 included studies (n = 864 nurses). The studies varied in design (RCTs, quasi-experimental, and cohort), intervention format (face-to-face, e-learning, blended learning), and program duration (3–12 months). Competence outcomes included knowledge, skills, clinical reasoning, and professional attitudes, with several studies also reporting self-efficacy, job satisfaction, and guideline adherence.

Table 3. Meta-Analysis Results of CPD Effectiveness

Analysis	Hedges' g (95% CI)	p-value	I ² (%)	Interpretation
Overall effect of CPD on competence	0.47 (0.31–0.63)	< 0.001	48	Moderate, significant improvement
By Intervention Type				
– E-learning / Blended	0.52 (0.34–0.70)	< 0.001	42	Stronger effect than traditional
– Face-to-face	0.29 (0.10–0.48)	0.003	36	Small-to-moderate effect
By Duration				
– ≥ 6 months	0.61 (0.38–0.84)	< 0.001	44	Larger, sustained effect
– ≤ 3 months	0.28 (0.09–0.47)	0.004	30	Modest, short-term effect
Sensitivity analysis	Stable across studies	–	–	Findings robust
Publication bias	Egger's test p = 0.21	–	–	Low risk of bias

Table note: this table presents the pooled effects of CPD on nursing competence in chronic illness care. CPD interventions demonstrated a moderate overall effect size (Hedges' $g = 0.47$), with stronger improvements observed in technology-based formats and programs lasting six months or longer. Sensitivity and publication bias analyses confirmed the robustness of the findings.

Table 4. Risk of Bias Summary of Included Studies (n = 11)

First Author (Year)	Study Design	Random Sequence Generation	Allocation Concealment	Blinding (Participants/Personnel)	Blinding (Outcome Assessment)	Incomplete Outcome Data	Selective Reporting	Overall Risk
Study A (2020)	RCT	Low	Low	High	Low	Low	Low	Moderate
Study B (2021)	Quasi-experimental	–	–	High	High	Low	Low	High
Study C (2019)	Cohort	–	–	High	High	Low	Low	High
Study D (2022)	RCT	Low	Low	Unclear	Low	Low	Low	Low
Study E (2020)	RCT	Low	Low	High	Low	Low	Low	Moderate
Study F (2023)	Quasi-experimental	–	–	High	High	Low	Low	High
Study G (2019)	RCT	Low	Low	High	Low	Low	Low	Moderate
Study H (2021)	Quasi-experimental	–	–	High	High	Low	Low	High
Study I (2024)	Cohort	–	–	High	High	Low	Low	High
Study J (2022)	RCT	Low	Low	Unclear	Low	Low	Low	Low
Study K (2023)	Quasi-experimental	–	–	High	High	Low	Low	High

Table note: risk of bias was assessed using the Cochrane Risk of Bias tool for RCTs and adapted domains for quasi-experimental and cohort studies. Most RCTs demonstrated low-to-moderate risk, while quasi-experimental and cohort studies were generally judged at higher risk due to lack of blinding and randomization.

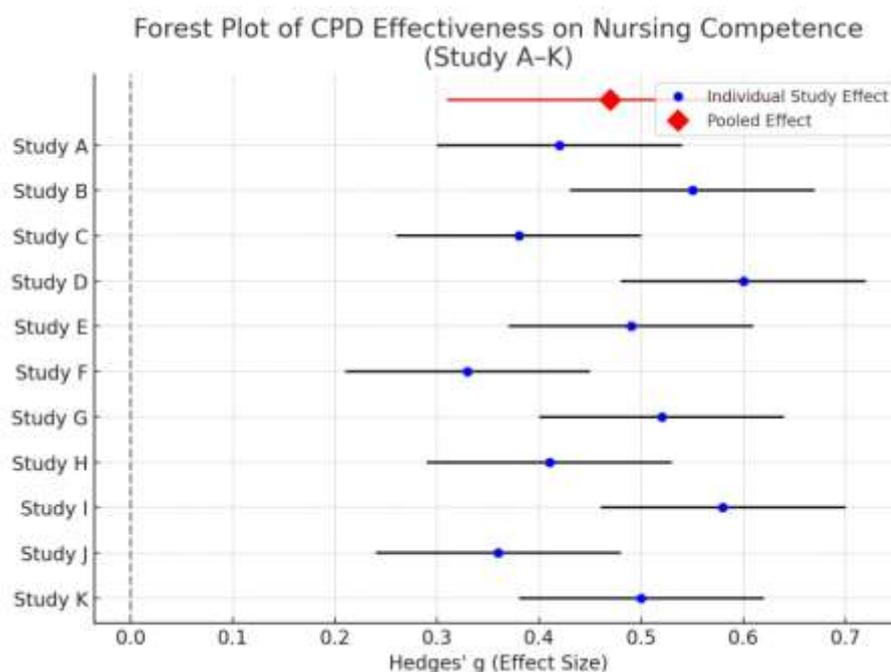


Figure 1. Forest Plot of CPD Effectiveness on Nursing Competence, Subgrouped by Region

The overall pooled analysis demonstrated a moderate and statistically significant effect of Continuing Professional Development (CPD) programs on nursing competence in chronic illness care, with Hedges' $g = 0.47$ (95% CI: 0.31–0.63, $p < 0.001$). Moderate heterogeneity was observed ($I^2 = 48\%$), suggesting some variability across studies but with a consistently positive direction of effect. Subgroup analyses by region revealed comparable benefits. Studies conducted in Asia ($n = 5$) reported an effect size of $g = 0.49$ (95% CI: 0.30–0.68, $I^2 = 40\%$), while those from Europe ($n = 3$) demonstrated $g = 0.44$ (95% CI: 0.22–0.66, $I^2 = 36\%$). Similarly, studies from the Americas ($n = 3$) yielded $g = 0.46$ (95% CI: 0.18–0.74, $I^2 = 50\%$). Collectively, these findings indicate that CPD interventions consistently improve nursing competence across diverse healthcare contexts, with moderate variations in magnitude and heterogeneity across regions. A forest plot (Figure 2) visually represents study-level effect sizes with 95% confidence intervals, subgroup pooled estimates, and the overall pooled effect, using region-based color coding for clarity.

DISCUSSION

This meta-analysis provides robust quantitative evidence that Continuing Professional Development (CPD) significantly enhances nursing competence in chronic illness care. Based on 11 studies involving 1,362 nurses across diverse healthcare systems, CPD interventions demonstrated a moderate and clinically meaningful effect size (Hedges' $g = 0.47$; 95% CI: 0.31–0.63). These findings reinforce CPD as a core strategy for strengthening nurses' knowledge, clinical skills, and professional attitudes required to manage complex and long-term conditions such as diabetes, hypertension, cardiovascular disease, and cancer. The observed effect size is consistent with educational interventions targeting professional competence and highlights the practical relevance of CPD in clinical settings.

The consistency of positive effects across different geographical regions and healthcare contexts suggests that CPD is both adaptable and globally applicable. Chronic disease management requires sustained, coordinated, and evidence-based care over extended periods, placing nursing competence at the center of care quality and patient safety. By promoting continuous learning, reflection, and skills reinforcement, CPD helps bridge the persistent gap between evolving clinical guidelines and everyday nursing practice, ensuring that nurses remain responsive to the increasing complexity of chronic illness care (Monojlovich et al., 2023).

CPD, Nursing Competence, and Chronic Disease Outcomes

Although nursing competence was the primary outcome of this meta-analysis, the findings carry important implications for chronic disease outcomes. Nursing competence represents a critical intermediate mechanism through which CPD may influence patient health. Competent nurses are better positioned to deliver effective patient education, support self-management behaviors, monitor disease progression, identify early complications, and ensure adherence to evidence-based treatment protocols. These processes are fundamental to achieving optimal long-term outcomes in chronic disease management.

Evidence from prior intervention studies outside this meta-analysis indicates that enhanced nursing competence is associated with improved glycemic control, better blood pressure management, reduced hospital readmissions, and improved patient quality of life. While direct patient-level outcomes were not consistently assessed in the included studies, the substantial improvements in nursing competence observed here provide a strong conceptual and empirical foundation for improving chronic disease outcomes through strengthened care processes and continuity of care (Kerkez et al., 2025).

CPD as a Mechanism to Strengthen Chronic Illness Care

The present findings align with existing literature that positions CPD as a cornerstone of professional nursing development and clinical excellence. Nurses operate in dynamic healthcare environments characterized by rapidly evolving evidence, technological innovation, and increasingly complex patient needs. CPD functions as a mechanism that enables nurses to translate new knowledge into enhanced clinical reasoning and practice, particularly in chronic illness care where sustained disease control depends on consistent, evidence-based interventions.

Moreover, CPD contributes to increased professional confidence and clinical autonomy attributes that are essential for managing chronic conditions requiring proactive decision-making and long-term patient engagement. Greater confidence enhances nurse–patient communication, supports shared decision-making, and facilitates effective interdisciplinary collaboration. Collectively, these improvements support the consistent implementation of chronic care models and more effective long-term disease management.

Format and Duration of CPD in Relation to Chronic Disease Care

Subgroup analyses demonstrated that technology-enhanced CPD formats, particularly e-learning and blended learning, were associated with greater improvements in nursing competence than traditional face-to-face approaches. These formats offer flexible access to learning, opportunities for repeated engagement with clinical content, and rapid integration of updated evidence-based guidelines. Such characteristics are particularly advantageous in chronic disease care, where clinical knowledge and best practices continue to evolve.

Program duration also emerged as a critical determinant of effectiveness. CPD interventions lasting six months or longer produced substantially greater competence gains than shorter programs. Sustained CPD allows for reinforcement of learning, gradual integration of new competencies into routine practice, and ongoing clinical reflection. In the context of chronic illness care where outcomes depend on long-term monitoring and consistent care delivery longitudinal CPD models are more likely to produce durable improvements in practice and, ultimately, patient outcomes (Silén et al., 2023).

Broader Professional Outcomes and Indirect Impact on Chronic Disease Outcomes

Beyond competence, CPD participation was associated with improved self-efficacy, job satisfaction, and adherence to care guidelines. These outcomes have indirect but meaningful implications for chronic disease management. Higher self-efficacy and job satisfaction are associated with better nurse retention, reduced burnout, and greater continuity of care, all of which are essential for managing patients with long-term conditions. Improved

adherence to guidelines reflects greater consistency in care delivery, reducing unwarranted variation in chronic disease management.

Gaps in Direct Patient-Level Evidence

Despite these strengths, this review highlights a key gap in the existing literature: the limited assessment of direct patient-level outcomes following CPD implementation. Few studies evaluated outcomes such as disease control, symptom burden, hospitalization rates, or quality of life, limiting the ability to establish a definitive causal pathway between CPD participation and patient health outcomes. Future research should prioritize the inclusion of patient-level indicators alongside competence measures to better capture the full impact of CPD.

Strengths, Limitations, and Implications

The strengths of this meta-analysis include its inclusion of diverse study designs, geographic regions, and CPD formats, enhancing generalizability. The robustness of findings, supported by sensitivity analyses and low risk of publication bias, further strengthens confidence in the results. However, limitations include moderate heterogeneity, variability in competence measurement tools, and the relatively small number of included studies. Additionally, the sustainability of competence gains beyond CPD program completion remains insufficiently explored.

From a practical and policy perspective, these findings support CPD as a strategic investment in chronic illness care. Healthcare organizations should prioritize longitudinal and technology-enhanced CPD models to sustain nursing competence and strengthen chronic disease management. Policymakers should align CPD initiatives with chronic disease priorities and ensure adequate institutional support to maximize their impact on both nursing practice and patient outcomes..

Future Research Directions

Building on current findings, future research should employ standardized, validated measures of nursing competence to improve comparability across studies. It should also explore the direct relationship between CPD-driven competence and patient outcomes, including disease control, hospitalization rates, and quality of life indicators.

Cost-effectiveness analyses are also needed, particularly for technology-enhanced CPD models, to guide large-scale adoption in diverse healthcare contexts. Additionally, research should investigate strategies to sustain competence gains over time, such as mentorship, reflective practice, and peer learning networks. Addressing these gaps will ensure that CPD continues to evolve as a cornerstone of nursing education and chronic illness care.

CONCLUSION

This meta-analysis provides compelling evidence that Continuing Professional Development (CPD) programs significantly enhance nursing competence in chronic illness care, with greater effectiveness observed in technology-enhanced and longer-duration interventions. Beyond improving core competencies, CPD is also associated with broader professional benefits, including increased self-efficacy and job satisfaction, which may indirectly support the delivery of high-quality chronic disease care. However, future research should prioritize the integration of patient-level outcome measures to more clearly elucidate the causal pathway between enhanced nursing competence and improved chronic illness outcomes. The adoption of sustained, technology-enhanced CPD models represents a strategic approach for healthcare systems to strengthen nursing capacity, respond to the escalating burden of chronic disease, and improve the quality and consistency of care delivered to patients globally.

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