The Effectiveness and Impact on Performance of Pharmacy-related Competency Development Frameworks: A Systematic Review and Meta-Analysis

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Acknowledgement

None

Conflict of Interest

None declared

Abstract

Background: Competency frameworks for education, training and development are widely used in the health professions, including pharmacy. Published studies suggest that competency frameworks have an impact on professional performance. Professional performance that is consistent with up-to-date knowledge and skills influences health care quality and patient safety. This review assessed the effectiveness of competency frameworks in facilitating improvement in pharmacists' performance.

Method: PubMed/Medline, CINAHL, Embase, ERIC, PsycINFO and Scopus electronic databases were searched to identify relevant literature. The findings of the included studies were synthesised qualitatively, and via a meta-analysis. The meta-analysis evaluated the odds of improved competency behaviour as a proxy measure of impact on pharmacists' performance. Study quality was assessed using 12 criteria adapted from the EPPI-Centre guidelines v0.9.7. The protocol for this review is registered on PROSPERO with reference number CRD42018096580.

Results: In total, nine interventional studies were identified for review. The review findings showed observable and significant improvement in pharmacists' performance when competency frameworks are used to appraise performance, identify knowledge gaps and tailor learning activities. A meta-analysis that involved a total of 348 pharmacists undergoing repeat peer assessment showed pooled odds for improved competency behaviour of 4.41 (95% CI: 1.89 – 10.29, I^2 = 83%). Subgroup analyses showed pooled odds with corresponding 95% CI of 6.50 (1.77 – 23.97, I^2 = 77%) vs 2.95 (0.59 -14.72, I^2 = 93%) for the studies that were conducted in countries within or outside Europe, respectively; 10.51 (3.73 – 29.62, I^2 = 24%) vs 2.39 (0.96 – 5.95, I^2 = 87%) for studies with reassessment conducted at ≤6 months from baseline, or more, respectively; 6.68 (1.63 – 27.45, I^2 = 88%) vs 2.80 (0.86 – 9.07, I^2 = 74%) for studies involving hospital or community pharmacists, respectively; and 2.80 (1.22 – 6.45, I^2 = 77%) for studies with low risk of bias.

Conclusion: These findings suggest competency frameworks facilitate improvement in pharmacists' performance, however, further evaluative studies are needed.

Keywords: Competency-based education, competency frameworks, health professions education, professional development, pharmacy

Introduction

Global reforms in health professional education involving the implementation of outcome and competency-based education and training (CBET) have occurred in recent decades. [1–3] Key drivers for the implementation of CBET within the health professions include the dissatisfaction with the outcomes of traditional theory-based education models, and the imperative for a flexible workforce that is adaptable to changing population health needs. [1] A crucial element of the CBET model is the identification of the competencies required for safe, effective, and consistent performance within the limits of professional practice. [4,5] Competencies refer to the knowledge, skills and attributes that are essential for effective professional performance. [6,7] A compilation of these competencies and their corresponding behaviours produces a framework that is used to design education and training curricular, define expectation of practice, regulate career entry, and support expertise development. [8] With the implementation of CBET in the training of health workers, competency frameworks that provide a shared understanding of the requirements for professional practice are now commonplace within the health professions. [9]

Competency frameworks in the health professions provide a blueprint of the required standards of practice, benchmarks of work accountability, and career progression pathways. [8] In Pharmacy, these frameworks include those containing generic competencies for a defined level of practice (for example, foundation [10–12] and advanced practice [13–15]), and others that are sector/role-related [16–19] or specialty-specific. [20–22] These frameworks are typically defined and developed by professional leadership bodies, regulatory or accreditation agencies. For example, the International Pharmaceutical Federation (FIP) has developed two global frameworks that describe the generic competencies for foundation and advance pharmacy practice respectively. [10,15] Other organisations have also developed regional, national, and institutional frameworks that map the expectations for pharmacy practice in the specified region or country. [23–27] A 2015 survey of 48 countries across the six World Health Organization (WHO) regions, showed that competency frameworks in pharmacy were either already in use or being developed in approximately 60% of the countries surveyed. [28]

Pharmacy-related competency frameworks generally comprise competencies grouped into clusters (or domains), and sub-divided into respective behavioural indicators (or behaviours). [4,10] The competency behaviours in the frameworks are the discrete measurable metrics of professional performance that are assessed to determine competence and identify knowledge/skills gaps or deficiencies. Professional performance refers to the way a practitioner carries out a given job function, role or task and describes what an individual actually does in practice. [29] There is evidence that suggest that the acquisition of knowledge about a subject matter does not guarantee or imply successful on-

the-job performance in daily practice. [1,30] Rather, professional performance is underpinned by the application of acquired knowledge, skills, and experience to solve problems and influence practice. [31,32] Professional performance that is consistent with up-to-date knowledge and skills influence health care quality and patient safety. [29] Existing evidence in pharmacy suggest that the use of competency frameworks to benchmark standards of practice, appraise performance and tailor learning activities aids the attainment of competence and improvement in professional performance. [33–35] However, the level of impact on performance of pharmacy-related competency frameworks remains unclear in the literature. This review aims to evaluate the evidence and determine the effectiveness of competency frameworks in facilitating performance improvement in pharmacy.

Method

Search strategy

Relevant literature was identified through systematic searches of six electronic databases including PubMed/Medline, Cumulative Index of Nursing and Allied Health Literature (CINAHL), Education Resources Information Centre (ERIC), Embase, PsycINFO and Scopus. Additional searching included Google Scholar, member organisation websites of the International Pharmaceutical Federation, and four electronic sources of grey literature (Scirus, Mednar, CiteSeerX and OpenGrey). Pharmacy-related journals (details included in Appendix 1) and bibliography of identified literature were also searched. Key words used were “competency”, “credential”, “credentialing”, “standards”, “competency framework”, “competency-based education”, “practice development”, “expertise development”, “professional performance”, “CPD”, “pharmacist”, “pharmacy technicians” and “pharmacy” (details provided in Appendix 1).

Boolean operators [OR & AND] as well as key word truncation (for example, competenc*, pharmac* and credential*) were employed in the database literature searches to ensure inclusion of relevant Medical Subject Headings (MeSH) terms (details of the database search strategy is presented in Appendix 1). Databases were searched from inception until July 2020. There was no limit imposed on the search output in relation to language, year of publication, geography or study design. This review is the second of a two-part series on the development, validation and effectiveness of competency frameworks in pharmacy. The review protocol is registered on PROSPERO (Reference number: CRD42018096580) and the findings are reported using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. [36]

Inclusion criteria

Primary research articles that evaluated effectiveness of competency frameworks in pharmacy were included. Specifically, these were interventional studies that evaluated change in pharmacists' performance with the use of a competency framework. Excluded literature were studies that did not evaluate performance, editorials and commentaries on competency-based education and competency-based curriculum development, as well as other publications that did not meet the pre-defined inclusion criteria. See Box 1 for details of the population of interest, study intervention, comparator and outcomes defined for this review.

Box 1 – Population, intervention, comparator, and outcomes

Population - The population of interest in this review was the pharmacy workforce and this included pharmacists, pharmacy technicians and other support staff
Intervention - The intervention involved the use of a competency frameworks to appraise performance and to tailor learning activities
Comparator - The comparator was usual training undertaken without a framework. For the before and after studies, the comparator was the repeat performance appraisal undertaken after training with a framework
Outcomes - The outcomes of interest were measures of change in performance with the use of a competency framework as defined in the selected studies

Study selection and quality assessment

The first author (AU) screened titles and abstracts for relevance with respect to subject and population of interest. Full paper screen was then conducted against the inclusion and exclusion criteria. The outcome of screening was thereafter reviewed independently by two other authors (DE and KG) with discrepancies resolved via discussion until consensus reached. A schematic of the literature selection process is presented in Figure 1. Although there was no restriction on research design for the literature included in this review, studies had to include at least one comparator to be selected. The quality of the included studies was assessed using a set of criteria adapted from the EPPI-Centre guidelines for extracting data and quality assessing primary studies in educational research version 0.9.7. [37] The EPPI-Centre tool used in this review is designed specifically for quality assessing primary research studies in education and training. Using the tool, the studies in this review were graded on 12 criteria namely: study aim and objectives, eligibility criteria, representativeness of study sample, sampling technique, sample size, consistency in intervention implementation, reliability of data collection method and tools, appropriate statistical methods, loss to follow up of less than 20%, outcome measure assessed

more than once, potential confounders, and reliability of the study findings. Each criterion received a score of zero if there was a risk of bias concern or 1 if none. Where a given criterion was not reported or unclear in a study, a score of zero was entered. Scores of 0 – 4 indicated high risk, 5 – 9 moderate risk, 10 and above low risk of bias.

Data extraction and analysis

Data extracted from the selected literature included study author(s), country, aim and objectives, study design including practice setting, intervention implementation and duration, recruitment and follow up, endpoint and overall study finding. This review involved a qualitative synthesis of published findings and used a matrix approach to combine themes and sub-themes identified in relation to the review objective. Quantitative synthesis of the study outcomes via a meta-analysis was also conducted. Pooled estimates in the meta-analysis was computed via a random-effects (RE) model [38]. The RE model was chosen *a priori* given the expected heterogeneity in sample composition with respect to area of pharmacy practice, time to reassessment in the intervention, and contextual disparity in pharmacy practice settings between and/or within countries.

The meta-analysis conducted via RevMan, [39] computed the pooled odds of improved competency behaviour at reassessment of performance. The log odds per study was calculated using the formula $In\left(\frac{p}{1-p}\right)$, [40] where p is the probability of an improved behaviour, which also corresponded to the proportion of behaviours that pharmacists showed a statistically significant improvement in performance from baseline to reassessment. The corresponding sample variance was computed as $Var_i = \left(\frac{1}{np} + \frac{1}{n(1-p)}\right)$ [40] for each study, where n is the total number of framework behaviours assessed in the respective studies. The standard error per study was derived from the square root of the variance. To account for proportions of 0 and 1, a continuity correction of 0.5 was employed across the relevant cells prior to computing the pooled odds estimates. Between-study heterogeneity was assessed quantitatively via the I-squared (I^2) statistic with values of 25%, 50%, 75% and above indicating low, moderate, and high heterogeneity, respectively. [41] Subgroup analyses based on the risk of bias classification, study location (Europe vs non-Europe), study population (hospital vs community pharmacists), and time to reassessment (≤6months vs >6months) was also conducted to assess robustness of pooled estimates.

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Figure 1: Schematic of literature selection process using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) [36]

Results

Characteristics of the selected literature

In total, 789 articles were identified from the database and manual literature searches conducted for this review. On deduplication, this included 643 articles identified from the electronic database searches, and two from google scholar and bibliography of the selected literature. Of this number, 518 articles were excluded after screening titles and abstract for relevance. The full text of 127 articles were further screened against the inclusion and exclusion criteria. At the end of the literature search and selection process, nine interventional studies that evaluated impact of a competency framework on professional performance in a pharmacy-related setting were selected for review (Figure 1). These included three studies conducted in United Kingdom, [42–44] and one each in Australia, [34] Croatia, [33] Serbia, [45] Singapore, [35] the Pacific Island Countries (PIC), [46] and USA [47] (Table 1). The study population included community pharmacists in Croatia [33] and Serbia [45]; hospital pharmacists in the studies conducted in Australia, [34] United Kingdom, [43,44] Singapore, [35] and USA [47]; community and primary care pharmacists in one study from United Kingdom [42]; and primary care pharmacists in the PIC study. [46] Eight of the included studies evaluated change in performance, [33–35,42–45,47] while one study evaluated change in performance and knowledge scores. [46]

Further, two of the studies involved the use of a control group [43,44] while the remaining seven were uncontrolled before-and-after studies (Table 1). Six of the included studies were multicentre [33,34,42–45] while the remaining were single centre studies. The sample size in the included studies ranged from 32 to 100 respondents. Six of the studies involved repeat peer assessment of performance using a competency framework, [33–35,43–45] two involved both self and peer assessments, [46,47] while one employed self-assessment [42] only. The study by Meštrović et al [33] employed covert observation of procedural skills during the peer assessment while the remaining involved overt observations. Seven of the studies used the United Kingdom CoDEG General Level Framework (GLF), [33–35,42–45] while the studies by Brown et al [46] and French et al [47] used the Essential Medicine Supply Management (EMSM) Competency Framework and the Pharmacist Annual Competency Evaluation (PACE) Framework, respectively.

The CoDEG framework used in the studies conducted in the United Kingdom, was adapted to population needs in the four studies conducted in the Croatia, [33] Serbia, [45] Australia [34] and Singapore, [35] respectively. The CoDEG GLF and the PACE frameworks mainly comprised patient care competencies while those in the EMSM framework were related to medicines supply and management. Reassessment of performance was conducted only once from baseline in seven of the included studies, and twice in the studies by French et al [47] and Antoniou et al, [43] respectively. Time to

performance reassessment ranged from three [44] to fourteen [34] months in the included studies. The number of competency behaviours for which pharmacists showed a significant improvement in performance from baseline to reassessment was the outcome reported in six of the included studies. [33–35,43–45] Of the remaining three studies, one reported the proportion of pharmacist that attained their desired performance level with the intervention, [42] while two others reported the outcome of performance [46] and self-efficacy scores [47] observed at the end of the intervention. Details of the characteristics of the included studies are presented in Table 1.

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Table 1: Study characteristics and main findings

Effectiveness and impact on performance

The findings of the nine studies included in this review demonstrate improvement in pharmacists' performance [33–35,42–45] and self-efficacy [47] when competency frameworks are used to evaluate performance, identify knowledge gaps and tailor learning activities. Of the two studies that included a control group, one showed improvement in performance for the pharmacists in the intervention group, but this was not observed in the control group. [44] On the other hand, the controlled study by Antoniou et al [43] showed improvement in performance at six months for both the intervention and control group. However, pharmacists in the intervention group demonstrated improvement in more behaviours (96% vs 28%, respectively, $p< 0.001$) [43] comparatively, and this was sustained at 12 months (96% vs 48%, respectively, $P<0.001$). The Antoniou et al findings suggested that the use of a competency framework facilitated performance improvement in greater number of competency behaviours compared to usual training without a framework. [43]

Similar findings were reported in four of the before-and-after studies with a significant improvement in pharmacists' performance observed from baseline for 56%, [34] 85%, [35] 87% [45] and 100% [33] of the competency behaviours evaluated in the respective frameworks. The improvement in pharmacists' performance was observed via peer assessment at six, [45] nine, [35] twelve [33] and fourteen [34] months from baseline, respectively. This was in line with the results in the Mills et al study that showed an increase in self-assessed competency score for practice and community pharmacists, [42] with both groups equally as likely to achieve their desired performance level at 12 months with the intervention. This suggested that the evaluated framework was applicable across the two sectors of practice represented in the study. Similarly, Brown et al [46] showed improvement in performance and mean competency scores for all (100%) of the six task-based competency stations that were evaluated while French et al [47] demonstrated a 12.5% increase in self-efficacy score on all (100%) of the five clinical

tasks that were assessed. The improvement in pharmacists' performance was observed at reassessment conducted after a 4-days training programme in the Brown et al study [46] and at one month in the French et al study. [47] However, subsequent reassessment at 12 months in the French et el study showed sustained improvement in only one of the five clinical tasks stations evaluated. [47] This was in contrast to the Antoniou et al study that showed sustained improvement at 12 months with the intervention. [43] The Antoniou et al study however showed a high number of participants lost to follow up (> 20%) at 12 months, and this was a key limitation. [43]

Most (78%) of the included studies had a low risk of bias (quality assessment score = 10 – 12) (details provided in Appendix 2). Key methodological strengths observed were the defined study intervention and implementation, evaluation of performance at more than one time point, recruitment of more than 80% of eligible participants. The moderate risk of bias in the Goldsmith et al study [44] was due to the small number of participants included in the control arm and the loss to follow up of more than 20% of the study participants. These may have contributed to the lack of observable change reported in the control group, potentially impacting on the reliability of the study findings. On the other hand, the inconsistency in intervention implementation due to the variability in time to repeat assessment was a key source of bias in the Rutter et al study [35] (Appendix 2). A summary of the main findings and risk of bias classification of the included studies is provided in Table 1.

Meta-analysis

The meta-analysis conducted in this review assessed the odds of improved competency behaviour at reassessment with a framework. Of the nine included studies, only Antoniou et al and Goldsmith et al involved both an intervention and control group. [43,44] Therefore, it was not possible to conduct a meta-analysis that compared the intervention effect of a competency framework to a control group undergoing usual training without a framework. Due to the heterogenous performance assessment methods observed in the nine included studies; we only included in the meta-analysis, the six studies that utilised similar methods of intervention implementation with repeat peer-assessment of performance. [33–35,43–45] Also, since the meta-analysis assessed the odds of improvement with a framework; we therefore included only the data from the intervention group in the two studies that incorporated a control group. In addition, due to greater than 20% participants lost to follow up at 12 months in the Antoniou et al study [43] and the potential for bias at this time point; we included only the study's baseline and 6 months data in the meta-analysis.

The random-effects meta-analytical model which involved a total of 348 pharmacists from six studies, showed pooled odds of improved competency behaviour of 4.41 (95% CI: 1.89 – 10.29; $p<0.001$) with an overall I^2 statistic of 83% that indicated high between-study heterogeneity due to factors beyond

sampling error (Figure 2). The meta-analysis also showed two studies (Goldsmith et al and Antoniou et al) with relatively higher 95% confidence interval (CI) and standard error (SE) values (Figure 2, Meta-analysis data table is presented in Appendix 2 of the supplementary material). The meta-analysis re-computed without these two extreme value studies showed pooled odds of 2.84 (95% CI: 1.26 – 6.41; < 0.001) (Figure 3). The subgroup analyses conducted in the meta-analysis are presented in Table 2. The odds of improved competency behaviour within the subgroups ranged from 2.39 – 10.51 while the I^2 statistic values ranged from as low as 24% in the group with reassessment conducted at ≤ 6 months, to 93% in the subgroup that included the studies conducted in countries outside of Europe (Table 2). This suggested that time to reassessment explained a significant amount of the observed between-study heterogeneity in the meta-analytical model.

Although the outcome of the meta-analyses indicated high between-study heterogeneity ($I^2 > 74\%$) overall, and within most of the subgroups; this is to be interpreted with caution given the known I^2 statistic characteristic of overestimating heterogeneity in meta-analyses of fewer than 10 studies. [41,48] Further, publication bias could not be explored in this meta-analysis, nor was it possible to fit a meta-regression model for further sensitivity analysis due to the limited number of interventional studies. Despite this, the consistency in the direction of effect across the subgroups suggest higher odds of an improved competency behaviour with the use of a competency framework.

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Figure 2: Forest plot showing odds of an improved competency behaviour with the use of a competency framework

Figure 3: Forest plot showing odds of an improved competency behaviour with the use of a competency framework (extreme value studies excluded)

Table 2: Table 2: Odds of an improved competency behaviour within subgroups

Discussion

Summary of the main findings

To the best of our knowledge, this is the first systematic review with a meta-analysis of the effectiveness of a key element of the CBET model and its impact on professional performance in pharmacy. The review findings provide preliminary evidence on the effectiveness of competency frameworks in facilitating performance improvement in pharmacy. These findings are in line with existing research in medicine that demonstrates the effectiveness of competency-based approaches in physician training. [49] The meta-analysis findings also indicate higher odds of improved competency behaviour with the use of a competency framework in a pharmacy-related setting. The pooled odds of improvement were higher for the hospital pharmacists' subgroup compared to the community pharmacists' (6.68 vs 2.80); suggesting a greater impact on performance for the former. This finding may be related to the Competency Development Group (CoDEG) General Level Framework used in the studies in the community pharmacists' subgroup. This framework was originally developed for hospital pharmacists in the United Kingdom [50] and adapted for use in community pharmacies in Croatia [33] and Serbia. [45] Consequently, the disparity in level of patient-facing involvement between community and hospital pharmacy practice areas may explain the variation in degree of impact on performance as shown by the pooled odds. This is in line with existing research that show differences in perceived degree of importance of patient care competencies between hospital and community pharmacists [51]; a feature that may also explain the disparity observed in the studies conducted in countries within or outside of Europe.

The meta-analysis results also demonstrate that time to reassessment from baseline is an important moderator in competency assessment as shown by the comparatively lower I^2-statistic value of 24% in the subgroup that included studies with reassessment conducted at 6 months or less. This is a key finding as it highlights the need for future research into the appropriate interval for routine training and competence reassessment in pharmacy. Overall, even though the findings of this review suggest that competency frameworks have a positive impact on pharmacists' performance; the majority (78%) of the included studies were before-and-after studies [33–35,45,46] with only two studies incorporating a control group. As a result, this makes it difficult to be certain that the observed improvement in pharmacists' performance reported in the studies were due to the frameworks alone and not linked to other factors. In addition, most (78%) of the included studies either used the CoDEG General Level Framework or a version of it that was adapted to specific country contexts. [33–35,42–45] It therefore remains unclear whether similar improvement in pharmacists' performance are likely to be observed with the use of other frameworks, and in other regions of the world beyond those represented in this

review. Further multicentre interventional studies with control group are therefore needed in the various pharmacy practice sectors and local contexts not represented in this review.

Strengths and limitations

This review has some limitations. The loss to follow up of greater than 20% of the participants in the Goldsmith et al and Antoniou et al studies limited their generalisability. [43,44] The small sample sizes in some of the included studies was also a key limitation. For example, three of the included studies comprised fewer than 50 pharmacists each, [35,44,45] while the largest comprised 100 pharmacists. Further, we approximated the standard error values in the meta-analysis from the variance computed per study as these were not reported in the literature selected for this review (data file provided in Appendix 2). This approximation is unlikely to be exact and may have resulted in an over or under estimation of the pooled estimates. In addition, the outcome of the meta-analyses showed observed heterogeneity that was above 50% overall, and in all but one of the subgroups analysed. This suggested significant between-study heterogeneity in the included studies. Although further exploratory analysis via a meta-regression was not possible due the few number of studies identified; the pooled odds estimate, and the consistency in direction of effect per study, indicate that competency frameworks facilitate performance improvement in pharmacy.

Policy implication of the review findings and future research

Some authors have questioned the effectiveness of CBET in the health professions with a few suggesting that the model is reductive in nature and demotivating to learners. [52,53] Proponents on the other hand, have highlighted the benefits of CBET including its focus on the resulting outcomes of education and training, the de-emphasis on time spent on training as a measure of competence, and its emphasis on abilities rather than theoretical knowledge and cognition. [1] Despite its widespread use in the health professions including pharmacy, very few studies have attempted to explore the effectiveness of this approach in health workforce training. [54] This feature was highlighted by the limited number evaluative studies identified for our review. Although only a few studies were identified in this review; our findings suggest the usefulness of competency frameworks in facilitating performance improvement in pharmacy. Our findings also suggest that the impact on performance of pharmacy-related frameworks is not country dependent. Further studies from more countries beyond those represented in this review are therefore required to explore the global implication of this finding. The small sample sizes in the studies included in this review, demonstrate the need for larger scale evaluative studies in this area alongside research on the ideal length of time needed for reassessment of competence after training. Given that the studies in this review included only

pharmacists; further evaluative studies involving other key staff groups in the pharmaceutical workforce including pharmacy technicians and pharmacy support staff are also needed.

Conclusion

The findings of this review suggest that the use of competency frameworks to appraise performance, identify knowledge gaps and tailor learning activities, facilitate improvement in pharmacists' performance. The impact of competency frameworks on professional performance as demonstrated in this review underscores the importance of competency-based approaches in pharmacy. However, the limited number of studies identified for review highlights the need for further research in this area. In addition, large scale multicentre evaluative studies in other countries not represented in this review and involving a wider range of competency frameworks developed for the various pharmacy practice settings are needed.

Acknowledgement

None

Conflict of Interest

None declared

Funding

This review did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Ethical approval

Not required

Disclaimer

None

Previous presentations

None

Figure legends

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- **Figure 2:** Forest plot showing odds of an improved competency behaviour with the use of a competency framework
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Table legends

- **Table 1:** Study characteristics and main findings
- **Table 2:** Odds of an improved competency behaviour within subgroups

Author contribution

AU - Conceptualisation, methodology, data curation, formal analysis, original draft preparation

ABT- Conceptualisation, methodology, validation, manuscript review and editing

DKE - Methodology, validation, manuscript review and editing

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562 **Figure 1: Schematic of literature selection process using the Preferred Reporting Items for**
563 **Systematic Reviews and Meta-Analysis (PRISMA)** [29]

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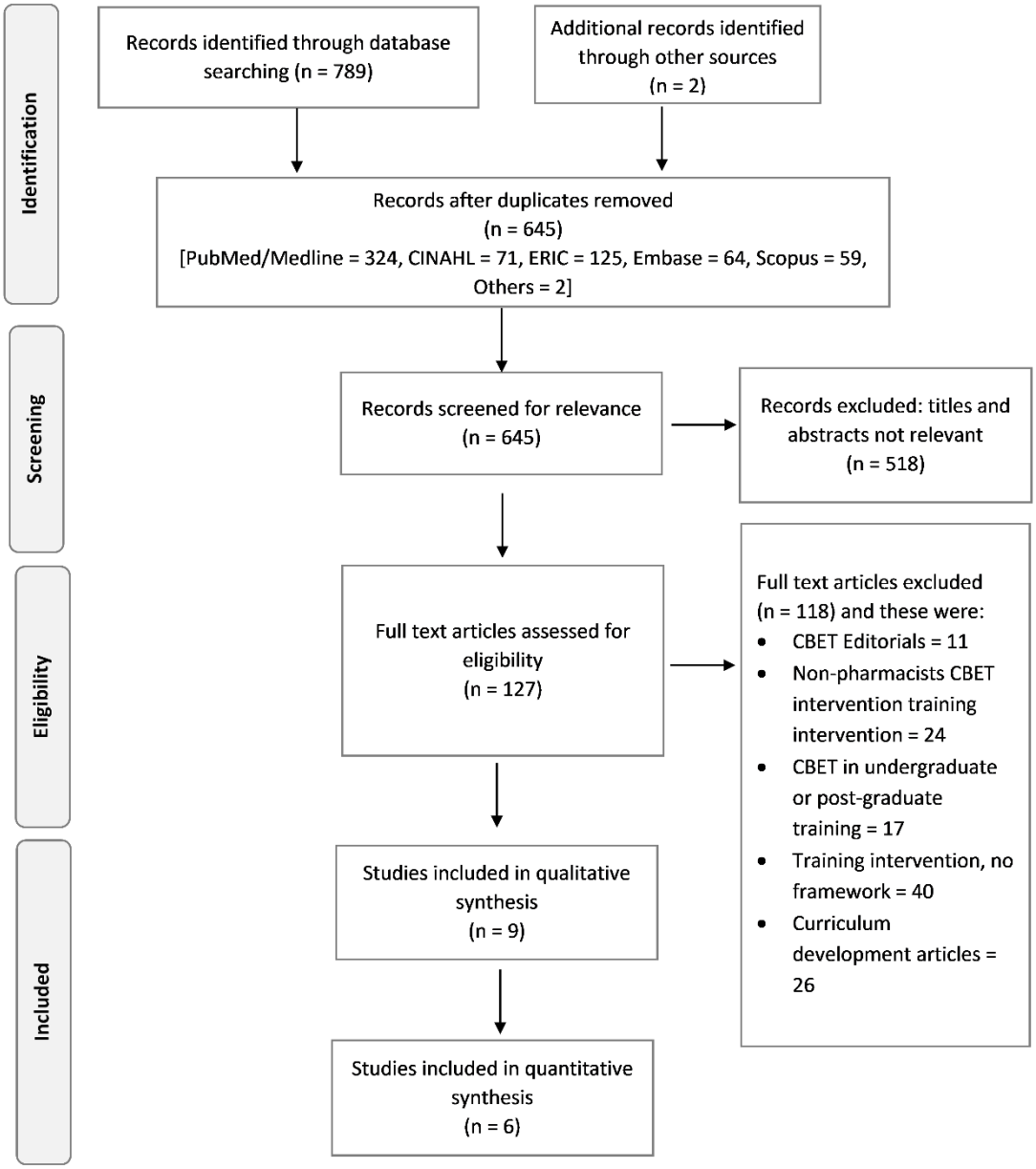

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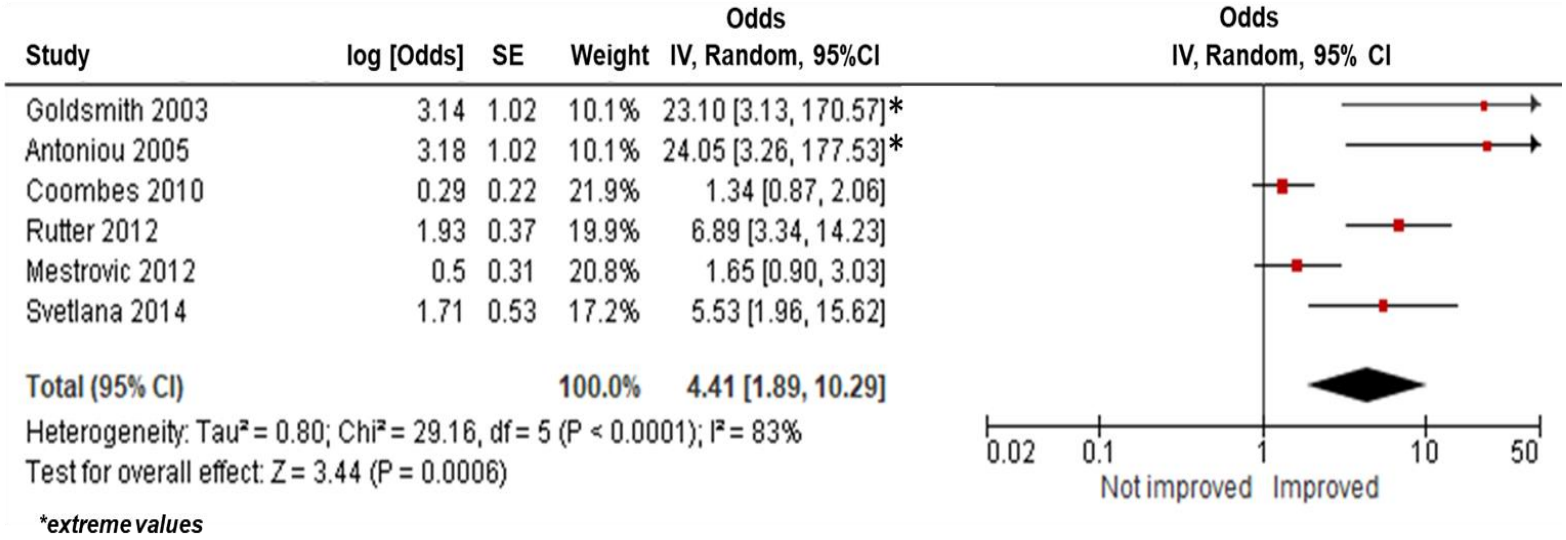
Figure 2: Forest plot showing odds of an improved competency behaviour with the use of a competency framework



**extreme values*

Figure 3: Forest plot showing odds of an improved competency behaviour with the use of a competency framework (extreme value studies excluded)

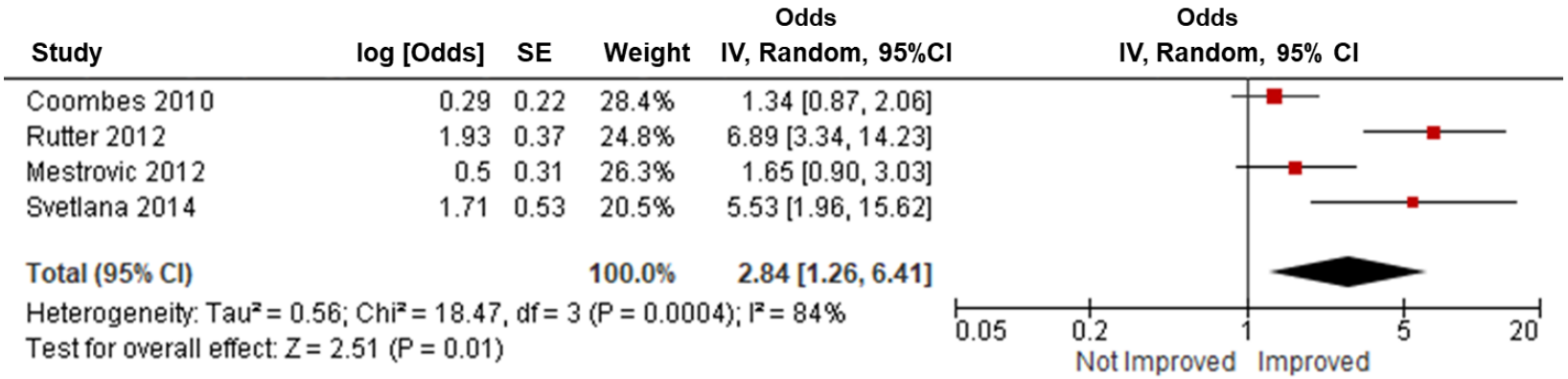


Table 1: Study Characteristics and Main Findings

Author (country)	Study design	Study population	Framework used	Assessment method	Time to re-assessment (months)	Intervention implementation/end point	Main findings	Risk of bias
Goldsmith et al., 2003 [44] (United Kingdom)	Multicentre, observational study with control group. Included 8 sites in intervention arm, one site in the control arm	Hospital pharmacists, Intervention arm (N=43), control arm (N=4)	CoDEG General Level Framework (GLF)	Peer-assessment	3	Assessed performance at baseline using a 4-point Likert scale. Intervention group received feedback on training needs that was tailored to the framework. Participants in the control group did not have access to the framework and standard training was provided by employer. A second assessment was conducted at three months in both groups. The study end point was change in performance from baseline to repeat assessment. Interviews with study assessors (n=20) were also conducted to determine usability of the framework.	At 3 months, the intervention group showed significant improvement in performance for 23 (96%) of the framework behaviours (Wilcoxon $p < 0.05$). There was no observable change in performance within the control group. Interviews with the tutors suggested they believed that the framework facilitated significant improvement within a shorter time span than usual training. The assessors also reported that the framework was easy to use and was a valuable performance appraisal tool. However, only 27 (63%) of the participants completed the intervention.	Moderate

Antoniou et al., 2005 [43] (United Kingdom)	Multicentre, observational study with control group. Included 13 sites in the intervention arm, 9 sites in control arm	Hospital pharmacists, Intervention arm (N=72), control arm (N=30)	CoDEG General Level Framework (GLF)	Peer-assessment	6, 12	Pharmacists performance was assessed at baseline using a 4-point Likert scale. Tailored feedback on training needs based on the framework was provided in the intervention arm, while the control group had no assess to the framework. The study end point was change in performance from baseline. Subsequently repeat assessment was conducted at 3, 6 and 12 months in the two groups.	At 6 months, intervention group showed improvement in performance for 24(96%) of the framework behaviours while the control group showed improvement in 7(28%) behaviours. Performance improvement was sustained at 12 months for the intervention group while the control group showed overall improvement in 12 (48%) of the competencies. At the end of the study, there was a significant difference in competency attainment between the two groups at 3, 6, and 12 months (log rank = 7.97, p=0.005). However, only 39% (n=41) of the participants in the intervention arm completed the 12-month assessment.	Low
Mills et al., 2008 [42] (United Kingdom	Multicentre, observational study, before-and-after study, included 3 primary care and local pharmaceutical committee clusters	Community and primary care pharmacists (N=69)	CoDEG General Level Framework (GLF) modified for primary care	Self-assessment	12	The intervention involved the use of the GLF to self-assess competence at baseline, identify individual learning needs, and aid practice development over a 12-month period. Peer feedback on self-assessment was also provided at 4 and 8 months. The study end point was a change in self-assessed competency score.	At 12 months, self-assessed competency scores increased for both the primary care and community pharmacists. When sector-specific desired performance level was used to define competence, both groups of pharmacists were equally likely to achieve their desired performance level (log rank $\chi 2$=0.023, P=0.88). However, compared to	Low

							community pharmacists, practice pharmacists had a higher aggregated score for their desired performance levels (Mann–Whitney U = 10.500, P < 0.001; median = 133.0 and 119.5 respectively).	

Author (country)	Study design	Study population	Framework used	Assessment method	Time to re-assessment (months)	Intervention implementation/end point	Main findings	Risk of bias
Coombes et al., 2010 [34] (Australia)	Multicentre, observational, before-and-after study, 18 sites	Hospital pharmacists (N=66)	CoDEG General Level Framework (GLF) adapted and validated for hospital in Australia	Peer-assessment	14	A 7-point Likert scale was used to assess and rate the frequency at which each behaviour in the framework was demonstrated with tailored feedback provided at baseline. A repeat assessment was then conducted thereafter (median time: 14 months, range:5-22). The study end point was change in performance from baseline to repeat assessment.	At reassessment, there was a significant improvement in pharmacists' performance for 35 (57%) of the 61 behaviours in the framework (P≤ 0.05). For 9 (15%) of the framework behaviours, pharmacists were already performing at the maximum level (median score 4) at baseline and no change was recorded between observations. Feedback after repeat assessment indicated that majority of the pharmacists found the framework useful for	Low

							clarifying the expectation of practice	
Meštrović et al., 2012 [33] (Croatia)	Multicentre, observational, before-and-after study, 55 sites	Community pharmacists (N=100)	CoDEG General Level Framework (GLF) adapted for community practice in Croatia	Peer-assessment	12	Used a modified GLF to assess performance and tailor training activities for the development of competence in patient care. Subsequent overt observation of performance was then conducted at 12 months and compared to baseline using a 4-point Likert scale to rate frequency at which each patient care competency was demonstrated.	At 12 months, study participants demonstrated statistically significant improvement in all of the 26 behaviours assessed with increase in mean competency scores observed from baseline ($p< 0.001$). The framework aided the identification of learning needs and supported the design and development of individualised training activities.	Low
Rutter et al., 2012 [35] (Singapore)	Single centre, observational, before-and-after study	Hospital pharmacists (N=35)	CoDEG General Level Framework (GLF) adapted for Hospital	Peer-assessment	9	Used a 7-point Likert scale to assess the rate at which each framework competency was demonstrated at baseline. Feedback was provided with an individualised training plan formulated for each participant. A repeat assessment was then conducted (median time: 9	The GLF facilitated the identification of learning needs at baseline. At reassessment, improvement in mean competency cluster score was observed for the three competency clusters of the framework with participants showing significant performance improvement in 55 (87%) of the	Moderate

			practice in Singapore			months, range: 4-8). The study end point was change in performance from baseline to repeat assessment.	63 framework behaviours assessed ($p < 0.05$).	
Svetlana et al., 2014 [45] (Serbia)	Multicentre, observational study, before-and-after, 21 sites	Community pharmacists (N=32)	CoDEG General Level Framework (GLF) adapted for community practice in Serbia	Peer-assessment	6	Appraised performance using a modified GLF with feedback and training needs defined for each participant. Used a 4-point Likert scale to assess the frequency at which each framework competency was demonstrated. The study end point was change in performance from baseline to repeat assessment.	The framework supported structured performance evaluation and aided identification of learning needs. At repeat assessment, a significant increase in mean competency score was observed from baseline for 22 (85%) of the 26 framework behaviours ($p < 0.05$).	Low

Author (country)	Study design	Study population	Framework used	Assessment method	Time to re-assessment (months)	Intervention implementation/end point	Main findings	Risk of bias
Brown et al., 2015 [46] (Pacific Island Countries)	Single centre, observational, before-and-after study	Primary care pharmacists, and other allied health personnel (N=59)	Essential Medicine Supply Management (EMSM) Competency Framework for Primary Healthcare Personnel in PICs'.	Self-assessment with peer feedback	4-days	Training activities were designed to facilitate learning of the EMSM Competency Framework. The study subjects participated in 15 learning workshops over four days. The workshop included group discussions, role plays and six competency-based workstations. Performance on the workstations were assessed before and after the training by an assessor using a 5-point Likert scale. The study participants also self-assessed their perception of the EMSM competencies before and after the training workshops.	Improvement in performance was observed at the end of each learning activity as shown by an increase in mean competency score for the six skills-based stations [t= 3.921 to 5.258; p<0.001). There was also a positive change in perception about the EMSM competencies with participants indicating that the training aided and improved their understanding of the requirement for practice.	Low
French et al., 2019 [47] (USA)	Single centre, observational, before-and-after study	Hospital pharmacists (N=50)	Pharmacist Annual Competency Evaluation (PACE)	Peer assessment, with subsequent self-assessment	1, 12	Evaluated self-efficacy on 5 clinical tasks stations using the PACE framework. Self-efficacy referred to confidence in carrying out the assigned clinical tasks. Training that was tailored to the PACE requirements was provided with competence evaluated after 1 month on a 5-point	At the end of the training, pharmacists showed improvement in self-efficacy in completing low-volume, high-risk clinical pharmacy tasks. Composite self-efficacy scores increased by 12.6% from pre-PACE to post-PACE at 1 month (79.6 ± 12.2 vs 89.7 ± 5.8; P < .001). However, despite	Low

		Likert scale checklist. Study end point was change in pharmacists' composite self-efficacy (PSE) scores at baseline, 1 and 12 months after the PACE programme.	improvements seen at 1-month, subsequent assessment at 12 months showed that the self-efficacy scores were not significantly different from baseline (82.8 ± 12.4 vs 78.1 ± 13.9, respectively; P =0.114) on all but one of the stations.

Table 2: Odds of an improved competency behaviour within subgroups

Subgroup	No. of included studies	Pooled odds (95% CI)	Heterogeneity
Studies conducted in Europe	4	6.50 (1.77, 23.92)	I^2 = 77%; p = 0.004
Non-Europe studies	2	2.95 (0.59, 14.72)	I^2 = 93%; p < 0.001
Hospital pharmacists	4	6.68 (1.63, 27.45)	I^2 = 88%; p < 0.001
Community pharmacists	2	2.80 (0.86, 9.01)	I^2 = 74%; p = 0.05
Time to reassessment > 6 months	3	2.39 (0.96, 5.95)	I^2 = 87%; p < 0.001
Time to reassessment ≤ 6 months	3	10.51 (3.73, 29.62)	I^2 = 24%; p < 0.001
Low risk of bias	4	2.80 (1.22, 6.45)	I^2 = 77%; p = 0.005