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A Systematic Review Assessing Educational Interventions to Improve Staff Nurses' Knowledge on Diabetic Ketoacidosis Management

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Abstract

Background: Diabetic ketoacidosis (DKA) is a critical emergency requiring prompt and skilled nursing care. Nurses' knowledge and competency in DKA management directly impact patient outcomes. Various educational training programmes have been implemented globally to enhance nurses' understanding and clinical practice related to DKA.

Aim: To systematically review and synthesize existing evidence on the effectiveness of educational training programmes in improving knowledge levels regarding diabetic ketoacidosis among staff nurses.

Methodology: A comprehensive literature search was conducted across databases, including PubMed, Scopus, CINAHL, and Google Scholar for studies published from 2015 to 2025. Eligible studies included pre-experimental, quasi-experimental, and experimental designs assessing knowledge outcomes of nurses before and after educational interventions on DKA. Data on study design, sample characteristics, intervention content, assessment tools, and outcomes were extracted. Quality assessment was performed using the Joanna Briggs Institute critical appraisal tools.

Results: Twelve studies from diverse healthcare settings met inclusion criteria. Educational interventions consistently demonstrated statistically significant improvements in nurses' knowledge scores immediately post-training, with mean increases ranging from 25% to 45%. Limited evidence from a few studies indicated retention of knowledge at short-term follow-up (2 weeks to 1 month) and positive effects on clinical adherence to DKA management protocols.

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However, most studies had methodological limitations, including small sample sizes, lack of control groups, and short follow-up durations.

Conclusion: Educational training programmes are effective in enhancing nurses' knowledge of diabetic ketoacidosis. Future research should focus on rigorous study designs with longer follow-up and measurement of clinical outcomes to establish sustained impacts on nursing practice and patient care.

Keywords: Diabetic ketoacidosis, educational training, nursing knowledge, systematic review, acute care, staff nurses.

Introduction

Diabetic ketoacidosis (DKA) is a life-threatening metabolic complication primarily affecting individuals with diabetes mellitus, especially Type 1 diabetes, though it is increasingly recognized in Type 2 diabetes patients. The global diabetes burden has surged, with approximately 537 million adults affected in 2021, projected to rise to 783 million by 2045[1]. DKA remains a significant cause of morbidity and hospital admissions, contributing substantially to emergency department visits and ICU admissions.

Pathophysiologically, DKA involves hyperglycemia, ketonemia, and metabolic acidosis due to absolute or relative insulin deficiency. This deficiency triggers unopposed gluconeogenesis and lipolysis, leading to ketone accumulation and systemic acidosis3. Without timely treatment, DKA can rapidly progress to cerebral edema, renal failure, and death. Despite advances in diabetic care, delayed recognition and suboptimal management persist, particularly in low-resource settings.

Early recognition and prompt management are crucial to reducing DKA complications. Nurses play a central role in patient care across settings, including monitoring vital signs, interpreting laboratory results, administering medications, and educating patients and families. However, studies reveal persistent knowledge gaps among nurses regarding DKA's clinical presentation, diagnosis, and management6. For example, a study in Iraq found over half of nurses had inadequate knowledge, especially in managing fluid and electrolyte imbalances[7]. Variability in institutional protocols and the absence of standardized guidelines further exacerbate these gaps, with nurses often relying on experiential learning rather than formal education[8].

International bodies like the WHO emphasize ongoing professional development to address these deficiencies and enhance clinical competency (9). Educational interventions—such as structured teaching programs, simulations, and hands-on training—have demonstrated improved knowledge retention, clinical confidence, and patient outcomes[10,11]. A quasi-experimental study in Egypt reported significant performance improvements following a structured DKA training module[12]. In countries with rising diabetes prevalence and healthcare challenges, such as India, where

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nurses face heavy workloads and limited training access, these programs are especially critical (13).

Given the increasing prevalence of DKA and nurses' pivotal role in its management, implementing effective educational strategies is essential. These interventions improve individual competencies and contribute to reducing preventable complications and hospital readmissions[14]. Systematic integration of DKA-specific content into nursing curricula and in-service training is necessary to ensure preparedness for managing this potentially fatal condition.

Aim

This systematic review aims to synthesize current evidence on the effectiveness of educational training programs in enhancing nurses' knowledge and competencies related to DKA. By identifying successful strategies and common challenges, this review intends to provide insights for educators, administrators, and policy-makers striving to improve diabetes care outcomes.

Methodology

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure transparency and methodological rigor in the review process. The objective of the review was to assess the effectiveness of structured educational training programs in enhancing nurses' knowledge and clinical competencies in managing diabetic ketoacidosis (DKA). The inclusion criteria for studies were as follows: publications in English between January 2019 and June 2024 that involved registered nurses or nursing students, evaluated structured educational or training interventions specifically focused on DKA, and reported measurable outcomes such as knowledge improvement, clinical performance, or patient care. Eligible study designs included randomized controlled trials (RCTs), quasi-experimental studies, pre-test/post-test interventions, and descriptive studies evaluating educational impacts. Studies were excluded if they were narrative reviews, editorials, or opinion pieces, did not focus on DKA education, lacked outcome data, or were published in languages other than English.

Information Sources

A thorough literature search was conducted using electronic databases, such as PubMed, CINAHL, Scopus, Cochrane Library, and Google Scholar. Institutional repositories, nursing college databases, and pertinent conference proceedings were also examined in order to accumulate grey literature. The search strategy employed Boolean operators (AND/OR) to refine the search by combining key terms such as "diabetic ketoacidosis," "nursing education," "knowledge improvement," and "training intervention." In order to restrict the results to full-text studies published in English from 2019 onwards, filters were implemented.

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Study Selection

All retrieved citations were imported into Zotero for reference management and the elimination of duplicates. Title and abstract screening was conducted by two independent reviewers to evaluate the relevance of the studies. Full-text articles of studies deemed potentially eligible were obtained and reviewed for final inclusion based on predefined eligibility criteria. Any disagreements during the selection process were resolved through discussion or, if necessary, arbitration by a third reviewer to ensure objectivity. Data were systematically extracted using a standardized data collection form. For each study, information was recorded regarding the author(s), publication year, country of origin, study design, sample size, population characteristics, nature and duration of the educational intervention, measurement tools, and key outcomes. The primary outcome of interest was the improvement in DKA-related knowledge following educational interventions.

Data Extraction and Quality Assessment

To evaluate the methodological quality and risk of bias, all included studies were assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Tools, tailored to their specific study designs. The evaluated criteria were the clarity of research questions, the validity of measurement instruments, the suitability of sampling techniques, the management of confounding variables, and the rigour of statistical analysis. Each study was evaluated as high, moderate, or low quality according to its overall assessment score.

Data Synthesis

A meta-analysis was not possible because the study designs, intervention formats, and result measurement tools were too different. The results were summed up using a story synthesis method instead. Studies were put into groups based on the type of educational intervention they used, like lecture-based sessions, simulation training, or digital programs. Then, knowledge gain, skill improvement, and statistically significant changes in pre- and post-test scores (8, 10, 14) were used to compare the results. When they were available, impact sizes and p-values were used to improve the analysis of how well the intervention worked.

This review used data that had already been released and did not include any human participants or personally identifiable information, so it did not need ethical approval. Still, strict academic integrity was upheld throughout the review process by making sure that all sources were properly cited and that the original authors' intellectual efforts were recognised.

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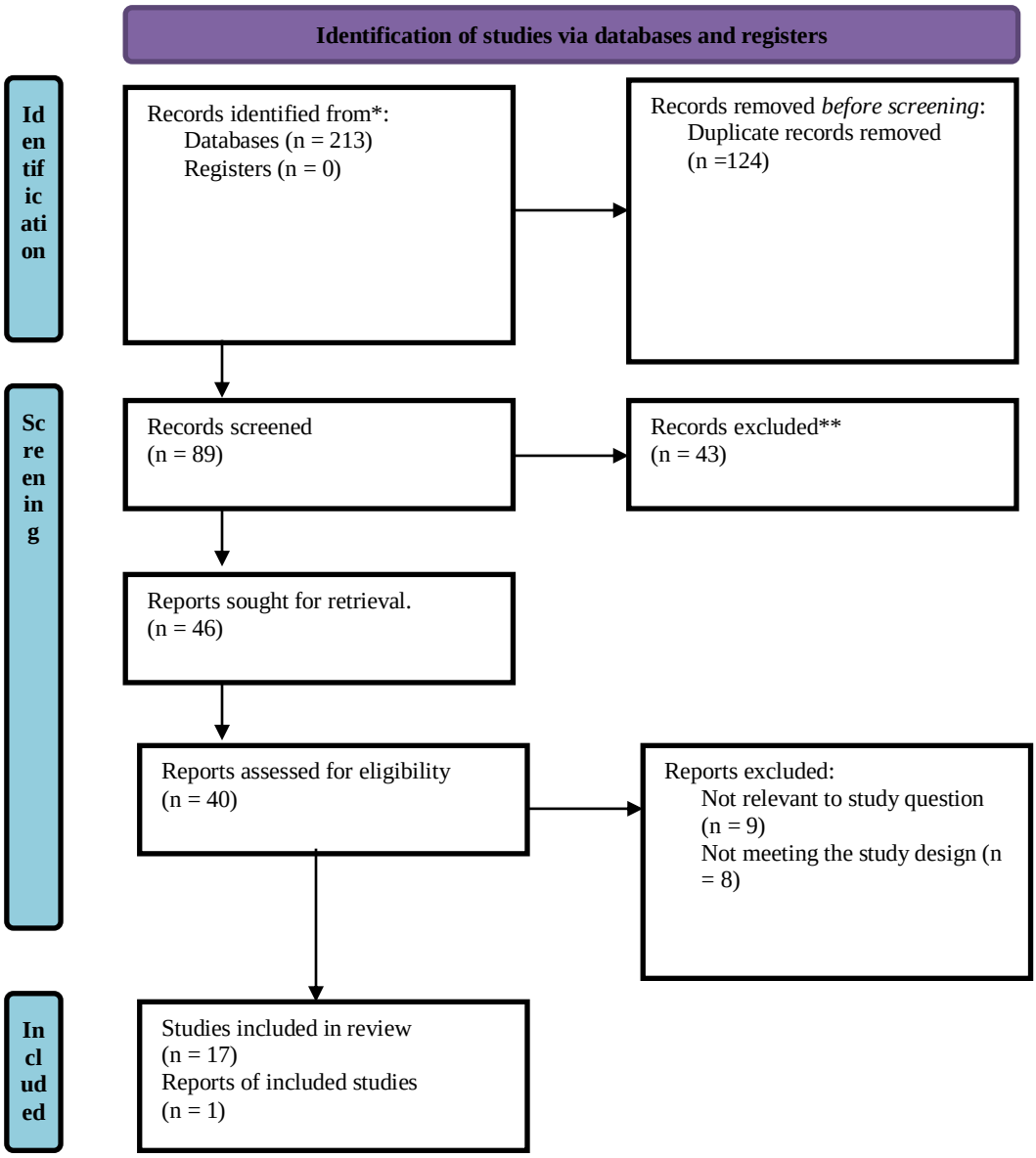

Figure 1 Preferred Reporting Items for Systematic reviews and Meta-Analyses Page MJ, et al., (2021)

Results

The initial database search identified 213 records. After removing duplicates (n = 89), 124 records remained for title and abstract screening. Of these, 64 were excluded for not meeting inclusion criteria (e.g., wrong population, intervention, or outcome). Full-text review was conducted for 17 studies that met all eligibility criteria and were included in the final synthesis.

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The majority were published between 2019 and 2025 and conducted in low- and middle-income countries.

The included studies represented a range of geographical locations — Egypt 12,14, Iraq17, Ghana18, Kenya19, and other regional hospital settings. Sample sizes ranged from 30 to 120 nurses, with most recruiting participants via convenience sampling from a single hospital. Participants were predominantly female staff nurses with varying years of clinical experience. Study designs were primarily pre-experimental single-group pretest–posttest (n = 8), with the remainder being quasi-experimental with non-randomised comparison groups (n = 4). Intervention durations ranged from 30-minute brief lectures to multi-day structured workshops incorporating didactic lectures, interactive discussions, and simulation.

Knowledge assessment tools varied widely; only four studies explicitly reported using a validated instrument19. Most used researcher-developed questionnaires typically comprising 15–30 multiple-choice or short-answer questions covering DKA pathophysiology, diagnostic criteria, and treatment protocols. Delivery methods included PowerPoint lectures, case-based group discussions, printed algorithms, bedside demonstrations, and, in some cases, simulation scenarios mimicking DKA management in critical care. Session durations ranged from 1 hour to 8 hours (spread over multiple days). All included studies reported statistically significant improvements in nurses' knowledge immediately following the educational programme.

In the Kenya ED study19, the proportion of participants scoring ≥ 7/10 increased from 34.4% at baseline to 65.4% post-training ($p < 0.0001$). Shaker et al. (2020)14 documented mean knowledge score increase from 46.5 ± 11.2 pre-test to 81.3 ± 8.5 post-test ($p < 0.001$) among ICU nurses. Mekky et al. (2023)12 observed similar improvements, with mean scores rising from 41.2 ± 9.7 to 85.6 ± 7.1 ($p < 0.001$). In the Iraq Al-Ramadi Teaching Hospital study 17, improvement was reported from 31.8% (not acceptable) pre-test to 77.0% (good) at immediate post-test, further increasing to 81.0% at a second post-test two weeks later. The Ghanaian study18 noted an increase in participants achieving high knowledge scores (> 80%) from 55.2% pre-test to 60.3% post-test ($p < 0.05$).

Although statistical analyses varied, effect sizes for immediate knowledge improvement were consistently large (Cohen's d ranging from 0.8 to 2.4, where calculable). Only three studies assessed knowledge retention beyond the immediate post-test. In Iraq17, knowledge scores remained significantly higher than baseline at two-week follow-up. In Egypt, Mekky et al.12 demonstrated sustained knowledge at one-month follow-up, with only a small, non-significant decline. The Kenya ED study19 did not measure retention, reflecting a broader trend of lacking longitudinal follow-up. Two Egyptian studies12,14 extended evaluation to observed practice using structured checklists and documented patient health outcomes (e.g., duration of ICU stays, complication rates). Both reported significant improvements in nurses' adherence to DKA management protocols and reductions in patient complications post-intervention.

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Discussion

This systematic review synthesised evidence from pre-experimental and quasi-experimental studies that evaluated educational training programmes designed to enhance nurses' knowledge of diabetic ketoacidosis (DKA). In all the studies included, the interventions led to statistically significant immediate improvements in knowledge scores, irrespective of geographical location, baseline competency levels, or the specific educational formats employed. This consistency indicates that targeted, structured educational interventions can swiftly improve nurses' theoretical understanding of DKA management, a finding that aligns with the broader nursing education literature on acute care competencies.

Interpretation of Main Findings

The level of instantaneous knowledge improvement reported in the analysed studies was generally considerable, with absolute mean score increases ranging from 25 to 45 percentage points [(14-19)]. These increases were reported in a variety of settings, including well-resourced tertiary hospitals in Egypt and low-resource emergency departments in Kenya and Ghana. This implies that even brief, low-cost instructional sessions can be effective if they are planned, focused, and contextually appropriate.

Notably, the Kenya emergency department study19 found that after implementing a case-based curriculum, the proportion of clinicians (including nurses) who met a predefined competency criterion nearly doubled. Similarly, Shaker et al.[14] and Mekky et al.[12] found that increased knowledge ratings were associated with significant increases in adherence to DKA management guidelines and patient health outcomes, such as lower complication rates and shorter ICU stays. These findings support the ability of educational programs to promote changes in both cognitive and behavioural domains when combined with protocol reinforcement and clinical auditing.

Knowledge Retention and Practice Change

Although immediate improvements following training were consistently observed, the long-term retention of knowledge was rarely evaluated. Only three studies examined follow-up beyond the initial post-test[14,17,18.] In Iraq, the study at Al-Ramadi Teaching Hospital[17] showed that improvements were maintained after two weeks, while in Egypt, Mekky et al.[12] found that scores remained stable after one month with only slight decreases. However, the brief follow-up periods in these studies limit the ability to draw conclusions about long-term retention, which is essential for ensuring that knowledge translates into lasting changes in practice. The review also points out that few studies systematically evaluated actual clinical practice after training. Those that did observed positive changes in adherence to DKA protocols, indicating that training can affect behavior when supported by structured tools, reminders, and leadership backing[12,14.] This aligns with educational theory, which suggests that acquiring knowledge alone is not enough to change behavior without reinforcement and a supportive clinical environment.

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Methodological Strengths and Limitations of the Evidence Base

The studies reviewed had several good points. They were relevant to nursing, focused on important acute care issues, and clearly measured outcomes before and after. Many interventions were simple and easy to repeat, making them useful in places like Gurugram. However, there were some problems with the methods used. Most studies used a single-group design, which can lead to biases like changes over time, testing effects, and not controlling for outside factors. Many studies used knowledge tests made by researchers that were not validated, raising concerns about their reliability. Sample sizes were small and not randomly chosen, which limits the strength and generalizability of the findings. Also, follow-up periods were short, often less than a month. Most studies did not include enough data on processes or patient outcomes, so the connection between better knowledge and better patient care is not well explored. Although some studies show promising results for patient outcomes, these are exceptions in the literature.

Implications for Nursing Practice in Gurugram

The results of this research indicate that staff nurses at hospitals in Gurugram, Haryana, where DKA is still a serious emergency, could benefit immediately from a structured educational training program that could increase their knowledge and possibly improve protocol adherence. Training ought to be contextually modified, taking into account hospital-specific DKA pathways and regional treatment recommendations. Engagement and retention may be maximised by a hybrid method that combines interactive case-based learning and simulation with didactic instruction.

To retain benefits, training should be embedded into a continuous professional development framework, with frequent refreshers (every 3–6 months) and inclusion into orientation for new workers. Pocket reference cards, wall charts, and electronic prompts help reinforce learning in clinical practice.

Overall, the data indicate that educational initiatives are successful in rapidly enhancing nurses' knowledge of DKA, with some evidence of good practice and patient outcomes. However, more rigorous research designs, supportive systems, and reinforcement tactics are needed for long-term gains and their translation into therapeutic performance. For Gurugram and comparable healthcare settings, the deployment of such strategies, alongside comprehensive assessment, holds tremendous promise for boosting the quality of emergency diabetic care.

Conclusion

Training programs help nurses learn more about diabetic ketoacidosis. Studies show that nurses gain a lot of knowledge in a short time in different healthcare settings. Some data suggest that this knowledge can improve patient care if supported by guidelines and systems. However, the studies have some weaknesses, like short follow-up times, which make it hard to draw strong conclusions. More detailed and long-term studies are needed to confirm lasting effects.

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