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Evidence-Based Practice Competencies among Nutrition Professionals and Students: A Systematic Review

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A B S T R A C T

Background: Evidence-based practice (EBP) promotes shared decision-making between clinicians and patients.
Objective: The aim was to determine EBP competencies among nutrition professionals and students reported in the literature.
Methods: We conducted a systematic review by searching Medline, Embase, CINAHL, ERIC, CENTRAL, ProQuest Dissertations and Theses Global, BIOSIS Citation Index, and clinicaltrials.gov up to March 2023. Eligible primary studies had to assess one of the 6 predefined EBP competencies: formulating clinical questions; searching literature for best evidence; assessing studies for methodological quality; effect size; certainty of evidence for effects; and determining the applicability of study results considering patient values and preferences. Two reviewers independently screened articles and extracted data, and results were summarized for each EBP competency.
Results: We identified 12 eligible cross-sectional survey studies, comprising 1065 participants, primarily registered dietitians, across 6 countries, with the majority assessed in the United States ($n = 470$). The reporting quality of the survey studies was poor overall, with 43% of items not reported. Only 1 study (8%) explicitly used an objective questionnaire to assess EBP competencies. In general, the 6 competencies were incompletely defined or reported (e.g., it was unclear what applicability and critical appraisal referred to and what study designs were appraised by the participants). Two core competencies, interpreting effect size and certainty of evidence for effects, were not assessed.
Conclusions: The overall quality of study reports was poor, and the questionnaires were predominantly self-perceived, as opposed to objective assessments. No studies reported on competencies in interpreting effect size or certainty of evidence, competencies essential for optimizing clinical nutrition decision-making. Future surveys should objectively assess core EBP competencies using sensible, specific questionnaires. Furthermore, EBP competencies need to be standardized across dietetic programs to minimize heterogeneity in the training, understanding, evaluation, and application among dietetics practitioners.
This study was registered at PROSPERO as CRD42022311916.

Keywords: clinical nutrition, evidence-based dietetic practices, evidence-based practice competencies in nutrition, evidence-based practice implementation in dietetics, health care

Introduction

Evidence-based practice (EBP) promotes shared decision-making between clinicians and patients/clients (henceforth referred to as patients) based on 3 foundational principles: *1*) the use of best available evidence, *2*) clinical or real-world experience, and *3*) the consideration of patients' values and preferences based on their unique circumstances [1,2]. Having

Abbreviations: ACEND, Accreditation Council for Education in Nutrition and Dietetics; COREQ, consolidated criteria for reporting qualitative studies; CROSS, consensus-based checklist for reporting of survey studies; DI, dietetic intern; DPD, Didactic Program in Dietetics; EBP, evidence-based practice; PICO, population/problem, intervention/exposure, comparison, outcome; RD, registered dietitian; RoB, risk of bias.

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originated from the concept of evidence-based medicine (EBM) first described by Guyatt in 1991 [3,4], EBP has been widely adopted by various health professions [5–9] for promoting fully informed decision-making, fostering optimal patient health outcomes, and enhancing overall health care quality and safety [10–12]. Studies have shown that skills in EBP competencies have resulted in improved patient outcomes [13,14]. An observational study in the field of internal medicine from Spain, involving 5 physicians and several nurses trained in EBP, demonstrated that formulating clinical questions to systematically find the best available research evidence, critically appraising the evidence using specific checklists for specific study designs, and summarizing the evidence as a critically appraised topic was associated with statistically and clinically significant drop in the mortality and length of hospital stay [13]. Another pretest posttest study from United States showed that a team of 58 health care professionals (e.g., nurses, occupational therapists, physical therapists, dietitians, and pharmacists), following a similar EBP approach to that of Emparanza et al. [13] was associated with a reduction in ventilator days and length of stay in the emergency department [14]. Research also indicates that some patients may feel uncomfortable about shared decision-making and prefer to entrust decisions to the clinician rather than engaging in a detailed discussion of study results [15]; however, many patients will find comfort and relief in making fully informed decisions by learning the specifics of the benefits and potential harms of a given nutritional intervention [2,16].

Based on the Users' Guides to the Medical Literature [17], EBP core competencies can be described as follows: *1*) formulating structured and answerable clinical questions; *2*) searching the literature for the best evidence to answer specific clinical questions (e.g., high-quality systematic reviews); *3*) assessing the methodological quality or risk of bias (RoB) of the best available evidence; *4*) interpreting the magnitude (size) of effects [e.g., absolute estimates such as risk difference and relative estimates such as relative risk, along with measures of precision (95% CI)] for all desirable (beneficial) and undesirable (harmful) patient-important outcomes; and *5*) applying results to clinical care based on the generalizability of the evidence to one's patient, including patient values and preferences based on the evidence for potential benefits, harms, and the burdens of an intervention. In this study, "values" refer to the relative worth, merit, or importance of health outcomes to a patient (e.g., mortality compared with nonfatal stroke compared with blood pressure) and based on the outcomes a patient values, "preferences" refer to a patient's preferred treatment choices after the best available evidence for alternative management strategies is shared with them [18].

Currently, the nutrition and dietetics field aims to rely on the best available evidence [19,20], including, if available, robust, up-to-date scientific summaries (i.e., trustworthy overviews of reviews, systematic reviews, and practice guidelines) for their decision-making using preappraised evidence from sources, like the Evidence Analysis Library and Practice-based Evidence in Nutrition [21,22]. The United States Accreditation Council for Education in Nutrition and Dietetics (ACEND) states in their 2022 Accreditation Standards that the curricula of didactic programs in dietetics (DPD) and dietetic internship (DI) should prepare dietetic students and interns to locate, interpret, evaluate, and use peer-reviewed nutrition literature to make evidence-based practice decisions [23]. Comparably, the Partnership for Dietetic Education and Practice in Canada, the National Competency Standards for Dietitians in Australia, and the British Dietetic Association state in their accreditation standards or curriculum framework that the dietetic programs should equip dietitians with the ability to employ or demonstrate evidence-based approaches to dietetic practices [24–26]. Given the global EBP mandate set forth by leading dietetic associations [23–26] and the precedent of assessing EBP competencies in other health professionals [27], it is timely to evaluate the knowledge, skills, attitudes, and behaviors of nutrition professionals and students regarding EBP competencies, competencies that are believed to optimally facilitate informed decision-making between patients and clinicians. Therefore, in this systematic review, our primary objective was to assess nutrition professionals' and students' knowledge, skills, attitudes, and behaviors in 1 or more of 6 core EBP competencies (Table 1). Our secondary objective was to evaluate the overall reporting quality of the existing cross-sectional and qualitative study literature that has documented evidence for 1 or more of 6 core EBP competencies.

Methods

Search methods for identification of primary studies

We searched 5 electronic databases: Medline, Embase, CINAHL, ERIC, and CENTRAL, from inception to March 2023. In addition, we searched the gray literature using ProQuest Dissertations and Theses Global, BIOSIS Citation Index, and clinicaltrials.gov up to March 2023. Reference lists of included studies were searched to help ensure that all eligible studies were identified. We did not restrict our search based on language of publication or publication status. See Appendix A for detailed Medline search strategies. Full search strategies are available on request. We followed Preferred reporting items for systematic reviews and meta-analyses [28] and Synthesis without meta-analysis [29] to report our review, and the protocol was registered in PROSPERO (CRD42022311916) [30]. Ethical approval was not required because all work was developed using aggregate level data.

Definition of evidence-based nutrition practice

Based on the competencies from the Users' Guides to the Medical Literature and a 2018 consensus statement on EBP competencies for health professionals, we adapted the International Confederation of Dietetic Association's definition to reflect our 6 core EBP competencies as follows: evidence-based dietetics practice involves the process of asking questions, systematically finding the best available research evidence, and assessing its validity, magnitude (size) and precision of effects, certainty of evidence, applicability, and importance to nutrition and dietetics practice decisions; and applying relevant evidence in the context of the practice situation, including professional expertise and the values and circumstances of patients/clients, customers, individuals, groups, or populations to achieve positive outcomes [11,17,31]. This definition encompasses the foundational domains of EBP, including ask, acquire, appraise and interpret, and apply.

TABLE 1
Comparison between 6 predefined EBP competencies and DPD and DI competencies

Six predefined EBP competencies used in this study [11,17]	EBP competencies outlined in DPD handbook [23]	EBP competencies outlined in DI handbook [23]
Formulating structured and answerable clinical questions Searching the literature for the best evidence to answer specific clinical questions (e.g., high-quality systematic reviews) Assessing the methodological quality or RoB of best available evidence Interpreting the magnitude (size) of effects, for example, absolute estimates such as risk difference and relative estimates such as relative risk, along with measures of precision, for example, 95% CI assessing the study results, for all desirable (beneficial) and undesirable (harmful) patient-important outcomes Interpreting the certainty of evidence for desirable and undesirable outcomes, ideally based on up-to-date high-quality systematic reviews with meta-analysis and/or practice guidelines based on such reviews Applying results to clinical care based on the generalizability of the evidence to one's patient, including patient values and preferences based on the evidence for potential benefits, harms, and the burdens of an intervention	Domain 1: Scientific and Evidence Base of Practice: Integration of scientific information and translation of research into practice. *K.R.D.N. 1.1* Demonstrate how to locate, interpret, evaluate, and use professional literature to make ethical, evidence-based practice decisions. *K.R.D.N. 1.2* Select and use current information technologies to locate and apply evidence-based guidelines and protocols. *K.R.D.N. 1.3* Apply critical thinking skills.	Domain 1: Scientific and Evidence Base of Practice: Integration of scientific information and translation of research into practice. *C.R.D.N. 1.2* Evaluate research and apply evidence-based guidelines, systematic reviews, and scientific literature in nutrition practice. *C.R.D.N. 1.3* Justify programs, products, services, and care using appropriate evidence or data. *C.R.D.N 1.4* Conduct projects using appropriate research or quality methods, ethical procedures, and data analysis using current and/or new technologies methods, ethical procedures, and data analysis. *C.R.D.N. 1.5* Incorporate critical thinking skills in overall practice.

Abbreviations: DI, dietetic internship; DPD, didactic programs in dietetics; EBP, evidence-based practice; K.R.D.N., knowledge for registered dietitian nutritionist; C.R.D.N., competencies for registered dietitian nutritionist; RoB, risk of bias.

Definition of variables

Regarding analyzing our data, we used the term outcomes to refer to the broader knowledge, skills, attitudes, and behaviors relevant to EBP competencies. We defined knowledge as the depth of learner's awareness and understanding of EBP concepts; skills as the ability to apply knowledge and perform EBP steps in a practical setting; attitudes (also related to perceptions, confidence, and willingness) as how individuals perceived the importance of EBP, including their willingness to apply EBP principles; and behaviors as to one's real-life execution of EBP steps in, for example, clinical practice [32,33]. We used the term competency to indicate the specific domains of EBP. That is, one needs to have knowledge, skills, attitudes, and behaviors in specific domains (e.g., formulating answerable clinical questions and assessing various study designs for methodological quality) to apply EBP effectively.

We elected to use the 5 EBP competencies based on the Users' Guides to the Medical Literature [17], while adding 1 additional competency based on a 2018 consensus statement on EBP competencies for health professionals, competencies that draw from the Users' Guides [11]. This sixth competency addresses interpreting the certainty of evidence for desirable outcomes (benefits) and undesirable outcomes (harms) based on study results, ideally based on up-to-date high-quality systematic reviews with meta-analysis and/or practice guidelines based on such reviews (Table 1). Our decision to evaluate competencies based on the Users' Guides and the 2018 consensus statement stems from their use of clear and objective EBP competencies, widely accepted and utilized across allied health professions, as opposed to the unspecific competencies described in the DPD and DI handbooks issued by ACEND (Table 1). Our competencies fall under the foundational EBP domains of ask, acquire, appraise and interpret, and apply, which also align with the definition of evidence-based dietetics practice by the International Confederation of Dietetic Associations (and adopted by the Academy of Nutrition and Dietetics [31]).

Criteria for study inclusion

We included primary studies that assessed knowledge, skills, attitudes, and behaviors related to 6 EBP competencies among participants (Table 2) [32,34–44]. Eligible participants included clinicians [i.e., registered dietitians (RDs) and nutritionists] and nutrition students (i.e., undergraduates, graduates, postgraduates, dietetic interns). Included studies could use subjective and/or objective approaches to assess EBP competencies and report results using quantitative or qualitative methods. Our target EBP competencies could be measured using questionnaires that were developed by the investigators, adapted from existing instruments, or adopted from already developed instruments, such as Fresno test [45] or Evidence-Based Practice Questionnaire [46]).

Study selection

Our search results were uploaded into a Microsoft Excel spreadsheet (2007), and any study duplicates were removed. Following the guidance from the Cochrane Handbook, 2 authors, independently and in pairs, screened the titles and abstracts and the full-text articles.

Data extraction

Study and participant characteristics

We extracted data, independently and in pairs, from all eligible articles including authors' last name, publication year, country or region of publication, study design, population characteristics (e.g., profession and education level), EBP

TABLE 2
Characteristics of studies documenting EBP competencies

Reference (country) study design	Respondent type (No. analyzed; response rate[1])	Outcomes and EBP competencies measured in the included studies
Metcalfe et al. (UK) [34]; non–web-based survey (postal)	RDs (n = 45, 73%)	*Attitudes in searching literature for best available evidence:* 24% of RDs did not find searching and reading research a high priority and 2% found it of no interest. There was no specific mention of the knowledge of databases and hierarchy of evidence when searching literature. *Skills in assessing quality and/or RoB of studies:* 60% of RDs were not capable of evaluating the quality of research[2]. *Knowledge in interpreting study results:* 78% of RDs reported that the statistical analyses in articles were not understandable for them. There was no specific mention of the knowledge of dichotomous vs continuous outcomes, the various data presentation methods, or measures of association for each type of outcomes, relative vs absolute effects for dichotomous outcomes, magnitude (size) of effects for absolute effects, or 95% CIs.
Thomas et al. (Australia) [35]; non–web-based survey (postal)	Pediatric dietitians (n = 59, 86%)	*Skills and behaviors in searching literature for best available evidence:* 81% of dietitians reported lacking the required skills to searching the literature (skills); 81% of dietitians searched electronic databases <5 times per month, although all dietitians had access to at least one electronic database. 39% of RDs searched Medline to answer clinical questions arising in their practice, and 1 RD used the Cochrane Library as their main source of information. 95% of dietitians performed literature searches themselves (behaviors). There was no specific mention of the hierarchy of evidence when searching literature. *Knowledge and skills in assessing quality and/or RoB of studies:* When participants evaluated articles, 93% of RDs considered study designs as an important criterion for study quality, 51% considered critical appraisal criteria published in JAMA Users' Guides to the Medical Literature or EBM textbooks as guides. 19% of dietitians considered systematic reviews as the best source for information, 12% considered randomized controlled trials as best, and 52% ranked clinical practice guidelines as the best source (knowledge). 86% of dietitians reported lacking the required skills to critically appraise the quality of research articles (skills).
Byham-Gray et al. (USA) [36]; non–web-based survey (postal)	RDs (n = 258, 52%)	*Behaviors in searching literature for best available evidence:* 17% of RDs searched the literature few days per week to help solve clinical questions among which 3% of RDs used Cochrane Library to find the answers. 33% of RDs searched <1 per month, and 17% never conducted a search. There was no specific mention of the hierarchy of evidence when searching literature. *Knowledge in interpreting study results:* RDs understood or had knowledge of the terms: relative risk (31%), absolute risk (30%), CI (32%), systematic review (29%), and meta-analysis (37%). There was no specific mention of the knowledge of dichotomous vs continuous outcomes, the various data presentation methods, or measures of association for each type of outcomes, relative vs absolute effects for dichotomous outcomes, or magnitude (size) of effects for absolute effects. *Attitudes in applying study results to practice:* RDs' mean score (±SD) was 4.00 (±1.1) on a scale from 1 to 5 (1 = strongly disagree, 5 = strongly agree) for the perception question, "I can use results from the published research in my job." Authors did not mention the proportion of RD responded to each option or how frequently they applied study results in their clinical practice.
Upton and Upton (UK) [37]; Non–web-based survey (postal)	Dietitians (n = 20, 85%)	*Skills in assessing quality and/or RoB of studies:* Dietitians' mean score was 4.18 on a scale of 1 to 7 (the lower the poorest, the higher the best) on skills for critically appraising the literature[2]. There was no information on how frequently they appraised the literature in their clinical practice. *Skills and attitudes in applying study results to practice:* Dietitians' mean score was 4.71 on a scale of 1 to 7 (the lower the poorest, the higher the best) in their skills to apply the evidence to their own clinical cases, but authors did not mention how frequently they applied the evidence in their clinical practice (skills). Dietitians' mean score was 3.88 on a scale of 1 to 5 (1 = least likely to act, 5 = most likely to act) in both willingness to act on evidence received from colleagues from the same profession and evidence from journal articles, indicating they valued both sources in a similar manner (attitudes).
Heiwe et al. (Sweden) [38]; non–web-based survey (postal)	Dietitians (n = 41, 78%) Occupational therapists (n = 57, 84%) Physical therapists (n = 129, 70%)	*Behaviors in searching literature for best available evidence:* Dietitians (n = 40) searched for 2–5 practice-relevant articles per month using Medline or other nonspecified databases. There was no specific mention of the hierarchy of evidence when searching literature. *Behaviors in assessing quality and/or RoB of studies:* Dietitians (n = 40) appraised 2–5 research articles related to their clinical practice each month[2]. *Knowledge in interpreting study results:* When asked about understanding of research terms (2 options were given: understand somewhat or understand completely), among 226 professionals (profession specific data were not available), 78%

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TABLE 2 (*continued*)

Reference (country) study design	Respondent type (No. analyzed; response rate[1])	Outcomes and EBP competencies measured in the included studies
		understood reliability, 80% understood validity, 58% understood systematic reviews, and 40% understood odds ratio. Publication bias and heterogeneity were somewhat understood by 30% of participants, and 38% somewhat understood CIs and meta-analysis. Among all respondents, 33% perceived that they lacked enough statistical knowledge to apply EBP. There was no specific mention of the knowledge of dichotomous vs continuous outcomes, the various data presentation methods, or measures of association for each type of outcomes, relative vs absolute effects for dichotomous outcomes, or magnitude (size) of effects for absolute effects. *Attitudes in applying study results to practice:* Dietitians ($n = 40$) scored a median of 5 (1 = strongly disagree, 5 = strongly agree) regarding their willingness to learn or improve EBP skills to implement in their practice, but authors did not mention how frequently they implemented this competency in their clinical practice.
Chiu et al. (Taiwan) [39]; non–web-based survey (postal)	RDs ($n = 67$, 79%)	*Skills in searching literature for best available evidence:* 23% of dietitians reported having skills and 43% of dietitians reported being deficient in the skills to search relevant literature for best evidence. Authors did not give the proportion of RDs who used these databases weekly or monthly. There was no specific mention of the knowledge of hierarchy of evidence when searching literature. *Skills in assessing quality and/or RoB of studies:* Among 62 dietitians, 13% reported having skills and 55% reported deficiency in skills to appraise the literature critically[2]. *Attitudes in applying study results to practice:* 82% of dietitians believed in applying EBN for the improvement of patient care quality, but authors did not mention how frequently they applied EBN in their clinical practice.
Vogt et al. (USA) [32]; web-based survey	RDs ($n = 198$, 9%)	*Knowledge and behaviors in searching literature for best available evidence:* RDs' ($n = 190$) mean score (±SD) was 1.58 (±0.87) on a scale of 1 to 5 (1 = unaware, 5 = aware and used weekly) on their awareness of Cochrane Library as an evidence-based database (knowledge). Among 190 RDs, 6% accessed databases a few days a week and 20% accessed databases twice a month (behaviors). There was no specific mention of the hierarchy of evidence when searching literature. *Attitudes in assessing quality and/or RoB of studies:* RDs' ($n = 193$) mean score (±SD) was 3.84 (±0.94) on a scale of 1 to 5 (1 = strongly disagree, 5 = strongly agree) for the perception question, "I am able to evaluate the quality of research."[2] *Knowledge in interpreting study results:* For understanding statistical analysis, RDs' mean score (±SD) was 3.85 (±0.99) on a scale of 1 to 5 (1 = strongly disagree, 5 = strongly agree). On a scale of 1 to 4 (1 = no understanding, 4 = understand and can explain), 188 RDs scored a mean of 2.64 (±0.93) when asked about understanding meta-analysis, 2.52 (±0.89) for understanding systematic reviews and 2.25 (±1.00) for understanding CIs. There was no specific mention of the knowledge of dichotomous vs continuous outcomes, the various data presentation methods, or measures of association for each type of outcomes, relative vs absolute effects for dichotomous outcomes, or magnitude (size) of effects for absolute effects. *Skills and attitudes in applying study results to practice:* RDs' ($n = 195$) mean score (±SD) was 4.14 (±0.91) on a scale of 1 to 5 (1 = strongly disagree, 5 = strongly agree) on their skills to apply research into practice, but authors did not mention how frequently they applied research in their clinical practice (skills). RDs' mean score ($n = 194$) was 4.59 (±0.52) on a scale of 1 to 5 (1 = strongly disagree, 5 = strongly agree) about their willingness to use EBP skills for patient care (attitudes).
Saeed (Pakistan) [40]; web-based survey	RDs and nutritionists ($n = 23$, 45%)	*Behaviors in searching literature for best available evidence:* 48% of RDs had access to different databases and 52% of RDs used them (e.g., Medline, Cochrane Library, and Evidence Analysis Library), but the author did not mention the frequency. There was no specific mention of the knowledge of hierarchy of evidence when searching literature. *Skills in assessing quality and/or RoB of studies:* 39% of RDs reported that they lacked the skills to critically appraise and apply nutrition literature in their practice[2]. *Attitudes and behaviors in applying study results to practice:* All participants had a positive attitude on applying EBN in clinical practice to increase the quality of patient care (attitudes) and 61% of responders used EBN skills in their clinical practice (behaviors).
Hinrichs (USA) [41]; web-based survey; focus group	Dietetic interns ($n = 14$ for survey, 88%; $n = 7$ for focus group, 44%)	*Knowledge and behaviors in formulating structured clinical questions:* Dietetic interns' mean score (±SD) on knowledge of the definition and structure of PICO was 0.17 (±0.25) on a scale of 0 = false to 0.5 = true (knowledge). On average, participants formulated PICO questions less than once per month (behaviors). *Behaviors in searching literature for best available evidence:* A scale of 1 to 5 (1 = never, 5 = 2 or more times per week) was used to measure the frequency of dietetic interns' access of databases. Their mean score (±SD) was 3.6 (±1.0) on accessing original research articles, 3.0 (±1.2) on accessing preappraised evidence (e.g., Evidence

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TABLE 2 (*continued*)

Reference (country) study design	Respondent type (No. analyzed; response rate[1])	Outcomes and EBP competencies measured in the included studies
		Analysis Library), and 2.1 (±1.0) on accessing Cochrane Library. *Knowledge and behaviors in assessing quality and/or RoB of studies:* Dietetic interns' mean score (±SD) was 0.79 (±0.43) of the maximum score of 1 on their knowledge on the best-quality study design to address questions on therapy or prevention and about hierarchy of evidence (knowledge). Dietetic interns' mean score (±SD) was 2.6 (±1.0) on a scale of 1 to 5 (1 = never, 5 = 2 or more times per week) on critically appraising articles (behaviors)[2]. *Knowledge in interpreting study results:* Dietetic interns' mean score (±SD) was 0.04 (±0.13) on a scale of 0 to 0.5 on knowledge of interpreting study results. There was no specific mention of the knowledge of dichotomous vs continuous outcomes, the various data presentation methods, or measures of association for each type of outcomes, relative vs absolute effects for dichotomous outcomes, magnitude (size) of effects for absolute effects, or 95% CIs. *Attitudes in applying study results to practice (focus group data):* Dietetic interns were interested in basing their future clinical practice on research evidence to inform clinical decisions.
Gooding et al. (Australia) [42]; web-based survey	Undergraduate nutrition students (n = 30, 32%) Postgraduate nutrition students (e.g., Masters) (n = 50, 53%) Professionals (e.g., accredited practicing dietitians, associate nutritionists, public health nutritionists, and registered nutritionists) (n = 87, 93%)	*Attitudes in assessing quality and/or RoB of studies:* 93% of participants (group specific data were not available) considered systematic reviews to be an extremely or very valuable source of evidence when they were asked, "How valuable or not valuable do you believe systematic reviews are as a source of evidence?" *Attitudes in interpreting study results:* 38% of participants felt very confident at interpreting the results of systematic reviews when asked, "How confident or not confident are you at interpreting the results of systematic reviews?" and given the options "extremely confident, very confident, quite confident, confident, not confident." There was no specific mention of the knowledge of dichotomous vs continuous outcomes, the various data presentation methods, or measures of association for each type of outcomes, relative vs absolute effects for dichotomous outcomes, magnitude (size) of effects for absolute effects, or 95% CIs. *Behaviors in applying study results to practice:* 50% of respondents used systematic reviews regularly to guide practice.
Amjad et al. (Pakistan) [43]; web-based survey	Dietitians (n = 81, no data provided)	*Behaviors in searching literature for best available evidence:* 14% of dietitians used online databases to find practice related literature once a month and 12% searched the databases 2–5 times per month. There was no specific mention of the knowledge of hierarchy of evidence when searching literature.
Young et al. (Australia) [44]; web-based survey	Dietitians (n = 124, 27%)	*Attitudes in formulating structured clinical questions:* Approximately 13% of dietitians strongly agreed and 5% of dietitians strongly disagreed that they were confident in formulating a clinical question to guide their literature review when asked about their confidence in the competency. They were given options to rate their confidence level from strongly agree, agree, neither agree or disagree, disagree, to strongly disagree. There was no specific mention of the knowledge of the definition of PICO. *Attitudes in searching literature for best available evidence:* Approximately 61% of respondents were confident in searching for the best evidence to answer a clinical question on a scale of strongly agree to strongly disagree. There was no specific mention of the knowledge of databases and hierarchy of evidence when searching literature. *Attitudes in assessing quality and/or RoB of studies:* Approximately 60% of participants agreed that they were confident in critically appraising the evidence on a scale of strongly agree to strongly disagree[2]. *Attitudes in interpreting study results:* Approximately 63% of participants were confident in determining the clinical significance of study results on a scale of strongly agree to strongly disagree. There was no specific mention of the knowledge of dichotomous vs continuous outcomes, the various data presentation methods, or measures of association for each type of outcomes, relative vs absolute effects for dichotomous outcomes, magnitude (size) of effects for absolute effects, or 95% CIs. *Attitudes in applying study results to practice:* Approximately 89% of participants were confident in determining whether evidence applies to their patients/context on a scale of strongly agree to strongly disagree, but authors did not mention how frequently they applied evidence in their clinical practice.

Abbreviation: PICO, patient or problem, intervention, comparison, outcomes.

[1] Response rate is based on how many participants were approached and how many responded.

[2] Authors did not specifically report the types of study design appraisal criteria that was applied or the specific appraisal criteria used.

outcomes (i.e., knowledge, skills, attitudes, and behaviors), EBP competencies (Table 2) and the detailed characteristics of EBP competency questions from available survey questionnaires (e.g., formulating answerable questions and assessing methodological quality of specific study designs) including their response options (e.g., Likert scale, multiple-choice, dichotomous questions, and qualitative data input) (Supplemental Table 1).

RoB assessment

Two reviewers independently assessed the potential RoB of each cross-sectional observational study [i.e., quantitative survey studies, both web-based and non–web-based, and qualitative study (i.e., focus group)]. RoB factors assessed included response rate, missing data, clinical sensibility of survey, data collection methods, data analysis methods, and clarity of study findings. For survey studies, we used a modified version of the CLARITY instrument that included an additional question on the use of sensitivity or subgroup analysis for potential confounding factors [47]. For each question, the instrument uses 4 response options: definitely low RoB, probably low RoB, probably high RoB, and definitely high RoB [48]. To categorize the overall RoB of a study, we used high RoB, moderate RoB, and low RoB (Supplemental Table 2). For focus group studies, we used the Critical Appraisals Skills Programme instrument to assess the RoB [49] with 3 response options: low RoB, intermediate RoB, and high RoB.

Quality of reporting assessment

Regarding the quality of study methods reporting, we used the consensus-based checklist for reporting of survey studies (CROSS) [50] instrument for quantitative studies and the consolidated criteria for reporting qualitative studies (COREQ) [51] instrument for qualitative focus group studies. These instruments assessed how comprehensively authors reported population characteristics, study design, data analysis methods, and study findings. Two reviewers independently categorized the reporting for each item as follows: *1*) clearly reported, *2*) partially reported, *3*) unclearly reported, and *4*) not reported.

Questionnaire characteristics and type of competency outcome measured

We extracted the characteristics of questionnaires that were used to assess EBP competencies. We categorized the questionnaires as follows: *1*) self-developed (if investigators developed survey questionnaires de novo), *2*) adapted (if investigators altered existing questionnaires before using them to suit their own study objectives), and *3*) adopted (if investigators used existing questionnaires verbatim). We also looked at how each study presented the questions from the instruments and categorized them as follows: *1*) clearly reported questions, *2*) partially reported questions, and *3*) unclearly reported questions. Furthermore, we categorized the competencies assessed by the questionnaires as follows: *1*) self-perceived (when participants reported their self-assessment of EBP competencies) [52] and *2*) objectively assessed (when instruments objectively measured participants' EBP competencies) [53]. If it was not clear from the study reports, we contacted the authors and asked them to provide the full questionnaire.

Data analysis

We report our findings descriptively under study and population characteristics, RoB of studies, and quality of reporting and characteristics of the EBP competency questionnaires, whereas documenting if competencies were self-perceived or objectively (e.g., written or multiple-choice answers) assessed. We could not conduct meta-analysis owing to heterogeneous methods used to assess the EBP competencies. There was considerable heterogeneity in the questions asked by each study to measure the competencies (e.g., dichotomous, multiple-choice, and open-ended questions) and variability in reporting central tendency and variance (e.g., some studies used dichotomous response options to calculate proportions, some used means with SDs, or IQRs).

Results

Study and participant characteristics

Our search yielded 2265 initial references. After deduplication, 2002 titles and abstracts were available for screening, and 1959 were excluded, leaving 43 full-text articles for full-text screening. We ultimately included 12 studies that were published between 2001 and 2020 [32,34–44], with studies having enrolled between 14 and 258 participants. Detailed study characteristics are reported in Table 2. All studies reported quantitative survey data (i.e., 7 web-based surveys; 5 non–web-based surveys) with one of the studies [41] also reporting qualitative data from a focus group. Our screening results are outlined in Figure 1.

Eligible studies comprised 1065 participants across 6 countries (United States, United Kingdom, Sweden, Pakistan, Taiwan, and Australia). Eleven studies [32,34–40,42–44] included nutrition professionals, and 1 study included dietetic interns [41]. Two studies from Pakistan and Australia [40,42] reported enrolling nutritionists; however, authors did not clarify if nutritionists differed in terms of registration or comprehensive training as compared to RDs. One study [42] reported including undergraduate nutrition students and postgraduate nutrition students. Seven studies reported on participants' age (ranging between 20 y and $\geq$ 66 y) [32,35,36,38–40,43], 7 studies reported on participants' education level (i.e., 37% and 46% had undergraduate and postgraduate degrees, respectively) [32,34,36,38–40,42], and 11 studies reported on participants' employment settings (i.e., 80% and 7% were involved in clinical practice and education and research, respectively) [32,34,38–40,42–44].

Only 1 study conducted a subgroup analysis between research RDs and clinical practice RDs to explore the potential impact of demographic characteristics on the EBP knowledge and attitudes of dietetic professionals [36]. The study revealed significantly higher scores for research RDs than their counterparts in general clinical practice, diabetes care, and nutrition support. Further, RDs employed by educational institutions exhibited significantly higher scores than those in other practice settings.

Questionnaire characteristics

Among 12 cross-sectional survey studies, only 3 studies (25%) clearly reported the questions they used to measure EBP competencies [38,39,42]. After contacting the authors of 9 studies for their full questionnaires, 5 authors responded with corresponding questionnaires. Among the questionnaires used in 8 studies, only Hinrichs [41] used an instrument that, in part, had

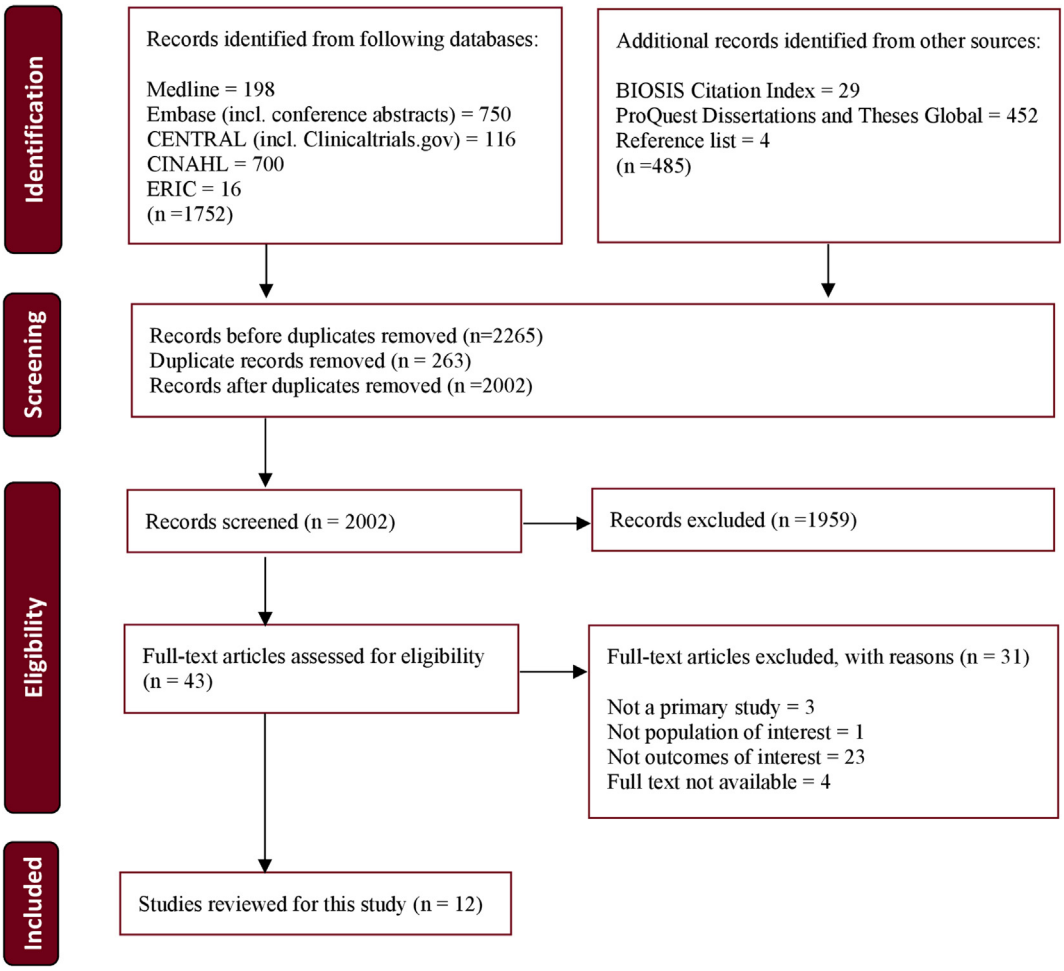

FIGURE 1. PRISMA flow diagram for outline of search strategy.

objective questions on 4 competencies: formulating structured clinical questions, searching the literature, assessing the quality of studies and, albeit vaguely, interpreting study results. For information regarding the measurement of EBP competencies on the questionnaires, see Table 2.

In terms of the evidence of psychometric properties, 5 questionnaires had evidence of both reliability and validity, of which 2 had psychometric testing in RDs [32,36], 1 had testing in physical therapists [43] and 2 had testing in an unspecified population [39,41]. Four questionnaires had evidence of validity only, with 2 reporting validity in an unspecified nutrition population [38,42] and 2 in an unspecified population [40,44]. One questionnaire had evidence of reliability only, tested in an unspecified nutrition population [34]. Despite some evidence of reliability and validity for our first 3 competencies, no instruments had explicit questions on interpreting the magnitude (size) of effects and none asked about the certainty of evidence for estimates. Furthermore, regarding applicability, none explicitly asked about the application of patient values and preferences relative to the size and certainty of effect estimates. Supplemental Table 1 summarizes the characteristics of the questionnaires.

RoB and quality of reporting assessment

The overall RoB of included studies varied substantially. Among 12 cross-sectional survey studies, 1 study was judged as having overall low RoB [36], 8 studies had moderate RoB [32,34,35,37–39,41,42], and 3 studies had high RoB [40,43,44] (Supplemental Table 2). The most common RoB issues included no reporting of sensitivity, subgroup, or adjustment analysis for potential confounding factors in 8 (67%) studies. The focus group component of the study by Hinrichs [41] was rated as having intermediate RoB (Supplemental Table 3). A comprehensive evaluation of 12 cross-sectional survey studies using the CROSS [50] instrument revealed that 43% of items were not reported, with only 33% clearly reported, whereas, in the focus group study employing the COREQ [51] instrument, 56% of items were clearly reported, and 38% were not reported. Reporting quality from the 40-item CROSS [50] and 32-item COREQ [51] instruments are shown in Figure 2 and Figure 3, respectively. For details on all items, see Supplemental Table 4 (CROSS) and Supplemental Table 5 (COREQ).

Evidence-based practice competencies

Formulating structured and answerable clinical questions

Knowledge, attitudes, and behaviors specific to formulating questions was examined by 2 (17%) studies [41,44]. Hinrichs [41] asked if dietetic interns ($n = 14$) knew what patient, population or problem, intervention, comparison, outcomes (PICO) referred to and reported that participants lacked knowledge about the definition and structure of PICO when formulating a clinical question. Young et al. [44] asked dietitians ($n = 124$) to

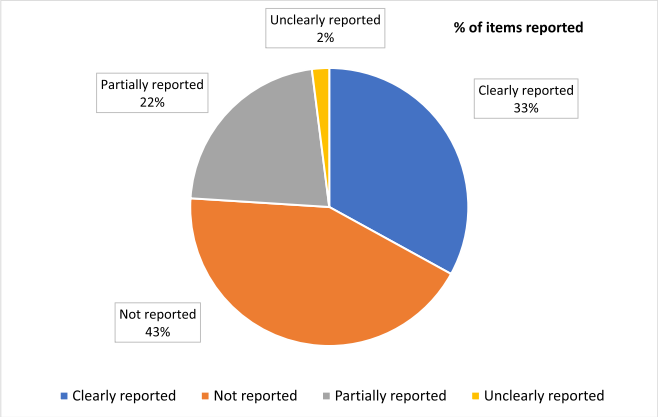

FIGURE 2. Reporting quality for cross-sectional survey studies.

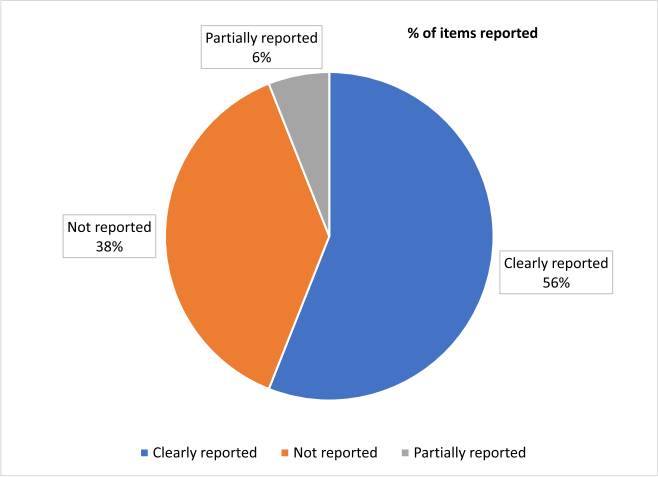

FIGURE 3. Reporting quality for focus group study.

rate their confidence in formulating a clinical question, reporting that only 13% of the participants perceived themselves as confident. Authors did not report how often they formulated clinical questions in clinical or research practice. Regarding behavior, dietetic interns reported formulating PICO questions, on average, less than once per month [41]. Data on the average number of patients over a particular time frame (e.g., per month) was not reported in any study (Table 2).

Searching literature for best available evidence to answer clinical questions

Knowledge, skills, attitudes, and behaviors specific to searching literature was reported in 10 (83%) studies [32,34–36,38–40,42–44]. Vogt et al. [32] looked at RDs' (n = 190) awareness (knowledge) of different databases containing evidence (e.g., Cochrane Library, Evidence Analysis Library, and Medline) and reported that RDs' awareness was low for the best source of summary data (i.e., Cochrane Library). Thomas et al. [35] and Chiu et al. [39] assessed participants' skills in searching the literature and reported that 81% of dietitians (n = 59) and 43% of dietitians (n = 67), respectively, lacked skills in searching databases (e.g., Medline) to inform clinical practice. Two studies reported on participants' attitudes in searching the literature [34,44]. Metcalfe et al. [34] reported that 24% of RDs (n = 45) did not believe that searching the literature was a high priority activity, whereas Young et al. [44] reported that 61% of RDs (n = 124) were confident in searching the literature to answer a clinical question. In both study reports, there was no specific evaluation of RDs' knowledge of databases or the hierarchy of evidence when searching the literature. Seven studies reported on the typical behaviors of participants when searching the literature (e.g., percentage and frequency of respondents who searched the literature and which databases were searched) [32,35,36,38,39,41,43]. In 6 studies (n = 629) [32,35,36,38,41,43], 26% of respondents searched the literature at least twice per month (data on average number of patients per month was not reported). The remaining study by Saeed [40] reported that 52% of RDs searched different databases but did not report on the frequency of searching (Table 2).

Assessing quality and/or the RoB of evidence based on different study designs

Knowledge, skills, attitudes, and behaviors specific to assessing the methodological quality of the studies was reported in 9 (75%) articles [32,34,35,37–41,44], with most reports using the term critical appraisal instead of more specific terms such as methodological quality or RoB. For this competency, no studies reported the specific questions (e.g., on selection bias and attrition bias) used to appraise selective study designs. Further, it was often unclear from the study reports if investigators measured participants' competency in assessing RoB for a specific study design (e.g., systematic review with meta-analysis, randomized controlled trial, and cohort study), or something else.

Two studies assessed participants' knowledge on the best-quality study design [35,41]. Thomas et al. [35] reported that 52% of RDs (n = 59) considered clinical practice guidelines, 19% considered systematic reviews, 17% considered local experts, textbooks, or case reports, and 12% considered randomized trials to be the best source of information to address questions on therapy or prevention. Hinrichs [41] reported that dietetic interns (n = 14) had moderate knowledge of the study designs and the hierarchy of evidence. Studies by Metcalfe et al. [34], Thomas et al. [35], and Chiu et al. [39] assessed RDs skills in critical appraisal of scientific literature and reported that 60% of RDs (n = 27), 86% of RDs (n = 51), and 55% of RDs (n = 62) lacked the skills, respectively. A study by Upton and Upton [37] reported that RDs' (n = 20) had moderate skills in critical appraisal skills; however, authors and available questionnaires used in the study did not define what was meant by critical appraisal.

Four studies reported on participants' attitudes regarding, again, undefined critical appraisal of the literature [32,35,42,44]. Among these studies, Thomas et al. [35] found that when participants (n = 59) evaluated articles, 93% of them considered study designs as an important criterion for study quality and 51% of them considered critical appraisal criteria published in the Users' Guides to the Medical Literature [17] or EBM textbooks. Gooding et al. [42] found that 93% of participants (n = 167) perceived systematic reviews to be an extremely or very valuable source of evidence, and Young et al. [44] reported that 60% of RDs (n = 124) perceived themselves as confident in critically appraising the evidence.

Two studies reported on participants' behaviors related to undefined critical appraisal of the literature (e.g., percentage and

frequency of participants who appraised the literature to inform clinical practice). Heiwe et al. [38] reported that RDs ($n = 40$) appraised 2 to 5 research articles per month, whereas Hinrichs [41] reported that dietetic interns ($n = 14$) performed appraisal activities on average less than once per month to help inform practice (Table 2).

Interpreting magnitude (size) of effects and corresponding precision of 95% CIs

Knowledge and attitudes specific to interpreting the study results was discussed in 7 (58%) studies [32,34,36,38,41,42,44]. Five studies reported on participants' overall knowledge in this competency [32,34,36,38,41]. For instance, Hinrichs [41] objectively assessed dietetic interns' ($n = 14$) knowledge in interpreting study results and found that all dietetic interns had inadequate knowledge in this competency. Another study [34] assessed RDs' ($n = 45$) self-perceived knowledge in interpreting study results and reported that to 78% of RDs, the statistical analyses in research papers were not understandable. Three studies [32,36,38] evaluated participants self-perceived knowledge of statistical terms rather than their actual knowledge of common relative (e.g., risk and odds or hazard ratios) and absolute (e.g., risk difference and number needed to treat) estimates of effect and corresponding estimates of precision (e.g., 95% CI). For instance, Byham-Gray et al. [36] asked about participants' ($n = 258$) knowledge of the terms relative risk and absolute risk difference and found that 31% and 30% of RDs, respectively, perceived that they understood or had knowledge of the terms.

Young et al. [44] and Gooding et al. [42] reported on participants' attitudes toward this competency. Young examined participants' ($n = 124$) confidence in determining the clinical significance of study results and 63% of participants reported confidence in their skills. Gooding et al. [42] asked participants ($n = 167$) "How confident or not confident are you at interpreting the results of systematic reviews?" and reported that 38% felt confident to very confident. However, Gooding et al. did not clarify what they meant by interpreting the results, leaving ambiguity regarding whether it pertained to interpreting effect sizes, CIs, or something else. No study explicitly reported on participants' skills to interpret the magnitude (size) of the estimate of effects (e.g., from a trivial to a small, moderate, and large effect) and the corresponding precision of the 95% CIs, nor did they report assessing participants skills in interpreting relative and absolute estimates of effect (Table 2).

Interpreting certainty of evidence for each health outcome of interest

Although Gooding et al [42] queried participants about interpreting the results from systematic reviews, no study examined competencies in interpreting the certainty of evidence (e.g., evaluation of consistency of evidence and assessment of publication bias) to support estimates of effect for outcomes of benefit or harm (particularly in the context of systematic reviews with meta-analysis).

Applying study results in clinical practice based on patients' values and preferences

Skills, attitudes, and behaviors in applying study results in clinical practice were heterogeneously assessed in 9 (75%) studies [32,36–42,44]. Vogt et al. [32] and Upton and Upton [37] examined participants' skills in applying study results to their practice and reported that participants generally perceived themselves as skilled in this competency. Eight studies reported on participants' attitudes or willingness in applying study results in practice, of which studies by Vogt et al. [32], Heiwe et al. [38], and Upton and Upton [37] reported that participants' ($n = 254$) had moderate to high degree of willingness toward this competency. Studies by Chiu et al [39], Hinrichs [41], and Saeed [40] reported that participants believed in (82% among 67 participants), were interested in (100% of 7 participants), or had a positive attitude toward (100% of 23 participants) applying study results, respectively. The remaining 2 studies by Young et al. [44] and Byham-Gray et al. [36] reported that participants perceived themselves as confident (89% among 124 participants) and capable of (most or all of 258 participants, no proportion was given) applying evidence in their practice, respectively. Two studies [40,42] reported on participants' behaviors in applying study results among which Gooding et al. [42] reported that 50% of the respondents ($n = 167$) regularly used systematic reviews to guide their practice.

What was meant by applicability was vague across all studies. For instance, it was unclear if investigators looked at participants' competency in applying the best available evidence (e.g., high -quality systematic reviews with meta-analysis) based on estimates of benefits and harms of an intervention with patients or something else. Moreover, no studies explicitly reported on applying patients' values and preferences based on the best available evidence (Table 2).

Discussion

Summary of findings

Our systematic review of EBP competencies included 12 cross-sectional surveys comprising 1065 participants (i.e., RDs, nutritionists, dietetic interns, and nutrition students) across 6 countries. The overall reporting quality among the surveys was poor with only 33% of items clearly reported, and the survey questions were predominantly self-perceived assessments. There were also considerable deficiencies across studies regarding the measurement of EBP competencies. For instance, the 6 competencies were often incompletely defined or reported [e.g., it was unclear what critical appraisal and applicability referred to and what study designs (e.g., systematic review compared with cohort study compared with other designs) were appraised by the participants], which made it difficult to compare studies and to reach an overall conclusion. Furthermore, no studies had explicit questions on 2 (33%) of the 6 core EBP competencies [i.e., interpreting the magnitude (size) of effects and the certainty of evidence for estimates] and study reports were unclear with respect to competencies in applying patient values and preferences relative to the size and certainty of effect estimates, skills that are essential for optimizing clinical and public health nutrition decision-making.

Strengths of this study

To our knowledge, this is the first systematic review that has evaluated EBP competencies in the field of nutrition. The competencies assessed are based on the Users' Guides to the Medical

Literature [17] and a consensus statement on EBP competencies for health care professionals [11], competencies that align with the International Confederation of Dietetic Associations' and the American Academy of Nutrition and Dietetics' definition of EBP, a definition that we adapted to create increased alignment in EBP across professions [31]. We worked with an experienced librarian to conduct a comprehensive search across 5 databases and 4 gray literature sources with no language restrictions, and we registered our study protocol on an open-access, publicly accessible website [30]. We performed screening, data extraction, and quality assessment independently and in pairs, including the assessment of our 12 studies using CROSS [50] and COREQ [51] reporting instruments. Finally, we used the Meta-analysis of Observational Studies in Epidemiology [28] and Synthesis without meta-analysis [29] reporting standards to provide a transparent and clear presentation of our findings.

Limitations of this study

Our study protocol, published a priori [30], underwent several revisions that were necessary once we better understood the available data. The first revision was the exclusion of a seventh competency, which involved self-evaluation of EBP competencies. This decision was made because it seemed impractical to expect participants to perform self-evaluation when there appeared to be limited objectively ascertained skills, knowledge, attitudes, and behaviors of the first 6 competencies. This aspect of limited understanding may have resulted from poor reporting in 12 eligible studies, as determined by CROSS [50] and COREQ [51] assessments and no reporting on fifth and sixth competencies [i.e., magnitude (size) of effects and certainty of evidence]. Although there has been a longer list of EBP competencies proposed for medical and allied health practitioners that involve competencies in diagnosis and prognosis [11], we emphasized 6 core EBP competencies that are long standing, directly related to clinical scenarios involving treatment and prevention practices [11,17], and relevant to nutrition and the broader health professions practice. With respect to the assessment instruments, the second departure from our protocol was the inclusion of an analysis of the reporting quality of surveys and focus groups. Post hoc, we decided to add these assessments given that we were surprised by how poorly the studies documented key items that were used to assess competencies (e.g., clear reporting of the questions regarding assessment of cross-sectional study methods and specifics on questionnaires used to assess EBP competencies). Finally, as documented in our protocol, we used the CLARITY [36] instrument to assess the RoB across survey studies, an instrument that does not have a peer-reviewed publication, or established evidence of validity and reliability. In keeping with rationale for the development of the CLARITY cross-sectional RoB instrument, we used the tool owing to our inability to find a comprehensive instrument that addresses RoB in surveys of attitudes and practices [54]. It should be noted that the response options on the CLARITY instrument [54] are based on the Cochrane RoB instrument, which has established evidence of validity and reliability [55].

Implications for education and clinical practice

Our systematic review findings make it challenging to draw definitive conclusions on current EBP competencies in dietetics. This challenge arises from poor-quality studies, which were influenced by the lack of comprehensive and objective instruments to measure the core EBP competencies [56,57] and, possibly, further influenced by the absence of comprehensive and objective guidance on EBP competencies from international dietetics organizations. The various accreditation standards for dietetic programs give flexibility for diverse programs [23–25] to define where and how to incorporate training in EBP competencies into their curricula. This leaves the possibility for heterogeneity in the understanding, training, evaluating, and application of EBP competencies among dietetics professionals and students. Our review demonstrates a need for improved clarity and specifics on EBP competencies through dietetic curricula. Objective and possibly standardized EBP competencies will lead to explicit clarification regarding the expected knowledge, skills, attitudes, and behaviors for educators and trainees. This, in turn, will bring about improvements in EBP education and evaluation, ultimately promoting higher-quality training and clinical care [58]. Our assessment also recommends including specific questions on universally endorsed [11], objective EBP competencies in RD board examinations, which will minimize heterogeneity in evaluating EBP competencies, ultimately improving their application in dietetics care.

Although our primary objective was not to systematically collect data on EBP training, we documented it whenever available. Only 7 (58%) studies from our review reported on participants' training [32,35,36,38,39,42,44]. For instance, Byham-Gray et al. [36] reported that 55% of RDs (n = 258) received critical appraisal training and Chiu et al. [39] reported that 27% of RDs (n = 67) took an educational course in evidence-based nutrition. Considering that EBP is an important skill endorsed by dietetic associations worldwide, conducting affordable training and workshops focused on standardized EBP competencies, and offering continuing education units, would be advantageous. This approach aims to guarantee that all practicing dietitians possess a mutual understanding of EBP competencies and remain informed about emerging EBP competencies and resources.

There are different approaches to teach foundational EBP competencies including journal clubs and critical appraisal courses, and educators may choose among those proven to be effective [12]. To further promote EBP competencies, incorporating case-based learning, which demonstrates how EBP is used in real-life situations within the Nutrition Care Process (such as when developing Problem, Etiology, and Signs/Symptoms statements and identifying suitable nutrition interventions), would help dietetic learners better understand and see the value of EBP competencies in making decisions in clinical settings [59].

Several studies have shown a growing reliance on evidence-based clinical practice guidelines in the field of dietetics [32,35,36,38,43]. Nonetheless, it is important to note that not all guidelines are created equal [e.g., many lack adherence to Institute of Medicine 2011 and National Guideline Clearinghouse Extent of Adherence to Trustworthy Standards 2019 criteria] and are not regularly updated (e.g., many of the reviews by the Evidence Analysis Library are outdated by >5 y) [60]. Therefore, it is essential to facilitate the guideline development process in accordance with established standards by providing

standardized EBP training to guideline committees and to facilitate the updating of evidence-based guidelines through increased funding mechanisms.

Guidelines developed by professional societies outside of dietetics (e.g., cardiometabolic disease risk [61] and pediatric nutrition [62]) require dietitians to be familiar with these societies and often involve fees to access the guidelines. This may hinder dietitians' adherence to evidence-based guidelines to the fullest. If feasible, granting full access to all relevant, robust evidence summaries and evidence-based nutrition guidelines from one platform would enable clinicians to effectively engage with the literature and better apply EBP competencies.

Implications for research

Future cross-sectional surveys should comprehensively and objectively assess knowledge, skills, attitudes, and behaviors for core EBP competencies using specific and sensible questionnaires that ideally possess validity and reliability [63]. In addition, they should follow reporting standards for cross-sectional studies using the CROSS instrument [50]. For instance, based on the gaps among the 12 included studies, in addition to assessing competencies on asking clinical questions, locating the best available evidence, critically appraising the quality of studies, understanding study results, and applying them in clinical practice, future studies assessing competencies in appraising and interpreting and applying study results should specifically evaluate competencies in the following: *1*) interpreting the magnitude (size) of effects, for example, absolute estimates such as risk difference and relative estimates such as relative risk, along with measures of precision, such as 95% CI [64]; *2*) interpreting the certainty of evidence for estimates for all patient-important outcomes, particularly for systematic reviews with meta-analysis and practice guidelines; and *3*) shared decision-making involving the integration of patient values and preferences relative to the patients unique circumstances, including the magnitude (size) of effects and certainty of effect estimates for all outcomes that matter to patients. These competencies, considered essential to decision-making [65], have not been evaluated in studies to date.

Our review also reveals a notable gap in research focused on dietetic students and interns from, for example, DPD or DI programs in the United States. Future research in this area would be beneficial, especially if it is grounded in standardized and well-defined EBP competencies sanctioned by dietetic programs and national bodies overseeing dietetic training programs such as ACEND. Research should be conducted to help elucidate how these competencies may impact satisfaction with the dietitian-patient encounter [16]. Furthermore, it is important to evaluate targeted professional groups that are focused on specific areas of practice (e.g., dietetic practice groups within the Academy of Nutrition and Dietetics, or international dietetic societies, such as Genetic Metabolic Dietitians International). This will help ensure that accurate data are gathered to gain insights into EBP competencies among practitioners in specific clinical settings. Finally, to improve EBP competencies, research on various teaching strategies (e.g., core curricular courses, seminars, workshops, and journal clubs) is also required [66,67].

Conclusion

Among 12 included articles, there were considerable deficiencies across studies regarding the measurement of EBP competencies. In addition to the questions being predominantly self-perceived, as opposed to objective assessments, the 6 competencies were often incompletely defined or reported, which made it difficult to compare studies. No studies reported explicit questions on 2 (33%) of the 6 core EBP competencies [i.e., interpreting the magnitude (size) of effects and interpreting the certainty of evidence for estimates], skills that are essential for optimizing clinical and public health nutrition decision-making. Future surveys should objectively assess core EBP competencies using sensible questionnaires that have evidence of validity and reliability. Further, similar to what has been done in medicine and other health professions, we believe that there needs to be a call to standardize EBP competencies across dietetic programs to minimize heterogeneity in the training, understanding, evaluation, and application among dietetic practitioners.

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Author contributions

The authors' responsibilities were as follows – BCJ: conceived the study; NRG, BCJ: designed the study; NRG, BCJ: developed a priori list of core evidence-based competencies for nutrition professionals and students; NRG, BCJ: designed and performed the search strategy; NRG, RAC: selected the articles; NRG, ZE, JZ, SGL: extracted the data; NRG: analyzed the data and wrote the first draft of the manuscript; BCJ reviewed the data of the draft manuscript; and all authors: critically revised the manuscript for important intellectual content and contributed to the writing of the final version of the manuscript, and agreed with the results and conclusions of this article. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted. NRG and BCJ are the guarantors.

Conflict of interest

Although unrelated to this work, BCJ received a grant from Texas A&M AgriLife Research to fund investigator-initiated research related to saturated and polyunsaturated fats. The grant was from Texas A&M AgriLife institutional funds from interest and investment earnings, not a sponsoring organization, industry, or company. All other authors report no conflicts of interest.

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Data availability

All data are included in the manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tjnut.2023.12.044.

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