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Preliminary Content and Construct Validity of a New Model to Differentiate Research Skills from Evidence-Based Practice Skills: Core, Evidence Application, Research (CEAR) Model

Raeanne Jordan
Case Western Reserve University, rkj28@case.edu

Rosanna P. Watowicz
Case Western Reserve University, rpw39@case.edu

Catherine Phillips
Case Western Reserve University, cmp162@case.edu

Rita Obeid
Case Western Reserve University, rxo76@case.edu

Rosa K. Hand
Case Western Reserve University, rkh30@case.edu

Author(s) ORCID Identifier:

Raeanne Jordan

Rosanna Watowicz

Rita Obeid

Rosa Hand

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ORIGINAL ARTICLE

Preliminary content and construct validity of a new model to differentiate research skills from evidence-based practice skills: Core, Evidence Application, Research (CEAR) Model

Raeanne Jordan[1] | **Rosanna P. Watowicz**[1] | **Carrie King**[2] | **Catherine Phillips**[1] | **Rita Obeid**[3] | **Rosa K. Hand**[1]

[1]Department of Nutrition, Case Western Reserve University, Cleveland, Ohio, USA

[2]Dietetics and Nutrition Department, University of Alaska Anchorage, Anchorage, Alaska, USA

[3]Department of Psychological Sciences, Case Western Reserve University, Cleveland, Ohio, USA

Correspondence
Rosa K. Hand, Department of Nutrition, Case Western Reserve University, 10900 Euclid Ave, Cleveland, OH 44106, USA.
Email: rosa.hand@case.edu

Funding information
Case Western Reserve University

Abstract

Background: Research is the scientific basis for the profession of dietetics, as it must be located and applied in evidence-based practice (EBP). EBP is often presented as a foundational skill for research. CEAR – Core, Evidence Application, Research – is a newly proposed model that separates Research and Evidence Application skills into distinct domains, jointly supported by a set of Core skills, thus acknowledging that education and advancement in one domain neither requires nor precipitates education and advancement in the other. The goal was to investigate the content and construct validity of the new CEAR Model.

Methods: A cross-sectional online survey of randomly selected dietitians in the United States was used to collect CEAR domain scores, validated measures of research or EBP skills and self-reported characteristics. Exploratory factor analysis, Cronbach's α and Pearson correlation between various tools and CEAR domains were used to assess validity and reliability. Analysis of variance (ANOVA) and multiple linear regression between CEAR domains and participant characteristics were used to assess convergent and divergent validity.

Results: One hundred and fifty-four responses with a valid CEAR score were received and led to a three-factor solution, supporting the theorised differentiation of research from evidence application skills (content validity). Internal reliability for the CEAR Model overall and for each domain was high. The hypothesised correlations between existing research or EBP measurement tools and the relevant CEAR domains were found (construct validity). Known groups analysis demonstrated the expected differences in CEAR domain scores based on participant characteristics.

Conclusions: The CEAR Model demonstrates preliminary validity and internal reliability. It adds to the current literature by acknowledging the separateness of evidence application skills from research skills.

KEYWORDS
dietetics, evidence-based practice, research

Key points

- The differentiation of research and evidence application skills as illustrated in the Core, Evidence Application, Research (CEAR) Model has good internal reliability, preliminary content and construct validity based on factor analysis, correlation with existing tools and known groups analysis.

- This model will help guide future education and professional development in nutrition and dietetics.

INTRODUCTION

Research serves as the foundation of the field of nutrition and dietetics and has routinely been referred to as the 'backbone' of the profession.[1] It serves as the basis for decisions and recommendations regarding nutrition-related education, public policy and practice.[1] Stakeholders who utilise dietetic services demand that these services are backed by research and evidence-based practice (EBP) guidelines.[1] In practice settings, research serves as one of three components of EBP.[2,3]

EBP is defined as the consideration of relevant research, patient values and preferences and contextual circumstances to attain positive outcomes for a particular patient or population.[2] EBP requires practitioners to ask questions, evaluate and analyse the research and determine its applicability to the patient or population while also considering professional and patient circumstances, with the overall goal of answering a practice question.[2–5] This is in contrast to the goal of research, which is to add to existing evidence by generating new, applicable knowledge.[4,5]

However, according to existing models for the progression of research skills in dietetics, EBP serves as the first of four levels on the research continuum.[6,7] The first level of the continuum in these existing models consists of dietitians obtaining research reports, critically reading them and applying the most recent findings to solve a clinical problem.[6] At the second level, dietitians serve as mentors to other dietitians, develop clinical guidelines at their place of work and write for peer-reviewed publications.[6] The third level consists of dietitians conducting research as part of a team.[6] Finally, at level four, dietitians take on leadership roles by conducting their own research.[6] This model was developed by Wylie-Rosett and colleagues in 1990[8] and was later modified by Byham-Gray et al.[6] in 2006 into a pyramid structure. The research pyramid indicates that to advance to the next level of skill, one must acquire the knowledge and skills of the lower levels.[6] Thus, according to this model, to become an advanced researcher, one must first develop EBP skills.[6] Further, by positioning EBP as the first stage of research expertise, there is a risk that dietitians may perceive EBP as being important *only* to those who are interested in research.

Conducting a research study requires practical skills and knowledge related to research administration, designing a research protocol and carrying out statistical analysis, for example. EBP requires skills related to the interpretation and synthesis of the said research, as well as strong communication skills required to explain research findings to patients and clients. Although many skills required for effective EBP are also required for effective research (e.g., being able to critically interpret results from a published manuscript) and these skills may in fact be foundational to the progression of research expertise, it is important that the dietetics profession not limit the discussion of EBP to its role within research.

Despite these nuanced differences, research and EBP are often conflated in the educational standards set forth by the Accreditation Council for Education in Nutrition and Dietetics (ACEND)[9–12] (the US-based accrediting body for dietetics education) or in the Standards of Practice (SOP) and Standards of Professional Performance (SOPP)[13] for US-based registered dietitian nutritionists (RDNs). For example, Domain 1 of the 2022 ACEND Accreditation Standards for Nutrition and Dietetic Internship Programs is titled 'Scientific and Evidence Base of Practice: *Integration* of scientific information and *translation of research* into practice' (emphasis added). Although most of the five competencies in this domain are related to evaluating and applying research, competency 1.4 states that interns must be prepared to 'conduct projects using appropriate research or quality improvement methods, ethical procedures and data analysis'. The implication is that to be able to *integrate* science into practice, one must also be able to conduct a research study.

If EBP is conflated with research or discussed as though it is completely enveloped by the greater umbrella of research, then the profession fails to recognise the importance of EBP for all dietitians, particularly for those who do not *conduct* research as part of their job, but are experts at the *application* of research.

All in all, current research skill models place EBP as a foundational skill, and there are no existing models in dietetics that present EBP as a separate skill set with its own progression, effectively undervaluing it. Although previously combined in the literature and educational standards, each skill has a different purpose and process. This paper describes the development and preliminary validation of a new model that more clearly differentiates between research and EBP skills in dietitians.

METHODS

Model development

Because of the differences in purposes and involvement between research and EBP, three authors (RKH, RPW, CK) created a new model to reflect the theory that research and

EBP skills are separate skills built on a shared foundation or core. The three developer authors are all PhD-prepared RDNs who serve as educators of dietetics students at various levels and who have a special interest in teaching research and EBP skills. Two of the three developer authors have experience as clinical practitioners, and one of the developer authors has experience as a practice-based researcher. After elucidating this initial theory, the developer authors identified skills from existing models, skill measurement tools and foundational documents that related to research or EBP in dietitians or other healthcare professionals (including the Practice-Based Dietetic Research Involvement Survey [PBDRIS],[14] the Research Involvement Questionnaire [RIQ],[15] SOP/SOPP for RDNs,[13] ACEND 2017 standards[9–12] and EBP competencies[16]) and utilised a consensus process to place those skills into the new model's three domains – Core, Evidence Application and Research. In some cases, the same skill was identified in several source documents. During this process, the model evolved to include five Research subdomains because of the large number of research skills. The developer authors also added skills deemed important based on their own experience in dietetics research or evidence application, fulfilling Step 1 of Boateng and colleague's[17] process for scale development and validation. After the model was developed, it was sent to six experts in research and/or EBP who were asked to evaluate the overall logic and the specific skills included in each domain or subdomain, representing Step 2 of Boateng et al.[17] Small wording changes were made to some skills based on this review; however, the reviewers were in agreement that the overall framework was logical, demonstrating initial content validity.

Model description

This new model was termed the Core, Evidence Application, Research (CEAR) Model (Figure 1). The CEAR Model places Research and Evidence Application as two separate domains, represented by two semicircles, built upon a shared Core domain. The Core contains skills that are necessary for both effective research and effective application of evidence. It consists of skills traditionally presented as part of the EBP process: posing a question to the scientific literature ('ask'), acquiring relevant scientific literature ('acquire') and appraising and interpreting the literature ('appraise'). Though these skills are critical to EBP, the model developers agree with previous models that have alluded to the importance of these skills as the first stage of research expertise as well and thus placed them as the core of the new CEAR Model, reflecting their necessity for both research and EBP. After mastering the Core skills, focus can be placed on one or both sides of the circle (i.e., either the Research or Evidence Application domains). The left semicircle represents the Evidence Application domain and incorporates skills related to the application of the scientific literature (i.e., making decisions about patient care based

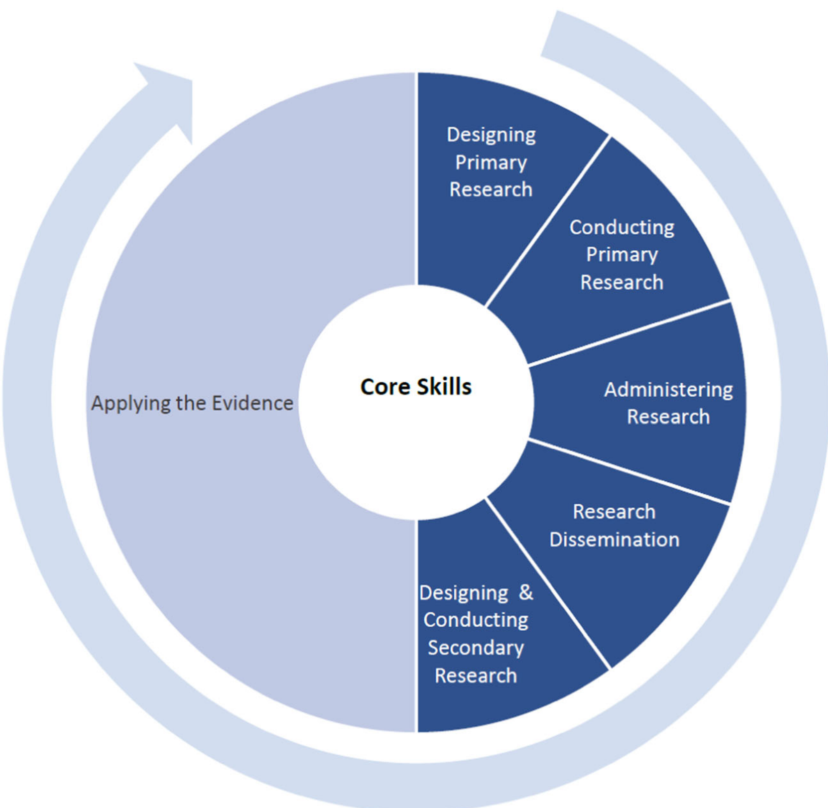

FIGURE 1 Core, Evidence Application, Research (CEAR) Model. CEAR Model places Research and Evidence Application as two separate domains, represented by two semicircles, built upon a shared Core domain. Within the right semicircle, there are five wedges, each representing a subdomain of research behaviours. The subdomains are (1) designing primary research, (2) conducting primary research, (3) administering research, (4) research dissemination and (5) designing and conducting secondary research. A clockwise arrow on the outside shows the direction in which the research process usually flows. The halves of the circle are equal in size because both research and evidence-based practice (EBP) hold equal importance; however, they are kept separate because education and advancement in one domain neither requires nor precipitates education and advancement in the other. After mastering the Core skills, focus can be placed on one or both sides of the circle (i.e., either the Research or Evidence Application domain).

on the available evidence), particularly in the context of a patient's values and the practitioner's expertise, as well as effective communication of the science to the patient and/or other healthcare professionals.[16] Within the right semicircle, there are five wedges, each representing a subdomain of Research (Figure 1). The subdomains are (1) designing primary research, (2) conducting primary research, (3) administering research, (4) research dissemination and (5) designing and conducting secondary research (i.e., systematic reviews or meta-analyses). A clockwise arrow on the outside shows the direction in which the research process usually flows. Within each subdomain is a list of skills (Table 1). The halves of the circle are equal in size because both research and EBP hold equal importance; however, they are kept separate because education and advancement in one domain neither requires nor precipitates education and advancement in the other. The CEAR Model addresses the limitations of previously validated models because it separates EBP and research into two skill sets with equal importance, while still acknowledging the shared skills at their core.

Validation plan

The validation plan followed the steps outlined by Boateng and colleagues.[17] The data source was a cross-sectional survey that consisted of five sections: (1) RIQ[15]; (2) PBDRIS[14]; (3) the author-developed CEAR Model questionnaire, based on the model and individual skills described earlier; (4) Knowledge of Research and Evidence Competencies (K-REC) quiz[18]; and (5) demographics/practice characteristics. The RIQ and PBDRIS are previously validated tools that have been used in the field of dietetics to assess the conduct of research by dietitians[19]; they are based on previous models of research in dietetics that place EBP as a foundational research skill (Table 2). The K-REC was validated in other professions and subsequently used in dietetics to measure skills specifically related to EBP[19] (Table 2).

Ethics

This study was reviewed by the Case Western Reserve University Institutional Review Board and was deemed to be exempt. Participants read an informed consent information page before proceeding with the survey. Responses were anonymous.

Survey population and data collection

The Commission on Dietetic Registration (CDR) provided 5000 randomly selected RDN email addresses through their student survey email request process. The sample size goal for this cross-sectional study was 250 RDNs (5%) based on typical electronic survey response rates in RDNs[22,23] and other health professionals.[24] To be included in the study, participants had to be credentialed RDNs residing in the United States. Because recruitment and completion of the survey took place via email, all participants had to have an active email address listed with CDR and have opted for CDR email communications.

Recruitment emails were sent via Qualtrics in July 2021. The email subject line was 'Research Project Invitation: Validating a Model for Research and Evidence-Based Practice Skills in Dietetics'. The consent form informed participants that the survey would take approximately 40 min; the median duration of time spent on the survey page was 21 min. The survey was open for a 4-week period. Targeted reminder emails were sent to individuals with incomplete surveys 15 days into the data collection period (August 2021). Because of the length of the RIQ, PBDRIS and CEAR Model questionnaire, participants were randomised by Qualtrics to complete only two of these three surveys, and the order of the selected surveys was randomised. Of the participants, 40% were randomised to complete RIQ and CEAR Model questionnaire, 40% were randomised to complete PBDRIS and CEAR Model questionnaire and 20% were randomised to complete RIQ and PBDRIS. The K-REC was included in all versions of the survey. To determine if participants read each survey question, attention-check questions were added to the RIQ, PBDRIS and CEAR Model questionnaire. Attention-check questions are randomly embedded within existing tools, and in these questions, participants are told to select a specific value, for example, 'for this question, please select "strongly agree" '. If a participant was randomly selecting answers, there was a one-in-five probability that they would randomly select the attention check, thus allowing us to flag and remove responses from most participants who were randomly selecting answers to move through the survey more quickly. As compensation for their time, the first 100 individuals to complete the survey received a $20 Amazon gift card. All individuals who completed the survey were entered into a raffle for one of five $100 Amazon gift cards.

Research questions, hypotheses and data analysis

Complete and partial responses were downloaded from Qualtrics. Scoring for each tool is described in Table 2. If a participant did not pass the attention check of one of the RIQ or PBDRIS or had only partial responses to the PBDRIS, RIQ or K-REC, then responses to that section were deleted, but responses to other tools from that participant were retained in the overall dataset for pairwise analysis if they had complete and valid CEAR Model questionnaire data.

TABLE 1 CEAR Model skills, sorted into domains and subdomains, with factor loadings, based on survey responses from 154 US RDNs in summer 2021.

Domain/subdomain	Skill	Factor[a] 1	2	3
Core	Evaluate available research evidence including consideration of validity, magnitude and relevance, and distinguish research evidence from opinion	0.519		
	Locate the best available research evidence	0.577		
	Define the PICO acronym and use it to structure questions	0.381		
	Differentiate and distinguish research, evidence-based practice (EBP) and quality improvement	0.473		
	Define EBP and its five steps	0.394		
	Describe/compare general research methodology/study designs	0.686		
	Describe principles for conducting research ethically	0.744		
	Participate in and/or describe the roles on a collaborative research team (e.g., practitioner who asked the question vs. interventionist vs. statistician)	0.769		
	Cronbach's $\alpha = 0.850$			
Evidence application domain	Assess patient preferences as part of the nutrition care process		0.635	
	Synthesise evidence from multiple primary or secondary sources	0.461	0.457	
	Communicate evidence to patients with varying literacy and numeracy		0.856	
	Interpret the risks and benefits of a particular decision, as present in the evidence, and communicate them with patients and professionals		0.871	
	Combine the evidence with professional expertise (including quality improvement data) and patient preference		0.857	
	Interpret and communicate the strength of evidence for a particular intervention		0.761	
	Lead the shared decision-making process with the patient, including choice talk, option talk and decision talk		0.652	
	Develop or make changes to practice at the individual practitioner level based on new evidence		0.716	
	Develop or make changes to practice or policy at the organisational level based on new evidence		0.485	
	Cronbach's $\alpha = 0.895$			
Research/designing primary research subdomain	Identify research gaps	0.652		
	Develop aims, objectives and/or hypotheses	0.797		
	Select appropriate independent and dependent variables, including primary and/or secondary outcomes	0.767		
	Select a research design to answer the question	0.812		
	Develop recruitment plans, including the development of inclusion and exclusion criteria	0.862		
	Develop data collection methods, including identifying data collection tools	0.844		−0.318
	Consider the feasibility and limitations of the research plan	0.849		
	Write a plan for the protection of human subjects as part of the Institutional Review Board (IRB) submission process	0.800		
	Design sampling protocol	0.802		
	Develop a data analysis plan	0.829		−0.310

TABLE 1 (Continued)

Domain/subdomain	Skill	Factor[a] 1	2	3
	Write project management plan including data management and quality assessment	0.797		−0.301
	Provide feedback to others on research plans	0.685		
Research/conducting primary research subdomain	Collect data	0.712		
	Recruit participants	0.737		
	Implement interventions	0.675		
	Follow rules for responsible conduct of research	0.828		
	Follow a plan for protecting human subjects (e.g., obtain consent and protect subject privacy and data confidentiality)	0.791		
	Conduct descriptive data analysis	0.825		
	Conduct bivariate data analysis	0.703		
	Conduct complex data analysis	0.721		
	Interpret data analysis	0.686		
	Supervise research as a principal investigator	0.731		
Research/administering research subdomain	Maintain IRB approval status (continuing reviews, regulatory binder) (for human subject research)	0.732		
	Manage and retain staff including ongoing education and support	0.495		
	Execute project activities within the parameters of the developed budget	0.597		
	Obtain IRB approval or exempt determination (for human subject research or quality improvement) or obtain an IRB determination for non-human subject research/quality improvement	0.768		
	Develop a research budget and assess the project financial feasibility	0.705		
	Hire and train research staff	0.626		
	Identify research funding mechanisms	0.666		
	Develop and submit a grant proposal	0.532		
Research/research dissemination subdomain	Present a research poster	0.650		0.373
	Create a research poster	0.671		0.374
	Write an abstract	0.776		
	Present a brief oral presentation related to research findings	0.681		
	Write the introduction section for a manuscript	0.665		0.409
	At the local or regional level, present a detailed oral presentation related to research findings	0.651		0.382
	Write the methods section of a manuscript	0.782		0.349
	At the national level, present a detailed oral presentation related to research findings	0.583		0.412
	Select an appropriate journal for manuscript submission and/or backup plans in case of rejection	0.667		0.363
	Write the results section of the manuscript	0.770		0.367
	Write the discussion section of the manuscript	0.770		0.385
	Respond to reviewer feedback	0.671		0.337

(Continues)

TABLE 1 (Continued)

Domain/subdomain	Skill	Factor[a] 1	2	3
	Serve as a peer reviewer for journal or conference submissions	0.498		
	Serve as a journal editor	0.334		
Research/designing and conducting secondary research subdomain	Perform data abstraction from articles that you or someone else has acquired for a systematic review or meta-analysis	0.602		
	Assess articles that you or someone else has acquired for whether they meet the inclusion/exclusion criteria of a systematic review or meta-analysis	0.611		
	Design and execute a database search as part of a systematic review or meta-analysis based on a research question developed by you or someone else	0.624		
	Assess articles for the risk of bias	0.557		
	Design systematic review methodology based on a research question that you or someone else developed (PICOTS questions covered in foundational skills)	0.558		
	With statistical assistance, carry out a meta-analysis based on studies that you or someone else has acquired and assessed	0.463		
	As part of a team, develop clinical practice guidelines based on systematic reviews or meta-analyses	0.394		
	Cronbach's $\alpha = 0.979$			
CEAR overall	Cronbach's $\alpha = 0.975$			

Abbreviations: CEAR, Core, Evidence Application, Research; EBP, evidence-based practice; PICO, population, intervention, comparison, outcome; RDNs, registered dietitian nutritionists.

[a]Factors 1 and 2 together explained 49.7% of the variance.

The sample demographics, practice characteristics and performance on existing tools were described using means and standard deviations or frequency, as appropriate. To compare across tools that had a different number of items in each tool, percentages were used.

Research question 1: Does the CEAR Model demonstrate content validity with research and evidence application skills separating into individual latent constructs? (Step 6 of Boateng et al.[17])

Hypothesis 1.1. CEAR Model questions will be divided into three factors, reflecting the three proposed domains (Core, Evidence Application and Research).

Hypothesis 1.2. Scores on the CEAR Core domain will correlate more strongly to those in the CEAR Research and Evidence Application domains than the CEAR Research domain and CEAR Evidence Application domain correlate to one another.

Analytic method 1: Exploratory factor analysis using principal axis factoring and varimax rotation (orthogonal)[25] was used to determine whether the CEAR skills were grouped into Core, Evidence Application and Research domains reflecting the CEAR Model. The Kaiser–Meyer–Olkin (KMO) measure was used to determine sampling adequacy, with 1.0 indicating the ideal sample size.[25] Eigenvalues were obtained for each component, and small coefficients were suppressed (<0.3).[25] In addition, Pearson's correlation coefficients between scores on each CEAR domain were examined.

Research question 2: Is the CEAR Model internally reliable? (Step 8 of Boateng et al.[17])

Hypothesis 2. The CEAR Model will demonstrate internal reliability, which also provides further evidence for content validity.[17]

Analytic method 2: Internal reliability was evaluated using Cronbach's α for the overall CEAR Model and the Core, Research and Evidence Application domains.

Research question 3: What is the construct validity of the CEAR Model, based on comparison with previously published validated tools measuring research and/or EBP skills? (Step 9 of Boateng et al.[17])

Hypothesis 3.1. RIQ and PBDRIS will correlate well with skills in the CEAR Research domain, demonstrating convergent construct validity.

TABLE 2 Description and scoring of tools to measure research or EBP skills in RDNs used in the present study validating the CEAR Model.

Tool	Description	Scoring	What it measures
RIQ	Previously validated tool from Whelen et al.[15] that evaluates self-reported research behaviours. Based on research continuum pyramid,[6,8] so the tool measures some EBP skills, which are considered level 1 activities in the pyramid model[a]	Six activities in each of four levels (totally 24 activities) rated on a five-point Likert scale for current involvement in activity (0 = not at all, 1 = a little, 2 = quite a bit, 3 = a lot and 4 = a great deal) The overall score is a sum of ratings for all activities; a higher score indicates higher skills. Maximum total score = 96	Primarily measures research skills, with a few EBP skills that fall into the CEAR Model's Core domain
PBDRIS	Previously validated tool by Plant et al.[14] that evaluates self-reported research behaviours; based on the DRIS by Byham-Gray et al.[6] Based on the research continuum pyramid,[6,8] so the tool measures some EBP skills, which are considered level 1 activities in the pyramid model[a]	Four activities on each of four levels (totally 16 activities), rated on a five-point Likert scale for frequency (1 = never to 5 = always) The overall score is a sum of ratings for all activities; a higher score indicates higher skills. Maximum total score = 80	Primarily measures research skills, with a few EBP skills that fall into the CEAR Model's Core domain
K-REC quiz	Previously validated objective quiz regarding EBP[18]	Uses multiple-choice, true/false and open-ended questions (maximum total score = 12); a higher score indicates higher knowledge	Measures EBP but primarily the 'ask', 'acquire' and 'appraise' steps, with no questions related to the 'apply' step of EBP. The steps tested by K-REC fall into the Core domain of the CEAR Model
CEAR Model	Made up of each skill identified within a domain or subdomain of the CEAR Model	Choices were on a five-point scale (0 = 'I have never learned this skill'; 1 = 'I have learned this skill but not performed it'; 2 = 'I have performed this skill under supervision/ mentorship'; 3 = 'I have performed this skill independently'; 4 = 'I have mentored others in this skill'). Scores were a sum of ratings for all skills assigned to the domain. Core domain – 8 items; maximum total domain score = 32 Evidence Application domain – 9 items; maximum total domain score = 36 Research domain – 51 items; maximum total domain score = 204 CEAR overall – 68 items; maximum total domain score = 272 We treated the CEAR Model questionnaire responses as continuous, based on the guidance that, when normality is confirmed, Likert-type response options can be treated as continuous data[20] and that when several Likert-type response options are grouped together in a scale, means are an appropriate measure of central tendency.[21]	Intended to measure Evidence Application and Research skills primarily as separate skills, with some shared Core skills

Abbreviations: CEAR, Core, Evidence Application, Research; DRIS, Dietitian Research Involvement Survey; EBP, evidence-based practice; K-REC, Knowledge of Research and Evidence Competencies; PBDRIS, Practice-Based Dietitian Research Involvement Scale; RDNs, registered dietitian nutritionists; RIQ, Research Involvement Questionnaire.

[a]The RIQ and PBDRIS are very similar given their shared theoretical model, but the PBDRIS has items that are considered more relevant to practice-based research, which, we would argue, are in fact Core domain skills. Thus, it was important to compare CEAR to both tools.

Hypothesis 3.2. K-REC will correlate well with the CEAR Core domain demonstrating convergent construct validity. Note that the K-REC was not expected to correlate well with the CEAR Evidence Application domain, despite K-REC's use as a tool for measuring EBP skills. The skills measured by K-REC closely aligned with the CEAR Core domain but not with the CEAR Evidence Application domain, as discussed in Table 2.

Hypothesis 3.3. There will be limited correlations between the CEAR Evidence Application domain and any existing tools demonstrating divergent construct validity.

Analytic method 3: After normality was tested, the Pearson correlation was conducted between the CEAR domain scores and total scores of each existing tool to determine the validity of the CEAR Model based on correlation, or lack thereof, with existing tools, in line with the hypotheses.

Research question 4: Does the CEAR Model demonstrate construct validity via known groups analysis, with skills varying based on demographic and practice characteristics? (Step 9 of Boateng et al.[17])

Hypothesis 4.1. CEAR Core domain scores, representing skills that are shared between research and EBP, will not differ based on practice area or training.

Hypothesis 4.2. Participants will score higher on the CEAR Evidence Application domain if they reported the following predictor variables:

- Having received EBP training (as opposed to never receiving EBP training or being unable to remember)
- A clinical practice area
- A specialty certification in one of seven certification areas awarded by the Commission on Dietetics Registration, the Certified Diabetes Care and Education Specialist or Certified Nutrition Support Clinician credentials, each of which should demonstrate clinical expertise based on examination

Hypothesis 4.3. Individuals will score higher on the CEAR Research domain if they reported the following predictor variables:

- Having received research training (as opposed to never receiving research training or being unable to remember)
- A research or education practice area
- Ever (vs. never) receiving any type of grant funding
- Ever (vs. never) had a publication
- Serving as a research mentor/teacher/preceptor

Analytic method 4: Domain scores from the CEAR Model questionnaire were compared based on demographic and practice characteristics. In addition to the predictor variables outlined in the individual hypotheses, in all three models, the following variables were used as a proxy for overall training and experience in the field of dietetics:

- Years as an RDN
- Highest level of education

TABLE 3 Characteristics of RDN participants in a survey about Research and Evidence Application knowledge distributed in summer 2021who had complete and valid data for CEAR.

Characteristics	***n***	**Mean ± SD or *n* (%)**
Gender – female	134	121 (90.3%)
Years as RDN	134	11.4 ± 12.2
Years in primary position	130	7.0 ± 9.1
Employment sector	131	
For-profit		56 (42.7%)
Non-profit (other than government)		45 (34.4%)
Self-employed		16 (12.2%)
Government (other than military)		12 (9.2%)
Military		2 (1.5%)
Work/practice setting[a]	132	
Ambulatory/outpatient care facility		26 (19.7%)
Other		24 (18.2%)
Acute care inpatient		18 (13.6%)
Acute care outpatient		11 (8.3%)
Private practice		10 (7.6%)
College, university or academic medical centre		8 (6.1%)
Health or fitness facility		7 (5.3%)
Long-term care facility		7 (5.3%)
Practice area[b]	130	
Clinical nutrition		75 (57.7%)
Other		41 (31.5%)
Research and education		14 (10.8%)
Highest level of education	133	
Bachelor's degree		53 (39.8%)
Master's degree		75 (56.4%)
Doctorate degree		5 (3.8%)
Member of Academy of Nutrition and Dietetics – yes	134	63 (47.0%)
Specialist certifications,[c,d]	134	
None		99 (73.9%)
Other[e]		14 (10.4%)
CDCES		12 (9.0%)
CNSC		10 (76.9%)
Read professional literature	133	
Monthly		43 (32.3%)

TABLE 3 (Continued)

Characteristics	n	Mean ± SD or n (%)
Weekly		43 (32.3%)
Bimonthly (twice a month or once every 2 weeks)		26 (19.5%)
Daily		12 (9.0%)
Do not read professional literature		9 (6.8%)
Training in EBP[f]	133	
Yes		45 (33.8%)
No		62 (46.6%)
I don't remember		26 (19.5%)
Practice mentor/teacher/ preceptor – yes	133	94 (70.7%)
Training in research[f]	133	
Yes		99 (74.4%)
No		30 (22.6%)
I don't remember		4 (3.0%)
Research mentor/teacher/ preceptor – yes	133	27 (20.3%)
Publication history[g]	133	
'I have never published research in a peer-reviewed journal'.		103 (77.4%)
'I have published research in a peer-reviewed journal once or twice'.		24 (18.0%)
'In an average year, I publish one or two papers in peer-reviewed journals'.		5 (3.8%)
'In an average year, I publish more than five papers in peer-reviewed journals'.		1 (0.8%)
'In an average year, I publish two to five papers in peer-reviewed journals'.		0
Grant funding – ever	132	32 (15.9%)
Acquisition of knowledge[h]	133	
Beginner: didactic learning in nutrition and dietetics		1 (0.8%)
Novice: supervised practice in nutrition and dietetics		2 (1.5%)
Competent: start of practice after registration (generally first 3 years of practice)		40 (30.1%)
Proficient: operational skills obtained and adeptly practised long-term		61 (45.9%)

TABLE 3 (Continued)

Characteristics	n	Mean ± SD or n (%)
Advanced practice: continues at the highest level of knowledge, skills and behaviours, including leadership, vision and/or advanced credentials		21 (15.8%)
Expert: builds and maintains knowledge, skills and credentials		8 (6.0%)
Assessment tools		Mean score ± SD in original units (mean score ± SD as a percentage of maximum possible)
PBDRIS	76	40.0 ± 10.3 (50.0 ± 12.8%)
RIQ	75	20.3 ± 19.0 (21.1 ± 19.8%)
K-REC	133	7.6 ± 1.7 (62.9 ± 13.9%)
CEAR	154	106.1 ± 46.5 (39.0 ± 17.1%)
Core domain		15.2 ± 5.9 (47.6 ± 18.5%)
Evidence Application domain		23.1 ± 7.2 (64.2 ± 20.1%)
Research domain		67.8 ± 39.9 (32.2 ± 19.6%)

Abbreviations: CDCES, certified diabetes care and education specialist; CEAR, Core, Evidence Application, Research; CNSC, certified nutrition support clinician; EBP, evidence-based practice; K-REC, Knowledge of Research and Evidence Competencies; PBDRIS, Practice-Based Dietitian Research Involvement Scale; RDNs, registered dietitian nutritionists; RIQ, Research Involvement Questionnaire; SD, standard deviation.

[a]Remaining categories had fewer than 5% each.

[b]Choices were collapsed into these three categories from a more extensive list. The 'other' category includes consultant, management and community.

[c]Sums to more than 100 because some participants had multiple specialty credentials.

[d]Collapsed into any specialty credential 'yes' or 'no'.

[e]Others included certified eating disorders RDN and the CDR (Commission on Dietetic Registration) specialty certifications.

[f]Collapsed into 'yes' and 'no'/'do not remember'.

[g]Collapsed into 'never' or 'ever'.

[h]Collapsed into 'beginner'/'novice'/'competent'; 'proficient'; 'advanced practice or expert'.

- Self-reported level of knowledge acquisition (beginner, novice, competent, proficient, advanced practice or expert; definitions are reported in full in Table 3) modified from the Council on Future Practice Dietetics Career Development Guide.[26]

The bivariate relationships between each domain and the individual predictor variables were examined using correlation or analysis of variance (ANOVA). When using ANOVA, the homogeneity of variance was tested using Levene's test. If the assumption was upheld, omnibus *F*-tests were used, followed by Bonferroni post hoc tests, if applicable. If the homogeneity of variance could not be assumed, Welch's robust ANOVA was used, followed by Tamhane post hoc tests.

Because many of the characteristics were related (e.g., having an advanced degree was related to working in a research or education practice area), after identifying the characteristics that were significantly related to CEAR domain scores at the bivariate level, we conducted multivariable linear regression. Variables were entered in order based on the theoretical/predicted chronology of acquisition of the characteristics (e.g., advanced degrees were theorised to be a precursor to other training, so education was entered into each model first). Standardised βs for each variable in each model are reported, along with the R^2 and F change between each model.

All analyses were carried out using SPSS version 28 (IBM Inc., Armonk, NY). Statistical significance was considered to be $p < 0.05$.

RESULTS

Three hundred and forty-four individuals opened the survey. Only complete and valid (based on responses to attention-check questions) CEAR Model questionnaire data from 154 participants were included. Some participants with complete and valid CEAR Model questionnaire data did not have complete or valid data for demographics and/or other assigned survey instruments, but they were included in pairwise analyses.

The majority of participants were female (90.3%), and they averaged 11.4 ± 12.2 years as an RDN with 7.0 ± 9.1 years in their primary position (Table 3). Data on other demographic and practice characteristics are listed in Table 3. Total scores on RIQ, PBDRIS, K-REC and CEAR Model questionnaire, as a percentage of maximum, were 21.1 ± 19.8%, 50.0 ± 12.8%, 62.9 ± 13.9% and 39.0 ± 17.1%, respectively (Table 3). Because differences in CEAR Model questionnaire total scores were not related to the hypotheses (and are heavily influenced by Research domain scores), further analysis using CEAR Model questionnaire total scores was not conducted.

Research question 1: content validity

To assess for factorability of the items or whether the items in the CEAR Model overall are assessing the same underlying dimensions, the correlation matrix was examined. In the matrix, all items correlated at a minimum of 0.3 with at least one other item, suggesting adequate correlations between items. Bartlett's test of sphericity was significant: $\chi 2$ (2278) = 10,617.82 and $p < 0.001$. Good sampling adequacy was demonstrated with a KMO statistic of 0.92. Thus, factor analysis was a suitable analysis plan. Principal axis factoring using a varimax orthogonal rotation was used in this analysis. In this initial factor analysis with small coefficients suppressed, 12 components with eigenvalues of Kaiser's criterion of 1 were identified, which together explained 75.8% of the variance. Inspection of the scree plot indicated that there were three underlying factors in the model. Factors with the highest eigenvalues for the strongest factor loading were retained; thus, based on the theoretical model with three components (Core, Evidence Application, Research), the factor analysis was rerun forcing three factors. A three-factor model explained 58.5% of the variance. However, no components were unique to factor 3. Factors 1 and 2 together explained 49.7% of the variance. Factor 1 represented all Core and Research domain items and one Evidence Application skill ('synthesise evidence from multiple primary or secondary sources'). Factor 2 represented all remaining Evidence Application skills. Table 1 shows factor loadings for each skill.

There were significant correlations between all CEAR domain scores. The strongest correlation was between the Core and Research domains ($r = 0.768$; $p < 0.001$; Table 4). There was a weaker but significant correlation between the Core and Evidence Application domains ($r = 0.322$; $p < 0.001$; Table 4). There was a weak but significant relationship between the Research and Evidence Application domains ($r = 0.163$; $p = 0.044$; Table 4).

Research question 2: internal reliability

The overall CEAR Model questionnaire showed strong internal reliability (Cronbach's $\alpha = 0.975$; Table 1). For the Core, Evidence Application and Research domains, Cronbach's α also indicated robust internal validity between the skills included in each CEAR domain (Table 1).

Research question 3: construct validity (convergent and divergent)

Moderate and statistically significant correlations were found between all existing tools and the CEAR Core and CEAR Research domains (Table 4). The correlations between the CEAR Evidence Application domain and the RIQ or PBDRIS were weak and non-significant (Table 4).

TABLE 4 Pearson correlation coefficients comparing new CEAR Model domains to existing tools measuring research (RIQ or PBDRIS) and evidence-based practice (K-REC).

		CEAR Core domain	CEAR Evidence Application domain	CEAR Research domain
K-REC ($n = 133$)	Pearson correlation	**0.369**[a]	**0.204**	**0.250**
	Two-tailed *p*-value	**<0.001**	**0.019**	**0.004**
RIQ ($n = 75$)	Pearson correlation	**0.531**	0.167[b]	**0.593**[a]
	Two-tailed *p*-value	**<0.001**	0.153	**<0.001**
PBDRIS ($n = 76$)	Pearson correlation	**0.443**	0.150[b]	**0.516**[a]
	Two-tailed *p*-value	**<0.001**	0.196	**<0.001**
CEAR Evidence Application domain ($n = 154$)	Pearson correlation	**0.322**[a]		
	Two-tailed *p*-value	**<0.001**		
CEAR Research domain ($n = 154$)	Pearson correlation	**0.768**[a]	**0.163**[b]	
	Two-tailed *p*-value	**<0.001**	**0.044**	

Note: Bold indicates significant correlations.

Abbreviations: CEAR, Core, Evidence Application, Research; K-REC, Knowledge of Research and Evidence Competencies; PBDRIS, Practice-Based Dietetics Research Involvement Survey; RIQ, Research Involvement Questionnaire.

[a]Hypothesised relationship.

[b]Lack of hypothesised relationship.

Research question 4: construct validity via known groups analysis

Hypothesis 4.1: core scores will not vary based on practice area or training

ANOVA demonstrated significant differences in Core domain scores across education levels of bachelor's, master's and doctorate degrees (12.3 ± 5.4, 16.1 ± 5.2, 25.4 ± 3.0, respectively; $p < 0.001$; Table 5). The CEAR Core domain scores of participants with beginner, novice or competent self-reported knowledge acquisition (14.5 ± 4.3) and the scores of participants with proficient knowledge (13.9 ± 6.2) were significantly lower than those of participants with advanced practice/expert self-reported knowledge (17.9 ± 6.5; $p = 0.008$; Table 5).

There was no significant difference in CEAR Core domain scores between those who worked primarily in a research area versus those who worked in a clinical or another practice area (Table 5). Those who did not receive or did not remember receiving EBP training had lower CEAR Core domain scores compared to those with EBP training (14.1 ± 6.1 vs. 16.6 ± 5.1, respectively; $p = 0.018$) just as participants without research training had lower Core domain scores than participants who received research training (11.2 ± 7.0 vs. 16.2 ± 5.0, respectively; $p < 0.001$; Table 5). Participants with publications or grants and who identified as a research teacher also had significantly higher CEAR Core domain scores (Table 5).

A seven-step linear regression analysis was conducted using only variables that were significantly related to CEAR Core domain scores at the bivariate level, entered in an order considered theoretically logical based on career chronology, beginning with education and entering self-reported knowledge last. Individual models for each step are reported in Table 6. The final linear regression model explained 34.1% (adjusted R^2) of the variance in CEAR Core domain scores and included significant coefficients for master's and doctoral degrees, EBP training, research training and having received a grant (Table 6).

Hypothesis 4.2: CEAR Evidence Application domain will vary based on participant characteristics

Based on bivariate statistics (*t*-test or ANOVA), participants who were practice mentors, teachers or preceptors had significantly higher CEAR Evidence Application domain scores (24.4 ± 6.7) than those who were not practice mentors, teachers or preceptors (20.4 ± 6.9; $p = 0.002$; Table 5). CEAR Evidence Application domain scores were also significantly higher in those with versus without a specialty certification (26.1 ± 5.9 vs. 22.3 ± 7.3, respectively; $p = 0.006$; Table 5). There was a trend towards higher CEAR Evidence Application domain scores among participants in clinical practice compared to other practice areas, though this did not reach statistical significance (Table 5). CEAR Evidence Application domain scores were also higher with higher levels of self-rated acquisition of knowledge ($p = 0.002$; Table 5).

A three-step linear regression analysis was conducted using only variables that were significant at the bivariate level, entered in an order based on theoretical career chronology, beginning with specialty certification and entering self-reported knowledge last. Individual models for each step are reported in Table 7. The final linear regression model explained 10.8% (adjusted R^2) of the variance in CEAR Evidence Application domain scores and

TABLE 5 Comparison of CEAR domain scores based on participant characteristics.

Characteristics		n	Core domain	Evidence Application domain	Research domain
Years of experience as an RDN (correlation)	r	134	−0.139	0.090	−0.077
	p-Value		0.133	0.300	0.374
Highest level of education (ANOVA)	Bachelor's	53	12.3 ± 5.4[a]	21.9 ± 6.9	44.3 ± 31.9[a]
	Master's	75	16.1 ± 5.2[b]	24.4 ± 6.7	73.8 ± 30.6[b]
	Doctorate	5	25.4 ± 3.0[c]	19.8 ± 9.5	164.4 ± 19.4[c]
	p-Value		**<0.001**	0.074	**<0.001**
Have received EBP training (t-test)	No or don't remember	88	14.1 ± 6.1	22.9 ± 6.7	61.9 ± 41.9
	Yes	45	16.6 ± 5.1	23.8 ± 7.6	72.4 ± 32.2
	p-Value		**0.018**	0.507	0.145
Have received research training (t-test)	No or don't remember	34	11.2 ± 7.0	22.6 ± 6.1	41.2 ± 40.0
	Yes	99	16.2 ± 5.0	23.5 ± 7.3	73.8 ± 35.5
	p-Value		**<0.001**	0.518	**<0.001**
Practice area (ANOVA)	Clinical	75	14.7 ± 5.7	24.1 ± 6.8	60.1 ± 32.7
	Research/education	14	18.4 ± 8.3	21.3 ± 7.7	101.6 ± 64.4
	Other	41	14.5 ± 5.1	22.3 ± 6.9	64.6 ± 31.4
	p-Value		0.073	0.225	0.075
Any specialty certification (t-test)	None	120	15.1 ± 5.8	22.3 ± 7.3	68.2 ± 40.3
	One or more	34	15.6 ± 6.5	26.1 ± 5.9	66.3 ± 38.9
	p-Value		0.683	**0.006**	0.803
Publication history (t-test)	Never	103	14.1 ± 5.8	23.0 ± 7.0	57.4 ± 33.8
	Ever	30	17.8 ± 5.6	24.1 ± 7.2	93.3 ± 43.7
	p-Value		**0.002**	0.426	**<0.001**
Any grant (t-test)	No grant	111	14.2 ± 5.7	23.1 ± 6.7	58.5 ± 35.8
	Any grant	21	19.2 ± 5.3	24.0 ± 8.7	102.8 ± 36.0
	p-Value		**<0.001**	0.576	**<0.001**
Serve as research mentor/teacher/preceptor (t-test)	No	106	14.3 ± 5.6	23.3 ± 6.3	60.1 ± 33.9
	Yes	27	17.5 ± 6.4	23.0 ± 9.4	86.4 ± 50.4
	p-Value		**0.010**	0.860	**0.015**
Serve as practice teacher/mentor/preceptor (t-test)	No	39	14.7 ± 4.8	20.4 ± 6.9	70.6 ± 35.4
	Yes	94	15.0 ± 6.3	24.4 ± 6.7	63.4 ± 40.5
	p-Value		0.740	**0.002**	0.335
Academy member (t-test)	No	71	14.1 ± 6.0	22.6 ± 7.3	60.6 ± 39.1
	Yes	63	15.7 ± 5.8	23.8 ± 6.8	70.4 ± 38.6
	p-Value		0.117	0.351	0.148
Self-rated knowledge (ANOVA)	Beginner, novice or competent	43	14.5 ± 4.3[a]	20.4 ± 6.5[a]	63.9 ± 22.8
	Proficient	61	13.9 ± 6.2[a]	23.9 ± 6.7[b]	58.6 ± 40.8

TABLE 5 (Continued)

Characteristics		n	Core domain	Evidence Application domain	Research domain
	Advanced practice or expert	29	17.9 ± 6.5[b]	26.1 ± 7.1[b]	82.2 ± 49.5
	p-Value		**0.008**	**0.002**	0.093

Note: The type of analysis is also specified in the first column. *p*-Values are for column comparisons; significant *p*-values for omnibus tests are indicated in bold. Numbers not connected by a matching letter are significant by post hoc tests at $p < 0.05$.

Abbreviations: ANOVA, analysis of variance; CEAR, Core, Evidence Application, Research; EBP, evidence-based practice; RDN, registered dietitian nutritionist.

TABLE 6 Multiple regression coefficients with CEAR Core as the outcome variable.

Model 1 summary		Predictors (β)	
R^2	F(2, 129)	Level of education – master's[a]	Level of education – doctorate[a]
0.224	18.624***	0.326***	0.424***

Model 2 summary		Predictors (β)		
Δ in R^2	Δ in F F (3, 128)	Level of education – master's[a]	Level of education – doctorate[a]	EBP training
0.042	7.412**	0.305***	0.431***	0.207**

Model 3 summary		Predictors (β)			
Δ in R^2	Δ in F F (4, 127)	Level of education – master's[a]	Level of education – doctorate[a]	EBP training	Research training
0.050	9.291**	0.228**	0.403***	0.138	0.248**

Model 4 summary		Predictors (β)				
Δ in R^2	Δ in F F(5, 126)	Level of education – master's[a]	Level of education – doctorate[a]	EBP training	Research training	Publication history
0.015	2.921	0.194*	0.344***	0.166*	0.243**	0.141

Model 5 summary		Predictors (β)					
Δ in R^2	Δ in F F (6, 125)	Level of education – master's[a]	Level of education – doctorate[a]	EBP training	Research training	Publication history	Grant history
0.035	6.951**	0.183*	0.305***	0.185*	0.221**	0.119	0.197**

Model 6 summary		Predictors (β)						
Δ in R^2	Δ in F F (7, 124)	Level of education – master's[a]	Level of education – doctorate[a]	EBP training	Research training	Publication history	Grant history	Research mentor/teacher
0.007	1.378	0.184*	0.286***	0.187*	0.223**	0.109	0.182*	0.089

Model 7 summary		Predictors (β)								
Δ in R^2	Δ in F F (9, 122)	Level of education – master's[a]	Level of education – doctorate[a]	EBP training	Research training	Publication history	Grant history	Research mentor/teacher	Self-rated knowledge – beginner[b]	Self-rated knowledge – advanced[b]
0.012	1.161	0.168*	0.259**	0.206**	0.216**	0.102	0.169*	0.082	0.009	0.121

Note: The R^2 for the final model is 0.386; adjusted R^2 is 0.341.

Abbreviations: CEAR, Core, Evidence Application, Research; EBP, evidence-based practice.

[a]Reference group: bachelor's.

[b]Reference group: proficient.

***$p = 0.001$; **$p = 0.01$; *$p < 0.05$.

included no significant coefficients (Table 7). In earlier steps of model building, specialty certification and service as a practice mentor/teacher/preceptor were significant, but once self-rated knowledge was added, no coefficients were significant predictors of CEAR Evidence Application domain scores.

Hypothesis 4.3: CEAR Research domain will vary based on participant characteristics

Based on bivariate tests (*t*-test or ANOVA), there was no significant difference in CEAR Research domain scores between participants who worked in research or education practice versus those who worked in a clinical practice area (Table 5). ANOVA demonstrated significant differences in Research domain scores across education levels of bachelor's, master's and doctorate degrees (44.3 ± 31.9, 73.8 ± 30.6, 164.4 ± 19.4, respectively; $p < 0.001$; Table 5).

TABLE 7 Multiple regression coefficients with CEAR Evidence Application as the outcome variable.

Model 1 summary		Predictors (β)
R^2	F (1, 131)	Specialty certification
0.072	10.093**	0.267**

Model 2 summary		Predictors (β)	
Δ in R^2	Δ in F F (2, 130)	Specialty Certification	Practice teacher/ mentor/preceptor
0.033	4.804*	0.203*	0.193*

Model 3 summary		Predictors (β)			
Δ in R^2	Δ in F F (4, 128)	Specialty certification	Practice teacher/mentor/ preceptor	Self-rated knowledge – beginner[a]	Self-rated knowledge – advanced[a]
0.030	2.220	0.147	0.144	−0.166	0.055

[a]Reference group: proficient.

***$p = 0.001$; **$p = 0.01$; *$p < 0.05$.

TABLE 8 Multiple regression coefficients with CEAR Research as the outcome variable.

Model 1 summary		Predictors (β)	
R^2	F (2, 129)	Level of education – master's[a]	Level of education – doctorate[a]
0.388	40.896***	0.379***	0.587***

Model 2 summary		Predictors (β)		
Δ in R^2	Δ in F F (3, 128)	Level of education – master's[a]	Level of education – doctorate[a]	Research training
0.061	14.048***	0.290***	0.560***	0.261***

Model 3 summary		Predictors (β)			
Δ in R^2	Δ in F F (4, 127)	Level of education – master's[a]	Level of education – doctorate[a]	Research training	Publication history
0.021	5.038*	0.251***	0.491***	0.265***	0.161*

Model 4 summary		Predictors (β)				
Δ in R^2	Δ in F F (5, 126)	Level of education – master's[a]	Level of education – doctorate[a]	Research training	Publication history	Grant history
0.052	13.825***	0.239***	0.443***	0.245***	0.129	0.240***

Model 5 summary		Predictors (β)					
Δ in R^2	Δ in F F (6, 125)	Level of education – master's[a]	Level of education – doctorate[a]	Research training	Publication history	Grant history	Research mentor/ teacher
0.005	1.228	0.240***	0.428***	0.247***	0.121	0.227***	0.073

Note: The R^2 for the final model is 0.527; adjusted R^2 is 0.504.

[a]Reference group: bachelor's.

*$p < 0.05$; **$p = 0.01$; ***$p = 0.001$.

Participants who did not receive or did not remember receiving research training had significantly lower CEAR Research domain scores than those who had received research training (41.2 ± 40.0 vs. 73.8 ± 35.5, respectively; $p < 0.001$), and there was a significant difference in CEAR Research domain scores between participants who were not research mentors, teachers or preceptors and participants who were research mentors, teachers or preceptors (60.1 ± 33.9 vs. 86.4 ± 50.4, respectively; $p = 0.015$; Table 5). Participants who had never published research had significantly lower CEAR Research domain scores than those who had published research (57.4 ± 33.8 vs. 93.3 ± 43.7, respectively; $p < 0.001$; Table 5). There was a significant difference in CEAR Research domain scores between participants who had never received a grant (58.5 ± 35.8) and participants who had received a grant (102.8 ± 36.0; $p < 0.001$; Table 5).

A five-step linear regression analysis was conducted using only variables that were significant at the bivariate level, entered in an order based on theoretical career chronology, beginning with education and entering service as a research teacher last. Individual models for each step are reported in Table 8. The final linear regression model explained 50.4% (adjusted R^2) of the variance in CEAR Research domain scores and included significant coefficients for master's and doctoral degrees, research training and having received a grant (Table 8).

DISCUSSION

The theory that research and EBP are separate skills, as described in the CEAR Model, appears to be preliminarily supported. Initial content validity is confirmed by factor analysis of the CEAR Model questionnaire that provided two distinct groupings: (1) Research and Core items and (2) Evidence Application items, confirming the assertion that Research and Evidence Application are two separate domains. The Core domain was maintained as a separate domain because many of the skills are objectively required for EBP[16] and thus should not be separated from EBP via placement in a Research domain only. Strong internal reliability was found, with Cronbach's α exceeding the 0.70 levels for all three domains and for the overall model (minimum $\alpha = 0.850$).

The weak correlation between the Research and Evidence Application domains in the CEAR Model further supports the theory that these are two separate sets of skills, whereas the stronger correlations between the Core domain and both Research and Evidence Application domains support the theory that there are shared foundational skills for both the Research and Evidence Application domains. The hypothesised correlations between individual CEAR domains and existing tools were identified, demonstrating both preliminary convergent and divergent construct validity.

Although a correlation between CEAR Core and RIQ or PBDRIS was not hypothesised, the resulting correlation is logical given that many of the skills from level 1 of the research pyramid (on which RIQ and PBDRIS are based) were placed into the Core domain of the CEAR Model. In addition, the correlation between CEAR Core and existing research tools may align with the factor analysis, which placed the Core and Research domains together. The statistically significant correlation between CEAR Research and the K-REC was not hypothesised and should be explored if confirmed.

As hypothesised in the known groups analysis, the Core domain score did not significantly differ based on the practice area but did differ based on education level (with higher scores related to a higher level of education), specific training in either EBP or research and the level of self-reported knowledge. This provides evidence that the skills inventoried in the Core domain are not specific to one practice area or another; however, this conclusion is complicated by the fact that those who had ever published or received a grant and those who identified as a research teacher/mentor did demonstrate higher Core domain scores. This may simply indicate that publication, grants and serving as a research teacher/mentor are related to a higher level of education (i.e., these may be more likely for RDNs with a PhD), as none, except receiving a grant, were significant in the final regression model.

A relationship between the Core domain scores and certain research-related variables is important for the validity of the CEAR Model. Many of the skills inventoried in the Core domain are explicitly described as EBP-related skills in the literature (e.g., writing a population, intervention, comparison outcome question is listed in the EBP competencies[16] and is part of nearly every EBP training). Therefore, there was more a priori theoretical support for including these skills as foundational to Evidence Application and more theoretical uncertainty as to whether the skills are foundational to Research as well. This study provides evidence that the skills inventoried in the Core domain are foundational to both Research and Evidence Application.

In line with the hypothesis, the Evidence Application domain scores were higher for those who serve as practice mentors and those who have a clinical certification and were also higher for those with higher overall self-reported knowledge. However, contrary to the hypothesis, Evidence Application domain scores were not higher for those with a clinical practice area versus a research practice area. It is possible that clinical certification and clinical mentorship are better indicators of expertise in this area than simply being employed in a clinical position; both variables were significant in the first steps of the regression model. Evidence Application domain scores being related to some measures of clinical expertise provides support for one of the underlying concepts of the CEAR Model – that Evidence Application skills are separate from research-related skills. However, because Evidence Application domain scores did not differ based on the practice area, the particular skills inventoried in this domain will need to be explored in further studies.

In line with the hypotheses, RDNs who had a higher level of education had higher Research domain scores, as did those who remembered receiving research training, those who were research mentors/teachers, those who had ever published and those who had ever received grant funding. However, like the Evidence Application domain and contrary to the hypothesis, the practice area was not significantly related to higher Research domain scores. Again, it is possible that years in a particular practice area or other variables (e.g., serving as a mentor/preceptor and publishing or receiving a grant) are better indicators of true expertise in a particular area versus current practice area alone. Overall, the Research domain scores were related to several variables indicating research expertise, both in bivariate testing and in the regression model.

Previous studies have demonstrated an association between the primary area of practice and research participation scores, using a variety of measurement tools including the Dietitian Research Involvement Survey (DRIS),[6] the Research Capacity in Context[27] and the RIQ.[28] In a survey of 258 randomly selected dietitians from seven practice groups in the Academy of Nutrition and Dietetics, the primary area of practice was highly correlated with research participation scores, with researchers and educators scoring higher than those in all other practice areas.[6] In a different study, the proportion of job roles designated to research was significantly associated with the number of research activities dietitians were involved in ($p < 0.001$).[27] Among dietitians who had completed a combined dietetic internship/master's degree programme with a focus on research, having research as part of the job description was significantly associated with performing more research activities during the prior year (4.3 ± 2.2 vs. 0.61 ± 1.3; $p = 0.001$).[28] RIQ scores were also significantly higher among those who had research as part of their job description (53.2 ± 26.7 vs. 20.3 ± 12.2; $p = 0.006$).[28] Further exploration of the CEAR Model and the skills included in the Research domain will help us understand why the same associations were not observed in this validation study.

The demographic characteristics of the sample were similar to a representative sample of US RDNs, except for work setting and years of experience.[29] The majority of US RDNs are female (92%), work in for-profit (39%) or non-profit (other than government) employment sectors, have a primary work/practice setting in an ambulatory/outpatient care facility (20%) and hold a master's degree (52%).[29] The sample had less experience as an RDN compared to the nationally representative sample (mean years as an RDN = 13 years).[29] Fewer individuals in the sample worked in an inpatient acute care setting (21% of the national sample), perhaps indicating that despite the efforts to ensure non-researchers they were needed in the survey, those already interested in research may have been more likely to open and complete the survey.

These differences in the sample could skew our results to represent a younger, less-experienced RDN population rather than the actual US RDN population. Nonetheless, the results on RIQ and PBDRIS were similar to previously published scores.[19] Another limitation is that the survey was long, with K-REC being the last of the tools taken by participants. There is the possibility that participants rushed through the survey to complete it faster. This could potentially explain the lower scores obtained on the K-REC compared to previously published scores,[19] as the K-REC was the last tool participants saw.

The known groups analysis was hindered by the limited number of participants who identified research or education as their practice area. Thus, the study had unbalanced groups and relatively few participants who would be expected to have high research skills. Grouping research and education practice areas together may have also decreased the differentiation around research skills, as educators may themselves be more skilled at applying evidence.

Self-rated acquisition of knowledge was significant at the bivariate level but was never significant in the regression models. This likely reflects its subjective nature and the human tendency to either over-inflate (sense of competence) or under-assess (imposter syndrome) one's own performance.

The response rate was similar to other online surveys of RDNs[22,23] and health professions.[24] Research has demonstrated that response rate is not a good indicator of bias,[30] and evidence-based strategies to decrease bias were used: incentives, email reminders and connection to the desired respondents.[24] KMO statistics suggested that the sample size was adequate despite it being low compared to the guidance that 200–300 responses are necessary for factor analysis.[17]

The findings re-emphasise that the RIQ and PBDRIS are measures of research skills rather than evidence application skills, despite the inclusion of certain EBP skills that the model developers would categorise as Core domain skills in the CEAR Model (these skills would fall into level 1 of the existing research pyramid model). Thus, a gap in the literature has been identified for a tool that measures the gamut of EBP behaviours. EBP can be divided into five steps: ‘ask’, ‘acquire’, ‘appraise’, ‘apply’ and ‘evaluate’,[16] but the K-REC, which is purported to measure EBP knowledge, does not measure skills related to the ‘apply’ or ‘evaluate’ steps of the EBP process. The skills listed in the Core and Evidence Application domains of the CEAR Model questionnaire may fill a gap in the literature[19] by providing a measure of EBP skills that can be used alone or in combination with measures of research behaviours, but further validation as a measurement tool is required. Future research might also expand the Evidence Application domain of the CEAR Model to add skills related to the ‘evaluate’ section. The ‘evaluate’ step of EBP also provides a link with quality improvement, which is an important component of many dietetic education programmes. Since the testing of the CEAR Model, a new EBP assessment tool for dietitians has been developed, called the Evidence-Based Dietetic Practice Questionnaire, which includes both objective and self-reported knowledge[31]; however, it still lacks questions related to the ‘apply’ step of EBP and thus may not be a complete measure of the Evidence Application domain of the CEAR Model.

Overall, the CEAR Model demonstrates preliminary content and construct validity in modelling the distinction between conducting research versus applying scientific evidence. These findings demonstrate that EBP and research are separate, equally important skills in the field of nutrition and dietetics. In the future, the nutrition and dietetics profession needs to provide clear education on the importance and differences between both research and EBP, rather than assuming EBP is a known concept or simply a stepping stone to research skills. The CEAR Model can be used by dietitians for self-assessment to guide professional development in Research or Evidence Application. The CEAR Model may influence education standards and local programme-level curriculum decisions that focus on CEAR Core domain skills, instead of teaching research and EBP as intertwined skills. Once it is further validated, the skills listed in the CEAR Model questionnaire can help educators and researchers determine whether programmes to increase research and evidence application skills have been successful.

AUTHOR CONTRIBUTIONS

Rosa K. Hand, Rosanna P. Watowicz and Carrie King developed the CEAR Model and survey. Rosa K. Hand, Rosanna P. Watowicz, Carrie King, Rita Obeid and Raeanne Jordan developed the methodology. Rosa K. Hand, Rita Obeid, Raeanne Jordan and Catherine Phillips completed the data analysis. Raeanne Jordan, Catherine Phillips, Rosa K. Hand and Rosanna P. Watowicz drafted the manuscript. All authors revised the manuscript and provided final approval.

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CONFLICT OF INTEREST STATEMENT

None of the authors have conflicts of interest to disclose.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

TRANSPARENCY DECLARATION

The lead author affirms that this manuscript is an honest, accurate and transparent account of the study being reported. The reporting of this work is compliant with STROBE guidelines. The lead author affirms that no important aspects of the study have been omitted and that any discrepancies from the study as planned have been explained.

ORCID

Raeanne Jordan http://orcid.org/0000-0002-9308-6450
Rosanna P. Watowicz http://orcid.org/0000-0001-5464-1354
Carrie King http://orcid.org/0000-0002-2589-7446
Rita Obeid http://orcid.org/0000-0002-0474-2517
Rosa K. Hand http://orcid.org/0000-0003-1314-1964

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AUTHOR BIOGRAPHIES

Raeanne Jordan, MS, RDN, LD, was a graduate student in the Department of Nutrition at Case Western Reserve University when the work was completed. At the time of publication, she is a clinical dietitian at UMPC Presbyterian.

Rosanna P. Watowicz, PhD, RDN, LD, is an assistant professor in the Department of Nutrition at Case Western Reserve University. Her research interests are evidence-based practice and paediatric obesity.

Carrie King, PhD, RDN, LD, CDCES, is a professor in the Dietetics and Nutrition Department at the University of Alaska Anchorage. Her research interests are dietitian research participation and training.

Catherine Phillips, BS, was an undergraduate student in the Department of Nutrition at Case Western Reserve University when the work was completed. She is currently a dietetic intern at Rush University Medical Center.

Rita Obeid, PhD, is an instructor in the Department of Psychology at Case Western Reserve University. Her research interests include autism stigma, and she teaches extensively.

Rosa K. Hand, PhD, RDN, LD, FAND, is an associate professor in the Department of Nutrition at Case Western Reserve University. She is interested in improving research and evidence-based practice skills among dietitians and questions surrounding dietetics staffing and time needed for care.

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