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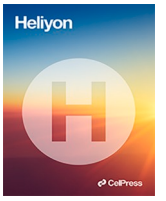

Psychometric properties of the research competencies assessment instrument for nurses (RCAIN) in Greece

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ABSTRACT

Background and Purpose: Evidence-based practice can improve quality of care and patient and system outcomes. Healthcare professionals need certain research competencies to achieve evidence-based practice. We aimed to evaluate the psychometric properties of the self-reported 19-item *Research Competencies Assessment Instrument for Nurses* (RCAIN) with Greek.

Methods: This cross-sectional study included in total, 520 respondents (within 33 health organizations) who completed the 5-point Likert-type RCAIN as well as the 8-item "*Research Utilization by Nurses*" that was used to assess construct validity. Expert scholars translated both survey questionnaires into the Greek language. A baseline one-factor model was compared against three-factor model (i.e., knowledge, skills, and application of knowledge and skills) that were developed based on the hypothetical design of the instrument.

Results: Participants were females (86.4%) 50 years old or younger (91%). The RCAIN had a Cronbach's alpha coefficient of 0.937 and intraclass correlation coefficient of 0.440 (95% CI 0.403 to 0.480, $p < .001$). Confirmatory factor analysis revealed a 3-factor solution (i.e., knowledge, skills, application of knowledge & skills). Fit indices for the three-factor model were statistically superior when compared with the baseline model. Reliability and validity of each subscale were acceptable. Further assessment of construct validity using hypothesis testing indicated that there is a statistically significant difference in research utilization by knowledgeable or not participants. Specifically, the effect size between knowledge synthesis and instrumental research use was eta squared = 0.020, meaning that approximately 2.0% of the variance in instrumental research use scores can be explained by knowledge in methods of knowledge synthesis. The predictive validity, based on correlations between the two instruments, showed that increasing levels of instrumental research use were associated with an increasingly positive and statistically significant pattern of correlations.

Conclusions: The RCAIN survey is a psychometrically sound tool for nurses. Providers, educators, and health administrators may use it for professional development and improvement of individual research competencies.

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1. Background

Evidence-based practice and knowledge translation process prerequisite health providers' research capacity and research competencies to base their care decisions on evidence and potentially improve quality of care and patient outcomes [1]. One of the most common barriers to evidence-based practice is difficulty to comprehend research language and terms, and to evaluate research findings [2]. Research capacity is important for nurse professional development [3]. To do so, nurses should critically evaluate research to inform the standards of care and provide the highest possible quality of care [4] and cost-effective services to society. Therefore, evaluation of nurses' knowledge and ability to understand and apply research literature in their practice is an essential component of advance nursing practice for better outcomes for patients, health organizations, and system.

Various relevant instruments have been developed to assess research competencies during the past decade [5] for undergraduate nursing students [6], doctoral students [7], or clinical nurses [8]. They focused on research *knowledge and skills* [8]; *interest and attitudes* [1,9]; *values* that lead to best nursing practice [10]; *ability* to *apply knowledge to solve problems innovatively* [6]; or *behaviours and actions* shaped around past experiences [4]. Other scholars have developed instruments to assess research utilization in healthcare [11,12], nurses' attitudes towards research utilization [13], nurse competencies for evidence-based practice [14], or research utilization [15].

Measurement instruments that assess evidence-based competencies or research utilization might measure research competencies as well [14]. We believe though that the concept of research competencies refer to the whole research process and research terminology, an individual nurse needs to be competent. On the other hand, competencies on evidence-based practice or research utilization refer to specific competencies that nurses need to use and synthesize research findings for evidence-based practice. Nurse scholars need to clarify these concepts' meaning, overlapping and distinct areas before measuring them. To our understanding, research competencies is a broader concept than evidence-based practice or research utilization. Overall, the existing related measurement tools use varied inconsistent definitions of research competencies. Recently, Chen and colleagues [5] are working in a scoping review to identify and summarize instruments measuring nurse research competencies that may guide educators, managers, and researchers to select the most appropriate instrument to assess nurse research competencies.

For this study, we refer to research competencies as knowledge, skills and attitudes toward the research process and research utilization. We used this theoretical definition in developing the *Research Competencies Assessment Instrument for Nurses* (RCAIN), in which knowledge, skills and attitudes to apply knowledge and skills in routine practices are operationalized. This is the first study, after the pilot with Canadian nurses [16] with a large sample.

1.1. Purpose

To test the psychometric properties of the RCAIN, we identified and captured research competencies at individual level and any differences in understanding the research-competencies concept based on the Researcher Pathway, which was the foundation for the initial development of the RCAIN [17]. The secondary purpose was to evaluate research competencies of nurses in Greece. Our main study objectives were to assess the reliability and construct validity of RCAIN. We hypothesized that nurses with high RCAIN scores would also use more research knowledge in their practice. This study was guided by the integrated Promoting Action on Research Implementation in Health Services conceptual framework [18]. Details about the framework for the development of the RCAIN are described elsewhere [16].

2. Methods

2.1. Design & settings

This is a non-experimental cross-sectional study, which was conducted in total 33 health organizations of any type (e.g., hospital, health center) in Northern Greece and Broader Area of Athens, Greece.

2.2. Participants

The *target population* of this study was registered nurses and other healthcare practitioners (e.g., dieticians, midwives, occupational therapists, physicians, physiotherapists) employed in any health organization for more than six months regardless age, gender, race, ethnicity, income, or other socio-economic characteristics. Our conveniently *accessible population* consisted of eligible healthcare providers, who were engaged in clinical practice, leadership, education, administration, or research. We would appreciate the opportunity to collect a random sample, but it was not possible to obtain it due to the lack of such records in the country. However, we collected the data from various areas in Greece for more representative sample and included multiple occupational groups to pilot the instrument with other healthcare professionals. The study design was cross-sectional and the final sample consisted of 520 nurses (i.e., staff nurse, clinical nurse specialists, and public health nurse). The total sample was 883 participants including physicians, dieticians, midwives, and other healthcare professionals.

2.3. Instruments and measures

We collected data (January to June 2018) using the FluidSurveys online application or using "paper & pencil" by distributing

hardcopies of the self-report 19-item RCAIN survey questionnaire that included three subscales of questions on knowledge (8 items), skills (6 items), and application of knowledge & skills (5 items). Participants responded on a 5-point Likert-type scale with the following response options: (1) "not at all", (2) "somewhat", (3) "uncertain", (4) "to a certain extent", and (5) "expert". In addition, questions on demographic characteristics (10 items) were included (for details, please see Appendix 1). Participants were invited to also complete the 8-item "*Research Utilization by Nurses*" [15] survey that is a standardized screening instrument that has been successfully studied in various countries and contexts. This instrument includes questions on instrumental or direct research use, conceptual or indirect, persuasive or symbolic, and overall research use scored on a five-point Likert scale: (1) "10% of the time or less", (2) "about 25%", (3) "about 50%", (4) "about 75%", and (5) "almost 100% of the time" (Appendix 2).

Three expert scholars in the field with fluent knowledge of both Greek and English languages (i.e., university professors) translated both survey questionnaires into the Greek language using a less bias method of back translation after initial translation. Specifically, one scholar completed the translation, while the other participated in this stage as a consultant to clarify differences in the English or Greek language. Thereafter, the third scholar proceeded to back-translation. Then, the first two scholars compared the original English version and the Greek version to identify any differences. Later, all three scholars met in-person to make necessary changes in grammatical and syntactical structure (e.g., removing redundant wording) and culturally adapting some terms commonly used in Greek. They agreed on the relevance and comprehensibility of the survey items for the local context, and the accuracy and quality of the translation. Finally, we conducted a pilot test by administering the Greek version of the survey to five registered nurses and two physicians to verify the clarity, understanding, cultural relevance and adjustment of the words and expressions used. The estimated response time for survey completion was about 25 min in total. The data were stored in encrypted server in Canada.

2.4. Data analyses

Using IBM SPSS Statistics version 26.0, we analyzed the data from nurses only (n = 520, 65.3% of all respondents) for validation of the RCAIN and estimated its reliability by calculating two types of reliability [19]. First, the internal consistency or reproducibility or homogeneity (i.e., Cronbach's alpha coefficient, split-half reliability) and second, its stability or test-retest reliability (i.e., intraclass correlation coefficient). We also estimated its validity by assessing construct validity (i.e., confirmatory factor analysis, hypothesis testing). Missing variables were addressed by excluding cases analysis by analysis. Confirmatory factor analysis (CFA) is a statistical technique used to verify the factor structure of a set of observed variables. It tests the hypothesis that a relationship between observed variables and their underlying latent constructs exists and attempts to reduce the overall number of observed variables into latent factors based on commonalities within the data.

2.5. Ethics approval

The study was approved by the Research Ethics Board at the University of Victoria, British Columbia, Canada (14–342/November 01, 2017) and by the local (Greek) Regional Ethics Committees (3rd DYPE of Macedonia D3b/41010/27-10-2017 & 15,818/9-10-17; 2nd DYPE Piraeus & Aegean 46,346/6-12-16; 1st DYPE Attikis 626/18-1-17).

Table 1
Demographic characteristics of respondents.

Demographic characteristic	Mean (SD)[b]	Frequency (%)
Gender (n = 520)[a] - Female		439 (86.4)
Age (in years; n = 490; range: 20–63)	41.08 (8.16)	
Experience (in years; n = 476)	15.12 (8.06)	
Job position (n = 520)		
Staff nurse		460 (88.5)
Clinical nurse specialist (CNS)		59 (11.3)
Public health nurse		1 (0.2)
Duration of employment (in years) in current … Position	9.38 (8.08)	n = 440
Department (e.g., surgery) (n = 473)	12.47 (8.52)	
Highest level of education (n = 505) - Diploma		277 (54.9)
Bachelor's degree		68 (13.6)
Master's degree		90 (17.9)
Doctoral degree		6 (1.2)
Attendance of workshops, conferences (n = 509) - Regularly		88 (17.3)
Sporadically or Never		313 (61.5) or 87 (17.1)
Annual personal income (in euros) (n = 503)		
Less than 12,000		151 (30.0)
12,001 to 24,000		234 (46.5)
24,001 to 89,600		26 (5.2)
More than 89,600		38 (7.6)

[a] Sample varies due to the missing values.
[b] SD = standard deviation.

3. Results

We distributed 1000 surveys and 883 completed were returned (response rate = 88.3%). Most participants (84%) were 50 years old or younger, females (82.4%) and nurses (86%) including public health nurses (1%) and nursing graduate students (4%) (Table 1). On average, half of the sample did not know/were not competent at all or were uncertain about their knowledge and skills across all 19-item RCAIN survey. Education was statistically significant factor for position of employment [Pearson $\chi^2_{(df = 340,\ n = 766)} = 112.70$, p = .009, Cramer's V = 0.425]; conferences attendance [Pearson r = .076, p = .031]; and personal annual income [Pearson r = .078, p = .027]. Means and standard deviations for each RCAIN subscale item are depicted in Table 2. All RCAIN inter-item correlations were statistically significant (not depicted).

1. Reliability

Internal consistency reliability was estimated by the most commonly used Cronbach's alpha (α) coefficient for the RCAIN as a whole (19 items; n = 372; α = 0.937) as well as for each subscale (Table 2), indicating a very good internal consistency reliability (above 0.7) for the scale with this sample. The measurement error in our sample was 0.122 or 12.2% for the RCAIN as a whole; and for each subscale 0.152, 0.177 and 0.175 respectively. The overall (19 items) split-half reliability had a Cronbach's alpha of 0.909 and 0.898 for each part respectively. The correlation between them was 0.710, the Spearman-Brown coefficient was 0.830, and the Guttman split-half coefficient was 0.819.

Stability reliability (coefficient of stability or consistency) of a measuring tool can be estimated with the Pearson correlation coefficient (overestimation) or with the intraclass correlation coefficient that is more accurate than the Pearson correlation coefficient. The overall intraclass correlation coefficient for the RCAIN was 0.440 (95% CI 0.403 to 0.480, p < .001). For each subscale (number of items), internal consistency (Cronbach's alpha), and intraclass correlation coefficient are depicted in Table 2. To improve reliability of RCAIN, we need to use a homogeneous sample and standardized methods for data collection (e.g., paper-based administration of the survey or online; not both approaches at the same time).

2. Validity

We estimated the main categories of content-related and construct validity.

Content-related validity is assessed by the literature and experts' review regarding the construction of the scale. The RCAIN

Table 2
Means, SDs & Reliability of the RCAIN and its subscales.

Subscales		Mean (SD)	Cronbach's alpha (α)	Corrected item-total correlations	Cronbach's alpha if item deleted	ICC
Indicator	Knowledge (8 items; n = 496)					
IAQ1	Frameworks	3.19 (.980)	0.921	.691	.914	.593 (95% CI
IAQ2	KS	3.20 (1.085)		.761	.909	.558 to .628, p < .001)
IAQ3	KT	3.53 (.955)		.645	.917	
IAQ4	Reports	3.36 (1.013)		.724	.911	
IAQ5	Appraisal	3.10 (1.050)		.763	.908	
IAQ6	Lit analysis	2.90 (1.000)		.760	.909	
IAQ7	Data	3.33 (0.978)		.748	.910	
IAQ8	Methods-KS	3.08 (1.046)		.786	.906	
Skills (6 items; n = 432)						
IIBQ1	Protocols	3.87 (.799)	0.907	.712	.895	.620 (95% CI
IIBQ2	Guidelines	3.95 (.791)		.785	.885	.582 to .658, p < .001)
IIBQ3	QI	3.66 (.870)		.747	.891	
IIBQ4	Research-based evidence	3.72 (.811)		.724	.894	
IIBQ5	RU-QI	3.64 (.839)		.731	.893	
IIBQ6	Evidence to practice	3.68 (.837)		.765	.888	
Application of knowledge & skills (5 items; n = 444)						
IIICQ1	QN-Research	3.29 (.900)	0.908	.695	.903	.663 (95% CI
IIICQ2	QN-Design	3.19 (.890)		.785	.884	.627 to .699, p < .001)
IIICQ3	QL-Research	3.19 (.838)		.779	.886	
IIICQ4	QL-Analysis	3.16 (.889)		.817	.877	
IIICQ5	Org. resources	3.14 (.900)		.766	.888	

SD = standard deviation; ICC = intraclass correlation coefficient; KS = knowledge synthesis; KT = knowledge translation; QI = quality improvement; RU = research utilization; QN = quantitative; QL = qualitative.

content validity was examined at the primary development stages [16].

Construct validity refers to the fit between conceptual and operational definitions of the variables included in an instrument [20]. It is assessed by convergent and divergent validity, contrasting groups' validity, and using factor analysis. In this study, a confirmatory factor analysis (CFA) was performed using JASP (https://jasp-stats.org/), an open-source software supported by the University of Amsterdam, to investigate construct validity of the RCAIN. We selected several fit indices to test which CFA model best represents the current dataset: root-mean-squared error of approximation (RMSEA), comparative fit index (CFI) [21], chi-square, and change in chi-square given the change in degrees of freedom between models.

- RMSEA is a measure of the average of the residual variance and covariance; good models have RMSEA values that are at or less than 0.08 [22].
- CFI is an index that fall between 0 and 1 (the closer to 1, the better the fit of the model), with values greater than 0.90 considered to be indicators of good fitting models [22].
- A lower chi-square value indicates a better fit, given an equal number of degrees of freedom, when comparing models.

Based upon the hypothetical underlying constructs for the RCAIN [16], two models were developed to represent the best fit for the overall data. Baseline model of one-factor in comparison against the Factor model of three-factors with knowledge, skills, and application of knowledge and skills, treated as latent factors. Specifically, we tested the fit of a model compared to baseline and estimated the factor loadings. The Factor model is comprised of three common factors: knowledge, skills, and application of knowledge and skills; all indicated by observed variables (e.g., Knowledge has eight indicators: IAQ1 to IAQ8). The present dataset satisfied all CFA requirements for normality, multicollinearity, residual values, and multivariate outliers [23].

According to the fit indices, the Factor model was a significant improvement over the Baseline model. Factor model had a lower RMSEA value of 0.072, a higher CFI value (0.932), and a significant change in chi-square given the change in degrees of freedom when compared to Baseline model ($\chi^2_{(149)} = 925.968$, $p < .001$). From these results, Factor model was the best fit for the data. See the plot (Fig. 1) for a visual representation of the factor loadings, factor variances, factor covariances and the residual variances for the observed variables as well as Table 3. The chi-square test was used to test whether the null hypothesis, representing a perfect fit, was accepted. Although the Factor model is definitely not a perfect fit, the chi-square statistic is significantly lower for the Factor model compared to the Baseline model, indicating a better model fit. The better fit of the Factor model is also indicated by the Comparative Fit Index (CFI) value of 0.932.

CFA. The correlation matrix showed many coefficients of 0.3 and above (not depicted). The suitability of the RCAIN data for a CFA was assessed before conducting the analysis. The overall Kaiser-Meyer-Olkin value, a measure of sampling adequacy, was 0.947 that exceeds the recommended value of 0.6 [24]; and the Bartlett's [25] Test of Sphericity was statistically significant ($p < .001$). We conducted a CFA to assess RCAIN structure with the Greek sample and extract the number of underlying factors. The CFA revealed the existence of three factors. Factor 1 (8 items) reflects the dimension of "knowledge" with loadings ranging from 0.336 (methods of knowledge synthesis) to 0.489 (knowledge translation). Factor 2 (6 items) reflects to the dimension of "skills" with loadings ranging from 0.191 (guidelines) to 0.292 (quality improvement). Factor 3 (5 items) reflects to the dimension of "application of knowledge & skills", whose loadings were negative ranging from 0.224 (QL-analysis) to 0.343 (org. resources). For details on factor loadings, please see Table 3.

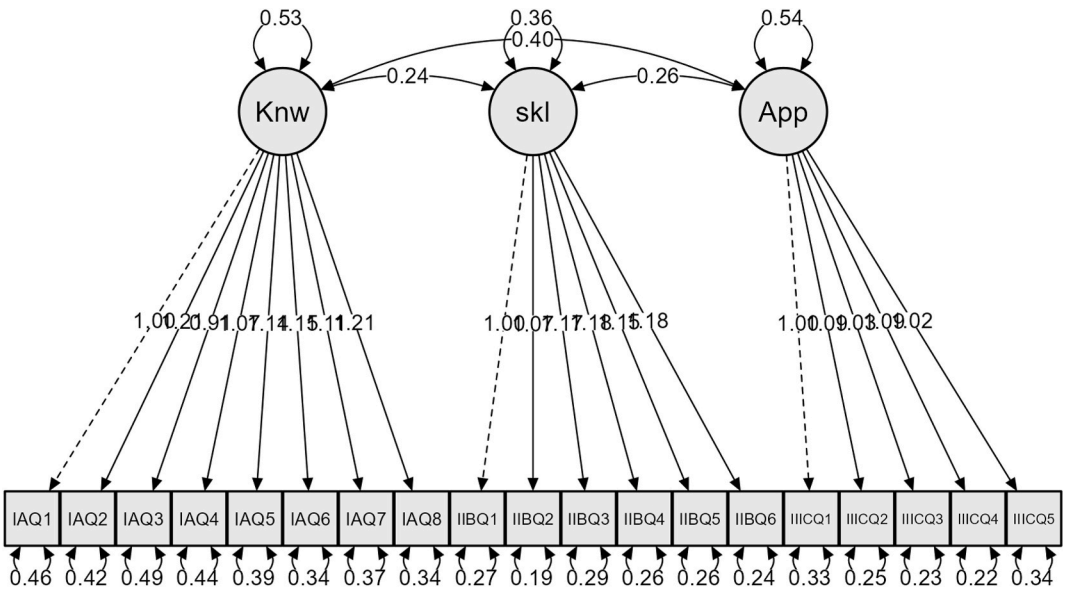

Fig. 1. Confirmatory factor model for the three-factor solutions.

Table 3
Standardized Factor Loadings by latent construct (n = 520).

Indicators/ Measures	Factors	Residual variances (standard error)	Factor Loadings (standard error)	Variances (standard error)	Covariances (standard error)	
					Factor 2	Factor 3
	Factor 1: Knowledge					
IAQ1	Frameworks	0.456 (0.024)	1.000 (–)[a]	0.531 (0.043)	0.244	0.399
IAQ2	KS	0.419 (0.023)	1.209 (0.050)		(0.021)	(0.029)
IAQ3	KT	0.489 (0.025)	0.915 (0.045)			
IAQ4	Reports	0.443 (0.024)	1.069 (0.047)			
IAQ5	Appraisal	0.385 (0.021)	1.143 (0.048)			
IAQ6	Lit analysis	0.342 (0.019)	1.146 (0.048)			
IAQ7	Data	0.369 (0.020)	1.106 (0.047)			
IAQ8	Methods-KS	0.336 (0.020)	1.214 (0.050)			
Factor 2: Skills						
IIBQ1	Protocols	0.275 (0.016)	1.000 (–)	0.355 (0.030)		0.258
IIBQ2	Guidelines	0.191 (0.012)	1.069 (0.044)			(0.258)
IIBQ3	QI	0.292 (0.017)	1.166 (0.053)			
IIBQ4	Research-based evidence	0.260 (0.015)	1.176 (0.052)			
IIBQ5	RU-QI	0.258 (0.016)	1.147 (0.052)			
IIBQ6	Evidence to practice	0.237 (0.015)	1.177 (0.053)			
Factor 3: Application of knowledge & skills						
IIICQ1	QN-Research	0.329 (0.019)	1.000 (–)	0.539 (0.041)		
IIICQ2	QN-Design	0.253 (0.016)	1.092 (0.041)			
IIICQ3	QL-Research	0.234 (0.015)	1.027 (0.039)			
IIICQ4	QL-Analysis	0.224 (0.015)	1.087 (0.041)			
IIICQ5	Org. resources	0.343 (0.021)	1.023 (0.044)			

[a] Standardized factor coefficients and the standard errors of the coefficients. Entries marked with (–) were constrained at a raw factor coefficient of 1.0 and, thus, yielded no standard error estimates.

Hypothesis testing. To further assess construct validity of the RCAIN, we examined certain hypotheses using the one-way between-groups analysis of variance (ANOVA) in conjunction with the *Research Utilization by Nurses* relevant measurement tool determining significance at an a priori alpha level of 0.05. We used *planned comparisons* since we were interested in only a subset of possible comparisons rather than *post-hoc tests* due to power issues. For example, our hypothesis was that participants in Group 5 (know very well; expert) used instrumental research more often than those in Group 2 (know somewhat) and Group 4 (know to a certain extent) combined. We were ignoring Group 1 (do not know at all) and Group 3 (not sure I know; uncertain). We conducted a series of ANOVA using as independent variable each of the 19-RCAIN items. The findings are depicted in Table 4. The effect size between each RCAIN

Table 4
ANOVA comparing IRU across five RCAIN groups.

Variable	Group 1	Group 2	Group 3	Group 4	Group 5	df	F	p	η^2
	Mean (SD; n)								
Frameworks	1.97 (1.320; 36)	2.23 (1.235; 65)	1.89 (1.023; 174)	2.08 (1.035; 180)	2.63 (1.116; 19)	4	2.83	.024	.024
KS	1.94 (1.311; 48)	2.06 (1.139; 64)	1.87 (1.024; 142)	2.12 (1.060; 190)	2.47 (1.047; 32)	4	2.46	.045	.020
KT	2.09 (1.477; 22)	2.21 (1.264; 43)	1.91 (.977; 129)	1.98 (1.063; 231)	2.49 (1.063; 49)	4	2.89	.019	.025
Reports	1.97 (1.354; 31)	2.09 (1.311; 56)	1.79 (.922; 141)	2.14 (1.065; 208)	2.44 (1.119; 39)	4	3.62	.006	.030
Appraisal	2.10 (1.389; 51)	1.89 (1.113; 57)	1.86 (.913; 191)	2.23 (1.132; 151)	2.54 (1.140; 26)	4	4.06	.003	.033
Literature analysis	1.98 (1.208; 51)	2.04 (1.112; 68)	1.88 (.981; 221)	2.30 (1.133; 115)	2.85 (1.068; 13)	4	4.93	<.001	.041
Data	1.85 (.967; 26)	2.10 (1.242; 48)	1.92 (1.051; 170)	2.10 (1.085; 188)	2.45 (1.063; 33)	4	2.13	.077	.018
Methods-KS	1.98 (1.250; 49)	2.05 (1.208; 55)	1.82 (.951; 188)	2.27 (1.080; 154)	2.42 (1.121; 19)	4	4.40	.002	.037
Protocols	1.43 (1.134; 7)	2.10 (1.261; 21)	2.11 (1.107; 56)	2.04 (1.041; 272)	2.25 (1.218; 69)	4	1.13	.340	.011
Guidelines	1.00 (0.000; 4)	2.10 (1.221; 21)	1.79 (1.044; 53)	2.06 (1.044; 269)	2.24 (1.202; 98)	4	2.48	.044	.022
QI	1.93 (1.486; 15)	2.14 (1.207; 22)	1.81 (.895; 113)	2.09 (1.080; 236)	2.26 (1.207; 66)	4	2.23	.065	.020
Research-based evidence	1.00 (.000; 5)	2.00 (1.275; 17)	1.87 (.966; 123)	2.07 (1.088; 235)	2.33 (1.201; 70)	4	3.23	.012	.028
RU-QI	1.40 (1.265; 10)	1.82 (.795; 22)	1.78 (.844; 130)	2.18 (1.170; 233)	2.25 (1.109; 55)	4	4.53	.001	.039
Evidence to practice	1.56 (1.130; 9)	2.00 (.943; 19)	1.74 (.912; 120)	2.14 (1.132; 240)	2.34 (1.153; 61)	4	4.50	.001	.039
QN-Research	1.65 (1.115; 17)	2.11 (1.086; 53)	1.90 (1.040; 163)	2.15 (1.043; 184)	2.60 (1.258; 25)	4	3.57	.007	.032
QN-Design	1.61 (1.033; 23)	2.10 (1.091; 41)	1.91 (1.009; 197)	2.22 (1.103; 166)	2.88 (1.310; 16)	4	5.28	<.001	.046
QL-Research	1.19 (.544; 16)	1.93 (.944; 40)	1.96 (1.036; 225)	2.28 (1.134; 149)	2.82 (1.286; 17)	4	7.20	<.001	.061
QL-Analysis	1.58 (.987; 26)	1.88 (.931; 43)	1.90 (.971; 220)	2.30 (1.152; 141)	2.95 (1.395; 20)	4	8.54	<.001	.071
Org. resources	1.52 (.975; 27)	2.17 (1.130; 40)	1.93 (.998; 214)	2.30 (1.122; 125)	2.53 (1.375; 17)	4	5.03	<.001	.046

IRU = Instrumental research utilization; SD = standard deviation; KS = knowledge synthesis; KT = knowledge translation; QI = quality improvement; RU = research utilization; QN = quantitative; QL = qualitative.

item and instrumental research use was calculated using eta squared (η^2), indicating the approximate percentage of the variance in instrumental research use scores that was explained by each RCAIN item, while the remaining percentage of the variance resulted from other factors.

Readability is an essential element of the reliability and validity that strengthens them. For the Greek version of the RCAIN was at the sixth to seventh grade level for participants to be able to understand the items and complete them consistently and accurately.

3.1. Research utilization by nurses

In our sample, the tool had a Cronbach's alpha of 0.915 (intraclass correlation coefficient = 0.573; 95% CI 0.536 to 0.612, $p < .001$). Research evidence was used about 25% of the time (30.4%–35.5% of the sample) or about 50% of the time (17.8%–25% of respondents). Pearson correlations among the RCAIN scales, demographics and Research Utilization by Nurses items were all statistically significant at the 0.01 level (2-tailed).

4. Discussion

The study results support the conclusion that the RCAIN is psychometrically stable and can be used to estimate research competencies of nurses and other healthcare professionals. Healthcare providers struggle with the research process [26], while clinicians are expected to be research competent for evidence-based practice [5,14]. Being research-competent means adequate knowledge, skills and positive attitudes toward research, which are strong predictors of future behavior of appraising, synthesizing, and implementing research findings for evidence-based practice and quality of care.

The RCAIN focuses on research-based evidence only, a modifiable element of evidence-based practice components, and can be used by practitioners themselves as a valuable source for professional development, educators, and healthcare employers. Nurse educators need to focus intensively into evidence-based practice, regularly assess knowledge and skills relevant to research utilization, and develop appropriate curricula that may guide to continue education and learning for improvement of research competencies. Administrators in healthcare settings can also use the RCAIN to achieve consistent implementation and sustainability of evidence-based practice, high quality health outcomes, and efficient system performance. Systematic facilitation for research use at personal and organizational levels are also required to comply with the mandate of evidence-based practice. In addition, Chen and colleagues [27] suggest education programmes for clinical nurses to promote and improve their critical thinking.

The estimated reliability of the RCAIN was excellent. The RCAIN internal consistency was 0.944, 0.926 for the knowledge subscale, 0.911 for skills, and 0.914 for application of knowledge & skills subscale. The tool stability was 0.468 for the whole instrument, 0.610 for knowledge, 0.630 for skills, and 0.679 for the application of knowledge & skills subscale. These findings are consistent with a Canadian sample of nurses [16] suggesting a promising reliable measuring tool. Specifically, the reliability of the whole under-development instrument (48 items) assessed with the Cronbach's α coefficient was 0.975, while the alpha coefficient for subscales ranged from 0.813 to 0.961.

The existing evidence also supported the RCAIN validity. Specifically, construct validity was assessed and supported by factor analysis (i.e., CFA) and hypothesis testing. CFA specified three factors that are consistent with our hypotheses and the literature [16]. Similarly, the explanatory factor analysis in the Canadian sample [16] revealed three factors: comprehension of research process (8 items), skills for research utilization (6 items), and application of knowledge and skills for conducting research (5 items). Hypothesis testing was reinforced by ANONA planned comparisons indicating statistically significant differences between "expert" and "know somewhat and/or know to a certain extent" participants. The findings indicated that higher levels of research competencies were associated with increasing instrumental research use in an increasingly positive and statistically significant pattern of correlations.

4.1. Strengths and limitations

Both strengths and limitations of this study are relevant to the sample (size, representation), data collection method (online, pencil & paper), and data analyses. The *sample* was large enough (strength) to capture the variety of research competencies in certain areas in Greece, but it was not representative (limitation) of the country nurses. Therefore, our results are not generalizable to the population (limitation). Selection bias may also exist, since the survey was self-reported, and the sample was not homogeneous (e.g., education). In Greece, awareness of issues on implementation of research-based evidence is quite different. A few nurses have a bachelor's degree for their nursing education and evidence-based practice is not required in nursing. Using both online and pencil & paper *methods to collect* the data include weaknesses related to validity of the data (limitation). Also, the translated survey questionnaire had a potential bias caused by different understanding of the concepts and questions, since the education level varies among the participants. In terms of the *data analyses*, use of ANOVA with large sample quite small differences could become statistically significant (limitation), even if the actual differences in the mean scores among the groups were small and of little practical importance (e.g., η^2 ranged from 0.020 to 0.071). However, use of planned comparisons strengthened the study and provided direct tests of hypotheses. Finally, the inclusion of other healthcare professionals (not only nurses) in the study may be a strength that provides the opportunity to test the instrument validity to various healthcare professionals.

4.2. Relevance to nursing practice, education, policy or research

Findings of this study hold several important implications for practice, education, policy and future research. In *practice*, the RCAIN

can assess modifiable personal characteristics such as nurse research competencies, and might explain variance in clinical processes and patient outcomes. Using the RCAIN may assist nurses and their managers to enhance support related to research utilization and evidence-based practice for better quality of care. In nursing *education*, the RCAIN can be used to evaluate courses or training programmes on research and development of research competencies preparing nurses for evidence-based practice. *Policy-makers* for education need to focus on the development of nurse research competencies at the undergraduate level of educational programs (e.g., research internship), because research-based evidence is core for contributing to evidence-based practice, quality of care and outcomes as well as to critical thinking. For *future research*, use of the RCAIN may assess the status of research competencies for a given individual nurse. In addition, examination of potential factors need to be explored that may influence nurse research competencies within a setting. We will replicate this study in other areas of Greece and continue assessing its psychometric rigor in other countries and cultures, as well as with other healthcare professionals.

5. Conclusion

The study findings indicate that the RCAIN is a psychometrically sound tool to measure research competencies in the specific sample of Greek nurses. RCAIN is a potential source for assessing nurse research competencies for educators and healthcare employers.

Author contribution statement

Anastasia A. Mallidou: Conceived and designed the study; Collected part of the data; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper. Anna Deltsidou: Collected part of the data; Analyzed and interpreted the data. Christina Nanou: Collected part of the data. Efrosini Vlachioti: Collected part of the data; Contributed reagents, materials, analysis tools or data.

Data availability statement

Data will be made available on request from the first author (A.A. Mallidou).

Additional information

No additional information is available for this paper.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix 1. The Research Competencies Assessment Instrument for Nurses (RCAIN)

A. Section I – Knowledge: "Do you know …"	1*	2	3	4	5
1. … how theoretical frameworks/conceptual models guide the way researchers approach phenomena under investigation?					
2. … at least one method for doing knowledge synthesis (e.g., integrative literature review, scoping review, systematic review)?					
3. … how publications, presentation and blogging contribute to knowledge translation (KT) activities?					
4. … any research reports relevant to your own practice area?					
5. … any appraisal activities used to evaluate the quality of the literature?					
6. … activities performed for literature analysis (e.g., conceptual/thematic analysis, numerical analysis, mapping the literature)?					
7. … how diverse sources of data (e.g., qualitative, quantitative) are used to better inform practice?					
8. … any rigorous methods used in knowledge synthesis (e.g., integrative literature review)?					
B. Section II – Skills: "Are you competent …"					
1. … using agency (e.g., hospital) protocols for routine practices?					
2. … applying evidence-based practice (EBP) guidelines (e.g., in your healthcare organization)?					
3. … engaging in activities related to quality improvement (e.g., assisting with quality improvement campaigns)?					

(*continued on next page*)

(*continued*)

A. Section I – Knowledge: "Do you know …"	1*	2	3	4	5
4. … using research-based evidence to address a clinical problem?					
5. … using research findings in practice for quality improvement?					
6. … using evidence to improve practice?					
C. Section III – Application of knowledge & skills: "Are you knowledgeable and skillful to …"					
1. … apply basic research activities in quantitative research such as how to form a research question and/or hypothesis?					
2. … design a quantitative study (e.g., correlational, experimental)?					
3. … apply basic research activities in qualitative research (e.g., how to form a research question)?					
4. … enact basic research activities in qualitative research such as to analyze data (e.g., content analysis)?					
5. … use organizational resources (e.g., journal clubs, webinars) to support research learning, KT activities, and routine EBP?					

*__1__ = not at all; __2__ = somewhat; __3__ = not sure (uncertain); __4__ = to a certain extent; __5__ = very well/highly.

Appendix 2. Research Utilization by Nurses*

Overall, on your last typical work day *how often* have you used research findings in any way of the following or in any aspect of your work?

Type of RU	% of Time				
	10% or less	About 25%	About 50%	About 75%	Almost 100%
Instrumental (direct)					
Conceptual (indirect)					
How to perform your work (perform)					
Raise your awareness about new ways to accomplish your work					
Change your mind about what you do in your practice (change mind)					
Give you new ideas about how to do your job (new ideas)					
Help you make sense of things you have been doing in your nursing role (make sense)					
Persuasive (symbolic)					
Overall					

*Estabrooks, C.A. (1999). The conceptual structure of research utilization. *Research in Nursing and Health*, *22*(3), 203–216. Used with permission.

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