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A New Clinical Pain Knowledge Test for Nurses: Development and Psychometric Evaluation

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Abstract

Background: All nurses care for patients with pain, and pain management knowledge and attitude surveys for nurses have been around since 1987. However, no validated knowledge test exists to measure post-licensure clinicians' knowledge of the core competencies of pain management in current complex patient populations.

Aims: To develop and test the psychometric properties of an instrument designed to measure pain management knowledge of post-licensure nurses.

Design: Psychometric instrument validation.

Settings: Four large Midwestern United States hospitals.

Participants: Registered Nurses employed full and part-time August 2015 to April 2016, age $M=43.25$ years; time as RN, $M=16.13$ years.

Methods: Prospective survey design using email to invite nurses to take an electronic multiple choice pain knowledge test.

Results: Content validity of initial 36-item test 'very good' (95.1% agreement). Completed tests that met analysis criteria, $N=747$. Mean initial test score, 69.4% correct (range 27.8-97.2).

Following revision/removal of 13 unacceptable questions, mean test score, 50.4% correct (range 8.7-82.6). Initial test item percent difficulty range, 15.2% to 98.1%, discrimination values range, 0.03 to 0.50; final test item percent difficulty range, 17.6-91.1%, discrimination values range, -0.04-1.04. Split-half reliability final test, 0.66. High decision consistency reliability with test cut-score of 75%.

Conclusions: Final 23-item Clinical Pain Knowledge Test demonstrates acceptable discrimination, difficulty, decision consistency, reliability and validity in the general clinical inpatient nurse population. This instrument will be useful in assessing pain management

knowledge of clinical nurses to determine gaps in education, evaluate knowledge post pain management education, and measure research outcomes.

Keywords

instrument development; knowledge test; nurse; pain management; psychometrics

Unresolved pain is costly to health care institutions in both monetary terms and in lack of patient comfort and satisfaction with care (Tasso & Behar-Horenstein, 2004). Barriers include an evolving change in the characteristics of patients admitted to inpatient hospital care involving acute on chronic pain, opioid tolerance, misuse or abuse, and a lack of clinical education about pain and its treatment (Arnstein & St. Marie, 2010). To overcome these barriers, growing national momentum towards incorporating core competencies in interprofessional pre-licensure pain management education is occurring (Fishman et al., 2013; Herr et al., 2015; Institute of Medicine, 2011). However, there is still no instrument that is both valid and relevant to the core competencies and changes in the comorbid features of inpatients to assess the knowledge of nurse clinicians.

Background

Pain management knowledge and attitude surveys for nurses have been around since 1987 (Ferrell & McCaffery, 2014; Manworren, 2001) but no validated knowledge test exists to measure post-licensure clinicians' knowledge of the mechanisms, treatments, and recently determined core competencies of pain management for the contemporary patient (Fishman et al., 2013; Herr et al., 2015). Many advances have been made in the understanding and treatment of pain. More than ever, scientists and clinicians understand how peripheral and central neuro-mechanisms account for a variety of pain experiences. Knowledge about assessment of pain and pain management interventions involving opioids, non-opioids, and non-medicine modalities is growing, yet patients continue to be undermanaged across the continuum of care (Institute of Medicine, 2011). Education of healthcare clinicians and the measurement of clinicians' knowledge is imperative.

Realizing the complex pain management needs of the hospitalized patient population today underscores the need for pain education and understanding of the clinicians' pain knowledge. Between 1999-2008, opioid overdose deaths have quadrupled (Paulozzi, Jones, Mack, & Rudd, 2011; Rudd, Aleshire, Zibbell, & Gladden, 2016; Dowell, Haegerich, & Chou, 2016), while the rates of hospitalizations and hospital length of stay among adults involving opioid overuse increased more than 150% between 1993-2012 (Owens, Barrett, Weiss, Washington, & Kronick, 2014). A study involving veterans showed that over half of medical inpatients had preexisting chronic non-cancer pain and nearly one in four hospitalized patients had current or recent chronic use of opioid for the treatment of pain at the time of hospital admission for non-surgical conditions (Mosher et al., 2013). Moreover, the combinations of prescription opioids, sedatives, and tranquilizers are an increasing cause of hospitalization and create challenges for inpatient healthcare providers caring for patients with high tolerance and potential risk for overuse or overdose (Coben et al., 2010; Gulur, Williams, Chaudhary, Koury, & Jaff, 2014; White, Hingson, Pan, & YeYi, 2011). This

increase in patients with opioid tolerance, chronic pain, substance use disorder, and acute on chronic pain indicates a significant change in the characteristics and prevalence of patients admitted to care in a hospital. Therefore, we must ensure that the healthcare team has measureable knowledge of the management of patients' pain with these additional healthcare conditions.

The development of interprofessional core competencies in pain management for pre-licensure healthcare providers offered a strong foundation for building a test measuring knowledge in pain management for inpatient hospital nurses (Fishman et al., 2013; Bemet et al., 2014; Herr et al., 2015). Core competencies for pain management were designed to provide consistent quality pain management education across disciplines in pre-licensure education (Fishman et al., 2013). The core competencies were developed within 4 domains, e.g. multidimensional nature of pain, pain assessment and measurement, management of pain, and clinical conditions. The multidimensional nature of pain includes the science, terminology, pain experiences, and impact of pain on society. Pain assessment and measurement contains the quantification of pain and how pain is communicated, and how the healthcare system and society affect assessment and measurement. The management of pain competency concentrates on decision making for pain management, knowing treatment options and understanding the importance of managing risk in the context of the clinical condition. Clinical condition competencies, referred in this study as knowledge application, focused on the clinicians' role with applying their knowledge to special patient populations across the healthcare continuum. To date there are no known published pain knowledge tests aligned with these core competencies. Analysis of this clinical pain knowledge test occurred for the total score and across these domains.

These competencies require that interdisciplinary healthcare teams stay current with pain information, and have their knowledge measured by a valid and up-dated tool (Matthews & Malcolm, 2007). With a valid and up-dated pain management measurement tool driven by these core competencies; hospital leadership, educators, and researchers can reliably measure current knowledge of post-licensure hospital-based clinicians, identify *need* for pain education initiatives, and measure *outcomes* of pain management education initiatives.

The research team designed a multiple-choice knowledge test to meet the need for an effective method of measuring cognitive knowledge of pain in the context of changes mentioned (Downing, 2011). This knowledge test was designed congruent to the methods described by Sorensen et al. (2015) regarding content, multiple choice question item structure, and consistent stems and options to maintain validity of the question items to accurately test knowledge.

The purpose of this study was to develop and test the psychometric qualities of the new Clinical Pain Knowledge Test in order to measure the nurses' pain management knowledge of hospitalized patients. This tool was designed to test pain management knowledge prior to implementing education initiatives and to measure outcomes of these initiatives.

Methods

Design

This psychometric instrument validation study used a prospective quantitative survey design with Item Response Theory (IRT) and descriptive analyses to investigate the psychometric properties of the Clinical Pain Knowledge Test developed by the researchers.

Instrument development

Content of the initial 36-item test was based on the current literature, the research team's collective expertise in current pain management practice and previous pain management knowledge and attitude surveys for nurses (Ferrell & McCaffery, 2014; Manworren, 2001; Schreiber et al., 2014), and practice pain management test items made publically available from American Nurses Credentialing Center (American Nurses Association and American Society for Pain Management Nursing, 2016), and National Council Licensure Examination (NCLEX; 2016). The research team honed the test items so they were based within the four domains of the core competencies of pain management: 1) multidimensional nature of pain; 2) pain assessment; 3) management (treatment) of pain; and 4) application of knowledge in various populations and contexts (Fishman, et al., 2013; Bemet et al., 2014; Herr et al., 2015). The steps in test development are depicted in Figure 1.

Sample

The sample size of respondents required to answer all test items depended on a variety of factors: 1) the ratio of subjects to questions, 2) the relationship between the items, and 3) number of factors observed. Research by Pearson and Mundform (2010) suggests in the presence of dichotomous items, consistent with the present study, sample sizes of at least 300 showed good agreements when the ratio of responders to items is at least 8:1, or preferably 10:1. Based on the initial question pool of 36 items, the preferred sample size was between 288 and 360 responders. This sample size would also be adequate for evaluations of the item response theory evaluation where for two-parameter models, sample sizes of at least 200 are recommended (Thorpe & Favia, 2012). The goal of recruitment was to seek broad clinical experiences among the nursing population working at four large healthcare systems in the Midwest United States. The inclusion criteria were 1) work full or part time as a Registered Nurse at one of the facilities, 2) fluent in English (test written in English), and 3) available to access a web-based test through a link between August 2015 and April 2016.

Procedure

Institutional Review Boards (IRBs) from four institutions approved the study and a letter was emailed to all the nurses at the study sites who met the inclusion criteria. This letter provided study information, invitation to participate, and a link to access the test. Informed consent was implied when the nurse clicked on the link, provided responses to the questions and demographic information to the REDCap database; a secure, web-based application designed to support data capture for research studies (Harris et al., 2009). The nurses approached for the study were working in medical-surgical, intensive care, orthopedics, labor and delivery, oncology, and float pool; initially had up to 14 days to respond. After 14

days a reminder email was sent again to all nurses. A third and final reminder email was sent after another 14 days in order to elicit participation. Because of high hospital census in one of the participating healthcare systems, the IRB approved another round of recruitment that occurred 6 months from initial recruitment, when recruitment could occur more readily.

Data Analysis

Analyses were conducted in *R*, version 3.3 (R Development Core Team, 2010) and SAS software version 9.4 (SAS Institute, 2016). Responses to the knowledge questions were treated as a dichotomous variable (correct–not correct), and sum scores for the total number of correct responses were created. Categorical factors were summarized using frequencies and percentages, while continuous measures (in the demographic data) were described using means, standard deviations and percentiles of interest (median, quartiles, and range). Associations between demographic factors and total scores were assessed using Spearman correlations and Kruskal-Wallis tests. Item response methods were used to evaluate the quality of the questions and their ability to differentiate between groups of responders (Thorpe & Favia, 2012). Split-half reliability (Cody & Smith, 2014) and decision consistency reliability (Huynh, 1990) were used to determine reliability of the test. The Cronbach's alpha statistic was not used because it is not helpful in determining reliability of a dichotomously scored knowledge test in a single test that measures many individual areas of comprehensive knowledge (Sijtsma, 2009). A significance level of 0.05 was applied for all statistical tests.

Results

Description of the sample

A total of 1,423 nurses responded to take the test/survey and an adequate sample size of 747 completed the test, including answers to demographic questions. The characteristics of the sample are listed in Table 1. Of the total number of nurses completing the test, 56.2% reported having formal education in pain management, with a mean of four total course hours completed (range 1-300 hours, median 4 hours, mode 2 hours). A statistically significant negative correlation ($p<0.01$) was found between nurse age and total test score, such that the greater the nurses' age, the lower the test scores. There was no statistically significant correlation between total test score and nursing experience in years, however, the higher the nurse's education, the higher their total test score ($p<0.05$).

Content Validity

Content validity of the initial 36-item test was determined prior to offering the test to nurse-participants. The input from nine content experts with extensive knowledge in the field of pain management was elicited through email: advanced practice nurses (N=5), physicians (N=2), pharmacist (N=1), and pain researcher (N=1). The content validity index (CVI) indicated 95.1% agreement for relevance and 98.2% agreement for importance (Lynn, 1986). Following content validity analysis, the research team discussed each test item, reviewed comments by the experts, and made revisions to the test. Content experts were again consulted for their expertise and the final 36 test items were determined.

Item Difficulty

Item difficulty refers to the proportion of participants who were able to correctly answer each test item. Ideally, item difficulty should range between 10% and 90% correct, or the item is considered 'too difficult' or 'too easy', respectively (McDonald, 2011). On the initial 36-item test, participants had a mean test score of 69.4% correct (range 27.8-97.2%) and the item difficulty index ranged from 0.15 (15% of participants scored the item correctly) to 0.98 (98% of participants scored the item correctly). Eight test items were answered correctly by >90% of participants, so those items were eliminated, for a new total of 28 test items. No test items were determined to be too difficult; none were answered correctly below the cut-off line of 10%. In the final 23-item test, item percent difficulty was in an acceptable range of 17.6% to 91.1% with a mean score of 50.4% correct (range 8.7-82.6).

Discriminating Index

The initial 36-item test data was split into low and high scores. The low scores (25%) included respondents who were correct on 62% of the questions, and high scores (25%), included respondents who were correct on 75% of questions. Comparisons were calculated on these groups to determine indices of discrimination. For confidence in our indices of discrimination, analyses were also performed using alternate cuts (10% and 33%) and these were similar. All original 36 items were statistically significant and positively associated with the total score. Five additional test items were eliminated for low-scoring discrimination between high and low scoring participants, for a final total of 23 test items. See Table 2.

A two-parameter Rasch model that measures unconstrained difficulty and discrimination were fit to the final 23 items on the test. This calculation was done to determine the degree to which the final test items discriminated between a high scoring participant and a low scoring participant. The discrimination parameters show how well the question differentiates overall low and high performing responders, by measuring the slope of the item response function. Higher levels reflect better discrimination performance, while values near or below zero reflect similar performance across the range of responders. Discrimination estimates on the final test had an acceptable range of -0.04 to 1.04, indicating each item's predictive ability of total exam performance.

Construct Validity

Construct validity was tested by comparing the test results between groups who had different expected levels of knowledge based on their level of pain management education (i.e. known groups technique). There was a positive significant correlation between nurses who had taken any pain course and their test scores ($p < 0.001$). An independent samples t-test was used to compare the total scores between those registered nurse respondents who had 20 hours or greater of pain management education (determined by the research team to be a significant amount of extra pain management education; $n = 45$) from those who had 19 hours or less of pain management education ($n = 670$); there was a statistically significant difference in total scores between groups, $t(713) = (3.86)$, $p = 0.00$, indicating good construct validity of the test.

Split-half Reliability

A split-half reliability score for the final 23-item test indicated a moderate reliability score of 0.66. In this knowledge test of four domains of competency, a moderate reliability was expected because it is a single test measuring many individual areas of knowledge (Cody & Smith, 2014).

Decision Consistency Reliability

Decision consistency reliability measured how consistent the test answers were for the individual test-taker (Huynh, 1990). The decision consistency reliability value of the final test showed high reliability when using a cut-score of 75% correct. The mean correct score on the final 23-items was 50.4% correct, with a $SD=11.3\%$. When looking at the recommended two standard deviations from the mean correct score, the total is 73.0%, near the 75% cut-score indicating the test was reliable and good at detecting consistent decision-making on the part of the test-taker.

Core Competency Domains Application

The four core competency domain categories for this test were 1) multidimensional aspect of pain, 2) pain assessment and measurement, 3) management of pain, and 4) knowledge application in clinical conditions. Categorical factors were summarized using frequencies and percentages between continuous demographics (total pain course hours a nurse reported taking, nurses' age, years of nursing experience, level of education, and attainment of any certification in any specialty) compared to these domains and final 23-item total pain test scores.

A significant positive correlation ($p<0.01$) existed between the reported number of total pain course hours taken outside this study (three clusters: 0 hours, 1-19 hours, 20+ hours) and the total test score. Furthermore, test scores were significantly different among the clusters. When total pain course hours were compared across the four domains (multidimensional aspect of pain, pain assessment and measurement, management of pain, and knowledge application), a significant association was observed for all domains except pain assessment, which was nearly significant ($p=0.055$). See Table 3.

Further associations between scores and age of the nurse, years of experience, level of education, and attainment of any certification were analyzed. There was a small negative correlation between age and total score ($p=0.015$), and age and the pain assessment domain score ($p=0.013$), indicating that nurses tended to do slightly worse on the test and specifically within the domain of pain assessment, as age increased. There were no significant associations between test scores and years of experience.

Those with more education had higher scores overall, and in the domains of pain assessment and knowledge application, as shown on Table 4. The only significant correlation in test scores between participants who attained a certification of any kind and their test scores, was in the domain of pain management ($p=.008$).

Discussion

The Study Population

Inpatient nurses were the population chosen because the clinical expertise of the research team, employed by hospital systems, created awareness of the changing comorbidities of patients admitted to hospitals. These changes in comorbidities of hospitalized patients were confirmed by the literature and changes involved opioid overuse among adults (Owen et al., 2014), increases in preexisting chronic non-cancer pain diagnoses (Mosher et al., 2013), increases in overdoses from prescription opioids and sedatives or tranquilizers (Coben et al., 2010; White et al., 2011), and opioid tolerance increasing length of stay and higher readmissions (Gulur et al., 2014).

Given all the recent changes in hospitalized patients, the research team wanted to investigate how the knowledge of the nurses compared when asked questions pertaining to these changes. Of the total number of nurses from four hospital system sites (N=1,423), only 53% completed the online test most likely due to time constraints in completing 36 items in the initial test. When the research team adjusted the total number of items by removing the items because of low difficulty, the mean score on the test changed from 69.4% to 50.4%. It was apparent from the decrease in the mean correct test score that there is a general lack of understanding on managing pain in inpatients within these trending co-morbidities.

Validity and Reliability of the Test

This test, like knowledge tests found in academic settings or certification exams, had only one correct answer per item, producing a dichotomous data set (correct answer or incorrect answer). This posed challenges to determining reliability because the commonly used Cronbach's alpha was not appropriate. Further challenging the reliability statistics was the brevity of a test measuring knowledge in complex pain management. The initial 36-item test was designed to cover the four core competencies with only 5-11 test items in each domain. Moreover, dozens of items could have been placed in each category to cover essential knowledge (such as is found on a certification test), but the researchers/pain experts knew that in practical use, the test needed to be short.

Face and content validity were determined by the expert panel to be high in importance and content relevance for all the initial 36 items. Although challenging for a short test on an extremely large and complex topic; the difficulty index, discriminating index, construct validity, reliability measures, and decision consistency reliability showed this test to have moderate yet acceptable properties. And when test questions were matched to domains, they were effective in evaluating the clinical knowledge of pain in these domains as well as in the total test.

Revisions and Final Test

Revisions and deletions of test items were made to the test based on the aforementioned analysis resulting in a final Clinical Pain Knowledge Test with 23 items (see Appendix). Eight test items were removed from the original test due to low difficulty, and five more test items were removed due to a discrimination index score <0.20. Two test items with low

discriminating index scores were retained by the research team because during the content validity, expert panel had previously deemed knowledge of opioid dosing had high clinical relevance to pain management.

Limitations

Limitations to this study included the lack of ability to conduct test-retest reliability analysis due to the nature of sending and receiving anonymous test responses via email. Additionally, recruiting experts and novices a priori for known-groups technique would have helped with construct validity. These limitations were inherent in the design that looked to include a large and diverse population of practicing nurses across the Midwestern portion of the United States using email. In future studies, these limitations should be addressed.

This knowledge test was not designed to measure attitudes and although some may consider that a limitation, the authors felt that measurement of attitudes was futile if basic pain management knowledge was not present. Without proper education and tools to measure nurses' knowledge of patients with acute and chronic pain, opioid tolerance and substance use disorder; adequate pain management cannot be delivered (Morgan, 2014; St. Marie, 2014; Merrill, Rhodes, Deyo, Marlatt, & Bradley, 2002; Upsher, Luckmann, & Savageau, 2006; Vallerand & Nowak, 2009; Morgan, 2006). Although negative attitudes of healthcare providers towards patients with substance use disorder, chronic pain or both are common and contribute to less than optimal care (VanBoekel, Brouwers, van Weeghel, & Garretsen, 2013), measuring attitudes of clinicians was intentionally left to be designed and measured in a different project.

Implications for Practice

Understanding the knowledge of nurses in pain management within the changing co-morbidities of hospitalized patients is important to nursing practice and science. This new instrument for assessing the pain management knowledge of post-licensure nurses in the clinical setting aligns with core competencies, can be used to determine gaps in education, to evaluate knowledge after pain management education measures are instituted, and can be used for research outcomes.

Conclusion

This rigorous psychometric study of a new Clinical Pain Knowledge Test (CPKT) resulted in the development of a valid and reliable measure of pain management knowledge. The final 23-item CPKT measures knowledge in the four domains of the core competencies of pain management with satisfactory validity and reliability measures. Continually revising and assessing the validity and reliability of this knowledge test will be necessary due to the evolving nature of the essential knowledge required of nurses regarding the ever-changing science of optimal pain care, especially in the era of scrutiny for opioid use for pain, and national and federal guidelines (Dowell et al., 2016; American Nurses Association and American Society for Pain Management Nursing, 2016). Further studies are needed to validate this test in interdisciplinary populations such as physicians, physical therapists and

pharmacists working with patients in pain and are expected to have a level of knowledge of pain management that will provide the most optimum care for patients.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.
Steps in the development of the Clinical Pain Knowledge Test.
CVI = content validity index.

Table 1.

Sample characteristics (N = 747)

	M; range (SD)
Age (in years)	43.25; 21-74 (12.65)
Years as registered nurse	16.13; 1-48 (12.91)
	n (%)
Highest Nursing Education Level	
Diploma	45 (6.0)
ADN	187 (25.0)
BSN	466 (62.4)
MSN	47 (6.3)
Doctorate	2 (0.3)
Primary work area	
Medical/Surgical	193 (25.7)
Intensive Care Units	94 (12.5)
Cardiac	56 (7.5)
Hematology/Oncology	54 (7.2)
Operating/Post-Anesthesia	46 (6.1)
Orthopedics	44 (5.9)
Emergency Department	35 (4.7)
Other	225 (30.4)

Table 2.

Item Difficulty and Discrimination Results from the two-parameter Rasch model of the final 23-item Clinical Pain Knowledge test ordered by discrimination.

Item	Difficulty	Discrimination	Correct Estimate (percent of test-takers that got item correct) %
q3_true_about_opioids	1.489	1.039	17.6
q7_safe_opioid_relapse_risk	-0.942	1.025	72.4
q16_cultural_considerations	-1.653	0.967	83.2
q32_postop_take_home_opioids	-0.469	0.884	60.2
q21_assessment_components	-2.886	0.808	91.1 *
q27_opioids_physical_dependence	-3.009	0.723	89.8
q29_assess_patient_acute_joking	-1.653	0.705	76.2
q18_develop_opioid_tolerance	-3.233	0.694	90.4 *
q5_provide_analg_based_on	-0.800	0.664	63.0
q2_multimodal_example	-0.405	0.614	56.2
q28_breakthru_non_cancer_pain	-1.571	0.610	72.3
q1_reliable_pain_indicator	-0.015	0.604	50.2
q20_crps_example_type_pain	2.283	0.580	21.0
q9_optimal_route_cancer	0.154	0.578	47.8
q30_nonpharm_nonverbal_older_adult	-1.683	0.550	71.6
q24_nurse_actions_unrelieved_acute_pain	-2.162	0.535	76.1
q17_stress_unrelieved_pain	-4.153	0.450	86.6
q6_pain_assess_sleeping	0.526	0.444	44.2
q23_patient_unrelieved_high_doses	1.974	0.431	29.9
q25_non_pharm_calm_therapy_acute_pain	1.322	0.373	37.9
q26_opioids_constipation	-1.877	0.284	63.0
q11_morphine_equiv_oxycodone	-27.354	0.048 *	78.9
q13_safety_high_dose_morphine	-8.272	-0.042 *	41.4

* indicates items retained on final test by decision of research team due to expert-determined importance of content, despite low discrimination scores and high correct scores on model

Table 3.

Association between total score and domain scores on the final 23-item Clinical Pain Knowledge Test with categories of total pain course hours a nurse reported taking (n = 715 ^{*})

	rho (95% CI)	0 hours (n [*]=326)	1-19 Hours (n [*]=344)	20+ hours (n [*]=45)	p-value
Total Score	0.18 (0.11, 0.25)	11[10,13] ²³	12[10,14] ¹³	14[11,15] ¹²	<0.001 ^b
Multidimensional Aspect	0.08 (0.01, 0.16)	2[2,3] ³	2[2,3]	3[2,3] ¹	0.013 ^b
Pain Assessment/Measurement	0.07 (-0.00, 0.15)	4[3,5]	4[3,5]	4[3,5]	0.055 ^b
Management of Pain	0.19 (0.12, 0.26)	5[4,6] ²³	5[4,7] ¹³	6[5,8] ¹²	<0.001 ^b
Knowledge Application	0.13 (0.06, 0.20)	2[2,3] ²³	3[2,3] ¹	3[2,4] ¹	<0.000 ^b

Statistics presented as Median [P25, P75].

p-values:

^b=Kruskal-Wallis test.

rho: Spearman's correlation; CI: confidence interval

¹: Significantly different from 0 hours

²: Significantly different from 1-19 Hours

³: Significantly different from 20+ hours

^{*} n total of 715 includes only responders who indicated the number of pain course hours they had taken

Table 4.

Association between total score and domain scores on the final 23-item Clinical Pain Knowledge Test with level of nursing education

	Diploma (n=45)	ADN (n=186)	BSN (n=466)	MSN or Doctorate (n=49)	p-value
Total Score	11[10,13]	12[10,13] ⁴	12[10,13]	13[11,14] ²	0.020 ^b
Multidimensional Aspect	3[2,3]	2[2,3]	2[2,3]	3[2,3]	0.12 ^b
Pain Assessment/Measurement	4[3,4] ⁴	4[3,5] ⁴	4[3,5]	4[4,5] ¹²	0.005 ^b
Management of Pain	5[4,6]	5[4,6]	5[4,6]	6[5,7]	0.11 ^b
Knowledge Application	3[2,3]	2[2,3] ⁴	3[2,3]	3[2,3] ²	0.006 ^b

Statistics presented as Mean ± SD, Median [P25, P75], Median (min, max) or N (column %).

p-values:

^b =Kruskal-Wallis test.

¹: Significantly different from Diploma

²: Significantly different from ADN

³: Significantly different from BSN

⁴: Significantly different from MSN/Doctorate

A significance level of 0.008 was used for pairwise ad-hoc comparisons.