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Effects of implementation leadership of head nurses on nurses' evidence-based pain management practices behavior

Lingyu Li[1†], Quanru Wang[1†], Ying Cao[1], Ling Liao[1], Binjie Yang[1] and Min Tan[1*]

Abstract

Background Nurses' evidence-based practice competencies were positively correlated with the implementation leadership (IL) of head nurses. However, there was no study to analyze the effect of IL on nurses' evidence-based pain management practices (EBPMP) behavior from the hierarchical linear model (HLM) perspective. The objective of this study was to investigate the current status of head nurses' IL and nurses' EBPMP behavior, and to analyze the effects of head nurses' IL on nurses' EBPMP behavior.

Methods In September 16, 2024 to September 30, 2024, nurses from 17 secondary and tertiary hospitals in Sichuan Province were selected by convenience sampling and investigated with the demographic characteristics, implementation leadership scale (ILS), and nurses' evidence-based practice behavior questionnaire for pain management. The influence of the head nurses' IL on nurses' EBPMP behavior was analyzed using the HLM.

Results A total of 2124 nurses were included in the analysis. The scores for head nurses' IL were (M = 2.88, SD = 0.74) and nurses' EBPMP behavior was (M = 3.98, SD = 0.76). The results of the HLM analysis showed that IL of head nurses had a positive predictive effect on nurses' EBPMP behavior ($p < 0.001$); Nurses' attitudes towards pain management and participation in pain education and training had a positive predictive effect on nurses' EBPMP behavior ($p < 0.001$).

Conclusions The EBPMP behavior of nurses and the IL of head nurses are at medium-high levels and still need further improvement. The IL of head nurses positively affected the nurses' EBPMP behavior. Hospital managers can construct programs to improve the level of head nurses' IL to facilitate the implementation of EBPMP and the implementation of more clinical evidence-based practices behavior.

Clinical trial number Not applicable.

Keywords Head nurse, Implementation leadership, Pain management, Evidence-based practice, Evidence-based pain management practices, Hierarchical linear model, A multicenter cross-sectional study

†Lingyu Li and Quanru Wang are co-first authors.

*Correspondence:
Min Tan
mintan81@163.com
[1]Affiliated Hospital of North Sichuan Medical College, Nanchong, Sichuan, China

Introduction

Pain was officially listed as the fifth vital sign by the World Health Organization in 2001, following respiration, pulse, temperature, and blood pressure. According to the 'China Pain Medicine Development Report (2020)', pain in hospitalized patients in China is as high as 63.08% [1]. Nurses play a crucial role in pain management as the assessors of pain conditions, implementors of analgesic measures, collaborators of other professionals, and educators and mentors of pain patients and their families [2]. Evidence-based Pain Management Practices (EBPMP) are comprehensive behavior that based on the best are based on the best research evidence, combined with clinical experience, to assess the pain experience and provide interventions [3], based on the effectiveness of EBPMP in improving patients' painful outcomes and their satisfaction with pain management [4, 5]. The majority of studies on pain management behavior among nurses, both domestically and internationally, focus on assessing the current status of their pain assessment behavior, knowledge, and attitudes [6–10]. Studies focusing on nurses' EBPMP have mostly used the Chinese version of Carlson's EBPMP Prior Conditions Instrument, which, although it contains the dimensions of pain assessment, pain control, pain intervention, as well as feedback and communication, does not involve the contents of non-pharmacological interventions, pain education, and other content. There is a gap with the constantly updated pain management guidelines, and the study population is limited to a certain specialist group of nurses [11, 12]. Therefore, it is necessary to understand the current situation of nurses' EBPMP behavior more systematically and comprehensively, to improve the quality of patients' pain management.

Implementation Leadership (IL) is the process by which nursing managers directly or indirectly influence individuals, environments, and organizations through their behavior to motivate nurses to apply research evidence in clinical practice [13]. As the direct manager of clinical nurses, the nurse manager's support, encouragement, and empowerment of clinical nurses are key factors in ensuring the successful implementation of evidence-based nursing practice [14]. The study has shown that the IL of head nurses is positively correlated with nurses' evidence-based practice competence [15], which is one of the key factors influencing the successful implementation and maintenance of evidence-based practice in healthcare [16]. However, the current domestic and international studies on the impact of the head nurses' IL on evidence-based practice are all based on traditional linear regression, which cannot effectively distinguish the relationship between individual effects and cluster effects [17], and no study has yet explored the impact of IL on nurses' EBPMP behavior. Therefore, this study took nurses from 17 secondary and tertiary hospitals in Sichuan Province as the research object to investigate the level of head nurses' IL and nurses' EBPMP behavior. Based on the hierarchical linear model (HLM) to explore the impact of head nurses' IL (cluster effects) on nurses' EBPMP behavior, to provide a scientific reference to improve the level of nurses' EBPMP behavior.

Methods

Study design and participants

In this study, convenience sampling was used to select clinical nurses from 17 secondary and tertiary hospitals in Sichuan Province of China as the research objects in September 16, 2024 to September 30, 2024 for a multicenter cross-sectional survey. Since nurses who have worked in this unit for six months or more are more familiar with the leadership style of the unit managers and the work procedures related to pain management and can make more accurate evaluations, the inclusion criteria for this study were: (1) registered nurses; (2) working in the department for more than half a year; (3) informed consent and voluntary participation in this study. Exclusion criteria: (1) probationer nurse, standardized training for nurses, or further training; (2) nurses who were not on duty during the survey period; (3) Nursing manager. The sample size of the cross-sectional study was calculated by the formula $n=(\mu_{1-\alpha/2}\ \sigma/\delta)^2$. According to the pre-experimental results of the reliability and validity test of the questionnaire, the standard deviation of the dimension with the largest difference in the score of nurses' evidence-based pain management practices behavior was 0.57, and the permissible error $\delta=0.03$, $a=0.05$, $\mu_{1-a/2}=1.96$. The sample size of this study was obtained to be 1387, and considering 10 to 20% of invalid questionnaires, the sample size was determined to be at least 1734. To ensure adequate sample size for this study, 2541 nurses were surveyed, of which 2124 nurses effectively completed and returned the questionnaire, which was in line with the expected sample size.

Questionnaire

Demographic characteristics

Demographic data included sex, age, department, working years, education level, professional titles, grade A tertiary hospital, pain pilot hospital, attitudes towards pain management, attended pain education and training, and attitudes towards participation in pain management training.

Implementation leadership scale

Implementation Leadership Scale (ILS) was developed by Aarons et al. in 2014 [18], and in 2019, Hu et al. [19] translated it into a scale suitable for Chinese culture and situations for assessing managers' IL. ILS was divided

into the supervisor version and staff version, and this study used the staff version for the investigation, which had 4 dimensions, namely proactive leadership, knowledgeable leadership, supportive leadership, and perseverant leadership, with a total of 12 items. The scale score ranges from 0 to 4, from 'not at all' to 'a very great extent'. The total scale score is the average of all the scores of the items, and the dimension score is the average of all the scores of the items in the dimension; the higher the score, the stronger the IL. The Cronbach's α coefficient of the original scale was 0.95, and the Cronbach's α coefficient of each dimension was 0.90–0.95. Meanwhile, the Chinese version of the ILS showed good reliability (α = 0.86–0.95). In this study, Cronbach's α coefficient for this scale was 0.96.

Nurses' evidence-based pain management practices behavior questionnaire

The questionnaire was designed by the research group. Firstly, we systematically and comprehensively searched the relevant literature on pain management for nurses at home and abroad, and then formed the best evidence summary of nurses' EBPMP after the process of literature screening, evaluation, evidence extraction, evidence integration and grading, based on the evidence summary, combined with group discussion and brainstorming, the questionnaire item pool was constructed. A total of 15 experts were invited to participate in the questionnaire consultation, and the experts were from Sichuan, Jiangsu, Guangdong and Chongqing. The questionnaire was adjusted and revised through two rounds of Delphi expert consultation. The positive coefficients of the two rounds of expert consultation were 78.7% and 100%, the expert authority coefficients were 0.854 and 0.910, and the Kendall coordination coefficients were 0.237 and 0.252, respectively ($p < 0.001$). Then the reliability and validity of the questionnaire were tested. The results showed that three common factors were extracted by exploratory factor analysis, and the cumulative variance contribution rate was 75.773%. The results of confirmatory factor analysis showed that $\chi^2/df = 2.952$, RMSEA = 0.07, IFI = 0.917, TFI = 0.905, CFI = 0.916, and the 3-factor model had a good overall fit. The item-level content validity of the questionnaire was between 0.833 and 1.000, and the average scale-level content validity index was 0.976. The Cronbach's α coefficient of the total questionnaire was 0.966, the Cronbach's α coefficient of each dimension was 0.938–0.965, the split-half reliability was 0.843, and the test-retest reliability was 0.860. Finalize the nurses' EBPMP behavior questionnaire. The questionnaire included 3 dimensions of pain screening and comprehensive assessment, pain intervention and education, and pain nursing record, with a total of 21 items (See Appendix). A 5-point Likert scale from 'never' to 'always' was used, with scores ranging from 1 to 5, the total score ranged from 21 to 105, the higher the score, the stronger the nurses' EBPMP behavior.

Data collection

This study adopts the questionnaire survey method, using the "Wenjuan Xing" platform to distribute the questionnaire. Before the survey, the person in charge of the group contacted the director of the nursing department of each hospital and the managers of relevant departments, and explained the purpose, significance, methods of this study and the protection measures for the rights and interests of the participants in detail. After obtaining the consent of the relevant managers, the research group explained the purpose, significance, requirements for filling out the questionnaire, voluntary nature of filling out the questionnaire, confidentiality of information, and the possible risks and benefits of participating in the research to the nurses of each department through the WeChat platform. After the clear informed consent of the respondents was obtained, the two-dimensional code or link of the questionnaire was distributed by the WeChat platform to ask the relevant nurses to voluntarily fill in the questionnaire. The research subjects filled in the questionnaire anonymously and submitted it, and the same WeChat account settings are only allowed to fill in 1 time; to ensure the completeness of the questionnaire, all items were set as mandatory, and the questionnaire could not be submitted until all the questions were filled in. After submission, the person who fills in the form can get 1 to 3 RMB as compensation. After the questionnaire collection was completed, Excel data were exported and sorted out by two researchers in the research group, and the quality of the questionnaires was checked one by one, invalid questionnaires with a response time of less than 2 min, obvious regularity of responses, or obvious logical errors were excluded.

Data analysis

The data were first statistically analyzed using IBM SPSS Statistics 27, with the mean and standard deviation describing the measurement data that conformed to normal distribution, the median and interquartile range describing the measurement data that did not conform to a normal distribution, and the frequency and percentage describing the categorical data. Between-group differences in nurses' EBPMP behavior scores were compared using t-tests and one-way analysis of variance (ANOVA). Then Mplus Editor 8.3 software was used for HLM analysis. A null model without any explaining variables was first constructed to assess whether there were significant interstratified differences in nurses' EBPMP behavior scores, and the intraclass correlation coefficients (ICC) were calculated, which represent the proportion of total

variance explained within a region. ICC > 0.059 means that the between-group effect cannot be ignored, and HLM is required for data analysis [20]. Meanwhile, the mean value of the within-group variance index $r_{wg(j)}$ for IL of head nurses (staff version) has been calculated to be 0.952, which is greater than 0.70, indicating that this variable can be elevated from the individual level to the group level [21]. Then, control variables (statistically significant items) and explanatory variables (IL) were introduced on the null model, and the randomized ANCOVA model, the intercept model, and the full model were constructed respectively for the HLM analysis.

Ethical approval

This study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Medical Ethics Committee of the Affiliated Hospital of North Sichuan Medical College (Ethical Approval Number: 2024ER475-1). All respondents gave informed consent and volunteered to participate in this study.

Results

Demographic characteristics

In this study, a total of 2,541 questionnaires was distributed, and 2,124 valid questionnaires were recovered, with a valid questionnaire recovery rate of 83.59%. Then all the departments included were divided and collated based on the first-level diagnostic and treatment subjects, which were finally grouped into 8 departmental categories: internal medicine, surgery, ophthalmology and otorhinolaryngology, pediatrics, emergency department, psychiatry, obstetrics and gynecology, and intensive care unit. Details of the general information are shown in Table 1.

The current state of nurses' EBPMP behavior

The total score of nurses' EBPMP behavior was (M = 83.56, SD = 15.86), and the average score of items was (M = 3.98, SD = 0.76), which was moderately high, and the three dimension scores in descending order were: pain nursing record (M = 4.11, SD = 0.88), pain screening and comprehensive assessment (M = 4.05, SD = 0.72), and pain intervention and education (M = 3.86, SD = 0.88), as shown in Table 2.

The current status of head nurses' IL

The total score of head nurses' IL (staff version) was (M = 34.53, SD = 8.89), and the average score of items was (M = 2.88, SD = 0.74), which was at a medium to high level, and the scores of the four dimensions from the highest to the lowest were: supportive leadership (M = 3.13, SD = 0.76), Perseverant leadership (M = 3.00, SD = 0.78), Knowledgeable leadership (M = 2.84, SD = 0.82), and proactive leadership (M = 2.54, SD = 0.98), as detailed in Table 3.

A univariate analysis of the current state of nurses' EBPMP behavior

The results showed that the in nurses' EBPMP behavior was statistically significant depending on the department, attitude towards pain management, participation in pain education and training, and attitude towards pain management training ($p < 0.05$), as shown in Table 1.

Effects of head nurses' implementation leadership on nurses' EBPMP behavior

Null model

An HLM was used to analyze the impact of head nurses' IL on nurses' EBPMP behavior. First, a null model is constructed, i.e., Model 1. The results yielded a within-group variance of 0.541 and a between-group variance of 0.051, so the Intraclass Correlation Coefficient (ICC) in this study was 0.086, indicating that there was an influence of unit-level factors on the nurses' EBPMP behavior, and based on Cohen's criterion for judgment [20], when the ICC is > 0.059, the study needs to construct a HLM for the analysis. The values assigned to each variable are shown in Table 4.

Randomized ANCOVA model

Based on Model 1, individual-level variables were introduced to construct a randomized ANCOVA model, i.e., Model 2. It was found in the results that nurses' attitudes towards pain management had a positive impact on their EBPMP behavior ($p < 0.001$), and nurses who believed that pain management was important had a higher level of EBPMP behavior; and nurses who had participated in pain education and training had a positive effect on their EBPMP behavior ($p < 0.001$), and nurses who had participated in pain education and training had higher levels of EBPMP. The effect of pain management training attitudes on nurses' EBPMP behavior was not significant in model 2, as shown in Table 5.

Intercept model

An intercept model, i.e. Model 3 was constructed by introducing department-level variables based on Model 1. The results showed that the IL of head nurses had a positive effect on nurses' EBPMP behavior ($p < 0.01$), and the higher the level of head nurses' IL, the higher the level of nurses' EBPMP behavior; there were no significant differences among the departments, as shown in Table 5.

Full model

Finally, the full model, model 4 was established, and individual-level variables and department-level variables were included in the model to observe the comprehensive influence of variables, as well as analyze the moderating effect of the department-level variables on the relationship between the individual-level variables and

Table 1 Demographic characteristics and comparison of nurses' EBPMP behavior scores with different characteristics ($n = 2124$)

	Nurses [*n* (%)]	Behavioral status score		*t/F-value*	*p-value*
		Mean	SD		
Sex				-1.415	0.157
Male	60(2.82)	80.70	17.43		
Female	2064(97.18)	83.64	15.81		
Age				1.819	0.162
20–29	844(39.74)	83.57	15.77		
30–39	1009(47.50)	83.11	16.05		
≥ 40	271(12.76)	85.18	15.38		
Hospital department				2.732	**0.010**
Emergency department	80(3.77)	80.94	15.70		
Intensive care unit	92(4.33)	84.51	14.31		
Internal medicine	885(41.67)	84.34	16.07		
Obstetrics and gynecology	105(4.94)	83.50	17.47		
Ophthalmology and otorhinolaryngology	92(4.33)	84.59	15.68		
Pediatrics	144(6.78)	77.98	19.76		
Psychiatry	14(0.66)	89.79	13.10		
Surgery	712(33.52)	83.64	14.49		
Working years				2	0.076
≤ 2	327(15.40)	81.65	16.28		
3–5	343(16.15)	84.97	15.47		
6–10	548(25.80)	83.38	15.70		
11–15	547(25.75)	83.25	16.26		
16–20	167(7.86)	84.08	16.51		
>20	192(9.04)	85.20	14.29		
Education level				0.99	0.372
Below the undergraduate	505(23.78)	83.54	15.96		
Undergraduate	1602(75.42)	83.62	15.82		
Master and above	17(0.80)	78.18	16.87		
Professional titles				1.496	0.224
Primary title	1368(64.41)	83.51	15.80		
Intermediate title	668(31.45)	83.28	16.16		
Senior title	88(4.14)	86.38	14.31		
Grade-A tertiary hospital				-0.122	0.903
Yes	1947(91.67)	83.54	15.83		
No	177(8.33)	83.69	16.30		
Pain pilot hospital				0.113	0.910
Yes	1224(57.63)	83.59	15.98		
No	900(42.37)	83.51	15.70		
Attitudes towards pain management				5.662	**<0.001**
Perceived pain management as important	2100(98.87)	83.76	15.71		
Perceived pain management as unimportant	24(1.13)	65.46	18.82		
Attended pain management education and training				14.751	**<0.001**
Yes	1194(56.21)	87.92	13.63		
No	930(43.79)	77.95	16.75		
Attitudes towards pain management training				4.979	**<0.001**
Desire for more pain management training	1919(90.35)	84.11	15.68		
No desire for more pain management training	205(9.65)	78.34	16.64		

Bold values represent statistical results that are significant and statistically significant

nurses' EBPMP behavior. For the simplicity of the model, only significant interaction variables were retained. The results showed that attitude towards pain management, having attended pain education and training, and IL of head nurses remained a significant positive influence on nurses' EBPMP behavior ($p < 0.001$), but none of the interaction effects between variables were statistically significant. See Table 5 for details.

Table 2 Nurses' EBPMP behavior total score and dimension score ($n = 2124$)

Dimensions	Range	Total average score		Item average score	
		Mean	SD	Mean	SD
Pain screening and comprehensive assessment	9–45	36.48	6.47	4.05	0.72
Pain intervention and education	9–45	34.74	7.96	3.86	0.88
pain nursing record	3–15	12.33	2.64	4.11	0.88
Total	21–105	83.56	15.86	3.98	0.76

Table 3 IL of head nurses total score and dimension score ($n = 2124$)

Dimensions	Range	Total average score		Item average score	
		Mean	SD	Mean	SD
Proactive leadership	0–12	7.61	2.95	2.54	0.98
Knowledgeable leadership	0–12	8.51	2.45	2.84	0.82
Supportive leadership	0–12	9.40	2.29	3.13	0.76
Perseverant leadership	0–12	9.00	2.34	3.00	0.78
Total	0–48	34.53	8.89	2.88	0.74

Discussion

The results in Table 2 show that nurses' EBPMP behavior total score (M = 83.56, SD = 15.86), and the overall item mean score (M = 3.98, SD = 0.76), were at a medium to high level, and nurses' EBPMP behavior needs to be further strengthened. The dimensions of pain screening and comprehensive assessment, and pain nursing record were given relatively high scores, while the dimensions of pain intervention and education were given the lowest scores. On the one hand, the reason may be that nurses have a heavy workload and lack enough time to implement pain intervention and education for patients [22]. Some studies have pointed out that when nurses have a large workload, they usually give priority to completing treatment and nursing care while neglecting the work of health education and guidance and other related 'soft indicators' [23]. On the other hand, the pain management education and training received by the nursing staff was insufficient; only 56.21% of the nurses in this study had received training related to pain management education, which was much higher than the findings of Alemu et al. (16.9%) [24] and Mekonen et al. (32%) [25], but still, almost half of the nurses had not received pain management education and training. A meta-analysis reported that clinical nurses who had received pain management education had significantly higher clinical practice competence in analgesic drug use and non-pharmacological pain management compared with those who had not received pain management education [26]. Therefore, nursing managers need to pay attention to the pain management

Table 4 Variable assignment

Variables	Assignment
Attitudes towards pain management	1 = Perceived pain management as important; 0 = Perceived pain management as unimportant
Attended pain management education and training	1 = Yes; 0 = No
Attitudes towards pain management training	1 = Desire for more pain management training; 0 = No desire for more pain management training
Department	1 = Surgery; 2 = Ophthalmology and otorhinolaryngology; 3 = Intensive care unit; 4 = Internal medicine; 5 = Pediatrics; 6 = Obstetrics and gynecology; 7 = Emergency department; 8 = Psychiatry
Implementation leadership	Measured value

Table 5 Results of hierarchical linear model analyses

		Model 1	Model 2	Model 3	Model 4
Individual level variables	Attitudes towards pain management		**0.752**** (0.169)		**0.756**** (0.168)
	Attended pain management education and training		**0.466**** (0.037)		**0.468**** (0.037)
	Attitudes towards pain management training		0.079 (0.063)		0.078 (0.064)
Department level variables	Department			0.004 (0.019)	0.011 (0.016)
	Implementation leadership			**0.356*** (0.115)	**0.370**** (0.101)
Random effect	Between-group variance	0.051	0.041	0.035	0.024
	Within-group variance	0.541	0.482	0.542	0.483
	ICC	0.086	0.078	0.061	0.047

Note: Figures in parentheses are standard errors of estimates

$^{*}p < 0.01$; $^{**}p < 0.001$

Bold values represent statistical results that are significant and statistically significant

education and training of nurses. At the same time, it is suggested that nursing majors in colleges and universities can set up pain management courses in the future, to systematically promote nurses' EBPMP behavior. In addition, it was found in the results that there was no difference in nurses' EBPMP behavior scores between the pain pilot hospitals and the non-pain pilot hospitals; the reasons for this may lie in the fact that (1) In January 2023, National Health Commission of the People's Republic of China issued the "Notice on Issuing the Pilot Program for Comprehensive Management of Pain" [27], and the establishment of integrated pain management programs in pain pilot hospitals is currently in the initial stages of implementation; (2) The sample size included was small and could be further validated by a larger sample size study at a later stage.

The IL of head nurses in this study had a total score of (M = 34.53, SD = 8.89) and a mean score of (M = 2.88, SD = 0.74) for all items, which was similar to the findings of Shuman et al. [28] and Guo et al. [29], suggesting that although the IL of head nurses in China is at an intermediate-to-high level at present, it still needs to be further improved in the future. Among all the dimensions, the supportive leadership dimension and perseverant leadership dimension scored high, while the knowledgeable leadership dimension and proactive leadership dimension scored relatively low, this result was consistent with the findings of Li et al. [30], Hu et al. [16], and Guo et al. [29]. The unsatisfactory score for the knowledgeable leadership dimension may be attributed to head nurses' insufficient understanding of the specific content and methods of evidence-based practice, which hampers their ability to provide timely and valuable guidance to nurses [30]. This indicates a need for head nurses to stay current with disciplinary trends and enhance their own knowledge of evidence-based practices to improve the scientific rigor and effectiveness of their guidance. There are two primary reasons for the low score in the proactive leadership dimension. First, the lack of evidence-based knowledge among head nurses hinders their ability to formulate targeted evidence transformation plans. Second, the entrenched executive mindset of department managers limits the development of innovative thinking necessary for effective evidence-based implementation management [31]. It suggests that evidence-based ability special training and proactive leadership behavior training can be provided for head nurses, and the obstacles in the implementation process of evidence-based practice can be systematically identified to make targeted decision-making. Top hospital managers can effectively promote head nurses to implement evidence-based practice by organizing evidence-based practice projects, creating an evidence-based knowledge learning atmosphere and providing resource support.

The results of the HLM analysis indicated that the IL of head nurses is a positive predictor of nurses' EBPMP behavior. Specifically, as the level of head nurses' IL increases, so does the level of nurses' EBPMP behavior. Leadership is a crucial factor influencing the adoption of evidence-based practice [19]. As the direct supervisors of clinical nurses, head nurses' support, encouragement, and empowerment are essential for ensuring the successful implementation of evidence-based nursing practice [14]. Head nurses who have relevant knowledge of evidence-based practice can support nurses in implementing evidence-based practice, create a positive atmosphere for evidence-based practice, and solve problems when nurses encounter them, effectively promoting the implementation of evidence-based practice for nurses. At the same time Leadership helps to create positive employee attitudes [32], such as learning and practice, and this positive attitude helps to improve the enthusiasm for learning, to further improve the motivation and initiative to implement the evidence-based practice. The results of this study confirmed that the IL of head nurses has a positive impact on nurses' EBPMP behavior, suggesting that hospital managers should pay attention to the cultivation of the head nurses' IL, improve the level of the IL of nursing managers, create a good environment for evidence-based practice, and then improve the learning enthusiasm of the staff, which can prompt the nursing staff to translate the high-quality evidence related to pain management into the clinical practice, and improve the level of the EBPMP behavior in the clinic, optimize the quality of pain management, and improve patient satisfaction.

The results showed that 98.87% of the nurses thought pain management was important and 56.21% of the nurses had participated in pain education training. The results of the HLM analysis showed that nurses' participation in pain education and training and positive attitudes toward pain management were positively predictive of nurses' EBPMP behavior. Nurses' attitudes toward pain management directly influence their willingness to engage in pain management clinical practice [33], and pain management education and training can effectively improve nurses' pain management knowledge and confidence level, thus promoting their pain management clinical practice [26, 34, 35] and improving patients' prognosis, consistent with the findings of Alemu et al. [24] and Fekede et al. [36]. Therefore, it is recommended that nursing administrators provide resources for nurses' pain management education and training, and conduct regular pain management education and training in the department; systematic learning of general knowledge of pain, pain pathophysiology, and pharmacological analgesic and non-pharmacological analgesic interventions can be carried out, and at the same time, interactive

learner-centered education methods such as scenario simulation, role-playing, audio-visual demonstration can be used to learn in conjunction with actual clinical cases [37, 38], to promote the improvement of training effect. In the future, we can adopt the organizational format of Interprofessional Education (IPE) to enhance systematic collaboration in pain management among healthcare professionals from various disciplines. High-Fidelity Simulation (HFS) technology, online platforms, and Standardized Patients (SP) can be utilized to provide ongoing education in pain management for practicing nurses. This approach aims to reduce communication barriers and improve the efficiency of pain management [39]. For example, hospital managers can create realistic clinical scenarios through a comprehensive training program utilizing high-fidelity simulation in pain management, combined with systematic training in pain management knowledge and skills. This initiative can significantly enhance nurses' understanding of pain management, their attitudes, critical thinking abilities, and skills in pain assessment and intervention. Ultimately, it should help bridge the gap between nurses' attitudes and practices in pain management, thereby improving the quality of pain care [40].

In a one-way analysis of variance, the differences in nurses' EBPMP behavior among different departments were statistically significant ($p < 0.05$). However, when included in the HLM analysis, the results were not statistically significant. This suggests that the department itself does not significantly influence the level of nurses' EBPMP behavior, which aligns with the findings of Fekede et al. [36]. Due to variations in rules and regulations among different departments, there may be varying degrees of differences in clinical practice processes, which warrant further investigation in the future. At the same time, the one-way analysis of variance indicated that nurses' attitudes toward pain management training would affect their EBPMP behavior. However, this relationship was not statistically significant after inclusion in the HLM analysis. Although most nurses express a desire for more pain management training, the implementation of such training is often inadequate due to a combination of factors, including lack of leadership support, insufficient unit resources, and constraints of the working environment [40]. As a result, the impact of training attitudes on nurses' EBPMP behavior was not significantly reflected in the HLM analysis.

Finally, only 60 male nurses were included in this study, which is 2.82%, and the limited number of male subjects actually available may be a possible reason for this. Also, only 8.33% of nurses' workplaces were non-grade-a tertiary hospital, which may be related to the insufficient number of non-grade-a tertiary hospital included. Due to the relatively low proportion of male nurses and nurses from non-grade-a tertiary hospital. Therefore, the conclusion that sex and hospital level are not factors that influence the nurses' EBPMP behavior in this study may not be sufficient. Future studies should balance sex distribution and workplace hierarchy among research participants, to more accurately assess the effects of sex and hospital-level differences on measured variables.

Strengths and limitations

The strengths of this study are (1) the HLM used can better differentiate between individual effects and cluster effects [17], thus this study concluded that the IL of head nurses has a positive impact on nurses' EBPMP behavior, and the precision of its results is relatively higher. (2) Adopting a multi-center, large-sample survey with a wide coverage of departments, can better reflect the current status of nurses' EBPMP behavior comprehensively.

The limitations of this study include the following: (1) A cross-sectional survey was used, so it was not possible to determine a causal relationship between the IL of head nurses and nurses' EBPMP behavior; a relevant longitudinal study could be conducted in the future to further confirm this. (2) Sampling by convenience sampling method, the survey area is limited (only part of Sichuan province) and the sample lacks representativeness; in the future, the random sampling method can be considered to expand the range of sample sources and enhance the representativeness of the sample. (3) The questionnaire survey method was used, relying on the results of nurses' self-assessments, which may have a reporting bias.

Conclusions

This study found through a cross-sectional survey that the IL of head nurses and nurses' EBPMP behavior was overall at a medium to high level, which still needs to be further improved; IL of head nurses can promote nurses' EBPMP behavior. In the future, programs can be constructed to improve the level of head nurses' IL to promote EBPMP and more clinical evidence-based practice behaviors implementation. Given that the study employed a cross-sectional survey design, it is not possible to establish a causal relationship between the IL of head nurses and the nurses' EBPMP behavior. Future research could explore this area through longitudinal studies to gain a deeper understanding of the mechanisms by which head nurses' IL influences the nurses' EBPMP behavior. Field study methods could also be employed, utilizing on-site observations and multi-method data collection to reveal the dynamic relationship between the two factors. Additionally, exploring the mechanisms of mediating or moderating factors such as the work environment and team atmosphere can further elucidate their pathways of influence, thereby offering more targeted recommendations for clinical pain

management. It should also be noted that data collection in this study relied on self-assessments by nurses, which may be subject to reporting bias. Future studies could consider incorporating multiple data collection methods, such as observations and patient feedback, to validate the findings and obtain more comprehensive and objective data.

Abbreviations

IL	Implementation Leadership
ILS	Implementation Leadership Scale
EBPMP	Evidence-Based Pain Management Practices
HLM	Hierarchical Linear Model
ANOVA	Analysis of Variance
ICC	Intraclass Correlation Coefficient
IPE	Interprofessional Education
HFS	High-Fidelity Simulation
SP	Standard Patient

Supplementary Information

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Supplementary Material 1

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Author contributions
Lingyu Li, design the study, data analysis and manuscript writing and revision. Quanru Wang, questionnaire development, collection the data and data analysis. Ying Cao, questionnaire development, collection the data. Ling Liao, questionnaire development, collection the data. Binjie Yang, collection the data. Min Tan, design the study, review the manuscript and revision.

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Data availability
The relevant data in this study can be obtained from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Medical Ethics Committee of the Affiliated Hospital of North Sichuan Medical College. All respondents gave informed consent and volunteered to participate in this study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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