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Juan Lu, Xiaodong Han, Ying Liu, Yanhua Li & Xiaohong Liu

Knowledge, attitude, and practice regarding radiation dermatitis among radiotherapy patients across Shanxi: A cross-sectional study

Juan Lu[1†], Xiaodong Han[1†], Ying Liu[1], Yanhua Li[1*], Xiaohong Liu[1*]

[1]Gynecological Radiation Therapy Ward, Shanxi Province Cancer Hospital/Shanxi Hospital Affiliated to Cancer Hospital, Chinese Academy of Medical Sciences/Cancer Hospital Affiliated to Shanxi Medical University, ShanXi, 030000, China.

[†]These authors contributed equally to this work.

[*]Corresponding Author:

Xiaohong Liu

E-mail: 1413467561@qq.com

Tel: +86-13546729505

Yanhua Li

E-mail: 335298055@qq.com

Running title: KAP on radiation dermatitis in radiotherapy patients

Abstract

This cross-sectional study was conducted at Shanxi Province Cancer Hospital between July and August, 2025, using a self-administered questionnaire. A total of 523 valid questionnaires were analyzed (effective response rate: 87.17%) with a mean age of 59.39 ± 11.66 years. The knowledge, attitude, and practice scores were 11.64 ± 3.51 (possible range: 0-16), 29.77 ± 2.50 (possible range: 8-40), and 42.12 ± 4.82 (possible range: 10-50), respectively. Positive correlations were observed between knowledge and attitude (correlation coefficient $r = 0.204$, $P < 0.001$), knowledge and practice ($r = 0.144$, $P = 0.001$), and attitude and practice ($r = 0.294$, $P < 0.001$). The structural equation modeling (SEM) analysis of mediating effect showed that knowledge directly affected attitude (standardized path coefficient $\beta = 0.160$, $P < 0.001$) and practice ($\beta = 0.110$, $P = 0.038$), while attitude directly affected practice ($\beta = 0.670$, $P < 0.001$). Further, knowledge indirectly affected practice through attitude ($\beta = 0.110$, $P < 0.001$). Radiotherapy patients demonstrated a moderate level of knowledge, a generally neutral attitude, and relatively proactive practices concerning radiation dermatitis. The findings further indicate that attitude plays a mediating role in linking patient knowledge to self-care behaviors, suggesting that educational interventions targeting both knowledge improvement and attitude enhancement may help promote more effective skin care practices during radiotherapy.

Keywords: Radiation injuries; radiotherapy; radiation dermatitis; knowledge, Attitudes, Practice; cross-sectional study

Introduction

Radiation dermatitis (RD) is a prevalent adverse effect encountered by patients with cancer undergoing radiotherapy. It arises from the damage inflicted on basal epidermal cells and capillary microvasculature due to ionizing radiation, initiating a multifaceted inflammatory response [1]. Clinically, RD manifests a spectrum of symptoms, ranging from mild erythema and dry desquamation to severe complications such as moist desquamation, ulceration, and tissue necrosis [2]. Epidemiological investigations indicate that RD is highly prevalent among patients receiving radiotherapy, with reported incidence rates ranging from 74% to 100% worldwide [3]. In China, acute RD has likewise been reported at a high frequency among patients undergoing radiotherapy for breast, head and neck, and gynecological cancers [4, 5]. This considerable clinical burden not only markedly diminishes patient quality of life but may also precipitate treatment interruptions, potentially undermining the efficacy of cancer therapies [3].

Despite the significance of RD, there are currently no universally accepted guidelines for its prevention and management within the field of radiation oncology. Existing clinical approaches predominantly emphasize the maintenance of skin hydration, the minimization of exposure to irritants, and the application of topical corticosteroids when indicated [3]. Within the Chinese healthcare context, traditional herbal topical preparations are frequently employed as adjunctive treatments [6]. However, the efficacy of these

interventions is heavily contingent upon patients' understanding and adherence to appropriate self-care practices, which are essential for both the prevention and mitigation of RD severity. Evidence suggests that comprehensive patient education, coupled with early intervention, can significantly alleviate RD severity and enhance the patient experience during radiotherapy [3].

The Knowledge, Attitudes, and Practices (KAP) model is a structured survey framework extensively utilized in healthcare to evaluate individuals' understanding, perceptions, and behaviors concerning specific health issues [7, 8]. Grounded in established health behavior theory, the KAP model posits that knowledge influences attitudes, which subsequently govern behaviors and decision-making processes [9]. As a crucial instrument for assessing health literacy, the KAP framework provides actionable insights that inform the development of targeted educational interventions and evidence-based behavior modification strategies [7]. In oncology, KAP studies have proven particularly effective in identifying discrepancies between patients' theoretical knowledge and their actual behaviors regarding treatment adherence and side-effect management [10, 11]. However, there exists a notable paucity of research focusing on KAP in relation to radiation dermatitis, particularly within Chinese cancer patient populations, thereby limiting the formulation of culturally relevant educational interventions and comprehensive patient care protocols.

This study aimed to investigate radiation dermatitis–related knowledge, attitudes, and practices among patients receiving radiotherapy in the Chinese healthcare setting. Given the high clinical burden of RD and its potential impact on quality of life and treatment continuity, understanding patients' awareness, perceptions, and self-care behaviors is essential for optimizing supportive care. Using the KAP framework as a structured approach, we sought to identify modifiable gaps and barriers that could inform the design of targeted educational strategies and skin-care management protocols.

Methods

Study design and participants

This cross-sectional study was conducted at the Shanxi Province Cancer Hospital between July and August 2025, employing a self-administered questionnaire. Participants were selected based on specific inclusion criteria: 1) they had undergone radiotherapy at the Shanxi Provincial Cancer Hospital; and 2) they possessed the ability to read and complete electronic questionnaires independently. The exclusion criteria included: 1) the presence of severe mental disorders or cognitive impairments that would hinder independent completion of the questionnaire. Ethical approval was granted by the Shanxi Province Cancer Hospital (Approval No: KY2025097), and informed consent was obtained from all participants prior to the administration of the survey.

Procedures

This study employed a self-designed questionnaire informed by pertinent clinical guidelines and existing literatures [12-19]. The preliminary draft underwent expert review by two senior specialists to evaluate item relevance, clarity, and comprehensiveness. One expert was an Associate Chief Nurse and Head Nurse of the Gynecological Radiotherapy Unit with 21 years of clinical experience, and the other was an Associate Chief Physician from the Radiotherapy Department with 18 years of clinical experience. Based on their feedback, several items were revised to improve wording accuracy and content coverage, thereby ensuring adequate content validity of the questionnaire. A subsequent pilot study was conducted, in which 40 questionnaires were distributed; all were returned and deemed valid for analysis. Reliability testing demonstrated acceptable internal consistency, evidenced by a Cronbach's alpha of 0.8604 for the overall instrument. Construct validity was further examined using confirmatory factor analysis (CFA). Model fit indices indicated acceptable construct validity, with a root mean square error of approximation (RMSEA) of 0.076, Tucker–Lewis index (TLI) of 0.806, comparative fit index (CFI) of 0.832, and standardized root mean square residual (SRMR) of 0.095. Detailed CFA results are provided in the Supplementary Materials (**Supplementary Table 1** and **Supplementary Figure 1**). The final iteration of the questionnaire, administered in Chinese, comprised four sections totaling 54 items: 28 items concerning sociodemographic and clinical background, 8 items evaluating

knowledge, 8 items assessing attitudes, and 10 items measuring practices related to the prevention and management of radiation dermatitis.

Scoring procedures were delineated as follows. The knowledge dimension consisted of 8 items, with responses scored on a 3-point scale ranging from 1 (“Unclear”) to 3 (“Very familiar”), yielding a theoretical total score range of 8–24. The scoring scheme for the knowledge items was designed to reflect increasing levels of cognitive familiarity and information mastery. Specifically, assigning higher scores to “Very familiar” and intermediate scores to “Heard of” allowed differentiation between superficial awareness and more comprehensive understanding, while “Unclear” represented the absence of relevant knowledge. This ordinal weighting approach has been commonly adopted in KAP survey instruments to capture graded levels of knowledge without imposing excessive response burden on participants. This scoring strategy is consistent with commonly used KAP survey methodologies that apply ordinal knowledge scales and Likert-based attitude and practice measures to assess progressive levels of awareness, perception, and behavioral engagement in health-related research[20]. The attitude dimension included 8 items and the practice dimension included 10 items, both assessed using a 5-point Likert scale ranging from 1 (“Strongly disagree”) to 5 (“Strongly agree”). For the attitude domain, items 1–4, 6, and 8–10 were scored directly, while items 5 and 7 were reverse-scored. Total score ranges were 8–40 for attitude

and 10–50 for practice. To facilitate interpretation, categorical cutoffs were established for each domain post-data collection: scores below 50% signified insufficient knowledge, scores between 50% and 75% indicated moderate knowledge, and scores exceeding 75% denoted adequate knowledge, consistent with commonly adopted categorization approaches in KAP survey methodology [20]. Total scores for each KAP dimension were calculated by summing the corresponding item scores rather than using individual item values. This aggregation strategy was applied to reduce the influence of any single item and to ensure that each dimension represented an overall construct-level measure.

Questionnaire distribution and quality control

Participants were recruited through convenience sampling, targeting individuals currently undergoing radiotherapy for malignant tumors. Data collection was executed via an online survey created on the Wenjuanxing platform (https://www.wjx.cn/). Participants accessed the questionnaire by scanning a unique QR code and completed it using WeChat APP. To enhance response quality and ensure data integrity, several technical measures were implemented, including restricting each IP address to a single submission and mandating that all questions be answered. The research team conducted manual checks on each response to verify completeness, internal logical consistency, and coherence in response patterns. Questionnaires were excluded if the completion time was less than 90 seconds or if the response patterns suggested

inattentiveness, such as uniform selections across the entire KAP section.

Sample size estimation

Sample size was calculated using the formula for cross-sectional studies [21]: α=0.05, $n = \left(\frac{Z_{1-\alpha/2}}{\delta}\right)^2 \times p \times (1 - p)$, where n represents the required sample size, $Z1-\alpha/2$ denotes the standard normal deviate corresponding to the desired confidence level (1.96 for a two-sided α of 0.05), p indicates the assumed population proportion (set at 0.5 to maximize sample size in the absence of prior estimates), and δ represents the allowable margin of error (set at 0.05). This single population proportion formula is widely employed for KAP and other cross-sectional surveys in health research[9, 22]. The theoretical sample size was 480 which includes an extra 20% to allow for subjects lost during the study.

Statistical analysis

Statistical analysis was performed using Stata version 17.0 (StataCorp, College Station, TX, USA). Continuous variables were summarized as means and standard deviations (SD), and categorical variables were presented as frequencies and percentages (n, %). Correlations between KAP dimension scores were assessed using Spearman correlation analysis. Before conducting the structural equation modeling analysis, all KAP dimension scores were standardized using Z-score transformation in Stata to place variables on a common scale (mean = 0, standard deviation = 1), thereby

minimizing potential bias caused by differences in score ranges and measurement units. Structural equation modeling (SEM) was utilized to investigate the interrelationships among the constructs of knowledge (K), attitudes (A), and practices (P). The hypothesized pathways included: (1) knowledge directly influencing attitude, (2) attitude directly influencing practice, and (3) knowledge influencing practice both directly and indirectly, in accordance with the KAP theoretical framework. Statistical significance of the estimated SEM path coefficients was evaluated using two-sided hypothesis testing, and corresponding P-values were reported. A P-value < 0.05 was considered statistically significant.

Results

Questionnaires quality verification

Initially, 600 questionnaires were distributed for this study; however, 8 participants opted not to respond, resulting in a total of 592 cases. The following exclusions were implemented: 1) Two cases were removed as the participants were under 18 years of age; 2) Based on height and weight data, extreme and biologically implausible BMI values were identified during data cleaning. A total of 58 cases with BMI values outside the predefined plausible range (<14 or >38) were excluded from further analysis; 3) two cases were excluded due to anomalous responses to the question, “6. What is your ethnicity?”; 4) Nine cases were excluded due to the presence of underlying medical conditions, whether specific or unspecified. Ultimately, 523

valid cases were retained, yielding an effective response rate of 87.17%.

Demographic characteristics on participants and KAP scores

This study involved 523 patients undergoing radiotherapy (66.54% female; mean age 59.39 ± 11.66 years), all of Han ethnicity, and identified significant sociodemographic and clinical factors that influenced KAP outcomes. The knowledge, attitude, and practice scores were 11.64 ± 3.51 (range: 0-16), 29.77 ± 2.50 (range: 8-40), and 42.12 ± 4.82 (range: 10-50), respectively. Higher levels of education were significantly correlated with improved knowledge ($P = 0.001$), with individuals possessing associate or bachelor's degrees achieving the highest scores compared to those with only primary education. Medical professionals demonstrated markedly superior knowledge relative to non-medical participants ($P < 0.001$), despite constituting only 1.53% of the sample. Furthermore, income had a notable impact on knowledge ($P < 0.001$), with patients earning over 10,000 CNY per month scoring 14.63 ± 4.20, whereas those earning less than 2000 CNY scored 11.44 ± 3.46. The location of radiotherapy significantly affected knowledge outcomes ($P < 0.001$): patients treated in the inguinal area (14.35 ± 4.13) or other non-torso sites (14.00 ± 4.51) outperformed those receiving treatment in the head/neck region or chest/abdominal areas. Current smokers exhibited significantly poorer practices compared to non-smokers ($P = 0.003$), while patients engaging in moderate to high levels of physical activity demonstrated better practices than their sedentary

counterparts (P = 0.003). Patients expressing feelings of being "a bit nervous but optimistic" achieved the highest knowledge scores (P = 0.005), although they paradoxically recorded the lowest practice scores (P = 0.002). Those receiving strong family support exhibited superior knowledge compared to individuals with partial support (P < 0.001) and also displayed more positive attitudes (P < 0.001). Patients diagnosed with late-stage cancer showed more favorable attitudes than those in mid-stage (P = 0.015). Additionally, patients undergoing combined cancer treatments demonstrated enhanced knowledge (P = 0.003) and improved practices (P = 0.020). Finally, a preference for meat-heavy diets was linked to inferior practices compared to those adhering to balanced diets (P = 0.015) (**Table 1**). The distributions of self-reported underlying medical conditions and routine skin care practices among participants are presented in **Supplementary Figure 2**.

Distribution of Knowledge, attitude, and practice dimension

The distribution of knowledge dimensions showed that the three questions with the highest number of participants choosing the 'Unclear' option were 'Ionizing radiation can damage the DNA of skin cells, leading to cell death and dysfunction, which in turn triggers a series of skin reactions.' (**K2**) with 79.92%, 'Local cold compresses can relieve skin redness, pain, and itching; wet compresses can reduce skin inflammation and pain and promote absorption of exudate.' (**K8**) with 74.95%, and 'The key to treating acute radiation dermatitis is to quickly control the inflammatory

response, prevent secondary infections, and promote skin healing.' (**K7**) with 71.89% (**Supplementary Table 2**). Responses to the attitude dimension showed that 21.61% strongly agreed and 49.52% agreed that radiation dermatitis will seriously affect your quality of life (**A7**), 14.34% strongly agreed and 36.9% agreed that they would feel resistant to radiotherapy due to concerns about radiation dermatitis (**A5**). On the other hand, 21.99% disagreed and 1.72% strongly disagreed that (**A4**) (**Supplementary Table 3**). Responses to the practice dimension showed that 18.93% rarely and 8.41% never share their experiences and knowledge about radiation dermatitis with other patients who are about to undergo radiotherapy (**P10**), 19.31% rarely and 4.21% never pay attention to the experiences of other radiotherapy patients and learn from their methods of dealing with radiation dermatitis (**P9**), 3.25% rarely and 6.12% never avoid using medications or skincare products on the treatment site without the doctor's approval (**P8**) (**Supplementary Table 4**).

Spearman Correlation analysis

The significant positive correlations were found between knowledge and attitude ($r = 0.204$, $P < 0.001$), knowledge and practice ($r = 0.144$, $P = 0.001$), as well as attitude and practice ($r = 0.294$, $P < 0.001$), respectively (**Table 2**).

SEM analysis and mediation effects

The SEM analysis of mediating effect showed that knowledge directly affected attitude (β = 0.16, P < 0.001) and practice (β = 0.11, P = 0.038), attitude directly affected practice (β = 0.67, P < 0.001). Further, knowledge indirectly affected practice through attitude (β = 0.11, P < 0.001) (**Table 3, Figure 1**).

Discussion

Radiotherapy patients exhibited moderate knowledge, a generally neutral attitude, and overall proactive practices concerning radiation dermatitis. Quantitative analysis demonstrated significant positive associations between attitude and practice (r = 0.294, P < 0.001), knowledge and attitude (r = 0.204, P < 0.001), and knowledge and practice (r = 0.144, P = 0.001), supporting the interrelated structure of the KAP framework. Furthermore, SEM results indicated that attitude played a mediating role between knowledge and behavior. Based on these findings, the original contributions of this study can be summarized into three key aspects. First, this study quantitatively demonstrated the mediating role of attitude between knowledge and practice in radiotherapy patients with radiation dermatitis, providing empirical support for the behavioral pathway proposed by the KAP framework in a supportive oncology care context. Second, the analysis identified specific psychosocial and clinical factors, including emotional status and family support, that were associated with variations in KAP performance, highlighting the importance of psychosocial context in

shaping patient self-care behaviors. Third, this study extended KAP-based behavioral modeling to radiation dermatitis management, an area that has been insufficiently explored in previous patient-centered research, thereby expanding the application scope of the KAP framework in radiotherapy supportive care. From a clinical perspective, these findings suggest that targeted educational interventions aimed at improving patient understanding of radiation dermatitis may help foster more positive attitudes and, in turn, reinforce preventive and management behaviors in routine care settings.

Among the various associations examined in this study, the link between patient attitudes and practice behavior emerged with the most pronounced predictive strength. The structural equation model revealed that knowledge had a moderate direct effect on attitudes ($\beta = 0.160$, $P < 0.001$), a weaker direct effect on practices ($\beta = 0.110$, $P = 0.038$), and a significant indirect effect on practices through attitudes ($\beta = 0.110$, $P < 0.001$), indicating that attitudes serve as a key mediating pathway in translating knowledge into behavior. Although knowledge was weakly associated with behavior when considered in isolation, it did exert a measurable influence indirectly through its effect on shaping patient attitudes. These findings suggest that merely providing knowledge may be insufficient to induce preventive behaviors unless it successfully influences patients' attitudes, which act as a critical intermediary between cognition and action. Similar mediation mechanisms have been

observed in other KAP studies among cancer patients and chronic disease populations [8, 11].

This configuration aligns with behavioral models that recognize the role of intermediary affective and motivational processes in translating factual awareness into health-promoting actions. Previous studies in similar oncological contexts have reported that patients often retain fragmented knowledge about radiotherapy complications, yet demonstrate adherence to clinical recommendations when they feel adequately supported or emotionally prepared [23, 24]. In this light, the relatively modest correlation between knowledge and behavior observed here may reflect an underlying structural asymmetry: the cognitive effort required to process radiation-related risks may be high, but action may depend less on informational acquisition than on a sense of personal agency and external reinforcement. The structural equation model was specified as a saturated model with zero degrees of freedom, and therefore overall goodness-of-fit indices were not applicable. The estimated path coefficients directly reflect the strength and direction of relationships among knowledge, attitudes, and practices in this patient cohort.

A more granular review of the knowledge dimension revealed pronounced deficits in technical understanding. Most respondents lacked familiarity with the pathophysiological basis of radiation dermatitis and remained uncertain about symptomatology, treatment goals, and risk factors. This trend may not be surprising,

considering that the mechanisms of ionizing radiation and skin damage are rarely addressed during routine clinical consultations. It is possible that providers prioritize procedural or logistical explanations, leaving little room for in-depth pathophysiological education. Comparisons with findings from dermatological patient education studies suggest that unless structured educational content is embedded in a repeatable, comprehensible format, even patients with regular treatment contact may struggle to retain clinically actionable knowledge [25, 26].

Nevertheless, despite the limited knowledge base, attitudes remained relatively favorable across the sample. A substantial proportion of participants expressed a desire to learn more about radiation dermatitis and supported educational initiatives within clinical settings. There was also strong self-reported vigilance in monitoring skin reactions, although belief in the unavoidability or seriousness of dermatitis varied considerably. This ambivalence, particularly in items reflecting treatment resistance or quality of life concerns, may be shaped by prior exposure to informal patient narratives or personal treatment experiences rather than formal instruction. Inconsistent messaging or a lack of visual indicators during early stages of dermatitis may also dilute perceived severity. Comparative studies in other radiotherapy populations have documented similar fluctuations in risk perception, often influenced more by symptom onset than by preparatory counseling [25, 27].

In terms of practice, the behavioral profile was generally proactive, particularly with respect to physician-directed self-care and follow-up compliance. Yet engagement with peer education and patient-to-patient communication remained limited. Few participants reported consistently learning from others or sharing their own experiences, suggesting that although individual compliance is high, communal knowledge exchange is underdeveloped. This absence may reflect institutional cultures that emphasize vertical (doctor-patient) rather than horizontal (peer-peer) learning or it may signal cultural preferences for privacy and discretion in health matters. In either case, the lack of structured peer learning channels represents a missed opportunity. There is evidence from chronic care settings that peer engagement can facilitate the transfer of nuanced practical knowledge and increase psychological resilience, particularly in patients managing stigmatized or long-duration conditions [27, 28].

Demographic stratification provided further insights into knowledge disparities. Individuals with higher educational attainment or medical backgrounds exhibited markedly better understanding of radiation dermatitis, confirming a pattern widely observed in health literacy literature. Employment status and income also correlated with knowledge scores, reinforcing the influence of structural advantage in facilitating access to health-related information. Interestingly, however, these same sociodemographic variables showed little consistent association with either attitude or practice. This disconnect raises questions about the reach of cognitive

determinants in shaping behavior and suggests the possible buffering role of institutional protocols or interpersonal support mechanisms that standardize behavior regardless of prior knowledge [29, 30].

Indeed, the data suggested that even participants with limited knowledge might maintain appropriate behaviors, particularly when guided closely by clinical routines. Such a dynamic implies that practical compliance may not always serve as a valid proxy for understanding, and that surface-level behavior might obscure underlying uncertainty or distress. In the longer term, this disjunction could undermine adaptive coping or increase vulnerability to complications, especially if unexpected symptoms arise and patients lack the internal resources to interpret or respond effectively [31, 32].

The data also pointed to certain psychosocial factors associated with behavioral performance. For instance, respondents reporting better emotional states upon learning of their need for radiotherapy, as well as those who perceived greater familial support, tended to score higher on attitude and practice dimensions. Notably, an apparent knowledge–practice discrepancy was observed across emotional-state groups. Patients who reported being ‘a bit nervous but optimistic’ showed relatively higher knowledge yet comparatively lower practice performance. This pattern may reflect an intention–behavior gap, where information seeking increases knowledge, but emotional uncertainty, treatment-related stress, or physical

discomfort may hinder sustained implementation of self-care behaviors. In addition, optimistic expectations may reduce perceived urgency for strict adherence to preventive skin-care routines, while inadequate external reinforcement (e.g., limited caregiver involvement or insufficient follow-up reminders) may further weaken the translation of knowledge into consistent practice. These findings suggest that educational interventions should be coupled with psychological support and structured behavioral guidance to better address the knowledge–practice gap during radiotherapy. These findings lend support to ecological models of patient behavior, which frame engagement not solely as an individual cognitive process but as a relational and affective outcome shaped by social context and emotional readiness [31, 33]. Notably, patients experiencing anxiety or lacking strong support networks may require targeted interventions that extend beyond educational content, incorporating psychosocial counseling or support group participation as part of routine care.

Considering these patterns, several recommendations emerge. From a clinical perspective, it is recommended to develop structured educational interventions that not only disseminate knowledge but also actively shape patient attitudes through motivational interviewing and individualized counseling, thus enhancing practice adherence. Specifically, structured education may include brief standardized skin-care education sessions delivered at the initiation of radiotherapy, supplemented with printed or digital visual materials illustrating early signs of radiation dermatitis and step-by-

step self-care procedures. Motivational interviewing can be operationalized through short, nurse-led counseling encounters focused on identifying individual barriers, reinforcing perceived benefits of preventive skin care, and setting simple, achievable self-care goals. In addition, integrating routine skin assessment checklists into daily nursing rounds and providing automated reminder messages via hospital communication platforms may further support consistent practice. Establishing small-group patient education sessions or supervised peer-sharing activities within radiotherapy waiting areas could also facilitate experiential learning and improve patient engagement.

Patient education materials should be redesigned to emphasize interpretability and retention, especially for those with limited formal education. Visual aids, repeated reinforcement, and brief, modular content may help convey essential principles without overwhelming patients cognitively. Furthermore, given the robust predictive role of attitudes, efforts should be made to assess and cultivate positive expectancies through structured communication, including motivational dialogue and normalization of mild symptoms. This is particularly important for those who express resistance to radiotherapy based on skin-related concerns. Health professionals may also consider implementing screening tools that identify patients at risk of disengagement based on psychosocial profile, enabling early referral to supportive resources [34, 35].

Limitations

This study has several limitations that should be considered when interpreting the findings. First, the use of a cross-sectional design precludes any inference of causality between knowledge, attitudes, and practices, limiting conclusions to associations only. Second, as data were collected through self-reported questionnaires, responses may have been subject to recall bias or social desirability bias, potentially affecting the accuracy of reported behaviors. Third, the study was conducted at a single institution using convenience sampling, which may restrict the generalizability of the results to broader populations or different clinical settings.

Future research directions

Building on these limitations, future research may consider longitudinal study designs to better examine dynamic changes in knowledge, attitudes, and practices over time and to strengthen causal inference. In addition, longer-term follow-up studies could help evaluate the sustained effects of attitude-oriented educational strategies on patient self-care behaviors during and after radiotherapy.

Conclusion

Radiotherapy patients exhibited moderate levels of knowledge, neutral attitudes, and generally proactive practices concerning radiation dermatitis. Quantitative analysis showed that attitude was

strongly associated with practice ($r = 0.294$, $P < 0.001$) and served as a key mediating factor linking knowledge to behavior, with a significant indirect effect of knowledge on practice through attitude ($\beta = 0.110$, $P < 0.001$). In addition, knowledge exerted a direct effect on attitude ($\beta = 0.160$, $P < 0.001$) and a weaker direct effect on practice ($\beta = 0.110$, $P = 0.038$). These findings indicate that targeted educational interventions aimed at improving patient knowledge may foster more positive attitudes and, in turn, promote sustained engagement in effective skin care practices during radiotherapy

Declarations

Ethics approval and consent to participate

The study was approved by the Institutional Review Board of Ethics Committee of Shanxi Province Cancer Hospital (KY2025097). All participants were informed about the study protocol and provided written informed consent to participate in the study. I confirm that all methods were performed in accordance with the relevant guidelines. All procedures were performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analysed during this study are included in this published article.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Juan Lu and Xiao Hong Liu carried out the studies, participated in collecting data, and drafted the manuscript. Xiao Dong Han and Yan Hua Li performed the statistical analysis and participated in its design. Ying Liu participated in acquisition, analysis, or

interpretation of data and draft the manuscript. All authors read and approved the final manuscript.

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Table 1. Demographic Characteristics and KAP Scores of Radiotherapy Patients.

***N*=523**	**N (%)**	**Knowledge score**		**Attitude score**		**Practice score**	
		Mean±SD	**P**	**Mean±SD**	**P**	**Mean±SD**	**P**
Total score		11.64±3.51		29.77±2.50		42.12±4.82	
Gender			0.902		0.610		0.077
Male	175(33.46)	11.68±3.70		29.62±2.29		41.56±5.26	
Female	348(66.54)	11.61±3.41		29.84±2.59		42.40±4.55	
Age [22~84] (years)	59.39±11.66						
BMI [15.39~37.92] (kg/m2)	23.50±3.92						
Education level			0.001		0.107		0.143

Primary school or below	138(26.39)	11.12±3.04		29.63±2.72		41.56±5.30	
Junior high school	227(43.4)	11.29±3.39		29.62±2.33		41.95±4.97	
High school/technical secondary school	110(21.03)	12.4±3.68		29.84±2.36		42.60±3.72	
Associate/bachelor's degree or above	48(9.18)	13±4.31		30.70±2.71		43.41±4.64	
Employment status			0.002		0.212		0.068
Employed, self-employed. Other	330(63.10)	11.33±3.36		29.62±2.59		41.75±5.08	
Retired, unemployed	193(36.90)	12.15±3.70		30.03±2.31		42.75±4.25	

Occupation type			<0.001	0.677		0.328
Medical-related professional	8(1.53)	18.12±4.58		31±3.96	41.62±9.56	
Non-medical-related professional	515(98.47)	11.53±3.40		29.75±2.46	42.13±4.72	
Monthly income per capita			<0.001	0.154		0.257
<2000	238(45.51)	11.44±3.46		29.66±2.73	41.76±4.93	
2000-5000	238(45.51)	11.36±3.23		29.76±2.18	42.31±4.78	
5000-10000	36(6.88)	13.77±4.30		30.05±2.70	42.69±4.11	
>10000	11(2.10)	14.63±4.20		31.45±2.38	44.09±4.78	
Marital status			0.269	0.202		0.151

Unmarried, divorced, widowed	25(4.78)	12.52±4.05		30.52±2.78		40.6±6.31	
Married	498(95.22)	11.59±3.48		29.73±2.47		42.20±4.72	
Smoking			0.418		0.092		0.003
Never	361(69.02)	11.60±3.46		29.95±2.45		42.43±4.67	
Used to	148(28.3)	11.60±3.56		29.53±2.25		41.76±4.97	
Currently smoking	14(2.68)	12.92±4.23		27.64±4.48		38±4.96	
Alcohol			0.131		0.820		0.161
Never	379(72.47)	11.53±3.47		29.82±2.50		42.35±4.74	
Used to	140(26.77)	11.82±3.47		29.74±2.15		41.6±4.84	
Currently drinking	4(0.76)	15.25±6.5		26±7.65		39±9.20	
Chronic conditions							

(multiple choice)	
Hypertension	132(25.24)
Diabetes	69(13.19)
Rheumatoid arthritis	6(1.15)
Stroke	5(0.96)
COPD	1(0.19)
Coronary heart disease	7(1.34)
Cholecystitis	2(0.38)
Gallstones	5(0.96)
Hyperlipidemia	7(1.34)
None of the above	327(62.52)
Not sure	16(3.06)

Medical insurance			0.191	0.166	0.013
National medical insurance	510(97.51)	15.25±6.5	26±7.65	39±9.20	
No national medical insurance	11(2.1)	11.63±3.52	29.78±2.50	42.21±4.73	
No national insurance, but have commercial insurance	2(0.38)	12.36±3.07	29.81±2.13	39.18±7.01	
Current stage of cancer			0.483	0.015	0.003
Early stage	74(14.15)	12.24±3.99	29.72±2.66	40.41±6.35	
Middle stage	289(55.26)	11.51±3.50	29.53±2.49	42.67±4.25	
Late stage	160(30.59)	11.58±3.28	30.23±2.37	41.91±4.79	

Other cancer treatments			0.003	0.178		0.020
Yes	309(59.08)	11.98±3.72		29.96±2.41	42.55±4.47	
No	214(40.92)	11.14±3.12		29.50±2.59	41.50±5.22	
Previous radiotherapy site			<0.001	0.761		0.324
Head and neck	74(14.15)	11.37±3.37		29.71±1.63	41.21±5.23	
Chest/abdomen	372(71.13)	11.16±3.12		29.78±2.44	42.42±4.10	
Inguinal area	42(8.03)	14.35±4.13		29.66±3.36	41.30±6.96	
Other	35(6.69)	14.00±4.51		29.88±3.30	41.8±7.17	
The health condition of the skin			0.171	0.017		0.209
Very good, no skin	411(78.59)	11.49±3.50		29.89±2.45	42.36±4.42	

problems at all					
Good, occasional minor skin issues (e.g., dryness, itching)	98(18.74)	12.22±3.54		29.45±2.56	41.36±6.14
Average, some common skin issues (e.g., eczema, rash)	14(2.68)	11.85±3.18		28.5±2.82	40.21±4.59
Allergic to any substances			0.103	0.080	0.361
Yes	54(10.33)	12.31±3.79		30.40±3.37	42.29±5.79
No	469(89.67)	11.56±3.47		29.70±2.36	42.10±4.69
Usual skincare habits					

Use skincare products daily (e.g., lotion, cream)	204(39.01)			
Occasionally use skincare products	107(20.46)			
Never use skincare products	174(33.27)			
Frequently exposed to sunlight	21(4.02)			
Avoid direct sunlight	91(17.4)			
Other	18(3.44)			
Level of daily physical activity		<0.001	0.289	0.003

Very little activity, mostly sitting or lying down	49(9.37)	13.34±3.82		29.16±2.78	40.16±7.02	
Occasional activity, such as walking	111(21.22)	12.81±4.57		29.87±2.70	41.14±5.86	
Moderate activity, regular light exercise/ High activity, frequent sports or manual labor	363(69.41)	11.04±2.88		29.82±2.38	42.68±3.91	
Dietary habits			0.009	0.342		0.015
Prefer meat and greasy food	26(4.97)	13.57±4.68		28.57±3.92	38.53±8.81	

Balanced diet, mix of meat and vegetables	379(72.47)	11.36±3.36	29.86±2.27	42.63±4.04	
Prefer vegetarian food/Other	118(22.56)	12.08±3.52	29.73±2.74	41.27±5.45	
Sleep quality			0.076	0.960	0.035
Very good, fall asleep quickly and sleep deeply	258(49.33)	11.20±3.16	29.83±2.22	41.91±4.46	
Good, occasional sleep problems	150(28.68)	11.94±3.81	29.76±2.39	42.06±5.08	
Average, frequent mild sleep	115(21.99)	12.20±3.73	29.65±3.14	42.67±5.20	

problems/Poor, sleep issues significantly affect life					
Mental state after learning needed radiotherapy			0.005	0.004	0.002
Very anxious and worried	46(8.8)	11.36±3.61	29.71±2.77	43.56±4.18	
Quite anxious but accepting	201(38.43)	11.04±2.93	29.38±2.26	42.72±3.98	
A bit nervous but optimistic	83(15.87)	13.10±4.54	30.03±2.44	40.98±6.17	
Calm and facing it positively	193(36.9)	11.68±3.36	30.08±2.63	41.64±4.94	

Support from family or friends			<0.001	<0.001	0.104
A lot of support, family and friends accompany throughout	241(46.08)	12.45±3.93	30.26±2.66	41.78±5.38	
Some support, help available when needed	270(51.63)	10.93±2.95	29.39±2.20	42.49±4.04	
Limited support, mainly rely on myself /Almost no support	12(2.29)	11.08±2.42	28.5±3.37	40.66±7.81	

Table 2. Spearman correlation analysis.

Dimension	Knowledge	Attitude	Practice
Knowledge	1		
Attitude	0.204 (P□0.001)	1	
Practice	0.144 (P = 0.0010)	0.294 (P□0.001)	1

Table 3. SEM analysis and mediation effects.

Model paths		Total effects		Direct Effect		Indirect effect	
		β (95% CI)	P	β (95% CI)	P	β (95% CI)	P
Asum <-							
	Ksum	0.16 (0.10,0.22)	<0.001	0.16 (0.10,0.22)	<0.001		
Psum <-							
	Asum	0.67 (0.51,0.82)	<0.001	0.67 (0.51,0.82)	<0.001		
	Ksum	0.22 (0.11,0.34)	<0.001	0.11 (0.00,0.23)	0.038	0.11 (0.06,0.15)	<0.001

Figure legend

Figure 1. Structural equation model illustrating the relationships among knowledge, attitude, and practice scores. Single-headed arrows indicate hypothesized directional paths between latent constructs. Standardized path coefficients (β) are displayed along each path to represent the strength of associations. Observed variables and latent constructs are labeled to clarify the conceptual framework.