IJBMC International Journal of Body, Mind and Culture

Volume 13, Issue 7, Article e2026-1365
DOI: 10.61838/ijbmc.v13i7.1365

Article type:
Original Research

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The Impact of HBM-Based Education on Knowledge and Beliefs Regarding Lung Cancer Screening Among Male University Students

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ABSTRACT

Objective: To evaluate the efficacy of the health belief model–based educational program on knowledge and health beliefs regarding lung cancer screening among male university student smokers.

Methods and Materials: This quasi-experimental study included 144 undergraduates, purposively (non-randomly) assigned to two groups (experimental and control), each consisted 72 smokers at Telafer University. Data were collected at three time points: pre-test (baseline), post-test I (immediately after education), and post-test II (two months after education) with the Health Beliefs Scale for Lung Cancer Screening. After baseline assessment, a health belief model-based health education was delivered for students in the experimental group. A mixed-design analysis of variance was conducted in SPSS version 27 to determine changes in participants' knowledge and beliefs over time.

Findings: after education, participants in the experimental group showed statistically significant changes in the mean scores of knowledge, perceived risk, perceived benefits, and perceived self-efficacy ($p<0.05$). Significant time × group interactions were found for knowledge ($\eta^2 = 0.179$), perceived risk ($\eta^2 = 0.110$), and perceived benefits ($\eta^2 = 0.056$), whereas no significant interaction was observed for perceived barriers ($p = 0.07$), and the effect for self-efficacy was small ($\eta^2 = 0.023$). No statistically significant changes in the mean scores for knowledge and beliefs were observed among participants in the control group over time.

Conclusion: The intervention led to significant improvements in knowledge, perceived risk, and benefits, while the effect on self-efficacy was minimal (small effect size), and no significant change was observed in perceived barriers. Further investigation into the perceived barriers to low-dose computed tomography is needed.

Keywords: Health Belief Model, Smoking, Lung Cancer, University Students.

Article history:

Received 11 Mar 2026
Revised 18 Apr 2026
Accepted 24 June 2026
Published online 01 Jul 2026

How to cite this article:
Qasem, M. N., & Noori, A. K. (2026). The Impact of HBM-Based Education on Knowledge and Beliefs Regarding Lung Cancer Screening Among Male University Students. International Journal of Body, Mind and Culture, 13(7), Article e2026-1365.
https://doi.org/10.61838/ijbmc.v13i7.1365

Introduction

Lung cancer (LC) is a malignant, life-threatening disease, with an estimated 2.2 million new cases and 1.8 million deaths worldwide in 2025 (Luo et al., 2023). It is the second leading cause of cancer-related death globally, affecting individuals across different age groups (Organization, 2024). Early detection is challenging because LC often presents with no signs or symptoms at early stages, which delays diagnosis and worsens outcomes, causing physical and psychological burdens such as cough, chest discomfort, depression, anxiety, weight loss, and reduced quality of life (Polanco et al., 2021).

The most common type of lung cancer among smokers is non-small cell lung cancer (NSCLC), although small cell lung cancer remains possible (Gridelli et al., 2015). Smoking is strongly associated with LC due to the carcinogenic effects of nicotine and other components in cigarettes, which promote tumor formation and spread (Hecht, 2012).

Detection at earlier stages improves treatment efficacy, survival rates, and reduces the financial burden on healthcare systems (Tafazzoli et al., 2022). Low-dose computed tomography (LDCT) has been shown in population-based studies to reduce LC mortality by approximately 35–60% among high-risk groups (Huang et al., 2019). However, current international guidelines generally recommend LDCT screening for older high-risk smokers (e.g., adults aged 50–80 years with significant smoking history), and uptake among young adults remains limited (Force et al., 2021).

Traditional educational approaches, such as unstructured instructions, have yielded limited benefits in improving knowledge and health beliefs about LC screening (Hameed & Faraj, 2018). This may be due to the absence of a structured theoretical framework guiding the educational process. The Health Belief Model (HBM) is a widely used social cognition model that explains and predicts individuals' engagement in health behaviors, including screening tests, by addressing constructs such as perceived susceptibility, perceived benefits, perceived barriers, perceived severity, and self-efficacy (Luo et al., 2023). Previous studies have shown that HBM-based educational programs effectively improve knowledge and motivate early detection behaviors for cancers such as breast, cervical, and colorectal cancer (Baktash & Naji, 2019).

While some HBM-based interventions target cancer screening, few studies focus on lung cancer screening among smokers under 50 years of age, and most existing research is conducted in developed countries with older populations (Ismael & Mohammed Noori, 2019). Therefore, a knowledge gap exists regarding HBM-based education for lung cancer screening (LCS) in smokers under 50 years in developing countries, including Iraq. This study aims to evaluate the efficacy of an HBM-based educational program in improving knowledge and health beliefs regarding LCS among male university student smokers, without directly measuring actual screening behavior.

Methods and Materials

Study Design

This quasi-experimental study examined the effect of HBM-based health education on lung cancer screening knowledge and beliefs among university student smokers. The reporting of this quasi-experimental research adhered to the (TREND) criteria for non-randomized assessments, including a detailed flow diagram indicating enrollment, allocation, follow-up, and analysis (Figure 1.).

Intervention

The Health Belief Model (HBM) served as the foundation for the educational program delivered to the experimental group. The program consisted of weekly three-hour sessions for each college, with a 10-minute break halfway to maintain engagement. Participation was actively monitored through attendance sheets, interactive quizzes, and group discussions. A data display and a whiteboard were used throughout the sessions.

The curriculum was divided into two main sections, each explicitly linked to specific HBM constructs. Section one – Lung Cancer Education (Targeting Perceived Susceptibility and Severity): Overview of lung cancer, symptoms, risk factors (modifiable and non-modifiable), and treatment options. Interactive discussion and case scenarios helped participants recognize their personal risk and understand the seriousness of the disease.

Section two – Low-Dose Computed Tomography (LDCT) and Screening Barriers (Targeting Perceived

Benefits, Barriers, and Self-Efficacy), discusses the significance of early detection using LDCT. Identification of common barriers to screening (e.g., fear, cost, accessibility) and strategies to overcome them through role-play and Q&A sessions.

Skills-building exercises enhanced participants' confidence (self-efficacy) in undergoing future screenings.

All sessions were conducted by the same trained educator to ensure consistency. Session checklists were used to monitor adherence to the planned protocol, and all teaching materials were standardized across colleges. Visual aids, pictures, and videos were incorporated throughout to reinforce learning.

Participants

The study was conducted at Telafer University's College of Education and College of Basic Education in Nineveh Governorate, Iraq, and focused exclusively on male students, which limits the generalizability of the findings to other universities, regions, or female students.

The inclusion criteria included male students who were current smokers or had quit smoking within the past 15 years. The 15-year window was chosen to capture former smokers who may still be at risk of lung cancer, despite being under 50 years old. Female students were excluded due to cultural norms, low prevalence of smoking among females, and feasibility concerns, which should be considered when generalizing results.

About 160 students met the eligibility criteria. G*Power analysis indicated that a minimum of 140 students was required ($\alpha = 0.05$, power = 0.95, effect size $f = 0.25$, 2 groups, 3 repeated measurements, correlation among repeated measures $r = 0.5$). Although all 160 students enrolled, 16 did not complete the study due to scheduling conflicts or withdrawal of consent, leaving 144 participants for the final analysis.

Participants were purposively assigned to the experimental and control groups based on their academic class schedules and availability, with 72 individuals in each group, to ensure comparable group characteristics and minimize selection bias.

Study instruments:

The Lung Cancer Screening Health Belief Scale (LCSHB) was used as the study's instrument. Two sections make up the scale. The first section addresses general characteristics, habits of conduct, and medical history. The clinical history questions cover three topics: a history of chronic illnesses, lung cancer in the family, and chronic obstructive pulmonary disease. A yes/no approach was used for all three questions. Knowledge of lung cancer and low-dose computed tomography was assessed using six multiple-choice questions, with each correct answer scoring 5 points and each incorrect answer 0, yielding a total knowledge score ranging from 0 to 30; higher scores indicate greater knowledge. This scoring approach was chosen for clarity and consistency with prior validation studies.

The Health Belief Model served as the basis for the second section of the measure. This part included 35 items distributed into four subscales as follows: 1- perceived risks subscale (3 items), 2- perceived benefits subscale (6 items), 3- perceived barriers subscale (17 items), 4- perceived self-efficacy subscale (9 items). Students' responses were estimated on a 4-point Likert scale, with scores ranging from (1 strongly disagree/ not confident) to (4 strongly agree/ confident). To account for unequal item counts across subscales, all analyses used mean scores for each subscale rather than simple sums, ensuring comparability of constructs despite differences in item counts. The scale was originally in Arabic, and no translation was required for this study population.

Twelve specialized nurses checked the instrument's validity before data collection began. Their suggestions led to the elimination of some demographic questions that did not meet population standards. Validity evidence includes content validity (expert review), factor structure confirmed in prior studies, and convergent validity as reported by Zhong et al., (2026). The questionnaire's reliability was then assessed using Cronbach's alpha on a sample of 30 students ($\alpha = 0.817$) who were excluded from the study. Subscale reliability in this pilot sample was also calculated: perceived risk $\alpha = 0.72$, perceived benefits $\alpha = 0.78$, perceived barriers $\alpha = 0.81$, perceived self-efficacy $\alpha = 0.76$. A test-retest was conducted at 2-week intervals, revealing satisfactory overall instrument dependability ($r = 0.80$).

Data Collection

Data were collected at three time points using a self-administered questionnaire: pre-test (October 5, 2025), post-test I (October 22, 2025), and post-test II (December 22, 2025). Both experimental and control groups completed the questionnaires at the same time points under comparable classroom conditions.

The educational lectures were delivered only to the experimental group from October 8 to October 22, 2025, while the control group continued their regular academic activities without receiving the intervention. Post-test I was administered immediately after the final educational session on the same day, with no delay between intervention completion and assessment. To minimize social desirability bias, questionnaires were completed anonymously, and participants were assured of confidentiality and instructed to provide honest responses.

Ethical consideration

Both the Scientific Ethics Committee of the University of Baghdad's College of Nursing (letter No. 33, dated November 20, 2025) and the Ministry of Planning (letter No. 1/3/1/8/6829, dated December 1, 2025) granted permission to conduct this study. Prior to any research activities, all participants were provided with detailed information about the study's objectives, potential benefits and risks, and their rights, including the freedom to withdraw at any time. Written informed consent was obtained.

Participants were also informed about support services and counseling in case any distress or anxiety arose from the cancer-focused educational content. Data confidentiality and privacy were strictly maintained: all responses were anonymized, securely stored, and accessible only to the authorized research team. The study adhered to the ethical principles outlined in the 1964 Declaration of Helsinki and its subsequent revisions.

Data analysis

Data were analyzed using IBM SPSS, version 27. Descriptive statistics, including means, standard deviations, percentages, and frequencies, were used to characterize participants' demographic characteristics. Independent-samples t-tests and chi-square tests were conducted to assess baseline homogeneity between the experimental and control groups.

Assumptions for parametric testing were examined using Kolmogorov–Smirnov tests, skewness and kurtosis values, and Levene's test for equality of variances. A mixed-design ANOVA was performed to examine within-subject (time) and between-subject (group) effects. Mauchly's test of sphericity was assessed, and Greenhouse–Geisser corrections were applied when the sphericity assumption was violated.

Post hoc pairwise comparisons with a Bonferroni adjustment were conducted to control the family-wise Type I error rate across time points and outcome variables.

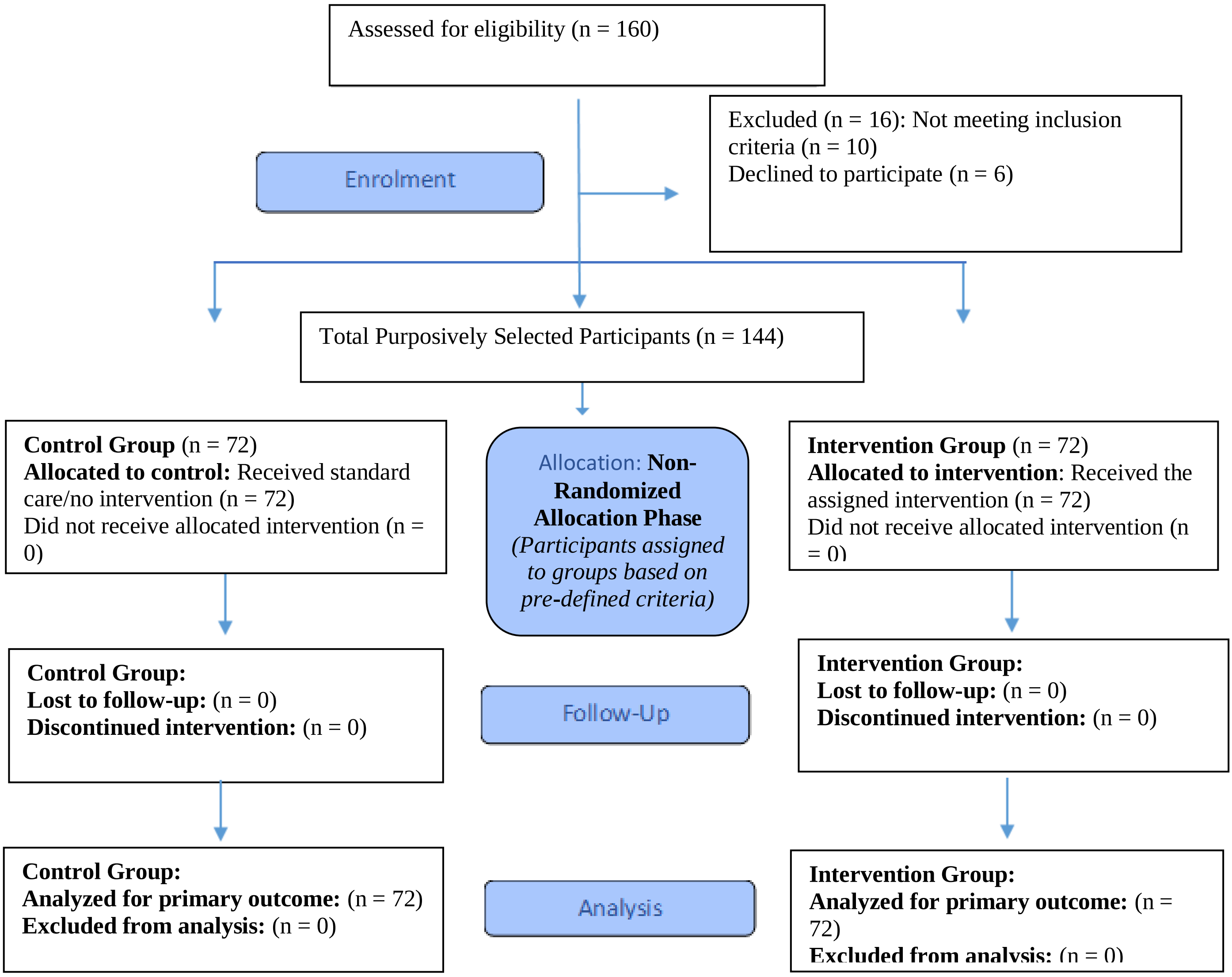

Figure 1.

TREND Flow Diagram of Participant Progress

Findings and Results

Table 1 presents the sociodemographic characteristics, behavioral habits, and clinical history of the 144 participants, with 72 students in the experimental group and 72 in the control group. The participants' average age was 21.50 ± 2.53 years; most were aged 18–21 years (53.5%). Place of residence was evenly distributed between urban (55.6%) and rural (44.4%) areas. Most participants were married (71.5%), and the majority were enrolled in the College of Basic Education (59.0%). Study levels were similar between the two groups.

Table 1.

Homogeneity of participants Sociodemographic Characteristics, Behavioral habits and Clinical history.

Sociodemographic Characteristics		Study group (n=72)		Control group (n = 72)		Total (n = 144)		χ2	p
		F	%	F	%	F	%		
Age	18-21	36	50.0%	41	56.9%	77	53.5%	1.069	٠.586
	22-25	33	45.8%	27	37.5%	60	41.7%		
	26-30	3	4.2%	4	5.6%	7	4.9%		
	M	21.44 (2.59)		21.56 (2.49)		21.50 (2.53)			
Place of Residence	Urban	38	52.8%	42	58.3%	80	55.6%	0.450	0.502
	Rural	34	47.2%	30	41.7%	64	44.4%		
Marital Status	Married	53	73.6%	50	69.4%	103	71.5%	0.307	0.580
	Unmarried	19	26.4%	22	30.6%	41	28.5%		
College	College of Basic Education	46	63.9%	39	54.2%	85	59.0%	1.407	0.236
	College of Education	26	36.1%	33	45.8%	59	41.0%		
Study Level	First Year	27	37.5%	28	38.9%	55	38.2%	0.319	0.956
	Second Year	16	22.٣%	14	19.4%	30	20.8%		
	Third Year	15	20.8%	14	19.4%	29	20.٢%		
	Fourth Year	14	19.4%	16	22.٣%	30	20.8%		
Behavioral habits Alcohol consumption	Drinking	6	8.3%	5	6.9%	11	7.6%	0.098	0.754
	Not deinking	66	91.7%	67	93.1%	133	92.4%		
Physical activity	Never	8	11.1%	8	11.1%	16	11.1%	0.819	0.976
	Less than one hour	18	25.0%	22	30.6%	40	27.8%		
	Less than three hours	16	22.2%	14	19.4%	30	20.8%		
	Less than five hours	10	13.9%	10	13.9%	20	13.9%		
	Less than seven hours	8	11.1%	6	8.3%	14	9.7%		
	7 hours or more	12	16.7%	12	16.7%	24	16.7%		
Clinical history Chronic diseases	Yes	5	6.9%	3	4.2%	8	5.6%	0.529	0.467
	No	67	93.1%	69	95.8%	136	94.4%		
Family history of Lung cancer	Yes	5	6.9%	7	9.7%	12	8.3%	0.364	0.546
	No	67	93.1%	65	90.3%	132	91.7%		
Medical history related to COPD	Yes	4	5.6%	3	4.2%	7	4.9%	0.150	0.698
	No	68	94.4%	69	95.8%	137	95.1%		

F: Frequency, %: Percent, M: Mean, SD: Standard deviation, t: t-test, χ2: Chi-square. All group differences p > 0.05.

Behavioral habits varied, with a small proportion reporting alcohol consumption (7.6%) and physical activity ranging from none (11.1%) to seven hours or more per week (16.7%). Clinical history was minimal: 5.6% reported chronic diseases, 8.3% had a family history of lung cancer, and 4.9% had a history of COPD.

No statistically significant differences were observed between the experimental and control groups for any demographic, behavioral, or clinical variables (all $p > 0.05$). This indicates baseline homogeneity, ensuring comparability between groups for subsequent analyses.

Table 2.

Baseline Homogeneity of Knowledge and Health Belief Model Constructs Between the Study and Control Groups

Variable	Study group (n=72)		Control group (n=72)			
	M	SD	M	SD	t	p
Knowledge	17.56	6.10	17.98	5.41	-0.433	0.666
Perceived risk	5.55	2.19	5.59	2.40	-0.109	0.914
Perceived benefit	17.02	3.84	17.13	3.75	-0.175	0.861
Perceived barriers	35.12	8.15	36.63	8.78	-1.072	0.286
Perceived self-efficacy	24.91	5.15	26.30	6.02	-1.485	0.140

M = mean; SD = standard deviation; t = independent-samples t-test; p = p-value. Health Belief Model constructs were scored from 1 to 4, and knowledge scores ranged from 0 to 30.

Table 2 shows baseline scores for knowledge and Health Belief Model (HBM) constructs. No significant differences were observed between the groups for knowledge, perceived risk, perceived benefits, perceived barriers, or perceived self-efficacy (all p > 0.05). This confirms that the two groups were comparable prior to the intervention, supporting the study's internal validity.

Table 3.

Comparing the study groups' knowledge and beliefs before and after the training, using descriptive statistics such as mean and standard deviation.

Time (Variable)	interventional group (72) Mean, (standard deviation)			Control group (72) Mean, (standard deviation)		
	test I	test II	test III	test I	test II	test III
Knowledge	17.56 (6.10)	25.13 (5.03)	21.87 (7.19)	17.98 (5.41)	17.56 (6.22)	18.33 (5.87)
Lower CI 95%-Upper CI 95% (SE)	16.13-19.1 (0.72)	23.96-26.32 (0.59)	20.19-23.56 (0.85)	16.71-19.25 (0.63)	16.10-19.03 (0.73)	16.95-19.71 (0.69)
Perceived Risk	5.55 (2.19)	7.04 (2.29)	6.86 (2.36)	5.59 (2.40)	5.41 (2.34)	5.43 (2.15)
Lower CI 95%-Upper CI 95% (SE)	5.04-6.07 (0.26)	6.50-7.58 (0.27)	6.31-7.42 (0.28)	5.03-6.16 (0.28)	4.86-5.96 (0.27)	4.92-5.93 (0.25)
Perceived Benefit	17.02 (3.84)	19.61 (4.31)	18.25 (4.15)	17.13(3.75)	17.34 (3.76)	17.00(3.64)
Lower CI 95%-Upper CI 95% (SE)	16.12-17.93 (0.45)	18.60-20.63 (0.51)	17.27-19.23 (0.49)	16.25-18.02 (0.44)	16.46-18.23 (0.44)	16.14-17.85 (0.42)
Perceived Barrier	35.12 (8.15)	33.36 (9.06)	32.76 (8.98)	36.63 (8.78)	36.80 (7.53)	37.05 (8.75)
Lower CI 95%-Upper CI 95% (SE)	33.21-37.04 (0.96)	31.23-35.49 (1.07)	30.65-34.88 (1.06)	34.57-38.70 (1.03)	35.03-38.57 (0.88)	34.99-39.11 (1.03)
Perceived Self-Efficacy	24.91 (5.15)	27.18 (6.53)	26.23 (6.43)	26.30 (6.02)	26.25 (6.38)	25.61 (5.94)
Lower CI 95%-Upper CI 95% (SE)	23.71-26.13 (0.61)	25.64-28.72 (0.77)	24.72-27.75 (0.76)	24.88-27.72 (0.71)	24.74-27.75 (0.75)	24.21-27.00 (0.70)

Table 3 presents the means, standard deviations, standard errors, and 95% confidence intervals for knowledge and Health Belief Model (HBM) constructs at three time points: pre-test (Test I), post-test immediately after the intervention (Test II), and follow-up post-test (Test III) for both the experimental and control groups.

In the experimental group, mean knowledge scores increased from 17.56 (SD = 6.10, SE = 0.72, 95% CI = 16.13–19.10) at baseline to 25.13 (SD = 5.03, SE = 0.59, 95% CI = 23.96–26.32) immediately post-intervention. At follow-up (Test III), scores partially declined to 21.87 (SD = 7.19, SE = 0.85, 95% CI = 20.19–23.56), indicating some decay in retention over time. The control group remained relatively stable across all three tests (17.98, 17.56, 18.33), with narrow confidence intervals indicating precision of the estimates.

The experimental group demonstrated an increase from 5.55 (SD = 2.19, SE = 0.26, 95% CI = 5.04–6.07) at baseline to 7.04 (SD = 2.29, SE = 0.27, 95% CI = 6.50–7.58) post-intervention, with a slight decline to 6.86 (SD = 2.36, SE = 0.28, 95% CI = 6.31–7.42) at follow-up. The control group scores remained nearly unchanged (5.59, 5.41, 5.43).

Scores in the experimental group increased from 17.02 (SD = 3.84, SE = 0.45, 95% CI = 16.12–17.93) to 19.61 (SD = 4.31, SE = 0.51, 95% CI = 18.60–20.63) immediately post-intervention, followed by a slight decrease to 18.25 (SD = 4.15, SE = 0.49, 95% CI = 17.27–19.23) at follow-up. The control group scores remained stable (17.13, 17.34, 17.00).

The experimental group showed a slight decrease in perceived barriers from 35.12 (SD = 8.15, SE = 0.96, 95%

CI = 33.21–37.04) at baseline to 32.76 (SD = 8.98, SE = 1.06, 95% CI = 30.65–34.88) at follow-up, suggesting a modest positive effect of the intervention. In contrast, the control group displayed a slight increase from 36.63 to 37.05 across the three tests, indicating minimal change without intervention.

Experimental group scores increased from 24.91 (SD = 5.15, SE = 0.61, 95% CI = 23.71–26.13) at baseline to 27.18 (SD = 6.53, SE = 0.77, 95% CI = 25.64–28.72) post-intervention, with a slight decrease to 26.23 (SD = 6.43, SE = 0.76, 95% CI = 24.72–27.75) at follow-up. The control group remained relatively constant (26.30, 26.25, 25.61).

Table 4.

Mixed-Design ANOVA Results for the Effects of Time, Group, and Time × Group Interaction on Study Variables.

Variable	Effect across time F[P]	Effect between Groups F[P]	Time*Group F[P]	Partial Eta Squared
Knowledge	F[1.91, 271.19] = 25.56, p< 0.001	F[1, 142] = 19.23, p< 0.0.1	F[1.91, 271.195] = 30.93, p < 0.001	0.179
Perceived Risk	F[1.91, 272.11] = 10.68, p< 0.001	F [1, 142] = 8.792, p= 0.004	F[1.91, 272.11] = 17.57, p< 0.001	0.110
Perceived Benefit	F[1.71, 243.11] = 11.79, p< 0.001	F[1, 142] = 4.08, p= 0.045	F[1.71, 243.11] = 8.45, p= 0.001	0.056
Perceived Barrier	F[1.89, 268.81] = 1.40, p= 0.24	F[1, 142] = 6.23, p= 0.014	F[1.89, 268.81] = 2.64, p= 0.07	0.018
Perceived Self-Efficacy	F[1.72, 245.42] = 2.76, p= 0.073	F[1, ١٤٢] = ٠.004, p= 0.948	F[1.72, 245.42] = 3.38, p= 0.042	0.023

Knowledge score ranged from 0 to 30. Belief scores ranged from 1 to 4. F = F statistic

Table 4 presents the mixed-design ANOVA results for the effects of time, group, and their interaction on the study variables. A significant main effect of time was observed (F[1.91, 271.19] = 25.56, p < 0.001), indicating that knowledge scores changed across measurement points. A significant between-group effect was found (F[1, 142] = 19.23, p < 0.001), and a significant time × group interaction (F[1.91, 271.19] = 30.93, p < 0.001, η^2 = 0.179) indicated that the increase in knowledge over time was larger in the experimental group than in the control group. The partial η^2 value indicates a moderate, practically meaningful effect of the intervention on knowledge.

Significant main effects of time (F[1.91, 272.11] = 10.68, p < 0.001) and group (F[1, 142] = 8.79, p = 0.004) were observed, along with a significant time × group interaction (F[1.91, 272.11] = 17.57, p < 0.001, η^2 = 0.110). These results indicate that the intervention moderately enhanced students' perception of lung cancer risk over time.

Main effects of time (F[1.71, 243.11] = 11.79, p < 0.001) and group (F[1, 142] = 4.08, p = 0.045) were significant, with a significant time × group interaction (F[1.71, 243.11] = 8.45, p = 0.001, η^2 = 0.056), suggesting modest but detectable improvements in perceived benefits due to the intervention.

No significant main effect of time was observed (F[1.89, 268.81] = 1.40, p = 0.24), but a significant between-group effect (F[1, 142] = 6.23, p = 0.014) was found. The time × group interaction was not significant (F[1.89, 268.81] = 2.64, p = 0.07), indicating similar temporal changes across groups. This shows that the intervention had a limited impact on perceived barriers.

No significant main effects of time (F[1.72, 245.42] = 2.76, p = 0.073) or group (F[1, 142] = 0.004, p = 0.948) were detected. However, a small but significant time × group interaction was observed (F[1.72, 245.42] = 3.38, p = 0.042, η^2 = 0.023), indicating modest differences in self-efficacy changes between the experimental and control groups over time. Notably, the control group showed slight improvements in self-efficacy from baseline to follow-up (p = 0.005) and from post-test to follow-up (p = 0.024), highlighting that some change occurred even without formal intervention.

Table 5.

Bonferroni Post-hoc Comparisons Across Measurement Times for the Experimental and Control Groups

Variable	Groups	Post hoc Using Bonferroni		
		(1) vs (2) (P)	(1) vs (3) (p)	(2) vs (3) (P)
Knowledge	Interventional group	(p< 0.001)	(p<0.001)	(p= 0.001)
	Non-interventional group	(p=1)	(p=1)	(p= 0.706)
Perceived Risk	Interventional group	(p<0.001)	(p<0.001)	(p= 1)
	Non-interventional group	(p=0.068)	(p=0.250)	(p=1)
Perceived Benefit	Interventional group	(p<0.001)	(p=0.068)	(p=0.139)
	Non-interventional group	(p=0.287)	(p=0.147)	(p=0.063)
Perceived barrier	Interventional group	(P=0.257)	(p=0.119)	(p=1)
	Non-interventional group	(p=1)	(p=0.797)	(p=1)
Perceived Self-Efficacy	Interventional group	(p=0.047)	(p=0.277)	(p=1)
	Non-interventional group	(p=1)	(p=0.005)	(p=0.024)

Table 5 presents Bonferroni post-hoc comparisons for all study variables across measurement times.

Knowledge: Scores increased significantly from baseline to post-test and follow-up ($p < 0.001$), with a smaller but still significant increase from post-test to follow-up ($p = 0.001$). *Perceived Risk:* Improved significantly from baseline to post-test and baseline to follow-up ($p < 0.001$), while no significant change occurred between post-test and follow-up ($p = 1$). *Perceived Benefits:* Increased significantly from baseline to post-test ($p < 0.001$), but changes from baseline to follow-up ($p = 0.068$) and post-test to follow-up ($p = 0.139$) were not significant.

Perceived Barriers: No significant changes were observed across any time points (baseline vs post-test $p = 0.257$, baseline vs follow-up $p = 0.119$, post-test vs follow-up $p = 1$), indicating that the intervention had a limited impact on perceived barriers. *Self-Efficacy:* Increased slightly from baseline to post-test ($p = 0.047$), with no further significant change at follow-up ($p = 0.277$ and $p = 1$).

Knowledge ($\eta^2 = 0.179$) and perceived risk ($\eta^2 = 0.110$) showed moderate effect sizes, indicating that the educational program produced meaningful practical improvements. Smaller effect sizes for perceived benefits ($\eta^2 = 0.056$) and self-efficacy ($\eta^2 = 0.023$) suggest modest but detectable impacts. Perceived barriers remained largely unaffected by the intervention

Discussion and Conclusion

This study aims to assess the effectiveness of a health belief model–based educational program in improving male student smokers' knowledge and beliefs about lung cancer screening. Results showed that after participating in education, college students demonstrated a better knowledge about lung cancer and enhanced perceptions of risks, benefits, and self-efficacy regarding low-dose computed tomography (LDCT).

The moderate-to-low scores in students' knowledge, perceived risk, perceived benefits, and perceived self-efficacy in the baseline assessment for both the experimental and control groups were expected. However, the unexpected finding was the stability of the unchanged perceived barriers score in the experimental group after the intervention.

Knowledge improved significantly (with a large effect size) in the experimental group after program delivery, whereas it remained relatively stable in the control group. This implies the efficacy of the health belief model–based educational program in elevating smokers' lung cancer-related knowledge. This finding is significant in clinical settings, as improving knowledge is a conventional disease-prevention method. This result is in line with previous studies like Al-Fayyadh et al. (2022). This indicated that model-based education has a significant impact on knowledge.

Although our findings are generally consistent with previous HBM-based educational interventions (Al-Fayyadh et al., 2022; Williams, Shelton, et al., 2021), it is important to note potential differences in study contexts. Participants in prior studies may have differed in age, educational background, or prior exposure to health information, and the healthcare systems in which those studies were conducted may have provided different access to LDCT screening. These differences could influence both baseline knowledge and beliefs, as well as the magnitude of changes observed after the intervention. Therefore, while comparisons provide useful insights, caution is warranted in directly generalizing results across populations and healthcare settings.

The study findings revealed that health education modestly improved students' beliefs concerning the risk of lung cancer, with post-intervention levels remaining moderate rather than reaching high endorsement. Students of the intervention group felt that they are vulnerable to lung cancer after education. This provides valuable information on an overlooked aspect of preventive behaviors among smokers under 50 years old. According to HBM, risk perception enhances willingness to participate in preventive activities. Therefore, these results facilitate nurses in concentrating on enhancing risk perception while motivating young adults to adopt healthy behaviors, such as LDCT. These findings are in line with those of Williams, Looney, et al. (2021), who found that, after participating in a health education program, participants' perceptions of their lung cancer risk improved.

Study results indicated that beliefs about the benefits of LDCT improved modestly among participants in the experimental group, with post-intervention scores reflecting only partial practical impact. College students participated in the health education and realized that LDCT is an efficient, cost-effective, and safe investigation for earlier lung cancer detection with minimal side effects. Earlier detection plays an important role in disease survival rates, treatment efficacy, and mortality. Perceived benefit is a key predictor of adopting a healthy lifestyle. Consistent with earlier studies, participants' knowledge of the benefits of lung cancer screening was increased after participating in an educational session based on the health belief model (Williams, Looney, et al., 2021) .

The intervention, based on the health belief model, improved students' confidence in their ability to conduct LDCT. After education, students in the experimental group were more confident about getting LDCT in the future, although the control group showed slight but measurable improvements in self-efficacy over time, indicating some natural or external influence. According to the HBM, perceived self-efficacy plays a significant role in determining behavioral outcomes. This observation is consistent with the research of Williams, Looney, et al. (2021), which revealed a significant effect of education on participants' self-efficacy.

The current study demonstrated no significant change in the perceived barriers score among students of both groups over time. This suggests that educating people about low-dose computed tomography (CT) scans alone is insufficient to reduce the practical, financial, logistical, or cultural barriers they face in performing the test. Additional qualitative investigation and policy-level interventions may be necessary to address these obstacles. Considering study findings, additional efforts by health care providers and researchers are essential to mitigate this issue. Alternative intervention approaches, such as developing and delivering health education programs about minimizing lung cancer screening barriers through social media may be useful. These results are consistent with the findings reported by Williams, Looney, et al. (2021). The results of this study showed little change in students' perceived barriers after education.

In summary, while the educational program improved knowledge and produced modest enhancements in beliefs, caution is warranted when interpreting its impact on actual LDCT screening behavior. The improvements in perceived risk, perceived benefits, and self-efficacy were meaningful but moderate, and perceived barriers remained largely unaffected, highlighting the need for additional systemic or practical interventions.

Implications for nursing

Health belief model–based educational programs can serve as a valuable intervention for nurses aiming to enhance knowledge and beliefs about lung cancer screening among young adults. However, claims regarding cost-effectiveness or ease of implementation should be made cautiously, as this study did not collect data on resource use, staff time, or participant burden. Nursing educators may consider integrating theory-based education into curricula to enhance understanding of lung cancer and the benefits of screening.

The study findings also suggest that interventions should specifically target HBM constructs that are most resistant to change, such as perceived barriers, to support more effective preventive behaviors. Policy recommendations for incorporating health education into routine care should account for these limitations, and further research is needed to evaluate whether changes in knowledge and beliefs translate into actual LDCT screening behavior.

Conclusion

Students at Telafer University reported modest improvements in health-related knowledge, risk perception, and benefit perception, while the self-efficacy was minimal (small effect size) for lung cancer screening after participating in a health belief model–based educational program. However, perceived barriers remained largely unchanged, and the intervention's small improvements in self-efficacy were observed only partly in the control group, indicating a partial effect of the intervention.

These findings should be interpreted cautiously, as the study did not assess actual screening behavior, and generalizability is limited due to the single-university sample and non-random allocation. Further research is warranted to explore strategies to reduce perceived barriers and to evaluate whether changes in knowledge and beliefs translate into real-world lung cancer screening behavior.

Acknowledgments

The authors express their gratitude and appreciation to all participants.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

The study protocol adhered to the principles outlined in the Declaration of Helsinki, which provides guidelines for ethical research involving human participants. Ethical considerations in this study were that participation was entirely optional.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

Funding

This research was carried out independently, with personal funding, and without financial support from any governmental or private institution or organization.

Authors' Contributions

All authors equally contribute to this study.

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