Thirdhand smoke beliefs and tobacco product use among hospital nurses: A cross-sectional study

Yasemin Çelik[1], Hasan Furkan Özdemir[2], Aydın Balcı[3]

ABSTRACT

INTRODUCTION Thirdhand smoke (THS) is persistent tobacco contamination on surfaces and in dust. Nurses' beliefs about this exposure may influence risk communication and tobacco-control practice. This study evaluated THS beliefs among hospital nurses and identified associated factors.

METHODS This cross-sectional study, conducted between June and September 2025, included 404 nurses who had worked for at least 1 year at a university hospital in Ankara, Türkiye. Participants completed a descriptive form and the Turkish version of the Beliefs About Thirdhand Smoke (BATHS-T) scale. Descriptive statistics, independent-samples t-tests, and multiple linear regression were used.

RESULTS The mean BATHS-T scale total score was 33.11 (SD=7.80). In the adjusted multivariable model, each one-category shift from never to former to current smoking was associated with a lower total score (B= -1.636; 95% CI: -2.564 – -0.709; β= -0.181, p=0.001). Compared with users, non-users of e-cigarettes and hookah had higher adjusted total scores (e-cigarette: B=3.330; 95% CI: 0.323–6.336; β=0.112, p=0.030; hookah: B=2.558; 95% CI: 0.062–5.053; β=0.103, p=0.045). Lack of prior THS knowledge was not independently associated with the total score (B= -1.723; 95% CI: -3.467–0.021; β= -0.094, p=0.053).

CONCLUSIONS The mean score for items was descriptively higher for health than for persistence. Scores decreased across smoking-status categories from never to former to current smoking, while non-users of e-cigarettes and hookah had higher total and/or subscale scores. The findings may help inform targeted THS education and consideration of THS within hospital tobacco-control strategies.

Tob. Induc. Dis. 2026;24(November):212 https://doi.org/10.18332/tid/240591

AFFILIATION
1 Department of Nursing, Faculty of Health Sciences, Afyonkarahisar Health Sciences University, Afyonkarahisar, Türkiye
2 Ankara Etlik City Hospital, Ankara, Türkiye
3 Department of Chest Diseases, Faculty of Medicine, Afyonkarahisar Health Sciences University, Afyonkarahisar, Türkiye

CORRESPONDENCE TO
Yasemin Çelik. Afyonkarahisar Health Sciences University, Faculty of Health Sciences, Department of Nursing, Ali Çetinkaya Campus, 03200, Afyonkarahisar, Türkiye
E-mail: yasemin.celik@afsu.edu.tr
ORCID iD: https://orcid.org/0000-0002-8134-3026

KEYWORDS
thirdhand smoke, nurses, tobacco products, health beliefs, environmental exposure

Received: 1 August 2026
Revised: 19 September 2026
Accepted: 1 October 2026

INTRODUCTION

Tobacco use remains a major preventable cause of morbidity and mortality[1]. Although the adverse effects of active and secondhand smoke are well established, thirdhand smoke (THS) has emerged as a distinct environmental health concern[2-4]. THS comprises residual tobacco pollutants that remain on walls, furniture, textiles, clothing, hair, skin, and dust after smoking has stopped. These residues may be re-emitted, resuspended, or transformed through reactions with indoor pollutants, creating prolonged exposure even where active smoking is prohibited[3-7]. Experimental and observational evidence has associated THS with oxidative stress, DNA damage, inflammation, immune dysfunction, pulmonary injury, and adverse developmental effects[8-12]. Tobacco-derived metals and other toxic constituents can

Published by European Publishing. © 2026, Çelik Y. et al. This is an Open Access article distributed under the terms of the Creative Commons Attribution 4.0 International License (https://creativecommons.org/licenses/by/4.0/).

also accumulate in settled dust, and urinary cotinine findings indicate that exposure may occur without reported active or secondhand smoking[13,14].

These findings have direct implications for patients because exposure can occur through inhalation of re-emitted compounds and contaminated dust, ingestion following hand-to-mouth contact, and dermal contact with polluted surfaces or objects[3,4,7,14]. Evidence of pulmonary injury, immune dysfunction, genotoxicity, developmental effects, and impaired wound healing also raises concern for patients with chronic respiratory disease, impaired immunity, healing wounds, or limited physiological reserve[8-12,15]. Infants and children may receive greater exposure because they frequently touch contaminated surfaces and place their hands or objects in their mouths[12,16,17]. Although much of this mechanistic evidence is experimental, it supports a precautionary approach for vulnerable patient populations.

THS is therefore potentially relevant to patient safety in healthcare, rather than being only a household exposure. Residues can be transported on clothing, hands, hair, and personal belongings and introduced into otherwise smoke-free indoor environments[4,7,16]. Consequently, indoor smoking bans alone may not prevent contamination carried from homes, vehicles, or other exposed settings. Nurses spend prolonged periods in close physical contact with patients, handle equipment and textiles, and provide respiratory and wound care, smoking-cessation counseling, and patient and family education. Under-recognition of THS persistence may lead to missed opportunities to explain that exposure can continue after visible smoke has disappeared and to promote protective practices. Stronger beliefs about THS harm have been associated with smoke-free homes and protective behavior[18,19]. Nurses' THS beliefs may therefore influence both personal tobacco behavior and professional risk communication.

Studies among healthcare professionals have documented awareness of THS alongside important gaps in understanding its persistence and exposure pathways[20,21]. A previous study in Türkiye examined BATHS-T scores among medical students and found no significant association with tobacco-use status[22]. To our knowledge, evidence focusing on practicing nurses remains limited, and the relationships of cigarette smoking, e-cigarette use, and hookah use with health- and persistence-related beliefs have not been adequately characterized. This study therefore evaluated THS beliefs among hospital nurses and examined the factors associated with BATHS-T total and subscale scores, with the broader aim of identifying educational and tobacco-control priorities that may reduce avoidable patient exposure.

METHODS

Study design

This cross-sectional study examined nurses' beliefs about THS and factors associated with those beliefs. Reporting followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidance[23] for cross-sectional studies (Supplementary file).

Setting and participants

The study was conducted at a university hospital in Ankara, Türkiye. The source population comprised 650 nurses employed during the study period. The minimum sample size was calculated as 242 using the formula for a known population, assuming a 95% confidence level, 5% margin of error, and p=0.50. Nurses who had worked at the hospital for at least 1 year and provided electronic informed consent were eligible. The 1-year criterion was intended to ensure sufficient familiarity with the hospital's clinical environment and institutional practices. Nurses employed for less than 1 year or declining consent were excluded. Invitations were distributed across the source population; however, the number who met the employment-duration criterion and the number who declined participation were not recorded separately. A total of 404 eligible nurses completed the questionnaire. Consequently, a formal response rate among eligible nurses could not be calculated; the analytic sample represented 62.2% of the source population. Sex/gender was not collected.

Data collection

Data were collected between June and September 2025 using an anonymous online questionnaire created in Google Forms and distributed through institutional e-mail. Before entering the questionnaire, participants received study information and provided

electronic informed consent. Questionnaire items were mandatory, which prevented item-level missing data in the final analytic dataset. No directly identifying personal information was collected.

Measures and variables

The questionnaire comprised a 15-item Nurse Descriptive Form and the Turkish version of the Beliefs About Thirdhand Smoke (BATHS-T) scale. The descriptive form assessed age in completed years, education level, clinical unit, cigarette smoking status, e-cigarette and hookah use, smokers in the home, home smoking rules, chronic disease, and self-reported prior knowledge of THS. Cigarette smoking status was self-classified as never, former, or current smoking. E-cigarette use, hookah use, smokers in the home, and prior THS knowledge were each classified from yes/no responses. Home smoking rules were classified as no smoking allowed, smoking allowed in some areas, or smoking allowed throughout the home. The questions on e-cigarette and hookah use did not specify frequency, duration, or a fixed recall period. Selection of variables was informed by previous research on THS beliefs, exposure, and tobacco-related behavior[3,4,18,19,24].

The BATHS scale was originally developed by Haardörfer et al.[24] and validated in Turkish (BATHS-T) by Çadırcı et al.[25]. It contains 9 items in 2 subscales: Health (5 items) and Persistence (4 items). Each item is scored from 1 to 5, producing a total score from 9 to 45; higher scores indicate stronger beliefs regarding the health effects and environmental persistence of THS. The Turkish validation study reported Cronbach's α values of 0.90 for the total scale, 0.86 for the health subscale, and 0.81 for the persistence subscale[25]. In the present study, the corresponding values were 0.932, 0.848, and 0.912, respectively.

The primary outcome was the BATHS-T scale total score; secondary outcomes were scores of the Health and Persistence subscales. Age was analyzed continuously in years. Smoking status was coded 1=never, 2=former, and 3=current smoking, and home smoking rules were coded 1=no smoking allowed, 2=smoking allowed in some areas, and 3=smoking allowed throughout the home; their coefficients represent a one-category increase across the stated order. Prior THS knowledge, e-cigarette use, and hookah use were coded 1=yes/user, and 2=no/non-user; therefore, their coefficients compare no/non-users with yes/users.

Statistical analysis

Data were analyzed using IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, NY, USA)[26]. Continuous variables are summarized as mean and standard deviation (SD), and categorical variables as frequency and percentage. Distributional normality was assessed with the Kolmogorov-Smirnov test. Independent-samples t-tests were used for group comparisons. Regression assumptions were assessed using residual plots, residual skewness and kurtosis, Breusch-Pagan tests, tolerance and variance inflation factor (VIF) values, Durbin-Watson statistics, and Cook's distances. Residual skewness and excess kurtosis were within ±2; Breusch-Pagan tests were nonsignificant p=0.120–0.219), VIFs ranged from 1.016 to 1.232, tolerance values from 0.811 to 0.985, Durbin-Watson statistics from 1.575 to 1.637, and the maximum Cook's distance was 0.060. No material violations of model assumptions or influential observations were identified. Candidate predictors were selected based on theoretical relevance, previous research, and preliminary univariable patterns; statistical significance in preliminary analyses was not required. To provide consistent adjustment and comparability across outcomes, the same six predictors – age, smoking status, prior THS knowledge, home smoking rules, e-cigarette use, and hookah use – were entered simultaneously into each model using the Enter method. Both unstandardized coefficients (B) with 95% confidence intervals and standardized coefficients (β) are reported. B expresses the expected score difference per unit or category change, whereas β facilitates comparison of relative association strength across predictors. All tests were 2-sided, and $p<0.05$ was considered statistically significant.

Ethical considerations

Ethical approval was obtained from the institutional Non-Interventional Scientific Research Ethics Committee (Decision no. 355; Meeting no. 2025/8; 13 June 2025), and permission was obtained from the study hospital. Participation was voluntary, electronic informed consent was obtained from all participants, and data were handled confidentially in accordance with the Declaration of Helsinki.

RESULTS

Participant characteristics

The analysis included 404 nurses. Their mean age was 30.54 years (SD=5.26). Most held a Bachelor's or postgraduate degree (81.7%) and worked in intensive care units (49.3%). Overall, 45.5% had never smoked, 23.8% were former smokers, and 30.7% were current smokers. E-cigarette use and hookah use were reported by 7.4% and 11.1%, respectively. Prior THS knowledge was reported by 23.3%, whereas 98.3% believed THS was harmful. Sex/gender was not collected (Table 1).

BATHS-T scale scores and prior knowledge

Mean BATHS-T Health, Persistence, and total scores were 18.83 (SD=4.09), 14.28 (SD=3.99), and 33.11 (SD=7.80), respectively (Table 2). Because the subscales contain different numbers of items, scores were also expressed per item; mean item scores were 3.77 for health and 3.57 for persistence. This comparison was descriptive and was not tested inferentially. Nurses reporting prior THS knowledge had a higher mean health score than those without such knowledge (19.54 [SD=4.37] vs 18.61 [SD=3.98]); the difference did not reach statistical significance (p=0.053). Persistence and total scores also did not differ significantly by self-reported knowledge (Table 3).

Factors associated with the total score

The total-score regression model, adjusted for age, smoking status, prior THS knowledge, home smoking rules, e-cigarette use, and hookah use, was statistically significant ($F[6, 397]=6.895$, $p<0.001$) and explained 9.4% of the variance ($R^2=0.094$; adjusted $R^2=0.081$). Smoking status was negatively associated with the total score, with scores decreasing across categories from never to former to current smoking (B= -1.636 95% CI: -2.564 – -0.709; β= -0.181, p=0.001). Compared with users, nurses who did not use e-cigarettes had total scores 3.33 points higher (B=3.330; 95% CI: 0.323–6.336; β=0.112, p=0.030), and nurses who did not use hookah had total scores 2.56 points higher (B=2.558; 95% CI: 0.062–5.053; β=0.103, P=0.045). Age,

Table 1. Demographic and tobacco-related characteristics of hospital nurses in a cross-sectional study at a university hospital in Ankara, Türkiye, June–September 2025 (N=404)

Variables	Category	n (%)
Age (years), mean (SD)		30.54 (5.26)
Education level	High school/ associate degree	74 (18.3)
	Bachelor's/ postgraduate degree	330 (81.7)
Clinical unit	Intensive care unit	199 (49.3)
	Inpatient ward	82 (20.3)
	Operating room	16 (4.0)
	Home healthcare	9 (2.2)
	Outpatient clinic	28 (6.9)
	Other	70 (17.3)
Smoking status	Never smoked	184 (45.5)
	Former smoker	96 (23.8)
	Current smoker	124 (30.7)
Cigarettes per day[a]	1–9	26 (21.0)
	≥10	98 (79.0)
Smoking duration (years)[a]	≤5	58 (46.8)
	>5	66 (53.2)
E-cigarette use	Yes	30 (7.4)
	No	374 (92.6)
Hookah use	Yes	45 (11.1)
	No	359 (88.9)
Prior knowledge of THS	Yes	94 (23.3)
	No	310 (76.7)
Smoker in the home	Yes	138 (34.2)
	No	266 (65.8)
Home smoking rules	No smoking allowed	127 (31.4)
	Smoking allowed in some areas	247 (61.1)
	Smoking allowed throughout the home	30 (7.4)
Belief that THS is harmful	Yes	397 (98.3)
	No	7 (1.7)
Place where most of life was spent	City center	319 (79.0)
	District	61 (15.1)
	Town/village	24 (5.9)
Diagnosed chronic disease	No	372 (92.1)
	Yes	32 (7.9)

Continued

Table 1. Continued

Variables	Category	n (%)
Type of chronic disease[b]	Asthma	21 (65.6)
	Bronchitis	6 (18.8)
	Type 1 diabetes mellitus	5 (15.6)

a Among current smokers (n=124). b Among participants with a chronic disease (n=32). Sex/gender was not collected. SD: standard deviation. THS: thirdhand smoke.

lack of prior THS knowledge, and home smoking rules were not independently associated with the total score (Table 4).

Factors associated with subscale scores

Both subscale models were adjusted for the same six predictors as the total-score model. The Health model explained 9.3% of the variance (R^2=0.093; adjusted R^2=0.080; F[6, 397]=6.820, p<0.001). Health scores decreased from never to former to current smoking (B= -0.864; 95% CI: -1.351 – -0.377; β= -0.182, p=0.001). Compared with users, nurses who did not use hookah had health scores 1.31 points higher (B=1.313; 95% CI: 0.003–2.623; β=0.101, p=0.049). The difference between e-cigarette non-users and users did not reach statistical significance (B=1.543; 95% CI: -0.035–3.121; β=0.099, p=0.055). The revised Persistence model explained 8.5% of the variance (R^2=0.085; adjusted R^2=0.071; F[6397]=6.162, p<0.001). Persistence scores decreased with age (B= -0.075 per year; 95% CI: -0.147 – -0.003; β= -0.099, p=0.043) and across smoking-status categories from never to former to current smoking (B= -0.772, 95% CI: -1.249 – -0.295; β= -0.167, p=0.002). Compared with users, e-cigarette non-users had persistence scores 1.79 points higher (B=1.786; 95% CI: 0.240–3.332; β=0.118, p=0.024). Lack of prior THS knowledge (B= -0.827; 95% CI: -1.723–0.070; β= -0.088, p=0.071), home smoking rules, and hookah non-use (B=1.244; 95% CI: -0.039–2.528; β=0.098, p=0.057) were not independently associated with persistence scores (Table 5).

DISCUSSION

Main findings

After accounting for the different numbers of items in the subscales, the mean item score was descriptively higher for health than for persistence (3.77 vs 3.57). This difference was not tested inferentially and should be interpreted descriptively. Smoking

Table 2. BATHS-T scale total and subscale scores among hospital nurses in a cross-sectional study at a university hospital in Ankara, Türkiye, June–September 2025 (N=404)

Scale/subscale	n	Minimum	Maximum	Mean (SD)
BATHS-T Health	404	5	25	18.83 (4.09)
BATHS-T Persistence	404	4	20	14.28 (3.99)
BATHS-T total	404	9	45	33.11 (7.80)

BATHS-T: Turkish version of the Beliefs About Thirdhand Smoke scale. SD: standard deviation.

Table 3. BATHS-T scale scores by self-reported thirdhand smoke knowledge among hospital nurses in a cross-sectional study at a university hospital in Ankara, Türkiye, June–September 2025 (N=404)

Scale/subscale	Knowledge present (N=94) Mean (SD)	No knowledge (N=310) Mean (SD)	t	p
BATHS-T Health	19.54 (4.37)	18.61 (3.98)	1.937	0.053
BATHS-T Persistence	14.90 (4.27)	14.09 (3.89)	1.737	0.083
BATHS-T total	34.45 (8.46)	32.70 (7.55)	1.906	0.057

An independent-samples t-test was used. BATHS-T: Turkish version of the Beliefs About Thirdhand Smoke scale. SD: standard deviation.

Table 4. Adjusted factors associated with the BATHS-T scale total score among hospital nurses in a cross-sectional study at a university hospital in Ankara, Türkiye, June–September 2025 (N=404)

Variables	B	SE	β	t	p	95% CI
Constant	32.426	4.477		7.242	<0.001	23.624–41.227
Age (years)	-0.108	0.072	-0.073	-1.508	0.132	-0.249–0.033
Smoking status, per-category trend	-1.636	0.472	-0.181	-3.468	0.001	-2.564 – -0.709
No prior THS knowledge vs prior knowledge	-1.723	0.887	-0.094	-1.943	0.053	-3.467–0.021
Home smoking rules, per-category trend	-0.673	0.718	-0.050	-0.938	0.349	-2.084–0.737
E-cigarette non-user vs user	3.330	1.529	0.112	2.177	0.030	0.323–6.336
Hookah non-user vs user	2.558	1.270	0.103	2.015	0.045	0.062–5.053

Model summary: R=0.307; R^2=0.094; adjusted R^2=0.081; F(6, 397)=6.895; p<0.001. All estimates are mutually adjusted for the six variables shown. Smoking status was coded 1=never, 2=former, and 3=current smoking; its coefficient represents a one-category increase. Home smoking rules were coded 1=no smoking allowed, 2=smoking allowed in some areas, and 3=smoking allowed throughout the home; its coefficient represents a one-category increase. Dichotomous variables compare the category stated with its comparator. B: unstandardized coefficient. β: standardized coefficient. CI: confidence interval. SE: standard error. THS: thirdhand smoke.

Table 5. Adjusted factors associated with BATHS-T subscale scores among hospital nurses in a cross-sectional study at a university hospital in Ankara, Türkiye, June–September 2025 (N=404)

Outcome	Variables	B	SE	β	t	p	95% CI
Health	Constant	18.413	2.350		7.835	<0.001	13.793–23.032
	Age (years)	-0.033	0.038	-0.043	-0.880	0.379	-0.107–0.041
	Smoking status, per-category trend	-0.864	0.248	-0.182	-3.489	0.001	-1.351 – -0.377
	No prior THS knowledge vs prior knowledge	-0.896	0.466	-0.093	-1.926	0.055	-1.812–0.019
	Home smoking rules, per-category trend	-0.478	0.377	-0.067	-1.268	0.205	-1.218–0.263
	E-cigarette non-user vs user	1.543	0.803	0.099	1.923	0.055	-0.035–3.121
	Hookah non-user vs user	1.313	0.666	0.101	1.971	0.049	0.003–2.623
Persistence	Constant	14.013	2.303		6.086	<0.001	9.486–18.540
	Age (years)	-0.075	0.037	-0.099	-2.035	0.043	-0.147 – -0.003
	Smoking status, per-category trend	-0.772	0.243	-0.167	-3.183	0.002	-1.249 – -0.295
	No prior THS knowledge vs prior knowledge	-0.827	0.456	-0.088	-1.812	0.071	-1.723–0.070
	Home smoking rules, per-category trend	-0.196	0.369	-0.028	-0.530	0.597	-0.921–0.530
	E-cigarette non-user vs user	1.786	0.786	0.118	2.271	0.024	0.240–3.332
	Hookah non-user vs user	1.244	0.653	0.098	1.906	0.057	-0.039–2.528

Health model: R^2=0.093; adjusted R^2=0.080; F(6, 397)=6.820; p<0.001. Persistence model: R^2=0.085; adjusted R^2=0.071; F(6, 397)=6.162; p<0.001. Each model includes the same six predictors. Smoking status was coded 1=never, 2=former, and 3=current smoking; its coefficient represents a one-category increase. Home smoking rules were coded 1=no smoking allowed, 2=smoking allowed in some areas, and 3=smoking allowed throughout the home; its coefficient represents a one-category increase. Dichotomous variables compare the category stated with its comparator. B: unstandardized coefficient. β: standardized coefficient. CI: confidence interval. SE: standard error. THS: thirdhand smoke.

status had the strongest standardized association with overall THS beliefs, with scores decreasing across the ordered categories from never to former to current smoking. Non-use of e-cigarettes and hookah was associated with higher total and/or subscale scores. In the consistently adjusted models, older age showed a small negative association with persistence, whereas self-reported prior THS knowledge was not independently associated with any outcome.

Comparison with previous evidence

The modest descriptive difference between means for health and persistence items is compatible with studies showing that healthcare professionals recognize health harm more readily than residue persistence and indirect exposure pathways[20,21,24]. Visible smoke has an immediate connection with respiratory harm, whereas THS remains after visible smoke has disappeared and can undergo chemical transformations on surfaces[4,6]. Education that focuses only on the harms of smoking may therefore leave gaps concerning surface contamination, re-emission, and transfer through clothing or hands.

Nurses who reported prior THS knowledge had somewhat higher health scores, but prior knowledge was not independently related to overall beliefs. This result is consistent with the possibility that simple familiarity with the term is less important than the depth and practical content of education. Earlier studies similarly found knowledge gaps among health professionals despite general recognition of THS[20,21]. Future educational interventions could consider explaining where residues accumulate, how long they persist, and why ventilation or avoiding visible smoke may not eliminate exposure.

THS belief scores decreased across the ordered smoking-status categories from never to former to current smoking. This pattern agrees with studies in which smokers reported lower beliefs about THS harm[18,27]. By contrast, a 2023 study of 392 medical students in Türkiye found no significant association between tobacco-use status and BATHS-T scale scores[22]. The present work differs by examining practicing nurses, separating current and former smoking, including e-cigarette and hookah use, and applying multivariable models. The contrast may reflect differences in professional experience, tobacco-use patterns, or the way smoking status was operationalized, but causal or developmental explanations cannot be inferred from either cross-sectional study.

Non-users of e-cigarettes and hookah had higher adjusted total scores; e-cigarette non-users also had higher persistence scores, whereas hookah non-users had higher health scores. Persistent environmental contamination from combustible tobacco smoke has been documented on indoor surfaces and in dust[13,28-30]. However, the present study measured beliefs rather than environmental exposure and did not assess product-use frequency or product-specific risk perceptions. The mechanisms underlying these associations therefore remain uncertain. The findings may help identify groups for future educational research but should not be interpreted as evidence that product use caused weaker THS beliefs or as direct evidence of product-specific environmental contamination.

Implications for tobacco-control and nursing practice

Nurses routinely provide cessation counseling and care for patients with chronic respiratory disease, cancer, immune compromise, or limited respiratory reserve. THS may be carried through hands, hair, uniforms, personal belongings, textiles, and indoor surfaces, extending exposure beyond periods of active smoking[4,7,15,31]. Counseling that emphasizes only smoke-free time or ventilation may overlook residual contamination. These findings may help inform future nursing curricula and continuing professional education and may support consideration of THS persistence, indirect transfer, environmental-cleaning limitations, and risk communication when hospital tobacco-control policies are developed or revised.

Future studies

Future studies should examine thirdhand-smoke beliefs and related counseling practices in multicenter and cross-national samples to assess contextual and cultural variation. Longitudinal and intervention studies are needed to determine whether competency-based education and staff smoking-cessation support improve thirdhand-smoke knowledge, risk communication, smoke-free practices, and institutional policy implementation. Studies combining self-reported measures with objective indicators, such as surface nicotine, environmental sampling, or biomarkers, could clarify the relationships among beliefs, professional practices, and actual exposure. Cross-cultural evaluation of the BATHS scale, including measurement invariance, would also strengthen international comparisons.

Strengths and limitations

Strengths include a relatively large sample of practicing nurses, use of a validated Turkish instrument, separate analysis of health and persistence beliefs, and examination of conventional and alternative tobacco-product use. Invitations across the source population, an anonymous self-administered questionnaire, and mandatory survey items were intended to reduce convenience-sampling, interviewer, social-desirability, and missing-data biases; however, self-selection, nonresponse, and self-report bias could not be eliminated. Several additional limitations should be considered. The cross-sectional design precludes causal inference, and the single-center setting limits generalizability. Exclusion of nurses employed for less than 1 year may have introduced selection bias if newly employed nurses differed systematically in their THS beliefs. Sex/gender was not collected, limiting description of the sample and assessment of generalizability. Because the numbers meeting the employment-duration criterion and declining participation were unavailable, a formal response rate and nonresponse analysis could not be calculated; participants represented 62.2% of the source population. Self-reported tobacco use and THS knowledge may be affected by recall or social-desirability bias. Prior knowledge was measured with one self-reported item rather than an objective knowledge test. E-cigarette and hookah use were measured using single yes/no items without a defined recall period or information on frequency, duration, or product-specific exposure. The Persistence subscale yielded a Cronbach's α of 0.912 despite containing only four items, higher than both the Health subscale in this study (α=0.848) and the Persistence subscale in the original Turkish validation (α=0.81). This may reflect strong inter-item homogeneity or similar response patterns and should not be interpreted as evidence of broader construct coverage. The comparison of health and persistence relied on means of descriptive items and was not tested inferentially. Finally, the consistently adjusted models explained modest proportions of score variance (R^2=8.5–9.4%), so residual and unmeasured confounding by professional, psychological, organizational, or other factors remains possible.

CONCLUSIONS

The mean score of items was descriptively higher for health than for persistence. Overall THS belief scores decreased across smoking-status categories from never to former to current smoking, and non-users of e-cigarettes and hookah had higher total and/or subscale scores than users. These associations identify potential educational target groups but do not establish causal effects or product-specific contamination. The findings may help inform future THS education and may support consideration of THS persistence and indirect exposure pathways in smoking-cessation counseling, nursing education, and hospital tobacco-control practice.

REFERENCES

1. Tobacco and nicotine. World Health Organization. June 26, 2026. Accessed October 1, 2026. https://www.who.int/news-room/fact-sheets/detail/tobacco
2. Kolci K, Garipkuş SN, Reis R. Thirdhand smoke exposure and its toxicological impacts: a review on target organ based studies. FABAD J Pharm Sci. 2023;48(2):303–318. doi:10.55262/fabadeczacilik.1144926
3. Jacob P 3rd, Benowitz NL, Destaillats H, et al. Thirdhand smoke: new evidence, challenges, and future directions. Chem Res Toxicol. 2017;30(1):270–294. doi:10.1021/acs.chemrestox.6b00343
4. Matt GE, Quintana PJ, Destaillats H, et al. Thirdhand tobacco smoke: emerging evidence and arguments for a multidisciplinary research agenda. Environ Health Perspect. 2011;119(9):1218–1226. doi:10.1289/ehp.1103500
5. Ganjre AP, Sarode GS. Third hand smoke—A hidden demon. Oral Oncol. 2016;54:e3–4. doi:10.1016/j.oraloncology.2016.01.007
6. Sleiman M, Gundel LA, Pankow JF, Jacob P 3rd, Singer BC, Destaillats H. Formation of carcinogens indoors by surface-mediated reactions of nicotine with nitrous acid, leading to potential thirdhand smoke hazards. Proc Natl Acad Sci USA. 2010;107(15):6576–6581. doi:10.1073/pnas.0912820107
7. Sheu R, Stönner C, Ditto JC, Klüpfel T, Williams J, Gentner DR. Human transport of thirdhand tobacco smoke: a prominent source of hazardous air pollutants into indoor nonsmoking environments. Sci Adv. 2020;6(10):eaay4109. doi:10.1126/sciadv.aay4109
8. Martins-Green M, Adhami N, Frankos M, et al. Cigarette smoke toxins deposited on surfaces: implications

for human health. PLoS One. 2014;9(1):e86391. doi:10.1371/journal.pone.0086391
9. Reis R, Kolci K, Özhan Y, Coşkun GP, Sipahi H. Third-hand smoke exacerbates H2O2-driven airway responses in A549 cells. Turk J Pharm Sci. 2024;21(5):376–389. doi:10.4274/tjps.galenos.2024.36153
10. Hang B, Snijders AM, Huang Y, et al. Early exposure to thirdhand cigarette smoke affects body mass and the development of immunity in mice. Sci Rep. 2017;7: 41915. doi:10.1038/srep41915
11. Hang B, Sarker AH, Havel C, et al. Thirdhand smoke causes DNA damage in human cells. Mutagenesis. 2013;28(4):381–391. doi:10.1093/mutage/get013
12. Rehan VK, Sakurai R, Torday JS. Thirdhand smoke: a new dimension to the effects of cigarette smoke on the developing lung. Am J Physiol Lung Cell Mol Physiol. 2011;301(1):L1–L8. doi:10.1152/ajplung.00393.2010
13. Matt GE, Quintana PJE, Hoh E, et al. Tobacco smoke is a likely source of lead and cadmium in settled house dust. J Trace Elem Med Biol. 2021;63:126656. doi:10.1016/j.jtemb.2020.126656
14. Moon SY, Kim TW, Kim YJ, KimY, Kim SY, Kang D. Public facility utility and third-hand smoking exposure without first and second-hand smoking according to urinary cotinine level. Int J Environ Res Public Health. 2019;16(5):855. doi:10.3390/ijerph16050855
15. Dhall S, Alamat R, Castro A, et al. Tobacco toxins deposited on surfaces (third hand smoke) impair wound healing. Clin Sci (Lond). 2016;130(14):1269–1284. doi:10.1042/CS20160236
16. Ferrante G, Simoni M, Cibella F, et al. Third-hand smoke exposure and health hazards in children. Monaldi Arch Chest Dis. 2013;79(1):38–43. doi:10.4081/monaldi.2013.108
17. Mahabee-Gittens EM, Merianos AL, Matt GE. Preliminary evidence that high levels of nicotine on children's hands may contribute to overall tobacco smoke exposure. Tob Control. 2018;27(2):217–219. doi:10.1136/tobaccocontrol-2016-053602
18. Winickoff JP, Friebely J, Tanski SE, et al. Beliefs about the health effects of 'thirdhand' smoke and home smoking bans. Pediatrics. 2009;123(1):e74–9. doi:10.1542/peds.2008-2184
19. Escoffery C, Bundy L, Carvalho M, et al. Third-hand smoke as a potential intervention message for promoting smoke-free homes in low-income communities. Health Educ Res. 2013;28(5):923–930. doi:10.1093/her/cyt056
20. Darlow SD, Heckman CJ, Munshi T, Collins BN. Thirdhand smoke beliefs and behaviors among healthcare professionals. Psychol Health Med. 2017;22(4): 415–424. doi:10.1080/13548506.2016.1189579
21. Quispe-Cristóbal B, Lidón-Moyano C, Martín-Sánchez JC, et al. Knowledge and opinions of healthcare professionals about thirdhand smoke: a multi-national, cross-sectional study. Healthcare. 2022;10(5):945. doi:10.3390/healthcare10050945
22. Çoşğun İG, Çilekar Ş, Balcı A, et al. The beliefs of medical faculty students about thirdhand smoke. Tob Induc Dis. 2023;21:17. doi:10.18332/tid/157202
23. von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. PLoS Med. 2007;4(10): e296. doi:10.1371/journal.pmed.0040296
24. Haardörfer R, Berg CJ, Escoffery C, Bundy ŁT, Hovell M, Kegler MC. Development of a scale assessing Beliefs About Thirdhand Smoke (BATHS). Tob Induc Dis. 2017;15:4. doi:10.1186/s12971-017-0112-4
25. Çadirci D, Terzi NK, Terzi R, Cihan FG. Validity and reliability of Turkish version of Beliefs About Third-Hand Smoke Scale: BATHS-T. Cent Eur J Public Health. 2021;29(1):56–61. doi:10.21101/cejph.a6578
26. Release notes - IBM® SPSS® Statistics 25.0. IBM Corporation. August 8, 2017. Updated July 12, 2019. Accessed October 1, 2026. https://www.ibm.com/support/pages/release-notes-ibm%C2%AE-spss%C2%AE-statistics-250
27. Roberts C, Wagler G, Carr MM. Environmental tobacco smoke: public perception of risks of exposing children to second- and third-hand tobacco smoke. J Pediatr Health Care. 2017;31(1):e7–e13. doi:10.1016/j.pedhc.2016.08.008
28. Continente X, Henderson E, López-González L, et al. Exposure to secondhand and thirdhand smoke in private vehicles: measurements in air and dust samples. Environ Res. 2023;235:116681. doi:10.1016/j.envres.2023.116681
29. Delgado-Rendon A, Cruz TB, Soto D, Baezconde-Garbanati L, Unger JB. Second and thirdhand smoke exposure, attitudes and protective practices: results from a survey of Hispanic residents in multi-unit housing. J Immigr Minor Health. 2017;19(5):1148–1155. doi:10.1007/s10903-016-0540-x
30. Lopez-Galvez N, Mahabee-Gittens EM, Quintana PJE, et al. Environmental tobacco smoke is a major contributor to lead, cadmium, and arsenic in settled house dust. Chemosphere. 2026;394:144820. doi:10.1016/j.chemosphere.2025.144820
31. Vanzi V, Lommi M, Stievano A, Rocco G, Zega M, Caggianelli G. Thirdhand smoke and neonatal/pediatric health: a scoping review on nursing implications. Healthcare (Basel). 2025;13(24):3289. doi:10.3390/healthcare13243289

ACKNOWLEDGEMENTS
The authors thank the nurses who participated in this study. Professional English-language editing was provided by Enago.

CONFLICTS OF INTEREST
The authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest and none was reported.

FUNDING
There was no source of funding for this research.

ETHICAL APPROVAL AND INFORMED CONSENT
Ethical approval was obtained from the institutional Non-Interventional Scientific Research Ethics Committee (Approval number: 355; Date: 13 June 2025), and permission was obtained from the study hospital. Participants provided informed consent.

DATA AVAILABILITY
The data supporting this research are available from the authors on reasonable request.

AUTHORS' CONTRIBUTIONS
YÇ and AB: conceptualization, formal analysis and interpretation. YÇ: methodology. HFÖ: data collection. YÇ and HFÖ: literature search, writing of original draft. YÇ, HFÖ and AB: writing, reviewing and editing of the manuscript. AB: supervision. All authors read and approved the final version of the manuscript.

AI DECLARATION
During manuscript preparation and revision, the authors used OpenAI ChatGPT (GPT-5; accessed July and September 2026) for English-language refinement, journal-format adaptation, and improvements to clarity and structure. The authors take full responsibility for the data, statistical results, interpretation, and final content.

PROVENANCE AND PEER REVIEW
Not commissioned; externally peer reviewed.

SUPPLEMENTARY FILE DISCLAIMER
The content has been provided by the author(s) and has not been reviewed, verified, or endorsed by European Publishing. It may not have undergone peer review. The views, opinions, and recommendations expressed are solely those of the author(s) and do not necessarily reflect the position of European Publishing. European Publishing accepts no responsibility or liability for any consequences arising from the use of, or reliance on, this content.