

Original Article



Third-hand Smoking Beliefs in Patients with Cancer

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Abstract

OBJECTIVE: Exposure to third-hand smoke (THS) represents an important health concern in many indoor environments. This study was conducted to test the beliefs of cancer patients about THS and to examine associations with effective factors.

MATERIAL AND METHODS: This cross-sectional study included 119 patients who were being treated for cancer in the oncology clinic of a University Hospital. The data were collected using a face-to-face questionnaire. This study consisted of the introductory characteristic form and the “Turkish Form of the Beliefs About Third-hand Smoke Scale”.

RESULTS: The mean age was 58.52±14.01, with 73% of the participants being female, and 58% reported not smoking. They had a moderate Third-hand Smoke Scale (3.53±0.45). The impact of THS on health was 3.92±0.48 and Persistence in the Environment was 3.21±0.57. Education, smoking, and having cancer relatives were significantly associated with the THS scale scores.

CONCLUSION: None of the participants had previously heard of the concept of THS. Beliefs about the harms of THS exposure were moderate. They believed that THS has a more harmful impact on health than its persistence in the environment. Graduate degrees, smoking, and those with cancer relatives believed the harms of third-hand exposure more than the others.

KEYWORDS: Belief, cancer, patient, third-hand smoke

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INTRODUCTION

There is no safe dose of exposure to the smoke and residues produced by the consumption of cigarettes or tobacco products. Therefore, 1.3 million people worldwide are exposed to passive smoking.¹ One of the less well-known forms of passive exposure is third-hand smoke (THS) exposure. THS is a new concept in the field of tobacco control. The term refers to residual tobacco smoke contamination that remains on the surface and in dust, carpets, upholstery, and clothing long after the cigarette or other tobacco products have been extinguished.² This residue can react with common indoor pollutants to create a toxic mix of compounds that pose a health risk, especially to children and infants who are in contact with contaminated surfaces or who breathe in the particles that become airborne.^{2,3}

The term “the four Rs” is often used to describe the characteristics of THS. Residual refers to residue left on surfaces, such as walls, furniture, and clothing, after tobacco smoke has cleared. The term reactive indicates that the chemicals in tobacco can react with other substances, such as cleaning products or pollutants in the air, creating new toxic compounds that can be harmful to health. Remains highlight that THS can persist in the environment for long periods, even after the cessation of active smoking, and can accumulate in indoor environments like homes and cars. Risks emphasize that THS poses health risks to non-smokers, especially children and infants, who may come into contact with contaminated surfaces or breathe in airborne particles.³ THS can be harmful to health and has been associated with respiratory infections, such as asthma and bronchitis, as well as with an increased risk of cancer and many other health problems. THS has been described in relation to cancer in previous studies, and it has been shown that THS contains many carcinogenic substances.^{3,4} THS undergoes long-lasting chemical transformations with ozone gases^{4,5} and nitrous

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acidmajority set in cars⁶ and homes⁷ producing secondary immensely carcinogenic pollutants, such as formaldehyde³ and the tobacco-specific nitrosamines 4-(methylnitrosamino)-4-(3-pyridyl)butanal (NNA) and 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK).^{6,8} THS exposure occurs through dermal absorption, ingestion, and inhalation. Nicotine in cigarettes often reacts with ozone, nitrous acid, and formaldehyde to form carcinogens and is re-dispersed as vapor or adsorbed on dust, thereby returning to an inhalable aerosol form to form THS exposure. Traditional cleaning methods are not effective in eliminating THS exposure. In contrast, the ability of THS compounds to strongly adsorb on surfaces and penetrate materials is an important factor in their survival in the environment. Vacuuming and wiping strategies can also cause THS particles to transform. THS compounds released on any surface may be resuspended in aerosol form, increasing the risk of inhalation exposure.⁹ In fact, a study reported that THS compounds remained in the tissue of clothing for more than 19 months.¹⁰ As an important pollutant and carcinogen source in the environment for a long time, THS is harmful to human health and can affect the healthy functioning of vital biological processes, as well as organ systems.^{11,12} It is a huge public health problem that affects many patient groups. To the best of our knowledge, few studies have described the knowledge and beliefs of patients with cancer related to THS, and no study has been conducted in Türkiye on this issue. This is the first and only study in which patients with cancer were asked about their knowledge of THS. After briefly explaining THS to the participants, they were asked if they believe THS is harmful to their health. Based on these findings, the aim was to test the beliefs of cancer patients about THS and examine the relationships between effective factors.

MATERIAL AND METHODS

Procedure and Participants

The study was an observational-descriptive study conducted to test the beliefs and behaviors of patients with cancer about THS. Informed consent forms, permission from the hospital management, and ethics committee approval (decision no: 55, date: 30.06.2022) from the Atatürk University Clinical Research Ethics Committee were obtained.

The study population consisted of 119 patients with cancer who were being treated in an oncology unit at a university hospital (in a province of Türkiye) and who completed a brief anonymous questionnaire. The inclusion criteria for this study were patients with cancer, treatment in the hospital where conducted research, not have to be psychiatric diagnosis. Participants had not heard of THS before the survey, so it was

explained that THS refers to residual tobacco smoke pollutants that linger on surfaces, fabrics, and in dust after cigarette smoking.

This study utilized a sociodemographic characteristics form, comprising questions about age, sex, marital status, education, presence of chronic illness, smoking habits, smoking at home or work, having a smoking household, treatment period, and having relatives with cancer. To measure patients' beliefs about THS, the Beliefs About Third-hand Smoke Scale (BATHS) was utilized. The BATHS was developed by Haardörfer et al.¹³ (2017) and was adapted by Odacı and Kitis¹⁴ (2021) to assess BATHS. The Likert scale is a 5-point Likert scale ranging from "1 = Strongly disagree to 5 = Strongly agree". The scale consists of nine items and two factors, namely "Persistence of THS in the Environment" and "Impact of THS on Health". The highest and lowest scores obtained from the scale are 5 and 1, respectively. The score was obtained by dividing the total score of the scale by the number of items. As the score approaches 5, the individual believes in the effects of THS on the environment and health, and as it approaches 1, the individual does not believe in the effects of THS on the environment and health. The original scale had excellent overall reliability (Cronbach's alpha = 0.91) and strong reliability in the subscales (Cronbach's alpha = 0.88 for both factors). The internal consistency of the nine items formed by Odacı and Kitis¹⁴ was 0.83. In our study, the value was 0.72. The internal consistency was 0.78 for impact on health and 0.63 for persistence in the environment. After obtaining informed consent, the data were collected face-to-face by the researcher.

Statistical Analysis

The data were analyzed using the Statistical Package for the Social Sciences 20.0 package program. Kolmogorov-Smirnov test and comparative analysis were used for data with normal distribution. The binary categorical variables (such as gender) and BATHS means were compared using the independent t-test, and variables with more than two groups were compared using the one-way ANOVA test.

RESULTS

The mean age was 58.52±14.01 in the study. 61.3% of the participants were female, 83.2% were primary school graduates, 14.3% were smoking at least a packet of cigarettes a day, and 78.2% had relatives with cancer. Table 1 shows the participants' demographic characteristics.

The highest frequency of the scale items was "Breathing air in a room today where people smoked yesterday can harm the health of adults (82.4%)" and "Breathing air in a room today where people smoked yesterday can harm the health of infants (81.5%)" (Figure 1).

The total score of BATHS was 3.53±0.45, the impact of THS on health was 3.92±0.48, and the persistence of THS in the environment was 3.21±0.57. A statistically significant difference was found between education ($P = 0.022$), smoking ($P = 0.027$), having relatives with cancer ($P = 0.036$), and BATHS. The mean score was higher among university graduates, smokers, and those with relatives with cancer. Further details are presented in Table 2. In our study, it was found that 82.4% of the participants

Main Points

- Smoking is the leading cause of death worldwide.
- Third-hand smoke (THS) is a relatively new phenomenon in the public health field.
- Third-hand tobacco smoke is composed of residual tobacco smoke gases and particles that settle on surfaces and dust.
- Exposure to THS poses significant health risks for nonsmokers as well as for smokers.

Table 1. Findings on the introductory characteristics

Age	Mean±SD	n	%
	58.52±14.01		
Gender	Female	73	61.3
	Male	46	38.7
Marital status	Married	111	93.3
	Single	8	6.7
Education	Primary school	99	83.2
	Secondary school	8	6.7
	University	12	10.1
Chronic illness	Yes	50	42.0
	No	69	58.0
Smoking	No	69	58.0
	Yes, but you should quit	33	27.7
	At least one packet in a day and more	17	14.3
Smoking at home or in the car	Yes	55	46.2
	No	64	53.8
Smoking household	Yes	61	52.1
	No	58	47.9
Treatment period	4-7 days	19	16.0
	1-8 months	44	37.0
	1-10 years	56	47.0
Having a cancer relative	Yes	93	78.2
	No	26	21.8
Total		119	100.0

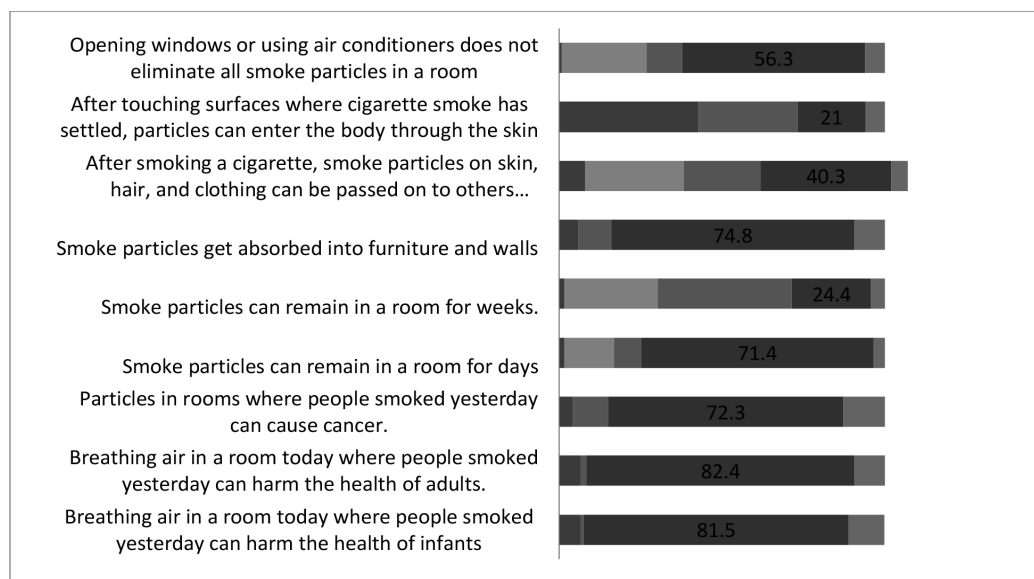
SD: standard deviation

stated that “Breathing air in a room where smoking took place yesterday may harm the health of adults” and 72.3% stated that “Particles in a room where smoking took place yesterday may cause cancer” (Figure 1).

DISCUSSION

This study is important to raise awareness about THS. One of the most important aspects of this study was to be related to patients with cancer. The total score of BATHS was 3.53 ± 0.45 , the impact of THS on health was 3.92 ± 0.48 , and the persistence of THS in the environment was 3.21 ± 0.57 . The mean BATHS score was higher among university graduates, smokers, and those with cancer. Eight out of ten people were of the opinion that “breathing air in a room where people had smoked the day before could harm the health of adults” and “breathing air in a room where people had smoked the day before could harm the health of babies”.

This study assessed the beliefs of Turkish patients with cancer about THS. Three different studies have been conducted on healthy individuals in Türkiye regarding the validity and reliability of the BATHS.¹⁴⁻¹⁶ Our study was the first to investigate the presence of THS in patients with cancer. Cronbach’s alpha values were in line with those of studies in the literature. The Cronbach’s alpha coefficient for BATHS ranged from 0.63 to 0.78. Internal consistency was 0.78 for the impact on health and 0.63 for persistence in the environment. The total BATHS score of the study group was found as 3.53 ± 0.45 , the effect of THS on health was 3.92 ± 0.48 , and the persistence in the Environment was 3.21 ± 0.57 . In a study on the perceived THS exposure of pregnant women, the mean BATHS score was 3.79 ± 0.859 .¹⁷ All participants in our study reported that they had never heard of THS before, which was an important finding for us. Exposure to firsthand and secondhand cigarettes is an active situation that has been tried to be prevented by several legal prohibitions, as well as individual measures, such as opening the windows while smoking, smoking in other rooms, operating the fans, or waiting for the smoke to disperse to reduce the harmful effects of smoking on others.

**Figure 1.** The items and answers of the BATHS scale

BATHS: Beliefs About Third-hand Smoke Scale

Table 2. Findings on comparison of introductory characteristics and BATHS

	BATHS total score	Impact on health	Persistence in the environment
Age			
r	-0.027	-0.083	0.015
P	0.770	0.037	0.871
	Mean±SD	Mean±SD	Mean±SD
Gender			
Female	3.51±0.52	3.89±0.56	3.21±0.65
Male	3.56±0.30	3.98±0.34	3.22±0.43
	t: -0.596	t: -1.072	t: -0.113
	P = 0.506	P = 0.236	P = 0.902
Marital status			
Married	3.52±0.44	3.91±0.49	3.21±0.57
Single	3.65±0.48	4.06±0.34	3.32±0.67
	t: -0.769	t: -0.800	t: -0.536
	P = 0.443	P = 0.425	P = 0.593
Education			
Primary school	3.49±0.45	3.90±0.51	3.17±0.57
Secondary school	3.45±0.37	3.90±0.32	3.10±0.53
University graduate	3.87±0.38	4.12±0.34	3.66±0.47
	F: 3.925	F: 1.076	F: 4.270
	P = 0.022*	P = 0.344	P = 0.016*
Chronic illness			
Yes	3.52±0.50	3.90±0.53	3.21±0.57
No	3.54±0.41	3.94±0.15	3.22±0.58
	t: 0.289	t: 0.540	t: 0.040
	P = 0.773	P = 0.590	P = 0.968
Smoking			
No	3.48±0.46	3.88±0.55	3.17±0.57
Used to but quit	3.48±0.39	3.90±0.36	3.14±0.53
Yes (at least a pk and more daily)	3.80±0.42	4.16±0.36	3.51±0.60
	F: 3.712	F: 2.341	F: 2.739
	P = 0.027*	P = 0.101	P = 0.069
Smoking at home or in the car			
Yes	3.60±0.44	3.95±0.45	3.32±0.59
No	3.47±0.45	3.90±0.51	3.13±0.56
	t: -1.532	t: -0.535	t: -1.787
	P = 0.594	P = 0.594	P = 0.077
Smoking household			
Yes	3.57±0.53	3.92±0.41	3.28±0.66
No	3.49±0.35	3.93±0.55	3.15±0.47
	t: -0.966	t: -0.147	t: -1.256
	P = 0.330	P = 0.883	P = 0.207
Treatment period			
4-7 days	3.46±0.49	3.77±0.61	3.22±0.63
1-8 months	3.45±0.38	3.89±0.43	3.10±0.46
1-10 years	3.61±0.47	4.00±0.47	3.31±0.63
	F: 1.912	F: 1.700	F: 1.645
	P = 0.152	P = 0.187	P = 0.198
Having a cancer relative			
Yes	3.49±0.47	4.07±0.39	3.34±0.44
No	3.67±0.33	3.88±0.50	3.18±0.60
	t: -1.766	t: -1.764	t: -1.273
	P = 0.036*	P = 0.047	P = 0.205
Total BATHS score	3.53±0.45		

r: Spearman's correlation analyses, t: independent t-test, F: one-way ANOVA test, *P < 0.05 statistical significance.

BATHS: Beliefs About Third-hand Smoke Scale, SD: standard deviation

While this is the case, THS continues to remain in an environment a hidden danger.² It is also an important source of carcinogens. Therefore, it is important to be aware of THS. Similar to our findings, Darlow et al.¹⁸ reported that two-thirds of the participants had never heard of THS before. The findings of this study and ours show that even health professionals are not yet entirely aware of THS. There is awareness of THS even in non-cancer populations. The literature has shown that the percentage of parents who believed that THS is harmful ranged from 42.4% to 91%.¹⁹

In this study, 53.8% of the participants reported that they did not smoke at home or in the car. There are countries with a low prevalence of indoor smoking bans, such as the United States (50.0%), Kuwait (2.0%), and China (35.2%), compared with countries with a high prevalence of indoor smoking bans, such as Italy (61%), Poland (66%), Canada (67.8%), and Australia (66.2%).^{13,20-24} In our study, we did not detect any difference between the smoking ban at home and the BATHS. Contrary to this, Haardörfer et al.¹³ (2017) found positive associations between THS beliefs and levels of home smoking bans. Shehab and Ziyab²³ (2022), on the other hand, reported that the effects of THS exposure on health and permanence in the environment scores were higher in those with a strict smoking ban at home. Winickoff et al.² (2009) found that beliefs about the health effects of THS were associated with smoking bans at home. The reason our study revealed a different result from the literature may be because the concept of THS has not been heard yet. This indicates the importance of awareness of this issue.

We found that 51.3% of the participants smoked at home. A statistically significant intergroup difference was observed between smoking status and BATHS. Our findings support those of previous studies. Similar studies have reported higher awareness of THS among non-smokers.^{17,22,23} A study conducted in Spain reported that smoking was not associated with THS.²⁴

In our study, a statistically significant difference was found between education and BATHS. The mean BATHS scores of university graduates were significantly higher than those of the other students. This demonstrated that BATHS could be increased through education and training activities. Among the studies in the literature, some have reported that higher education levels increase awareness of THS and that there is a significant relationship between them.^{17,22} However, a study conducted in Spain explained that there was no relationship between education levels and THS.²⁵

In this study, we did not find any significant relationship between income level, gender, age, smoking at home, and THS beliefs. However, Xie et al.²² (2021) reported that there was a significant difference between BATHS exposure, harm to health, and persistence in the environment due to a higher income level. Darlow et al.¹⁸ (2017) reported that having a female gender made it easier to discuss the effects of THS exposure with others. On the other hand, Xie et al.²² (2021) explained that being male created a significant difference in THS beliefs. However, the findings are similar findings to our study results.

In a study about THS exposure in pregnant women, no difference was found between income level, age, smoking in the home, and THS.¹⁷ In another study conducted with medical school

students, no statistically significant difference was determined according to gender, place of residence, family income level, and tobacco use status.²⁶

In our study, participants with relatives with cancer had higher BATHS scores than those without. This was evidence that diseases are also effective against beliefs. To our knowledge, our study is the first and only study to determine the THS beliefs of patients with cancer. Therefore, we could not find any studies that can compare our findings.

The limitation of this study is that it included patients with cancer in only one medical oncology clinic in a province.

CONCLUSION

As conclusion; we evaluated the beliefs of cancer patients about THS. Participants expressed concern about the harmful effects of THS on the environment and health. Furthermore, the belief that "smoking is harmful to health" was higher than "it is persistent in the environment". Education was an effective factor in the respondents' beliefs. University graduates expressed greater belief in the harmful effects of THS and its persistence on the environment than others. Smokers and those who have relatives with cancer believe more strongly in the harmful effects of THS. This study provides information about factors that influence beliefs about exposure to passive tobacco smoking. The most important outcome of the current study was improving tobacco control efforts. Educational and informational practices were recommended to recognize exposure to THS as a potential carcinogen and public health challenge. Future studies should try to determine the knowledge and beliefs of different samples about THS.

Ethics

Ethics Committee Approval: The study was approved by the Atatürk University Clinical Research Ethics Committee (decision no: 55, date: 30.06.2022).

Informed Consent: Consent form was filled out by all participants.

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Footnotes

Authorship Contributions

Surgical and Medical Practices - Concept – Design - Data Collection or Processing - Analysis or Interpretation – Literature Search - Writing: All authors contributed equally to all contribution sections.

Conflict of Interest: No conflict of interest was declared by the authors.

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