Original Article

Medical Students' Awareness of Third- And Fourth-Hand Smoking and its Implications: A Cross-Sectional Study

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Abstract

Context: Third-hand smoke (THS) is defined as a persistent smoke residue that sticks to dust and surfaces indoors and is then released back into the atmosphere, endangering public health. About two thirds of cigarette butts end up in the environment, which is known as fourth-hand smoke (FHS).

The purpose of this study is to gauge medical students' knowledge of the implications of third- and fourth-hand smoking.

Settings and Design: South Indian Medical College medical students

Methods and Materials: In the months of April through June of 2023, a cross-sectional study was carried out among medical students at a medical college in South India. The study covered all medical students who provided their consent. As it is Undergraduate college with 100 students each year, we decided universal sampling. The study participants completed a pre-made, semi-structured questionnaire via Google Forms, and their informed consent was obtained. Beliefs regarding THS were assessed using the Beliefs About Third Hand (BATHS) Scale.

Utilised statistical analysis: Frequency, percentage, mean, standard deviation, median, and interquartile range were computed using descriptive statistics.

Findings: Of the 360 individuals involved, only 35.6% (128) were aware of third-hand smoke, and only 23.3% (84) were aware of fourth-hand smoke. Of the individuals who were aware of THS, about 78 (60.9%) thought that children exposed to thirdhand smoke would first experience an acute respiratory tract illness, then asthma or wheeze. Out of 128 participants, 123 (96.1%) and 125 (97.7%) felt that smoking should be prohibited in homes and public areas, respectively.

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Conclusions: Since third-hand smoke has a negative impact on human health and was not well-known to medical students, efforts must be made to raise awareness among them. It is advisable to include instructional messages on third- and fourth-hand smoking in the medical curriculum.

Key words: Medical students, awareness, implications, third- and fourth-hand smoking

Introduction

Third-hand smoke (THS) is defined as a persistent smoke residue that sticks to dust and surfaces indoors and is then released back into the atmosphere, endangering public health.[1]

Although the term "third hand smoke" (THS) was first used in print in 2006, it wasn't until 2009 that it gained widespread recognition thanks to an article published in Paediatrics by Harvard Medical School associate professor of paediatrics Jonathan Winickoff and colleagues. In that study, the researchers found that perceptions about THS harming children were held by 65.2% of non-smokers and 43.3% of smokers, and that these beliefs were independently linked to the implementation of house smoking prohibitions.[2.]

Third-hand smoke is made up of the leftover pollutants from tobacco smoke that are either re-emitted into the gas phase after tobacco has been smoked, stay on surfaces and in dust after tobacco has been smoked, or react with oxidants and other substances in the environment to produce secondary pollutants. When tobacco is burned, improperly vented gas stoves produce nitrous acid, which reacts with the nicotine adsorbed onto surfaces to form tobacco-specific nitrosamines (TSNAs), such as 1-(N-methyl-N-nitrosamino)-1- (3-pyridinyl)-4-butanal (NNA), 4-(N nitrosomethylamino)-1-(3-pyridinyl) -1- -butanone (NNK), and N-nitrosonornicotine (NNN). There is some proof that NNA causes mutagenesis. The National Toxicology Program lists NNK and NNN as reasonably expected human carcinogens, while the International Agency for Research on Cancer lists them as human carcinogens. [2].

THS can infiltrate surfaces like furniture, drapes, walls, clothes, hair, and automobile upholstery in the form of ashes and dust.[2.] Up to two thirds of cigarette butts end in the environment, contributing to fourth-hand smoke.[3.] But the hazardous substances they contain are just as much of a problem as the waste's volume. Our streets, sewers, water, and sea are all ultimately contaminated by this hazardous waste,[4,5] leading to widespread contamination. Raising society's awareness of the issue could be the most significant response.

THS education initiatives for communities are expected to enhance the prevalence of smoke-free surroundings and hence reduce the possible negative health effects associated with THS exposure, according to a study that looked at THS knowledge levels. According to a study by Darlow et al., health professionals believed that smoking impacted the quality of parenting and stated that they did not smoke at home.[6] Their knowledge levels must also be greater than those of the general public. However, nearly two out of three participating health professionals in a worldwide study examining health professionals' understanding of THS were unaware of its existence, leading the authors to conclude that education should be made available. [7] Therefore, it is crucial to research our medical students' understanding of second- and third-hand smoking and its effects.

Aim & Objective(s) To estimate awareness of third- and fourth-hand smoking and its implications among our medical students

Materials and Methods

Study design and population

Between April and June of 2023, a cross-sectional survey of medical students at Government Theni Medical College in Tamil Nadu, South India, was carried out. Using the universal sample method, all medical students who gave consent were included in the study. As it is undergraduate college with 100 students each year, all were included in the study. Prior to the study commencing, clearance from the Institutional Ethical Committee was secured. The study participants completed a pre-designed, semi-structured questionnaire via Google Forms; informed consent was obtained from them prior to beginning the questionnaire, and participant anonymity was preserved.

Study questionnaire

Questionnaire was prepared to assess participants knowledge of third- and fourth-hand smoking. The Beliefs About Third Hand (BATHS) Scale was developed by Haardörfer et al.[9] to determine beliefs about THS. The survey consisted of two parts: evaluation of health effects (items 1,2,3,7,8); and permanence in the environment (items 4,5,6,9). Each item has a 5-point Likert-type response:1) Strongly disagree;2) Disagree;3) Not sure;4) Agree;5) Strongly agree.

Statistical analysis

The data was initially entered to Microsoft Excel 2010 and later the spreadsheets were used for analysis. Statistical analysis was done using statistical package of social science (SPSS trial version 20.0).

Descriptive statistics was calculated as frequency, percentage, mean and standard deviation, median and inter-quartile range. Descriptive data has been represented using various tables, graphs, diagrams etc.,

Results

The following findings were attained from the 360 students who provided consent for the current survey. Data were gathered using Google Forms. Merely 128 (35.6%) and 84 (23.3%) of the 360 participants were cognisant of third- and fourth-hand smoking, respectively. About 67 (52.3%) of the students who were aware of THS believed that exposure to THS would cause lung cancer, followed by chronic obstructive pulmonary disease, recurrent respiratory infections, and adult asthma. Approximately 78 (60.9%) individuals believed that children exposed to third-hand smoking would first experience an acute respiratory tract illness, then asthma or wheeze. Of the 128 participants that were aware of THS, 123 (96.1%) and 125 (97.7%) felt that smoking should be banned in home environment and public places respectively as shown in table 1 and 2.

The responses of the 128 participants are displayed in Figure 1, of which 69 (53.9%) strongly agreed and 27 (21.1%) agreed that breathing in a room where someone smoked the day before can be harmful to a child's or infant's health. It reveals that 66 (51.6%) individuals agreed and 9 (7%) strongly agreed that inhaling in a room where someone smoked the day before can be harmful to an adult's health. Additionally, it shows that 9 individuals (7%) highly agreed, 46 participants (35.9%) agreed, and 56 participants (43.8%) said they were not confident that particles in a room where someone smoked the day before might cause cancer. It shows that 71 people (55.5%) agreed that smoke particles can linger in a room for days, while 15 participants (11.7%) strongly agreed.

It was found that 12 (9.4%) people strongly agreed, 43 (33.6%) agreed, and 54 (42.2%) participants said they were not sure that the smoke particles can linger in a room for weeks. The results indicate that 18 (14.1%) people strongly agreed, 47 (36.7%) individuals agreed, and 49 (38.3%) participants said they were not sure that smoke particles could absorb into walls and furniture.

There were 48 (37.5%) participants who said they were unsure, 42 (32.8%) who agreed, and 8 (6.3%) who strongly agreed that smoke particles on skin, hair, and clothing can be transferred to others through touch. Additionally, 50 (39.1%) participants said they were unsure, 37 (28.9%) agreed, and 7 (5.5%) strongly agreed that smoke can enter the body through the skin. It also reveals that not all smoking particles are eliminated by opening windows or turning on air conditioning; 37 (28.9%) individuals said they were not sure, 61 (47.7%) agreed, and 19 (14.8%) strongly agreed.

There was no significant difference in the awareness level across the year of study of medical students. The mean score of third hand smoking impact on health is 3.4± 0.6088. The mean score of third hand smoking persistence in environment is 3.56 ± 0.6768.

Figure two shows about various solutions to overcome third- and fourth-hand smoke in which majority 66 (51.6%) participants suggested to avoid smoking in closed environment, followed by wet mopping of rooms used for smoking, adequate cross ventilation must be maintained and to quit smoking hence to increase the awareness about third- and fourth-hand smoke.

Table 1: Awareness levels of participants about

Third-hand and Fourth-hand smoking (n=360)

S.No	Content	Awareness level n(%)
1	Third -hand smoking	128 (35.6)
2	Fourth-hand smoking	84 (23.3)

Table 2: Awareness of Implications of Third-hand and Fourth-hand smoking (n=128)

S.No	Awareness/Opinion of Medical Students regarding Implications of THS and FHS	Awareness level n(%)
1	Effect on organs	102 (79.7)
2	Effect of tobacco residual smoke in lungs	112 (87.5)
3	Effect of inhaling residual smoke in lungs	127 (99.2)
4	Effect of inhaling residual smoke in heart	111 (86.7)
5	Knowledge of THS and FHS motivate people to be smoke free	117 (91.4)
6	THS and FHS is equally harmful like first-hand and second-hand smoking	88 (68.8)
7	Ban smoking in home environment	123 (96.1)
8	Ban smoking in public places	125 (97.7)
9	Disease caused by THS in Adults	
	Lung cancer	67 (52)
	Chronic Obstructive Pulmonary Disease	26 (20.1)
	Asthma	14 (10.9)
	Recurrent Respiratory Tract infection	18 (14)
	Others	4 (3)
10	Disease caused by THS in Children	
	Asthma, Wheeze	50 (39.1)
	Acute respiratory tract infection	78 (60.9)

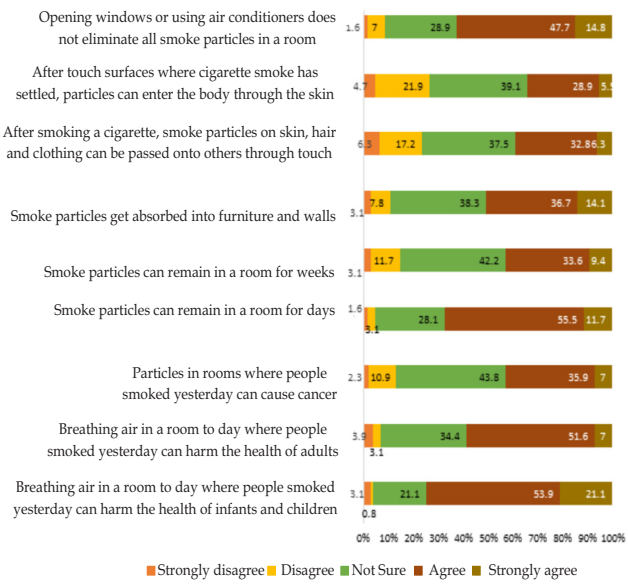

Figure 1: Medical students response to each of the 9-items assessed in beliefs about third hand smoke (baths) scale (n=128)

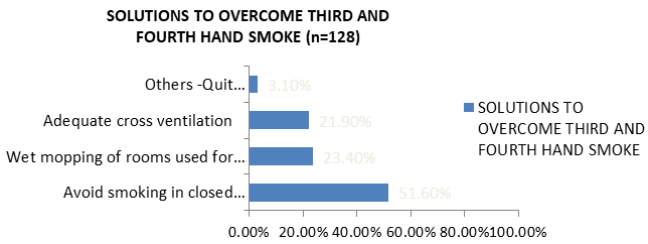

Figure 2: Solutions to overcome third- and fourth-hand smoke (n=128)

Discussion

The government has implemented a number of public awareness campaigns regarding first- and second-hand smoking, as well as the health risks associated with it. However, the public is largely unaware of the long-term effects of smoking as a pollutant, which is causing serious health problems. As a result, there needs to be a greater focus on third-hand smoking. In order to ascertain medical students' awareness of THS, Google Forms interviews with medical students in South India produced the surprising finding that, in contrast to a study conducted in Turkey, only 36.5% of medical students knew about third-hand smoke.[10] This indicates that the issue needs to be taken seriously since, as someone working in a field that involves educating the public about the effects of THS.

According to a study by Diez Izquierdo et al., just 27% of parents of young children know what thirdhand smoke.[11] Among those who knew about THS, 102 (79.7) percent of respondents agreed that organs are being affected, with the lungs being the major organ in their opinion. However, studies have shown that other organs, such as the heart and eyes, are also affected by THS, which further supports the idea that even medical professionals need to be briefed about THS. The majority of those affected are children, as they are the ones who are in direct contact with pollutants most of the time, whether they are crawling or walking.[12-14]

Conclusion

We were able to determine from this study that medical students in south India had a relatively low awareness of third- and fourth-hand smoke and its effects on human health. As a result, steps need to be taken to raise medical students' awareness of third- and fourth-hand smoke, such as role-playing and small-group discussions.

Recommendation

It is advisable to include health educational messages on third- and fourth-hand smoking in the medical curriculum.

Strength of the study strength of my study was using Google forms as source for collection of data, direct interview might have yield more reliable data and advantage of using Google forms are quicker collection of data and enables easier interpretation.

Relevance of the study

No studies with respect to awareness of third- and fourth-hand smoking and its implications among medical students have been found in literature in our study settings. This study will aid as one of the significant references which can enhance more researchers in future to conduct advance projects in similar area.

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References

1. Lovelina Francis D, Sampoornam Pape Reddy S. The silent assassin: Third hand smoking. J Glob Health. 2022 Dec 3;12:03079. doi: 10.7189/jogh.12.03079.
2. Burton A. Does the smoke ever really clear? Thirdhand smoke exposure raises new concerns. Environ Health Perspect. 2011 Feb;119(2):A70-4. doi: 10.1289/ehp.119-a70. PMID: 21285011; PMCID: PMC3040625.
3. Rendón AD, Unger JB, Cruz T, Soto DW, Baezconde-Garbanati L. Perceptions of Secondhand and Thirdhand Smoke Among Hispanic Residents of Multiunit Housing. J Immigr Minor Health. 2017 Feb;19(1):162-169. doi: 10.1007/s10903-015-0309-7. PMID: 26545600; PMCID: PMC7447142.
4. Tobacco and its environmental impact: an overview. World Health Organization, (2017), Licence: CC BY-NC-SA 3.0 IGO. Available from: http://www.who.int/tobacco/ publications/environmental- impact overview/en/ [accessed 23.07.17]
5. J.I. Granda-Orive, W. Girón-Matute, L. López-Yepes. Cigarette butts: the collateral effects of cigarettes on humans, animals and the environment. Arch Bronconeumol, 52 (2016), pp. 285 http://dx.doi.org/10.1016/ j.arbres.2015.07.019 | Medline
6. Darlow SD, Heckman CJ, Munshi T, Collins BN. Thirdhand smoke beliefs and behaviors among healthcare professionals. Psychology, health & medicine. 2017;22(4):415-24.
7. Quispe-Cristóbal B, Lidón-Moyano C, Martín-Sánchez JC, Pérez-Martín H, Cartanyà-Hueso À, Cabriada-Sáez Í, et al., editors. Knowledge and opinions of healthcare professionals about thirdhand smoke: a multi-national, cross-sectional study. Healthcare; 2022: MDPI.
8. J.I. Granda-Orive, L. López-Yepes, W. Girón-Matute, A.M. Granda-Beltrán, S. Solano-Reina, C.A. Jiménez-Ruiz, et al. Contaminación medioambiental por colillas del tabaco: el tabaco de cuarta mano. Prev Tab, 18 (2016), pp. 25-31
9. 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 Jan 17;15:4. doi: 10.1186/s12971-017-0112-4. PMID: 28104999; PMCID: PMC5240270.

10. Çoşğun İG, Çilekar Ş, Balcı A, Köymen BN, Moral S, Nur B, Yetim B. The beliefs of medical faculty students about thirdhand smoke. Tob Induc Dis. 2023 Jan 31;21:17. doi: 10.18332/tid/157202. PMID: 36762261; PMCID: PMC9887684.

11. Díez-Izquierdo A, Cassanello P, Cartanyà A, Matilla-Santander N, Balaguer Santamaria A, Martinez-Sanchez JM. Knowledge and attitudes toward thirdhand smoke among parents with children under 3 years in Spain. Pediatr Res. 2018 Nov;84(5):645-649. doi: 10.1038/s41390-018-0153-2. Epub 2018 Sep 7. PMID: 30194415.

12. Matt GE, Quintana PJ, Destaillats H, Gundel LA, Sleiman M, Singer BC, Jacob P, Benowitz N, Winickoff JP, Rehan V, Talbot P, Schick S, Samet J, Wang Y, Hang B, Martins-Green M, Pankow JF, Hovell MF. Thirdhand tobacco smoke: emerging evidence and arguments for a multidisciplinary research agenda. Environ Health Perspect. 2011 Sep;119(9):1218-26. doi: 10.1289/ehp.1103500. Epub 2011 May 31. PMID: 21628107; PMCID: PMC3230406.

13. Díez-Izquierdo A, Cassanello-Peñarroya P, Lidón-Moyano C, Matilla-Santander N, Balaguer A, Martínez-Sánchez JM. Update on thirdhand smoke: A comprehensive systematic review. Environ Res. 2018 Nov;167:341-371. doi: 10.1016/j.envres.2018.07.020. Epub 2018 Jul 11. PMID: 30096604.

14. Shehab K, Ziyab AH. Beliefs of parents in Kuwait about thirdhand smoke and its relation to home smoking rules: A cross-sectional study. Tob Induc Dis. 2021 Aug 30;19:66. doi: 10.18332/tid/140090. PMID: 34531710; PMCID: PMC8404267.