
Knowledge and Awareness of Thirdhand Smoke among Smokers and Non-smokers - A Comparative cross-sectional study

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Abstract: Third-hand smoke (THS) is the residual tobacco smoke contaminant that remains after a cigarette is extinguished. It can react with the indoor air pollutant nitrous acid to produce a carcinogen. THS exposure may occur long after second-hand smoke appears (SHS). A cross sectional questionnaire study was conducted in which a close-ended self-administered 20 item questionnaire was prepared. The data was collected from the smokers and non-smokers. Demographic characteristics, tobacco use status, attitudes toward awareness of third hand smoke and its adverse effects, was filled by the surveyed subjects. A total of 100 members with the mean age of 15-45 years participated in the study. The awareness of Third hand smoke is more among the non-smokers than compared with the smokers. The precautionary principle, which is a “strategy to cope with possible risks where scientific understanding is yet incomplete,” is widely used in Europe and in radiation protection in the United States. Extended producer responsibility promotes total-lifecycle environmental improvements, placing economic, physical, and informational responsibilities onto the tobacco industry. Efforts to further reduce THS exposure may ultimately reduce tobacco-related diseases and preserve the health of non-smoking adults and children.

Keywords: General population; smoking; smokers; third hand smoke; Tobacco.

INTRODUCTION

A large volume of data has accumulated on the issues of tobacco and health worldwide. The relationship between tobacco use and health stems initially from clinical observations about lung cancer, the first disease definitively linked to tobacco use. The term “third-hand smoke” (THS) has been coined to describe the residual tobacco smoke contamination that remains after a cigarette is extinguished. Previous research has demonstrated that smoking in the home is linked to persistently high levels of tobacco toxins, long after active smoking has occurred (Matt, 2004)

THS consists of residual tobacco smoke pollutants that remain on surfaces and in dust after tobacco has been smoked, are re-emitted into the gas phase, or react with oxidants and other compounds in the environment to yield secondary pollutants. The constituents of THS identified to date include nicotine, 3-ethenylpyridine (3-EP), phenol, cresols, naphthalene, formaldehyde, and tobacco-specific nitrosamines (including some not found in freshly emitted tobacco smoke) (Kuschner *et al.*, 2011)

The cigarette is an effective instrument for delivering nicotine to the body. The burned tobacco produces vaporized nicotine which will easily enter into the lungs. Within 10 to 15 seconds of puffing on a cigarette, nicotine is absorbed into the bloodstream of smokers and travels to the brain where it acts on nicotinic cholinergic receptors to produce a range of gratifying effects (Winickoff *et al.*, 2009)

According to the Global Adult Tobacco Survey (GATS), India 2017 the prevalence of current tobacco use among men was 42.4 percent and among women it was 14.2 percent. Every third adult (32.5%) from rural areas and every fifth adult (21.2%) from urban areas reported current use of tobacco. The prevalence of tobacco use varied across the states/UTs from 64.5 percent in Tripura to 9.7 percent in Goa. The prevalence of smoking tobacco among men was 19.0 percent and among women it was 2.0 percent. The prevalence of smoking was 11.9 percent in rural areas and 8.3 percent in urban areas. (Website, no date)

The majority of adults are aware that visible second-hand smoke is harmful to health, and some smokers take measures to protect non-smokers from this widely recognized harm (Borland *et al.*, 2006). Smokers have had to

adjust their smoking habits in response to environmental smoking restrictions either by reducing the amount they smoke or quitting, avoiding places where smoking is restricted, or by compensating and smoking more when they have the opportunity. Workplace bans on smoking typically lead to reduced cigarette consumption, but reductions in smoking prevalence are more controversial (Schick, 2011)

According to Benowitz NL et al in the year 2009, in many countries, lower socioeconomic status determines a person's vulnerability to smoke. In the US, 31.5% of adults with incomes below the federal poverty level smoked, while only 19.6% of those above the poverty level did (Benowitz *et al.*, 2009). Internationally, this trend holds among both men and women of high-income nations and among men in mid-income and most low-income nations.

India is the second phase of the tobacco epidemic with nearly one million persons dying due to a very high prevalence of chewing and smokeless tobacco use in the country. Henceforth, The Nicotine replacement therapy (NRT) which came into practice that temporarily replaced the nicotine from tobacco to reduce motivation to consume tobacco and nicotine withdrawal symptoms, thus easing the transition from cigarette smoking to complete abstinence. Various alternatives for nicotine sources (gum, transdermal patch, nasal spray, inhaler and sublingual tablets/lozenges) have been incorporated into tobacco cessation programs (Harini and Leelavathi, 2019)

Finally, a better understanding of THS and the associated risks to non-smokers, stricter norms and attitudes, and economic and social contingencies will motivate non-smokers not to start smoking and prompt addicted smokers to quit the habit. We have successfully completed numerous epidemiological and invitro studies for the betterment of our community (Prabakar, John and Srisakthi, 2016; Kannan *et al.*, 2017; Kumar, Pradeep Kumar and Preethi, 2017; Kumar, Pradeep Kumar and Vijayalakshmi, 2017; Prabakar, John, Arumugham, Kumar and Sakthi, 2018a, 2018b; Prabakar, John, Arumugham, Kumar and Srisakthi, 2018; Vishnu Prasad *et al.*, 2018; Khatri *et al.*, 2019; Manchery *et al.*, 2019; Mohapatra *et al.*, 2019; Neralla *et al.*, 2019; Pavithra, Preethi Pavithra and Jayashri, 2019; Pratha, Ashwatha Pratha and Prabakar, 2019; Shenoy, Salam and Varghese, 2019; Mathew *et al.*, 2020a; Samuel, Acharya and Rao, 2020). In this paper we are aiming for the understanding regarding third hand smoke (THS), also known as residual or aged tobacco smoke among smokers and the non-smokers. Our team has rich experience in research and we have collaborated with numerous authors over various topics in the past decade (Deogade, Gupta and Ariga, 2018; Ezhilarasan, 2018; Ezhilarasan, Sokal and Najimi, 2018; Jeevanandan and Govindaraju, 2018; J *et al.*, 2018; Menon *et al.*, 2018; Prabakar, John, Arumugham, Kumar and Srisakthi, 2018; Rajeshkumar *et al.*, 2018, 2019; Vishnu Prasad *et al.*, 2018; Wahab *et al.*, 2018; Dua *et al.*, 2019; Duraisamy *et al.*, 2019; Ezhilarasan, Apoorva and Ashok Vardhan, 2019; Gheena and Ezhilarasan, 2019; Malli Sureshbabu *et al.*, 2019; Mehta *et al.*, 2019; Panchal, Jeevanandan and Subramanian, 2019; Rajendran *et al.*, 2019; Ramakrishnan, Dhanalakshmi and Subramanian, 2019; Sharma *et al.*, 2019; Varghese, Ramesh and Veeraiyan, 2019; Gomathi *et al.*, 2020; Samuel, Acharya and Rao, 2020)

MATERIALS AND METHODS

A cross-sectional study was conducted among the population visiting the private dental college in Chennai in the month of July 2019. A total of 100 subjects recruited using a simple random sampling method. Participants took about 15 minutes to complete the questionnaire. Current smokers, voluntary participants were included in the study. Former smokers, people with systemic disease were excluded to avoid bias. Prior to the start of the study, ethical clearance was obtained from the Institutional ethics committee, Saveetha University (IHEC/SDC-PHD/1902/19/004). Informed consent was obtained from the participants before they started to fill the questionnaire. The anonymity of the participants was maintained.

Questionnaire: A 20 item questionnaire designed to obtain smoking and general population's demographic data, knowledge, attitudes, tobacco use status, practices, perspectives and experience regarding Tobacco use and knowledge about third hand smoke was used. Data analyses were performed using the statistical package of social science (SPSS version 23.0). Descriptive statistics to explain the demographic characteristics of the study participants. Chi square to find the association of the awareness of thirdhand smoke among smokers and non-smokers

Pretesting of questionnaire: Beliefs about Thirdhand Smoke scale Questions for the tested scale were developed after a thorough literature review by an expert panel including tobacco researchers from several universities. Only one item asking about whether breathing air in a room where people smoked previously can harm the health of infants and children was directly retrieved from Winickoff (Hovell and Hughes, 2009). THS health impact items were used to ask about the general health impact of THS on children [6, 11, 17] and adults [4, 23] as well as cancer specifically [24, 25] with three items. Three items pertaining to THS persistence included days, weeks, and months separately [7, 20]. Three additional items with statements about smoke particles settling with dust [11], accumulating on surfaces [4] and being absorbed into furniture and walls [8] aimed at THS accumulation in the built environment. Four items focused on THS removal with regular/thorough cleaning as well as painting, not being able to completely remove smell from rooms and smoke particles from surfaces, carpet, and walls [8, 26, 27]. Furthermore, three items had statements that addressed THS transmission beyond

breathing; these included transmission from skin, hair, and clothing [10, 11] as well as surfaces and children ingesting smoke particles after touching contaminated surfaces. Finally, the last three items focused on THS reduction behaviours: opening windows/ using air conditioners; smoking only in the bathroom [28]; and finally having a smoke-free home. Response options were on a 5-point Likert scale from strongly disagree to strongly agree coded as 1 through 5.

Statistical analysis: Data was analysed using IBM SPSS statistics version 23.0. Descriptive statistics were used for data summarization, presentation and chi-square tests were used to determine the association between knowledge, attitude and practice of smokers and non-smokers

RESULTS AND DISCUSSION

The table 1 shows the sociodemographic details of the study participants like gender, education, occupation, house ownership, home smoking ban and their smoking status with their frequency of distribution and the mean and standard deviation. Most of the study participants were males which constitute up to 77%. In respect to the education and occupation of the study population the kuppuswamy scale (Saleem and Community Medicine, 2019) was followed. The highest of 44% of the study participants completed middle school certificates and 44% had occupation of skilled agricultural & fishery workers. With regards to house ownership 57% of the study participants resided at rental houses.

Among smokers, most of the participants were under the age group of 15-25 years which constitute 30% followed by 26-30 years which constitute 26%, 31-35 years were 6%, 36-40 years with 14%, 41-45 years with 4%, 46-50 years with 10% and >50 years was 10%. Among non-smokers, most of the participants were under the age group of 15-25 years which constitute 34% followed by 26-30 years which constitute 30%, 31-35 years were 10%, 36-40 years with 8%, 41-45 years with 12% and 46-50 years with 6%. (Fig.2)

The socio economic status of the study population of smokers and nonsmokers in accordance with the kuppuswamy scale. Among smokers lower middle socioeconomic class was highest which constituted 62% and among non-smokers it is upper lower socioeconomic class which constitute 88%. The 19 item questionnaire with the percentage and the association between the answers for both smokers and non-smokers with the p value and chi square value was mentioned in (table 2). The difference between smokers and non-smokers in this study, although not statistically significant, non-smokers having higher levels of agreement that THS is harmful. This finding in our population corresponds with the findings of Winickoff et al (Winickoff *et al.*, 2009) that a greater proportion of non-smokers compared with smokers indicated a belief that THS harms children, and therefore, potential differences in attitudes among different populations may require further study. Compared with non-smokers who live with smokers, smokers themselves may be more receptive because they more often observed and complained about the stains and residue on surfaces in their homes. Overall, many participants in our study had not heard about THS and did not know what the term meant and many even disagreed that residue in dust and on surfaces could harm adults and children in the home. This finding was in contrast with study done by Cam Escoffery et al in the year 2013 (Escoffery *et al.*, 2013)

The education about THS has been incorporated into interventions to promote home smoking bans (Kegler *et al.*, 2015) Drehmer Found (Drehmer *et al.*, 2012) that THS harm beliefs were related to more strict enforcement of smoke free bans in homes and cars and increased numbers of quit attempts, which is encouraging evidence for inclusion of THS education in interventions aiming to decrease the impact of tobacco use (Hovell and Hughes, 2009)

Messages that reinforce that THS remains for months, and even after cleaning the home or replacing carpet or paint, could be an important deterrent to smoking in the home (Matt, 2004) There needs to be greater education about THS and how it can impact the health of others in the home, especially as evidence about its harmfulness begins to accumulate. Particularly, emphasizing the effect on the health of children is a salient message that may resonate with parents and grandparents. Children are especially susceptible to thirdhand smoke exposure because they breathe near, crawl and play on, touch, and mouth contaminated surfaces. At up to 0.25 g/day, the dust ingestion rate in infants is more than twice that of adults (Roberts and Dickey, 1995)

Kegler et al. (Kegler *et al.*, 2012) have incorporated messages about THS in their educational materials to promote a home smoking ban in a pilot study and found that 33% of participants (n = 40) reported making their homes smoke free.

As the science of thirdhand smoke matures, it will increasingly be used to help promote completely smoke-free places. To spread the awareness of Third hand smoke we can make initial steps such as incorporating into current tobacco control campaigns, programs, and routine clinical practice. The existing research on thirdhand smoke establishes the need for clinicians to communicate the cessation imperative. By using it, clinicians can help all smokers and non-smokers understand that there is no way to smoke tobacco without exposing friends and family. Our institution is passionate about high quality evidence based research and has excelled in various fields (Pc, Marimuthu and Devadoss, 2018; Ramesh *et al.*, 2018; Vijayashree Priyadharsini, Smiline Girija and Paramasivam, 2018; Ezhilarasan, Apoorva and Ashok Vardhan, 2019; Ramadurai *et al.*, 2019; Sridharan *et al.*,

2019; Vijayashree Priyadharsini, 2019; Chandrasekar *et al.*, 2020; Mathew *et al.*, 2020b; R *et al.*, 2020; Samuel, 2021)

CONCLUSION

This study demonstrated that beliefs about the health effects of thirdhand smoke awareness are very minimal among the smokers than non-smokers. Many researches should focus on understanding the levels of Thirdhand smoke carcinogens on household surfaces, pathways for their entry into humans and health effects. Educational and policy interventions may benefit by highlighting the exposure and health risks of THS as another critical reason for promoting smoke-free environments. Furthermore, quantitative surveys designed to assess perceptions regarding THS are needed to understand this phenomenon and to evaluate educational efforts for increasing its awareness.

CONFLICT OF INTEREST

No conflict of interest.

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Table 1: The sociodemographic details of the study participants with the number and frequency of distribution. Among the population males were 77% and females were 23%, smokers and non-smokers constitute 50% each. The education qualification was highest with a primary school certificate with 38%. Most of the participants were Skilled agricultural & fishery workers which constitute 44% and were residing at rental houses with 57%. The home smoking bans, strict ban constitute the highest with 73%

| Sociodemographic Variables | | N | % | Mean |
|----------------------------|--|----|----|------|
| Smoking status | smokers | 50 | 50 | 1.5 |
| | Non smoker | 50 | 50 | |
| Gender | Male | 77 | 77 | 1.28 |
| | Female | 23 | 23 | |
| Education | Graduate | 3 | 3 | 5.07 |
| | Diploma | 7 | 7 | |
| | High school certificate | 8 | 8 | |
| | Middle school certificate | 44 | 44 | |
| | Primary school certificate | 38 | 38 | |
| Occupation | Legislators, Senior Officials & Managers | 11 | 11 | 5.0 |
| | Professionals | 7 | 7 | |
| | Technicians and Associate Professionals | 5 | 5 | |
| | Clerks | 3 | 3 | |

| | | | | |
|------------------|---|----|----|------|
| | Skilled Workers and Shop & Market Sales Workers | 14 | 14 | |
| | Skilled Agricultural & Fishery Workers | 44 | 44 | |
| | Craft & Related Trade Workers | 14 | 14 | |
| | Plant & Machine Operators and Assemblers | 2 | 2 | |
| House ownership | Own house | 43 | 43 | 1.57 |
| | Rental house | 57 | 57 | |
| Home smoking ban | No ban | 1 | 1 | 1.72 |
| | Partially ban | 26 | 26 | |
| | Strictly ban | 73 | 73 | |

Table 2: shows the frequency distribution and the association of the awareness among smokers and non-smokers. From analysing the results, 50% of smokers and 44% of non smokers strongly agree to the point that opening windows or using air conditioners does not eliminate all smoke particles in a room. 48% and 54% of smokers and non smokers respectively strongly agree to the point that Having a smoke-free home will protect nonsmokers from smoke particles in your home and there was a statistically significant difference found on chi square association.

| Questions | Options | Non smokers | Smokers | P value | Chi square value |
|--|-------------------|-------------|---------|---------|------------------|
| Breathing air in a room today where people smoked yesterday can harm the health of infants and children. | Strongly disagree | 3(3%) | 6(6%) | 0.1 | 4.2 |
| | disagree | 47(47%) | 94(94%) | | |
| Breathing air in a room today where people smoked yesterday can harm the health of adults | Disagree | 26(26%) | 18(18%) | 0.8 | 4.6 |
| | Not sure | (18%) | 24(24%) | | |
| | Strongly agree | 54(54%) | 54(54%) | | |
| | agree | 2(2%) | 4(4%) | | |
| Particles in rooms where people smoked yesterday can cause cancer | Disagree | 16(16%) | 16(16%) | 0.8 | 4.8 |
| | Not sure | 32(32%) | 28(28%) | | |
| | Strongly agree | 42(42%) | 54(54%) | | |
| | agree | 10(10%) | 2(2%) | | |
| Smoke particles can remain in a room for days. | Strongly disagree | 18(18%) | 16(16%) | 0.9 | 3.8 |

| | | | | | |
|--|-------------------|---------|---------|-----|------|
| | Disagree | 40(40%) | 34(34%) | | |
| | Not sure | 34(34%) | 38(38%) | | |
| | Strongly agree | 8(8%) | 12(12%) | | |
| Smoke particles can remain in a room for weeks. | Strongly disagree | 18(18%) | 14(14%) | 0.5 | 10.4 |
| | Disagree | 40(40%) | 36(36%) | | |
| | Not sure | 20(20%) | 28(28%) | | |
| | Strongly agree | 22(22%) | 20(20%) | | |
| | Agree | 0(0%) | 2(2%) | | |
| Smoke particles can remain in a room for months | Strongly disagree | 26(26%) | 22(22%) | 0.7 | 5.9 |
| | Disagree | 60(60%) | 50(50%) | | |
| | Not sure | 8(8%) | 16(16%) | | |
| | Strongly agree | 6(6%) | 12(12%) | | |
| Cigarette smoke mixes and settles with dust | Strongly disagree | 36(36%) | 24(24%) | 0.1 | 13.2 |
| | Disagree | 46(46%) | 42(42%) | | |
| | Not sure | 12(12%) | 24(24%) | | |
| | Strongly agree | 6(6%) | 10(10%) | | |
| After someone smokes in a room, sticky particles are left on surfaces in the room | Strongly disagree | 14(14%) | 12(12%) | 0.4 | 15.6 |
| | Disagree | 30(30%) | 24(24%) | | |
| | Not sure | 24(24%) | 32(32%) | | |
| | Strongly agree | 20(20%) | 28(28%) | | |
| | Agree | 12(12%) | 4(4%) | | |
| Smoke particles get settled into furniture and walls | Strongly disagree | 14(14%) | 10(10%) | 0.7 | 11.5 |
| | Disagree | 24(24%) | 24(24%) | | |
| | Not sure | 28(28%) | 30(30%) | | |
| | Strongly agree | 32(32%) | 34(34%) | | |
| | Agree | 2(2%) | 2(2%) | | |
| The smell of cigarette smoke can return even after deeply cleaning a smoking room. | Strongly disagree | 12(12%) | 12(12%) | 0.7 | 11.9 |
| | Disagree | 54(54%) | 46(46%) | | |

| | | | | | |
|--|-------------------|---------|---------|-----|------|
| | Not sure | 20(20%) | 22(22%) | | |
| | Strongly agree | 10(10%) | 18(18%) | | |
| | Agree | 4(4%) | 2(2%) | | |
| Smoke stains on walls can reappear after walls have been painted. | Strongly disagree | 20(20%) | 16(16%) | 0.7 | 5.9 |
| | Disagree | 38(38%) | 40(40%) | | |
| | Not sure | 38(38%) | 32(32%) | | |
| | Strongly agree | 4(4%) | 12(12%) | | |
| Removing smoke particles from carpet is almost impossible | Strongly disagree | 30(30%) | 26(26%) | 0.1 | 13.5 |
| | Disagree | 26(26%) | 22(22%) | | |
| | Not sure | 30(30%) | 40(40%) | | |
| | Strongly agree | 14(14%) | 12(12%) | | |
| Sticky smoke particles cannot be removed from surfaces with regular cleaning | Strongly disagree | 28(28%) | 30(30%) | 0.9 | 8.5 |
| | Disagree | 34(34%) | 22(22%) | | |
| | Not sure | 26(26%) | 26(26%) | | |
| | Strongly agree | 10(10%) | 16(16%) | | |
| | Agree | 2(2%) | 6(6%) | | |
| After smoking a cigarette, smoke particles on skin, hair, and clothing can be passed on to others through touch. | Strongly disagree | 10(10%) | 10(10%) | 0.7 | 12.0 |
| | Disagree | 28(28%) | 30(30%) | | |
| | Not sure | 22(22%) | 28(28%) | | |
| | Strongly agree | 30(30%) | 28(28%) | | |
| | Agree | 10(10%) | 4(4%) | | |
| After touching surfaces where cigarette smoke has settled, particles can enter the body through the skin. | Strongly disagree | 22(22%) | 22(22%) | 0.4 | 15.8 |
| | Disagree | 32(32%) | 28(28%) | | |
| | Not sure | 34(34%) | 32(32%) | | |
| | Strongly agree | 10(10%) | 16(16%) | | |
| | Agree | 2(2%) | 2(2%) | | |
| Children who touch surfaces and then put their hands in their mouths can swallow smoke | Strongly disagree | 0(0%) | 2(2%) | 0.5 | 10.4 |
| | Disagree | 10(10%) | 18(18%) | | |

| | | | | | |
|---|-------------------|---------|---------|------|------|
| particles | Not sure | 24(24%) | 20(20%) | | |
| | Strongly agree | 54(54%) | 56(56%) | | |
| | Agree | 12(12%) | 4(4%) | | |
| Opening windows or using air conditioners does not eliminate all smoke particles in a room. | Strongly disagree | 10(10%) | 2(2%) | 0.01 | 30.7 |
| | Disagree | 10(10%) | 22(22%) | | |
| | Not sure | 14(14%) | 16(16%) | | |
| | Strongly agree | 44(44%) | 50(50%) | | |
| | Agree | 22(22%) | 10(10%) | | |
| Smoking only in the bathroom does not stop smoke particles from settling in other rooms | Strongly disagree | 12(12%) | 6(6%) | 0.2 | 19.0 |
| | Disagree | 10(10%) | 6(6%) | | |
| | Not sure | 18(18%) | 20(20%) | | |
| | Strongly agree | 52(52%) | 62(62%) | | |
| | Agree | 8(8%) | 6(6%) | | |
| Having a smoke-free home will protect nonsmokers from smoke particles in your home | Strongly disagree | 4(4%) | 2(2%) | 0.03 | 27.4 |
| | Disagree | 20(20%) | 28(28%) | | |
| | Not sure | 12(12%) | 20(20%) | | |
| | Strongly agree | 54(54%) | 48(48%) | | |
| | Agree | 10(10%) | 2(2%) | | |

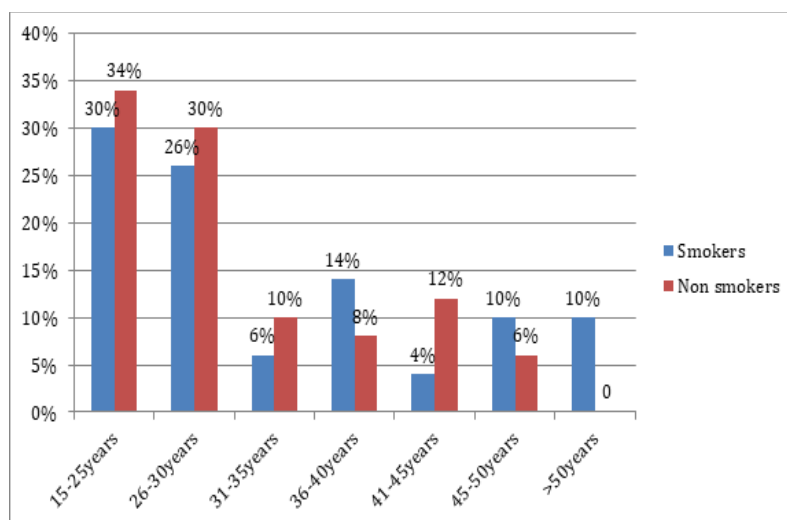


Fig.1: shows the distribution of age among the study population . X-axis represents the age in years and Y-axis represents the percentage of the study population. Among smokers, most of the participants were under the age group of 15-25 years which constitute 30%. Among non-smokers, most of the participants were under the age group of 15-25 years which constituted 34%.