RESEARCH ARTICLE

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Promoting Smoke-Free Environments: The Impact of Thirdhand Smoke Awareness on Smoking Bans at Home

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Abstract

Objective: A creating smoke-free home is a way to protect a vulnerable group from being exposed to secondhand smoke in the home, such as children, infants, and non-smokers. Studies reported an intervention for promoting a smoke-free home by using secondhand smoke messages and smoking cessation messages. However, the thirdhand smoke (THS) message has rarely been found. Therefore, this study aimed to explore the prevalence and correlations of smoking bans in homes. **Methods:** Secondary data from a community-based cross-sectional design survey was used for this study. Smoking ban status was defined as a smoking ban or no smoking ban. We used multiple logistic regression to test the association between factors and smoking ban status. An adjusted odd ratio and 95% confidence interval were reported. **Results:** Of the 882 participants included in this analysis, 38.66% (95%CI: 35.43, 41.97) had a smoking ban at home. A multiple logistic regression analysis showed that participants who believe that secondhand or THS harms children had a greater correlation with developing a smoking ban in the home compared with those who did not believe (odd ratio: 3.94, 95% confidence interval: 2.35, 6.60 and odd ratio:4.22, 95% confidence interval:2.6, 6.86, respectively). **Conclusion:** This study found that the belief that thirdhand smoke and secondhand smoke exposure harm children. The smoke-free home message's relevance to the harms of thirdhand smoke exposure should be adapted to be promoted, especially in homes.

Keywords: Smoking ban- thirdhand smoke- secondhand smoke

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Introduction

A smoking ban, whether in a public or private place, has the effect of reducing exposure to secondhand smoke (SHS) (Schechter et al., 2018). Exposure to SHS has an effect on non-smokers, especially children (Aziemah et al., 2015; Kim et al., 2018; Nadhiroh et al., 2020). A way to reduce SHS exposure in children is to create a rule or make a smoking-free home (Fu et al., 2018). Children or infants have spent time playing or doing an activity at home frequently. Infants or children who usually use their hands more frequently (hand-to-mouth) may be exposed to SHS that embeds in surfaces in the home like the door, sofa, window, or floor. This is also known as "third-hand smoke" (THS) (Jacob et al., 2017). The evidence shows that exposure to THS affects health, especially in infants (Ferrante et al., 2013).

Exposure to THS may lead to diseases for example a higher risk of cancer, effects on the lungs, and effects on the brain (James et al., 2022). Several studies examined the effects of THS on children. Matt et al. investigated the levels of tobacco smoke toxins in smokers' and non-smokers' houses and discovered that newborns residing in homes where smokers had previously resided had considerably higher levels of tobacco-specific nitrosamines, a hazardous compound present in THS. (Matt et al., 2004). An evidence shows that exposure to THS impairs lung development, increases oxidative stress, and modifies inflammatory responses (Rehan et al., 2011). In addition, Northrup et al. investigated the levels of tobacco smoke residues on surfaces in homes and cars and their potential health effects on infants. They discovered children who were exposed to greater amounts of THS had more nicotine metabolites in their urine, indicating exposure to tobacco smoke carcinogens(Northrup et al., 2016). It's critical to establish a smoke-free environment to protect infants from the harmful effects of THS exposure. A way to reduce exposure to THS or SHS in the home is by creating a home that is smoke-free. It may have been related to several factors, such as having a smoker at home, parental education, or the belief that secondhand or THS harms children. Therefore, this study aims to explore the prevalence and factors associated with smoking ban status in homes with children living.

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Materials and Methods

We used data from the Secondhand Smoke Survey (SSS) in 2010. SSS is a community-based cross-sectional study that was designed to estimate the prevalence of exposure to secondhand smoke in a home. This study was conducted in Kalasin and Roi-Et provinces, Thailand. The survey used a multistage cluster sampling technique. Clusters (districts) were selected based on a simple random method. We sampled two districts from 38 districts. Within two selected districts, we invited 890 participants by simple random sampling. This study excluded 8 participants because of incomplete data. Therefore, we analyzed 882 participants. For inclusion criteria, participants were parents of a child who had aged between 1 and 6 years and had no current smoking. A trained research assistant collected the data at the house of the study participants. A self-report questionnaire was used to collect data through a standard questionnaire.

Measurements

Smoking ban status was defined as by the self-reported question "Is smoking prohibited indoors in your home?". Respondents had a smoking ban if smoking wasn't permitted anyplace in their house, and they didn't have one if there were no rules or smoking was permitted everywhere (Williams et al., 2016).

Participants were presented with a question to assess their health beliefs regarding SHS. In response to the statement, "Inhaling smoke from a parent's cigarette can harm the health of infants and children," participants were asked to choose between the response options of strongly agree, agree, disagree, or strongly disagree. Those who strongly agreed or agreed with the statement were classified as holding the belief that SHS poses a health risk to children. Respondents who strongly disagreed or disagreed with the statement were classified as not believing that SHS in the home harms children's health (Winickoff et al., 2009).

To assess health beliefs regarding THS, participants were asked a specific question. They were presented with the statement: "Breathing air in a room today where people smoked yesterday can harm the health of infants and children." They were then asked to indicate their level of agreement or disagreement using the response options of strongly agree, agree, disagree, or strongly disagree. Participants were categorized as believing that THS causes a health risk to children whether they strongly agreed or agreed with the statement. Respondents who strongly disagreed or disagreed with the statement were classified as not having a belief that THS has an impact on children's health (Winickoff et al., 2009).

In addition, we collected age in years (<30, 31-40, >40), gender (male, female), occupation (unemployed, employee, agriculture, merchant, others), education (primary school, secondary school, university), monthly income in Thai baht (<15,000, 15,001-20,000, ≥20,000), alcohol drinking status (no, yes), having a smoker living together in home (no yes), and smoking and drinking during parties or meeting at home during past 1 month (no both, smoking only, alcohol drinking only, couse).

Statistical analysis

We described the data by using frequency and percentage across demographic data. A Chi-square test was used to test the association between a factor and smoking ban status in the home. The potential predictors were age, gender, occupation, education level, monthly income alcohol drinking, having a smoker in home, smoking and drinking during parties or meeting in home, and believe that SHS or THS harms children. Multiple logistic regression was used to analyze the association among factors and SBS. We presented an adjusted odd ratio (aOR) and 95% confidence interval (95%CI) that was to reflect the strength of association. All the statistical tests were two-sided. The level of significance was set at 5% ($P<0.05$). All results were analyzed by R (R Core Team, 2021).

Ethical Consideration

Ethical approval was obtained from the Mahasarakham University Ethics Review Board with number 019-340-2564.

Results

Of the 882 participants included in this analysis, 38.66% (95%CI: 35.43, 41.97) had a smoking ban at home. Among the respondents dominated female (70.50%), aged less than 30 years (49.77%), merchants (41.04%), secondary school levels (54.99%), monthly income less than 15000 Thai baht (70.07%), no alcohol drinking (70.29%), living with a smoker in the home (60.32%), smoking and alcohol drinking during parties or meetings at home (30.05%), and believe that SHS and THS harms children (59.86% and 60.66%, respectively). Table 1 shows the distribution of factors across smoking ban status. Compared to the smoking ban, there has been statistical significance in all factors. Therefore, we included all variables in the multivariable analysis.

A multiple logistic regression analysis was performed to assess significant determinants of smoking ban (vs no smoking ban). The results are shown in Table 2. The prevalence of smoking bans was positively associated with female sex, people age 31–40 and ≥ 41 years, having a merchant occupation, attending secondary school, having a monthly income >15000 Thai baht, no alcohol drinking, no smokers living together in the home, and no smoking or alcohol drinking during a party in the home. In addition, participants who believe that SHS or THS harms children had a greater correlation with developing a smoking ban compared with those who did not believe (OR: 3.94, 95%CI: 2.35, 6.60 and OR:4.22, 95%CI:2.6, 6.86, respectively).

Discussion

This study shows that a parent who has a higher monthly income, alcohol drinking, and having a smoker in the home had associated with a smoking ban in the home. In addition, we found that belief that SHS and THS harms children had associated with a smoking ban. The prevalence of a smoking ban in the home of our study is

Table 1. Baseline Characteristics by Smoking Ban Status at Home

Factors	Total n (%)	No n (%)	Ban n (%)	P value
	882	541	341	
Gender				< 0.001
Male	259 (29.50)	187 (34.69)	72 (21.24)	
Female	619 (70.50)	352 (65.31)	267 (78.76)	
Age (year)				< 0.001
<30	439 (49.77)	285 (52.68)	154 (45.16)	
31-40	339 (38.44)	214 (39.56)	125 (36.66)	
≥ 40	104 (11.79)	42 (7.76)	62 (18.18)	
Occupations				< 0.001
Unemployed	150 (17.01)	103 (19.04)	47 (13.78)	
Employee	247 (28.00)	174 (32.16)	73 (21.41)	
Agriculture	123 (13.95)	95 (17.56)	28 (8.21)	
Merchant	362 (41.04)	169 (31.24)	193 (56.60)	
Education level				< 0.001
Primary school	261 (29.59)	197 (36.41)	64 (18.77)	
Secondary school	485 (54.99)	284 (52.50)	201 (58.94)	
University	136 (15.42)	60 (11.09)	76 (22.29)	
Monthly income (Thai baht)				< 0.001
<15000	618 (70.07)	426 (78.74)	192 (56.30)	
15001-20000	176 (19.95)	87 (16.08)	89 (26.10)	
≥20000	88 (9.98)	28 (5.18)	60 (17.60)	
Alcohol drinking status				< 0.001
Yes	262 (29.71)	228 (42.14)	34 (9.97)	
No	620 (70.29)	313 (57.86)	307 (90.03)	
Having a smoker in home				< 0.001
Yes	532 (60.32)	388 (71.72)	144 (42.23)	
No	350 (39.68)	153 (28.28)	197 (57.77)	
Smoking and drinking during parties or meeting at home				< 0.001
No both	246 (27.89)	110 (20.33)	136 (39.88)	
Smoking only	170 (19.27)	101 (18.67)	69 (20.23)	
Alcohol drinking only	201 (22.79)	127 (23.48)	74 (21.70)	
Couse	265 (30.05)	203 (37.52)	62 (18.18)	
Believe that SHS harms children				< 0.001
Disagree	354 (40.14)	290 (53.60)	64 (18.77)	
Agree	528 (59.86)	251 (46.40)	277 (81.23)	
Believe that thirdhand smoke harms children				< 0.001
Disagree	535 (60.66)	424 (78.37)	111 (32.55)	
Agree	347 (39.34)	117 (21.63)	230 (67.45)	

Table 2 Multiple Logistic Regression Showing Significant Predictors Using Adjusted Odds Ratio and 95% Confidence Interval (95%CI)

Factors	Adjusted OR (95%CI)	p-value
Gender		
Female / Male	6.71 (5.46, 8.14)	< 0.001
Age (year)		
<30	1	
31-40	1.87 (1.14, 3.09)	0.04
> 40	3.35 (1.25, 5.19)	< 0.001
Occupations		
Unemployed	1	
Employee	0.52 (0.75,3.07)	0.577
Agriculture	0.26 (0.54,2.92)	0.94
Merchant	4.72 (2.42,9.23)	< 0.001
Others		
Education level		
Primary school	1	
Secondary school	3.29 (1.83,5.93)	< 0.001
University	1.92 (0.87,4.21)	0.088
Monthly income (Thai baht)		
<15000	1	
15001-20000	2.78 (1.53,5.06)	0.002
≥20000	3.15 (1.94,4.91)	0.013
Alcohol drinking status		
No / Yes	11.01 (5.73,21.15)	< 0.001
Having a smoker in home		
No / Yes	2.06 (1.25,3.41)	< 0.001
Smoking and drinking during parties or meeting at home		
No both	1	
Smoking only	0.53 (0.27,1.06)	0.001
Alcohol drinking only	0.75 (0.39,1.43)	0.067
Couse	0.3 (0.15,0.59)	< 0.001
Believe that SHS harms children		
Agree / Disagree	3.94 (2.35,6.60)	< 0.001
Believe that thirdhand smoke harms		
Agree / Disagree	4.22 (2.6,6.86)	< 0.001

the difference when compared with studies such as 71% in USA (Conley Thomson et al., 2005), full ban 59.5% in French, 63.5% in Irish, 61.3% in Italian, 74.4% in Czech and 87.0% in Swedish (Heck et al., 2010), 66.1% in Poland (Jankowski et al., 2020), and 62.2% in China (Wei et al., 2014). It might be the difference in the sample of a study such as adolescent, parents, or smokers. Our study sample is parents who look after children or children that were aged 1-6 years. This group is a vulnerable for exposure to both SHS and THS in their home.

In Thailand, there has a law that smoking at the home is prohibited. However, the prevalence of no smoking ban had quite high. This result is similar to a study from China, and they found that a home smoking ban is not widely adopted by families (Huang et al., 2016). In the others, a study on smoking factor aimed to test the association between smoking ban policies with smoking reduction and quit attempts, and the report suggested that living in a home with a total ban was significantly associated with smoking reduction compared to living in a home with no home ban (Zablocki et al., 2014), having both parents as smokers and not having an outdoor space were associated smoking ban (Bleakley et al., 2014). Another evidence from the reviews suggested that social norms, legislative bans on smoking in public places may encourage people to restrict smoking at home (Monson and Arsenault, 2017). This evidence is related to a study that reports that smoking bans both in public or home may affect in

reducing secondhand smoke exposure at home (Olivieri et al., 2019). In addition, our result found that belief of parents about the harms of THS associated with a smoking ban in the home. This is similar to Drehmer al., (2014) but not in a systematic review by Oktar et al., (2021) and they reported around 25% of parents does not believe THS is harmful to children's health (Najihah Zainol et al., 2015). The intervention for creating a smoke-free home in Thailand is mostly used a media, law, and an intervention that used an information of the smoking cessation benefit information or the danger of smoking information (Intarut et al., 2020).

Our findings on SHS and THS exposure can give families essential knowledge about the sources of possible harmful exposure for their kids. This knowledge may provide them with a greater incentive to change their home smoking habits in order to better protect the health of their kids (Intarut, 2021). Compared to simply providing information regarding obvious SHS exposure, which is already well-known to most families, health education initiatives focusing on THS may have a larger effect on inspiring families (Escoffery et al., 2013). Even if parents already understand the hazards associated with THS exposure and its damaging effects on children, being informed by healthcare experts about these risks and consequences may help them feel more motivated to protect their children's health. In order to improve healthcare services, inform public education promotions, and develop environmental health policies for both single- and multi-unit residential settings, formal experimental testing is needed. In addition, our results show a high prevalence of not believing that THS harms children (60.66%). Therefore, further study should aim to promote the dangers of THS exposure to family members.

Our study has some limitations. The fact that the data are from a cross-sectional survey and that it is not feasible to establish a causal relationship between a potential factor and the smoking ban. Despite the fact that we have incorporated the most frequent known confounders in our analysis, there may still be residual confounding from unmeasured or unknown variables, for example, cultural factors. The study was based on self-reported data when measuring smoking ban status. Further study may be needed to validate the self-reported information by using biomarkers, such as air nicotine monitoring (Henderson et al., 2023), to verify the accuracy of the reported smoking ban status.

In conclusions, this study found that there was a low prevalence of smoke bans. Evidence reveals that the belief that secondhand and thirdhand smoke harm children, a higher monthly income, alcohol drinking, and having a smoker in the home are related to a smoking ban status in the home. Especially, a smoke-free home message relevant to the harms of thirdhand exposure should be adapted to be promoted in a home.

Author Contribution Statement

NI, MT and PP: analysed and interpreted the data regarding the guidelines. NI: performed the quality control of the data set and were major contributors in writing the manuscript. All authors read and approved the final manuscript.

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Any conflict of interest

The authors declare that there is no conflict of interest.

References

Aziemah Z, Najihah Zainol A, Emilia Zainal A, et al (2015). Burden of Household Smoking Habits on the Occurrence of Respiratory Symptoms among Malaysian Adolescents. *Iran J Public Health*, **43**.

Bleakley A, Hennessy M, Mallya G, et al (2014). Home smoking policies in urban households with children and smokers. *Prev Med*, **62**, 30-4.

Conley Thomson C, Siegel M, Winickoff J, et al (2005). Household smoking bans and adolescents' perceived prevalence of smoking and social acceptability of smoking. *Prev Med*, **41**, 349-56.

Drehmer JE, Ossip DJ, Nabi-Burza E, et al (2014). Thirdhand smoke beliefs of parents. *Pediatrics*, **133**, e850-6.

Escoffery C, Bundy L, Carvalho M, et al (2013). Third-hand smoke as a potential intervention message for promoting smoke-free homes in low-income communities. *Health Educ Res*, **28**, 923-30.

Ferrante G, Simoni M, Cibella F, et al (2013). Third-hand smoke exposure and health hazards in children. *Monaldi Arch Chest Dis*, **79**, 38-43.

Fu M, Castellano Y, Tigova O, et al (2018). Prevalence and correlates of different smoking bans in homes and cars among smokers in 6 Countries of the EUREST-PLUS ITC Europe Surveys. *Tob Induc Dis*, **16**.

Heck JE, Stücker I, Allwright S, et al (2010). Home and workplace smoking bans in Italy, Ireland, Sweden, France and the Czech Republic. *Eur Respir J*, **35**, 969-79.

Henderson E, Rodriguez Guerrero LA, Continente X, et al (2023). Measurement of airborne nicotine, as a marker of secondhand smoke exposure, in homes with residents who smoke in 9 European countries. *Environ Res*, **219**, 115118.

Huang K, Chen H, Liao J, et al (2016). Factors Associated with Complete Home Smoking Ban among Chinese Parents of Young Children. *Int J Environ Res Public Health*, **13**, 161.

Intarut N (2021). Factors Related to a Smoke-free Home Status: A Parental Report. *Asian Pac J Cancer Prev*, **22**, 1865-8.

Intarut N, Chongsuvivatwong V, Pukdeesamai P (2020). Reducing secondhand smoke exposure at home in rural areas, Thailand: a cluster randomised controlled trial. *Int J Tuberc Lung Dis*, **24**, 1172-7.

Jacob P, 3rd, Benowitz NL, Destaillats H, et al (2017). Thirdhand Smoke: New Evidence, Challenges, and Future Directions. *Chem Res Toxicol*, **30**, 270-94.

James JM, George G, Cherian MR, et al (2022). Thirdhand smoke composition and consequences: A narrative review. *Public Health Toxicol*, **2**, 1-6.

Jankowski M, Pinkas J, Zgliczyński WS, et al (2020). Voluntary

Smoke-Free Home Rules and Exposure to Secondhand Smoke in Poland: A National Cross-Sectional Survey. *Int J Environ Res Public Health*, **17**.

Kim AS, Ko HJ, Kwon JH, et al (2018). Exposure to Secondhand Smoke and Risk of Cancer in Never Smokers: A Meta-Analysis of Epidemiologic Studies. *Int J Environ Res Public Health*, **15**.

Matt GE, Quintana PJ, Hovell MF, et al (2004). Households contaminated by environmental tobacco smoke: sources of infant exposures. *Tob Control*, **13**, 29-37.

Monson E, Arsenault N (2017). Effects of Enactment of Legislative (Public) Smoking Bans on Voluntary Home Smoking Restrictions: A Review. *Nicotine Tob Res*, **19**, 141-8.

Nadhiroh SR, Djokosujono K, Utari DM (2020). The association between secondhand smoke exposure and growth outcomes of children: A systematic literature review. *Tob Induc Dis*, **18**, 12.

Najihah Zainol A, Aziemah Z, Emilia Zainal A, et al (2015). Secondhand Smoke Exposure in Toddlerhood and Cognitive Ability among Malaysian Adolescents. *Iran J Public Health*, **43**.

Northrup TF, Khan AM, Jacob P, 3rd, et al (2016). Thirdhand smoke contamination in hospital settings: assessing exposure risk for vulnerable paediatric patients. Tob Control, 25, 619-23.

Oktar D, Ozcan L, Onsuz M, et al (2021). Parental Beliefs on the Harmfull Effects of Third Hand Smoke: Systematic Review and Meta-analysis. *Eur J Public Health*, **31**.

Olivieri M, Murgia N, Carsin AE, et al (2019). Effects of smoking bans on passive smoking exposure at work and at home. The European Community respiratory health survey. *Indoor Air*, **29**, 670-9.

Rehan VK, Sakurai R, Torday JS (2011). Thirdhand smoke: a new dimension to the effects of cigarette smoke on the developing lung. *Am J Physiol Lung Cell Mol Physiol*, **301**, L1-8.

Schechter JC, Fuemmeler BF, Hoyo C, et al (2018). Impact of Smoking Ban on Passive Smoke Exposure in Pregnant Non-Smokers in the Southeastern United States. *Int J Environ Res Public Health*, **15**.

Wei X, Zhang Z, Song X, et al (2014). Household smoking restrictions related to secondhand smoke exposure in Guangdong, China: a population representative survey. *Nicotine Tob Res*, **16**, 390-6.

Williams RS, Stollings JH, Bundy Ł, et al (2016). A Minimal Intervention to Promote Smoke-Free Homes among 2-1-1 Callers: North Carolina Randomized Effectiveness Trial. *PLoS One*, **11**, e0165086.

Winickoff JP, Friebely J, Tanski SE, et al (2009). Beliefs about the health effects of "thirdhand" smoke and home smoking bans. *Pediatrics*, **123**, e74-9.

Zablocki RW, Edland SD, Myers MG, et al (2014). Smoking ban policies and their influence on smoking behaviors among current California smokers: a population-based study. *Prev Med*, **59**, 73-8.