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# Associations and determinants of tobacco consumption in Thailand

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**Abstract**

This paper presents a study of household tobacco consumption in Thailand from 2006 to 2011. We investigated the nonlinear relationships between this behavior and household alcohol expenditure, household gambling expenditure, and demographic factors and used TreeNet to analyze datasets drawn from socio-economic surveys. Across all the years included in the survey period, we found consistent results whereby the likelihood of tobacco consumption was higher for households with higher expenditure on alcohol both consumed at home and away from home, located in the South or the Northeast, with lower income, a head of household with a lower educational level, a male head of household, and a head of household employed by a private company. We also found that over the focal period of the study, households headed by an older person were more likely to consume tobacco in the first half of the study period but this relationship changed such that households headed by a younger person (aged 18–25 years), showed the highest likelihood of consuming tobacco by the end of the study period. The discussion behind this shift, and how it is related to strategies from the tobacco industry are also provided.


## Introduction

Tobacco consumption is a considerable problem in Thailand. Recent statistics show that from 2006 to 2011, 50,710 premature deaths a year were attributed to major tobacco-related diseases. In terms of cost, in 2009 alone, Thailand spent THB 11.2 billion (USD 0.37 billion) on the direct and indirect costs of medical care for tobacco-related diseases. Further, in the years 2007–2013, 47 percent and 67.6 percent of youth were exposed to secondhand smoke inside the home and outside the home, respectively (Lian & Dorotheo, 2014). Note that the prevalence rate of tobacco use among Thais aged 15 years and above was 26.9 percent in 2011 (WHO, 2011b).

In the literature on tobacco, several studies have focused on analyzing tobacco consumption including trends related to this behavior. For example, CDC (2011) applied logistic regression to analyze the changes in the prevalence of smoking on a national scale in the US for the period 2005–2010 using 2005 as the baseline. For that period, the results showed an overall reduction in the prevalence of cigarette smoking among adults. However, neither the extent nor the direction of changes reported for this period was consistent from year to year. Hublet et al. (2006) used logistic regression to analyze smoking trends among adolescents from 1990 to 2002 in 10 European countries and Canada and classified the countries into groups based on tobacco consumption trends.

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Several articles that focused on the relationship between tobacco and alcohol showed that alcohol use and smoking frequently co-occur (Bonevski, Regan, Paul, Baker, & Bisquera, 2014; Burger, Mensink, Bronstrup, Thierfelder, & Pietrzik, 2004; Chiolero, Wietlisbach, Ruffieux, Paccaud, & Cornuz, 2006; Clausen, Charlton, & Holmboe-Ottesen, 2006; Kahler et al., 2008). In addition, some studies presented investigations into the directional associations between tobacco and alcohol use. An analysis by Jackson, Sher, Cooper, and Wood (2002) based on least-square regression and logistic regression showed that prior alcohol use predicted tobacco use more strongly than did the reverse. However, a study by Wetzels, Kremers, Vitoria, and de Vries (2003) using logistic regression showed that in a number of European countries, tobacco use predicted alcohol use more strongly than did the reverse. Several studies have investigated associations between alcohol, tobacco, and gambling. According to a review by Peters et al. (2015) of the literature on associations between gambling and the use of alcohol, tobacco, and illicit drugs, most of the studies found gambling to be associated with the use of these substances (Barnes, Welte, Hoffman, & Tidwell, 2009; Duhig, Maciejewski, Desai, Krishnan-Sarin, & Potenza, 2007; Stinchfield, 2010). In addition, the methods used most often to consider these associations were bivariate analysis, multiple linear regression, and logistic regression analysis.

The present paper provides a thorough study of household tobacco consumption in Thailand by focusing on nonlinear relationships between household tobacco consumption, household alcohol expenditure, household gambling expenditure, and demographic factors. We applied TreeNet to analyze datasets drawn from socio-economic surveys of 44,918 Thai households conducted in 2006, 43,055 Thai households in 2007, 43,844 Thai households in 2009, and 42,083 Thai households in 2011. Thai households consumed tobacco at a rate of 40.79, 33.84, 33.52, and 23.92 percent in 2006, 2007, 2009, and 2011, respectively. Note that we did not report the results for 2008 and 2010, as some factors were missing. The data, therefore, showed a trend of decreasing household tobacco consumption. However, the present study thoroughly synthesized the trends associated with the relationships between household tobacco consumption and household expenditures on alcohol and gambling and multiple demographic factors for the period of 2006–2011. Also, we were interested in determining the characteristics of households with the highest likelihood of consuming tobacco in order to guide programmatic efforts to reduce tobacco consumption in Thailand.

In this study, we implemented a new method that has never been used before in this context, namely, TreeNet. We used this method because it can reveal non-linear associations between responses and predictors, which can, in turn, provide the actual shape of the relationship between the predictor and the response (household tobacco consumption) and for the entire range of the predictor without a linear association being assumed. Note that our previous studies associated with socio-economic surveys in Thailand investigated alcohol consumption in 2009 (Changpetch et al., 2016), and studied the relationship of household alcohol consumption in Thailand relating to the age of the head of household between 2006 and 2011 (Changpetch & Haughton, 2017).

For all four years of the survey, TreeNet showed that the most important predictor of household tobacco consumption was household expenditure on alcohol consumed at home, followed by household expenditure on alcohol consumed away from home, the head of household's educational level, and household income. TreeNet suggested that the likelihood of consuming tobacco was higher for households with higher alcohol expenditure both consumed at home and away from home, with lower income, located in the South or the Northeast, with a head of household who was male, had a lower educational level, and worked for a private company.

We also found that over the focal period of the study, households with an older head person were more likely to consume tobacco in the first half of the study period but this relationship changed such that households with a younger head person (aged 18–25 years) showed the highest likelihood of consuming tobacco at the end of the study period. These findings should be helpful to policy makers responsible for tailoring programs to households most dependent on tobacco in order to reduce tobacco consumption in Thailand.

## Datasets and Method

### *Datasets*

We used a dataset collected via socio-economic surveys of 44,918 Thai households conducted in 2006, 43,055 Thai households in 2007, 43,844 Thai households in 2009, and 42,083 Thai households in 2011. Thai households consumed tobacco at a rate of 40.79, 33.84, 33.52, and 23.92 percent in 2006, 2007, 2009, and 2011, respectively. Note that we did not consider the survey data for either 2008 or 2010, as several predictors were not available for those years. The factors included in our analyses are shown in Table 1.

The response variable for this study was household tobacco consumption. The values for this binary variable were 1: household consumes tobacco and 0: household does not consume tobacco. The factors of interest shown in Table 1 comprised the factors used in studies related to tobacco in the past combined with some new factors including disability, welfare, amount of debt, and government funding. The new variables were included here, as they may be related to tobacco consumption in Thailand.

Note that the average exchange rate was THB 37.88 per US dollar in 2006, THB 32.21 per US dollar in 2007, THB 34.31 per US dollar in 2009, and THB 30.48 per US dollar in 2011.

### *Method*

In this section, we refined our understanding of household tobacco consumption in the following way. Specifically, we applied data-mining models which capture non-linearities. To demonstrate the techniques, we applied TreeNet models (www.salford-systems.com/treenet.html;

**Table 1**
Factors of interest

| Predictor | Details for each predictor |
|---|---|
| Region | Note: Region of household<br>1. Bangkok Metropolis (6.15%, 5.69%, 6.21%, 5.84%)[a],<br>2. Central (excluding Bangkok) (24.76%, 28.85%, 29.37%, 29.21%),<br>3. North (25.01%, 24.93%, 24.35%, 24.59%),<br>4. Northeast (26.38%, 26.40%, 25.66%, 25.92%),<br>5. South (13.74%, 14.13%, 14.41%, 14.44%) |
| Area | Note: Area of household<br>1. Municipal area (62.20%, 61.54%, 61.69%, 61.13%),<br>2. Non-municipal area (37.80%, 38.46%, 38.31%, 38.87%) |
| Number of household members | Note: Number of members in household<br>(Mean = 3.26, 3.22, 3.18, 3.04 & standard deviation = 1.62, 1.61, 1.63, 1.56)[b] |
| Income | Note: Average monthly total income per household (THB)<br>(Mean = 19,754; 20,160; 22,388; 24,290 & standard deviation = 38,351; 30,805; 38,058; 66,899) |
| Sex | Note: Sex of head of household<br>1. Male (66.96%, 66.58%, 64.84%, 63.63%),<br>2. Female (33.04%, 33.42%, 35.16%, 36.37%) |
| Age | Note: Age of head of household (years)<br>(Mean = 49.86, 50.78, 51.69, 52.66 & standard deviation = 14.85, 14.78, 14.77, 14.92) |
| Marital status | Note: Marital status of head of household<br>1. Single (9.10%, 8.82%, 8.88%, 9.62%),<br>2. Married (69.94%, 69.76%, 68.45%, 66.64%),<br>3. Widowed (15.19%, 15.82%, 16.61%, 17.41%),<br>4. Other (5.77%, 5.60%, 6.06%, 6.33%) |
| Religion | Note: Religion of head of household<br>1. Buddhist (95.10%, 94.78%, 94.92%, 94.95%),<br>2. Islamic (4.14%, 4.43%, 4.33%, 4.51%),<br>3. Christian and other (0.76%, 0.79%, 0.75%, 0.54%) |
| Disability | Note: Whether head of household is disabled<br>0. No (97.46%, 97.23%, 97.50%, 97.31%),<br>1. Yes (2.54%, 2.77%, 2.50%, 2.69%) |
| Welfare | Note: Whether head of household receives welfare or medical services<br>0. No (3.04%, 2.73%, 2.03%, 1.61%),<br>1. Yes (96.95%, 97.27%, 97.97%, 98.39%) |
| Gambling expenditure | Note: Average monthly expenditure on lottery tickets and other kinds of gambling per household (THB)<br>(Mean = 137.0, 120.8, 160.5, 182.8 & standard deviation = 1,498; 384.1; 508.4; 643.4) |
| Alcohol expenditure at home | Note: Average monthly expenditure on alcohol consumed at home per household (THB)<br>(Mean = 157.6, 123.1, 138.3, 67.3 & standard deviation = 494.8, 464.4, 499.4, 345.8) |
| Alcohol expenditure away from home | Note: Average monthly expenditure on alcohol consumed away from home per household (THB)<br>(Mean = 127.9, 96.5, 104.6, 34.7 & standard deviation = 594.7, 522.2, 540.7, 286.4) |
| Amount of debt | Note: Total debt at end of previous month (THB)<br>(Mean = 154,999; 149,915; 154,995; 159,082 & standard deviation = 626,557; 526,959; 616,876; 703,129) |
| Government fund | Note: Whether head of household borrowed money from a government fund<br>0. No (80.31%, 81.94%, 84.11%, 85.16%),<br>1. Yes (19.69%, 18.06%, 15.89%, 14.84%) |
| Education | Note: Educational level of head of household<br>1. Undefined (6.28%, 6.11%, 5.89%, 5.78%),<br>2. Primary level (58.44%, 59.08%, 58.15%, 58.42%),<br>3. Secondary level (24.22%, 23.75%, 24.35%, 24.00%),<br>4. Higher than secondary level (11.06%, 11.06%, 11.60%, 11.81%) |
| Work status | Note: Work status of head of household<br>1. Employer (8.02%, 6.67%, 6.31%, 4.61%),<br>2. Own-account worker (35.94%, 37.02%, 36.88%, 36.90%),<br>3. Contributing family worker (2.10%, 2.24%, 2.33%, 2.03%),<br>4. Government employee (11.37%, 11.33%, 10.68%, 10.33%),<br>5. State enterprise employee (0.97%, 0.95%, 0.98%, 0.79%),<br>6. Private company employee (21.93%, 21.16%, 21.47%, 21.63%),<br>7. Member of producers' cooperative (0.03%, 0.04%, 0.03%, 0.03%),<br>8. Housewife (4.09%, 4.20%, 4.26%, 4.58%),<br>9. Student (0.74%, 0.71%, 0.72%, 0.73%),<br>10. Child or elderly person (10.90%, 11.39%, 12.24%, 13.82%),<br>11. Ill or disabled person (1.32%, 1.47%, 1.36%, 1.52%),<br>12. Looking for a job (0.08%, 0.11%, 0.10%, 0.09%),<br>13. Unemployed (0.53%, 0.53%, 0.39%, 0.44%),<br>14. Other (1.89%, 2.12%, 2.22%, 2.48%) |

[a] Numbers in parentheses represent proportions of that category in years 2006, 2007, 2009 and 2011, respectively
[b] Numbers in parentheses represent means in years 2006, 2007, 2009, 2011 and standard deviations in years 2006, 2007, 2009 and 2011, respectively

Friedman, 2001). The non-parametric approach adopted here made it possible to handle a response variable with a large number of zero values. Models 1, 2, 3, and 4 were used to analyze the relationships between household tobacco consumption and the factors in Table 1 for years 2006, 2007, 2009, and 2011, respectively. The results of the TreeNet analysis are shown in Tables 2–5 and Figures 1–9. Note that TreeNet derived the relative importance of the predictors (with the most important variable assigned an importance of 100 for reference), as shown in Tables 2–5. Note that TreeNet determines the important predictors to the response but does not establish causality among these variables.

In Figures 1–9, the vertical axis represents a half of the log odds of tobacco consumption, tat is, $1/2^{*}\log(p/(1-p))$, where p is the probability of consuming tobacco and the horizontal axis represents the value of the predictor. For simplicity, we called the vertical axis 'log odds'. The interpretation from TreeNet is based on comparing the relative values of the log odds; that is, the higher the value of the log odds, the higher the probability or likelihood of tobacco consumption. However, we could not use the scale of the vertical axis to interpret the probability of tobacco consumption that is, the zero value of the log odds, for TreeNet does not imply that the probability of consuming tobacco is equal to the probability of not consuming tobacco.

## Results

Tables 2–5 show that the four variables most important for predicting the likelihood of household tobacco consumption are in order of importance: household expenditure on alcohol consumed at home, household expenditure on alcohol consumed away from home, the educational level of the head of household, and household income.

Figures 1–9 show the partial effects of each predictor on the predicted response (with other predictors held constant). In Figure 1(a–d), we can see an upward curvilinear relationship between household expenditure on alcohol consumed at home and the log odds of household tobacco

**Table 2**
Importance of variables in TreeNet Model 1 (2006)

| Variable | Score | Graphical score representation |
|---|---|---|
| ALCOHOL_EXPENDITURE_HOME | 100.00 | |
| ALCOHOL_EXPENDITURE_AWAY | 68.85 | |
| EDUCATION_LEVELS | 66.38 | |
| INCOME | 65.17 | |
| NO_HOUSEHOLD | 63.35 | |
| REGION | 60.04 | |
| SEX | 56.50 | |
| WORK_STATUS | 54.16 | |
| AGE | 48.52 | |
| AMOUNT_DEBT | 43.56 | |
| AREA | 39.42 | |
| GAMBLING_EXPENDITURE | 28.66 | |
| MARITAL_STATUS | 25.98 | |
| GOVERNMENT_FUND RELIGION | 12.27 | |
| DISABILITY | 11.94 | |
| WELFARE | 5.52 | |
| | 5.07 | |

**Table 3**
Importance of variables in TreeNet Model 2 (2007)

| Variable | Score | |
|---|---|---|
| ALCOHOL_EXPENDITURE_HOME | 100.00 | |
| ALCOHOL_EXPENDITURE_AWAY | 77.84 | |
| INCOME | 74.35 | |
| EDUCATION_LEVELS | 66.41 | |
| REGION | 61.30 | |
| NO_HOUSEHOLD | 60.40 | |
| SEX | 59.77 | |
| WORK_STATUS | 56.26 | |
| AMOUNT_DEBT | 53.31 | |
| AGE | 47.47 | |
| AREA | 42.02 | |
| GAMBLING_EXPENDITURE | 40.55 | |
| MARITAL_STATUS | 26.55 | |
| RELIGION | 14.27 | |
| GOVERNMENT_FUND DISABILITY | 12.56 | |
| WELFARE | 6.97 | |
| | 4.90 | |

**Table 4**
Importance of variables in TreeNet Model 3 (2009)

| Variable | Score | Graphical score representation |
|---|---|---|
| ALCOHOL_EXPENDITURE_HOME | 100.00 | |
| INCOME | 70.41 | |
| EDUCATION_LEVELS | 70.17 | |
| ALCOHOL_EXPENDITURE_AWAY | 62.48 | |
| NO_HOUSEHOLD | 62.16 | |
| REGION | 60.85 | |
| SEX | 60.72 | |
| WORK_STATUS | 57.35 | |
| AREA | 47.39 | |
| AMOUNT_DEBT | 46.58 | |
| AGE | 39.93 | |
| GAMBLING_EXPENDITURE | 37.98 | |
| MARITAL_STATUS | 25.41 | |
| RELIGION | 11.33 | |
| GOVERNMENT_FUND WELFARE | 11.01 | |
| DISABILITY | 7.13 | |
| | 3.92 | |

**Table 5**
Importance of variables in TreeNet Model 4 (2011)

| Variable | Score | Graphical score representation |
|---|---|---|
| ALCOHOL_EXPENDITURE_HOME | 100.00 | |
| INCOME | 76.92 | |
| ALCOHOL_EXPENDITURE_AWAY | 75.28 | |
| WORK_STATUS | 67.29 | |
| REGION | 59.22 | |
| EDUCATION_LEVELS | 59.05 | |
| NO_HOUSEHOLD | 58.77 | |
| SEX | 57.30 | |
| AGE | 53.42 | |
| AREA | 52.76 | |
| GAMBLING_EXPENDITURE | 44.49 | |
| AMOUNT_DEBT | 38.51 | |
| MARITAL_STATUS | 33.76 | |
| GOVERNMENT_FUND RELIGION | 20.98 | |
| WELFARE | 17.97 | |
| DISABILITY | 14.84 | |
| | 7.55 | |

consumption. However, Figure 1(a) also shows that there is a drop in the log odds when household expenditure on alcohol consumed at home is at about THB 3,000 in 2006.

Similarly, Figure 2(a–d) shows an upward curvilinear relationship between household expenditure on alcohol consumed away from home and the log odds of household tobacco consumption. However, Figure 2(a) also shows that there is a drop in the log odds when household expenditure on alcohol consumed away from home is at about THB 2,500 in 2006.

Figure 3(a–d) shows that the lower the educational level of the head of household, the higher the log odds of household tobacco consumption.

Figure 4(a–d) shows a downward curvilinear relationship between household income and the log odds of household tobacco consumption. However, Figure 4(c) shows an increasing trend after income of about THB 60,000–100,000 and then drops again after that, whereas Figure 4(d) shows an increasing trend after income of about THB 60,000–200,000.

Figure 5(a–c) shows an upward linear relationship between a household size up to about nine family members and the log odds of household tobacco consumption, whereas Figure 5(d) shows an upward linear relationship between a household size of up to about seven family members and the log odds of household tobacco consumption.

Figure 6(a–d) shows a positive association between household location in the South or Northeast region and the log odds of household tobacco consumption. Note that year 2006 includes "region 6," which refers to any region not clearly identified in the samples. Figure 6(d) shows that the log adds of the South and Northeast are relatively equal, which implies that these two regions had a relatively equal likelihood of tobacco consumption in 2011.

Figure 7(a–d) shows a negative association between female head of household and the log odds of household

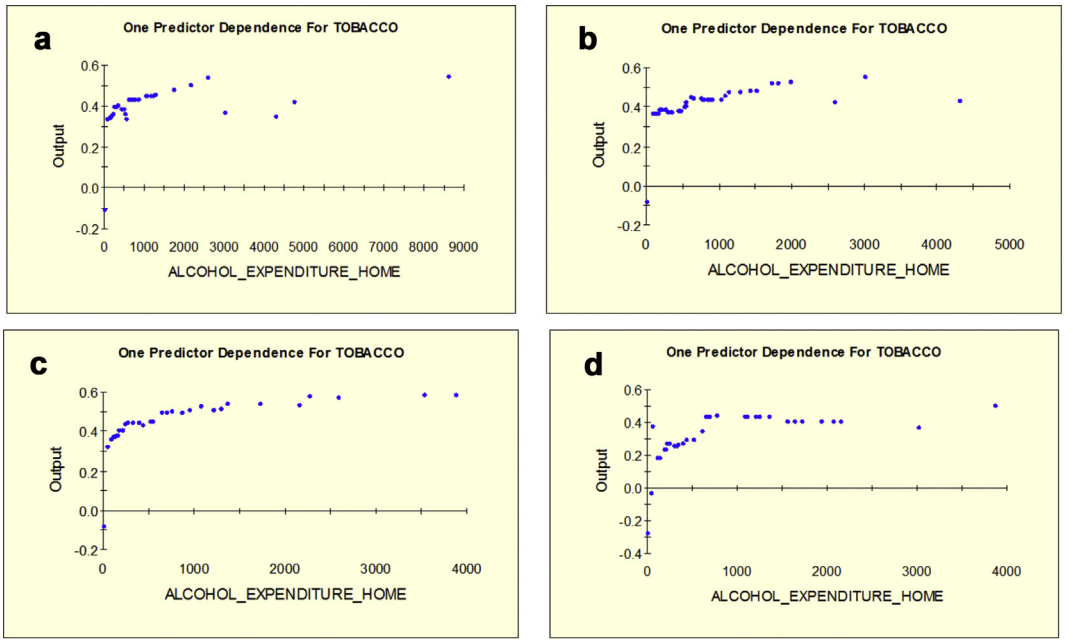


**Figure 1** (a–d) Household expenditure on alcohol consumed at home and log odds of household tobacco consumption in 2006 (above-left), 2007 (above-right), 2009 (below-left), and 2011 (below-right)

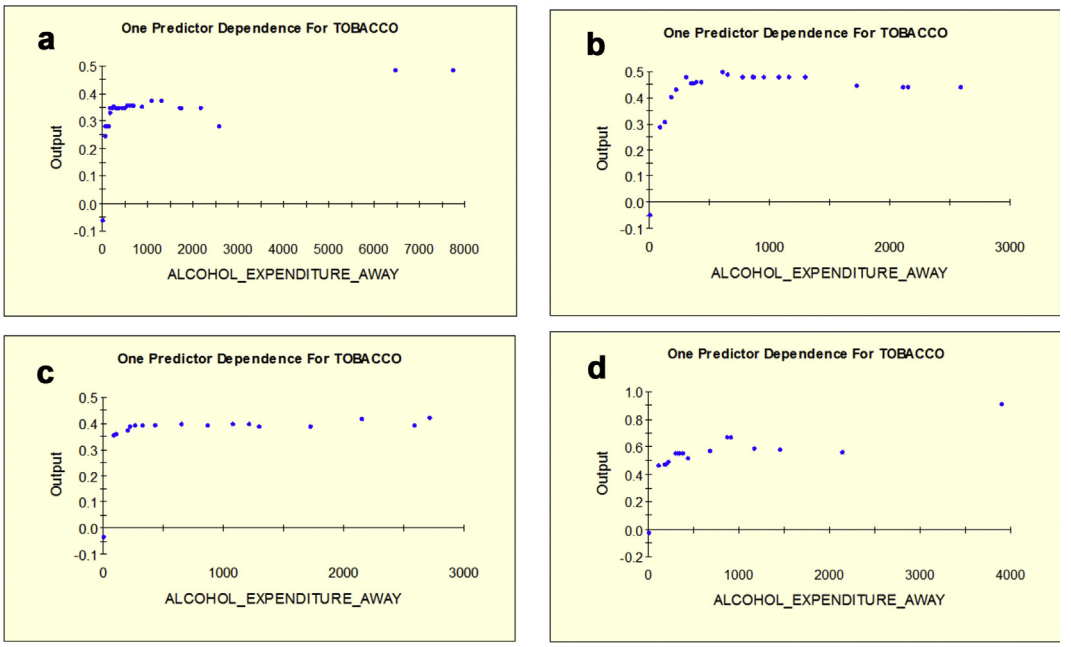


**Figure 2** (a–d) Household expenditure on alcohol consumed away from home and log odds of household tobacco consumption in 2006 (above-left), 2007 (above-right), 2009 (below-left), and 2011 (below-right)

tobacco consumption. Further, the differences in the log odds between male and female heads of household for each of the four years of the study were almost the same, which suggests that the differences in terms of the likelihood of tobacco consumption were almost the same for each of the four years of study likewise.

Figure 8(a–d) shows the highest positive association between households headed by an employee of a private company and the log odds of household tobacco consumption (with the exception of the year 2009 when household heads who were looking for jobs had the highest log odds).

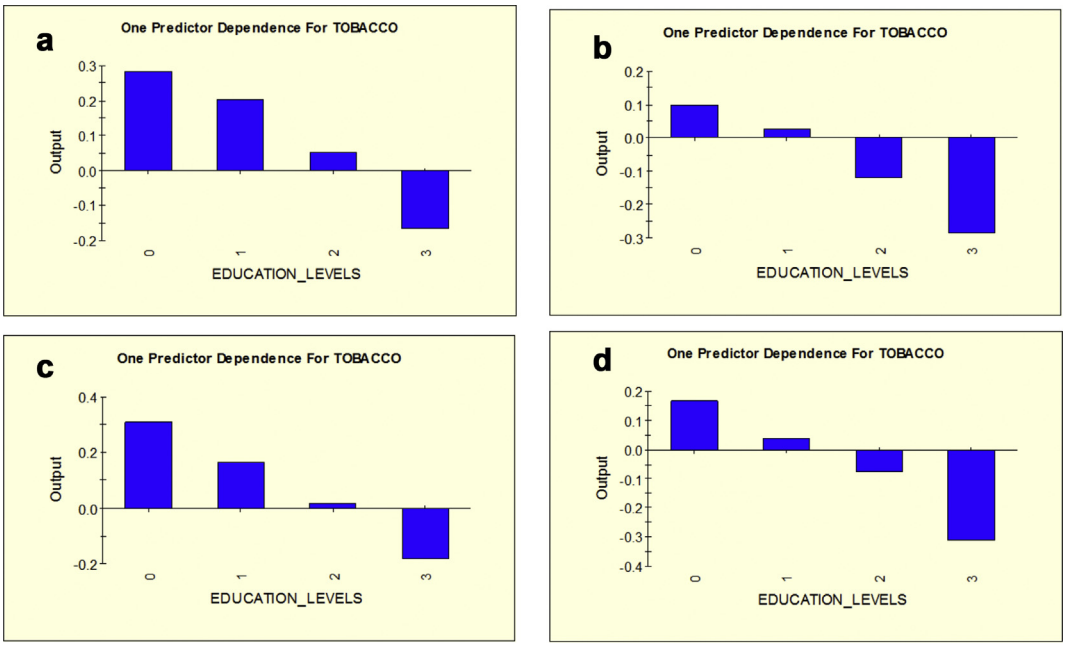


**Figure 3** (a–d) Educational level of head of household and log odds of household tobacco consumption in 2006 (above-left), 2007 (above-right), 2009 (below-left), and 2011 (below-right)

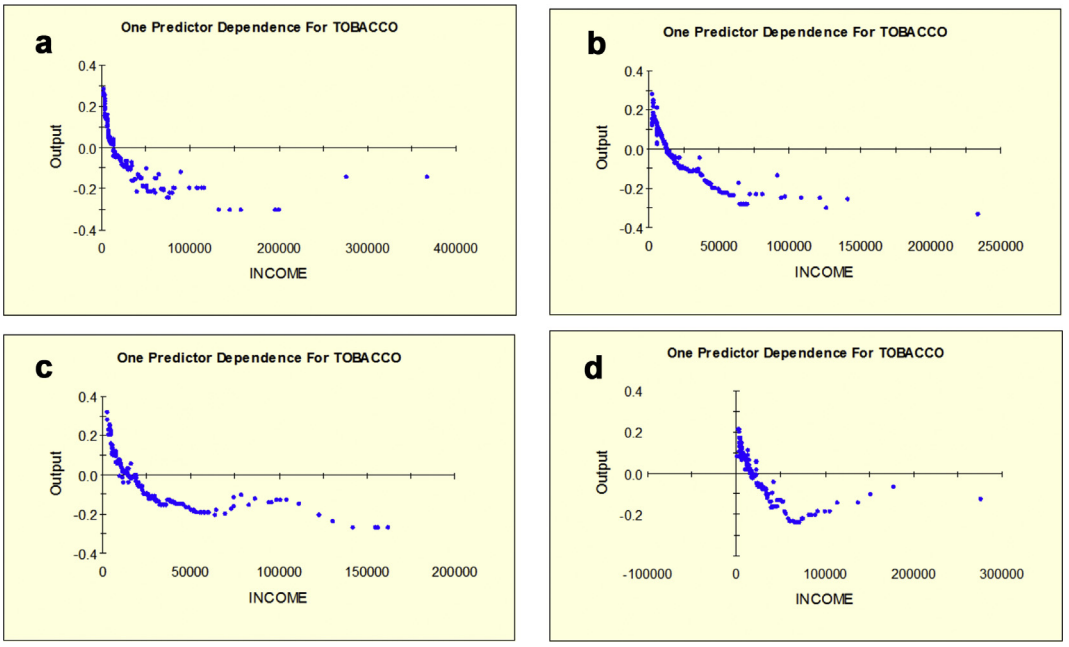


**Figure 4** (a–d) Household income and log odds of household tobacco consumption in 2006 (above-left), 2007 (above-right), 2009 (below-left), and 2011 (below-right)

For 2006, Figure 9(a) (top-left) shows that the log odds of household tobacco consumption increased with the age of the head of household from approximately 38–48 years and then increased again from 70 years old. For 2007, Figure 9(b) (top-right) shows several increasing steps. It shows that the log odds of household tobacco consumption increased with the age of the head of household from approximately 20–26 years and then increased again from 40 years. For 2009, Figure 9(c) (bottom-left) shows an increasing linear trend until an age of about 24 years, then a dropping quadratic curve from approximately 25–35 years and then an increasing quadratic curve from 40 to 63

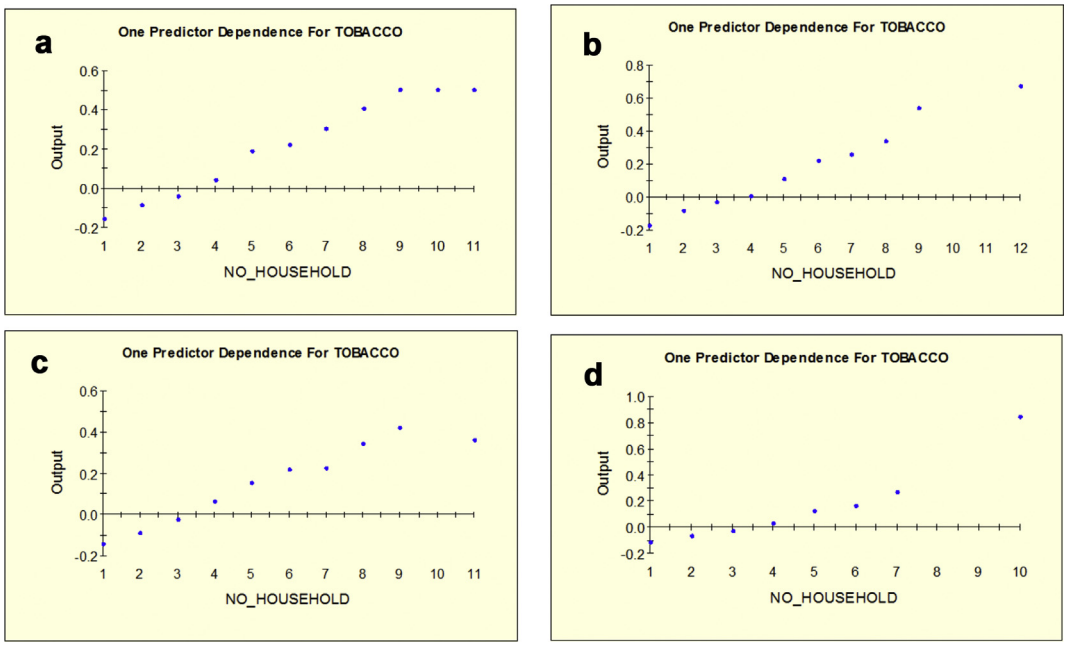


**Figure 5** (a–d) Number of members in a household and log odds of household tobacco consumption in 2006 (above-left), 2007 (above-right), 2009 (below-left), and 2011 (below-right)

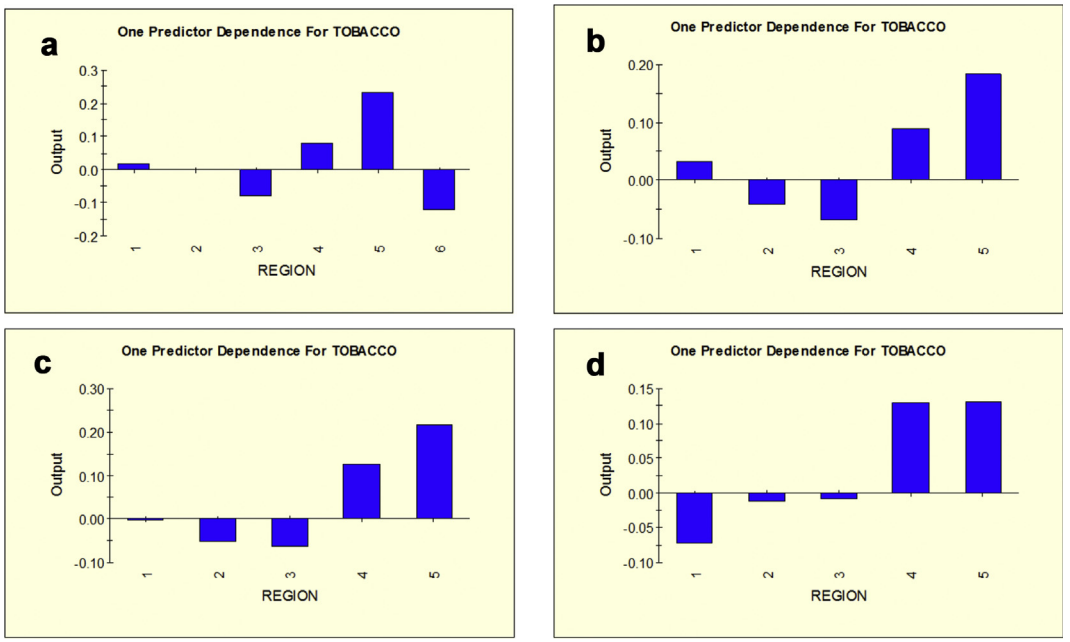


**Figure 6** (a–d) Region of the household and log odds of household tobacco consumption in 2006 (above-left), 2007 (above-right), 2009 (below-left), and 2011 (below-right)

years, followed by a dropping quadratic curve to age 70 years old and an increasing curve from 80 years old. For 2011, Figure 9(d) (bottom-right) shows a decreasing linear trend from 20 to 26 years and then the plot shifted up a little at age 27–28 years, followed by a decreasing quadratic curve to an age of around 37 years old. After this age, the points swung up and down around the reference line.

The significant feature is that the years 2006 and 2007 showed an increasing trend toward the likelihood of consuming tobacco from a younger age range to an older one. On the other hand, the plot for 2009 shows an

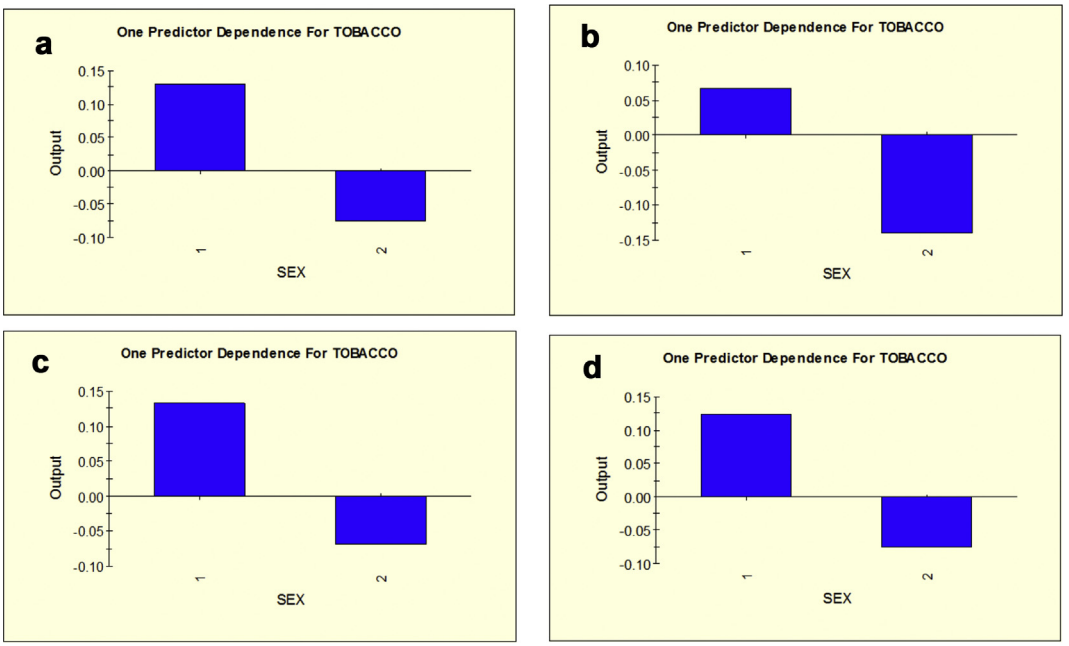


**Figure 7** (a–d) Sex of head of household and log odds of household tobacco consumption in 2006 (above-left), 2007 (above-right), 2009 (below-left), and 2011 (below-right)

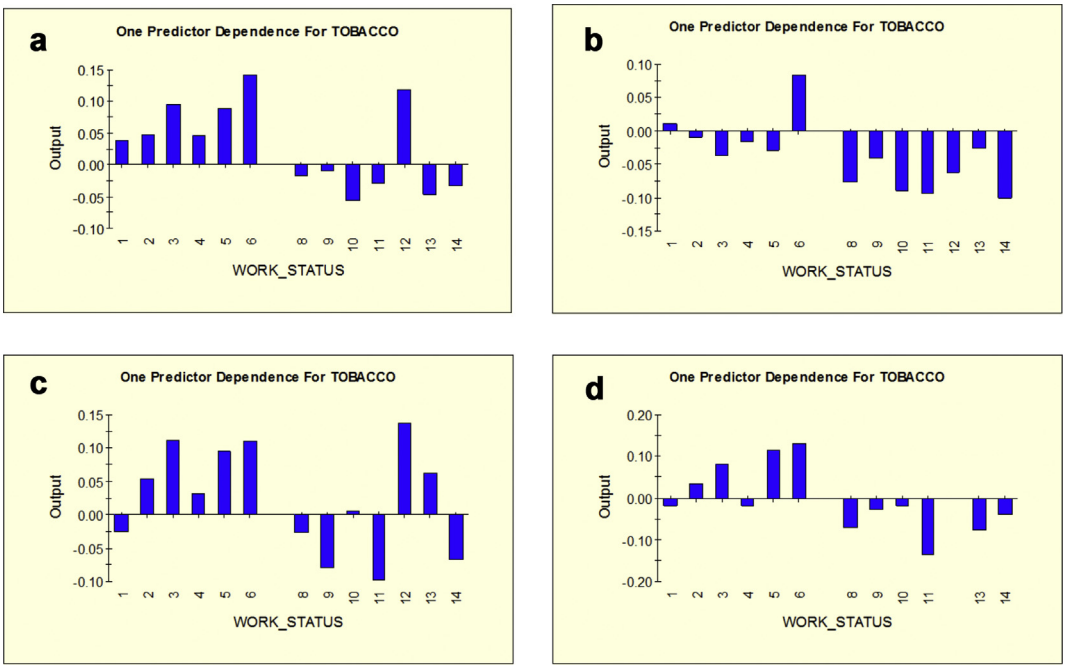


**Figure 8** (a–d) Work status of the head of household and log odds of household tobacco consumption in 2006 (above-left), 2007 (above-right), 2009 (below-left), and 2011 (below-right)

increasing trend from a young age to an age of around 23–24 years and then starts to drop at age 25 years, whereas the plot for 2011 peaks at an age of around 18 years old followed by an decreasing trend after this age until the age of 40 years. Therefore, Figure 9(a–d) suggests that the likelihood of consuming tobacco changed significantly over time. That is, there was a greater likelihood of households headed by an older person consuming tobacco in 2006 and 2007. In addition, in 2009, households headed by a person aged 20–25 years showed a greater increase in the likelihood of tobacco consumption compared to the increase shown by other age ranges. Moreover, households headed

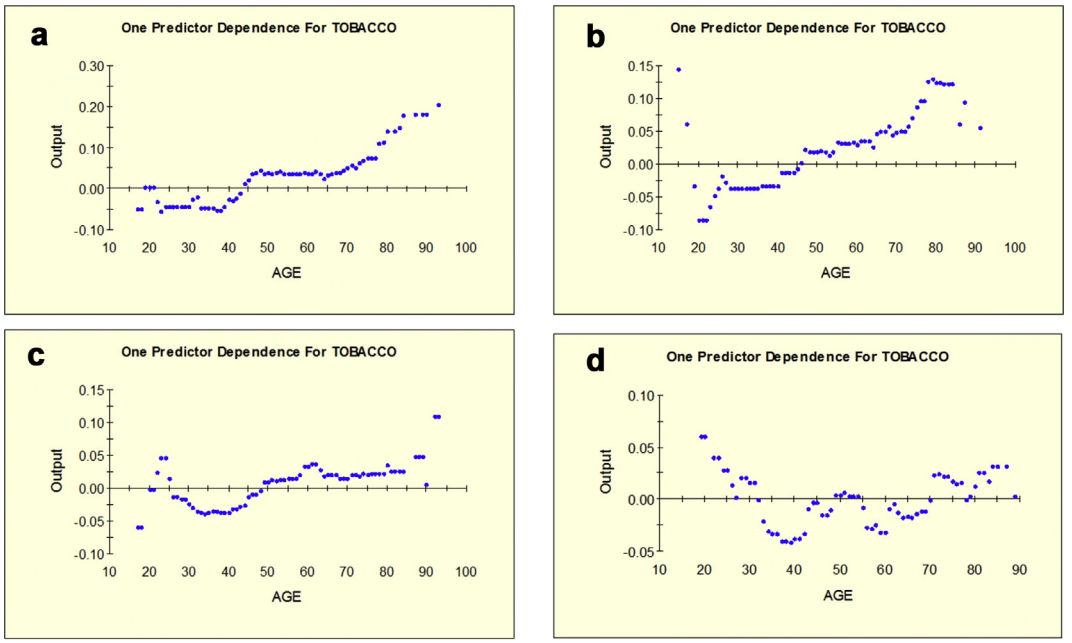


**Figure 9** (a–d) Age of head of household and log odds of household tobacco consumption in 2006 (above-left), 2007 (above-right), 2009 (below-left), and 2011 (below-right)

by young adults (aged 18–25 years) also showed the greatest likelihood of tobacco consumption in 2011.

Note that we did not discuss the plots for household debt, municipal area, gambling, marital status, government fund, religion, disability, or welfare, as these did not provide important findings for this study.

In summary, the TreeNet results for years 2006, 2007, 2009, and 2011 suggested that the likelihood of consuming tobacco was higher for households with higher expenditure on alcohol both consumed at home and away from home, with lower household income, located in the South or in the Northeast, with a head of household with a lower educational level, with a male head of household, and with a head of household employed by a private company. Over the study period, there was a change in the pattern relating to the relationship between the age of the household head and household tobacco consumption. From 2006 to 2011, the relationship between the age of the head of household and the likelihood of household tobacco consumption changed: In 2006–2007, households with an older head were more likely to consume tobacco than households with a younger head. However, in 2009, households headed by a person aged 20–25 years showed a greater increase in the likelihood of tobacco consumption compared to the increase shown by other age ranges. Moreover, households headed by young adults (aged 18–25 years) also showed the greatest likelihood of tobacco consumption in 2011.

## Discussion

This paper provides a thorough study of household tobacco consumption in Thailand in regard to the nonlinear relationships between household alcohol expenditure, household gambling expenditure, and demographic factors. We applied TreeNet to explore predictors associated with the likelihood of household tobacco consumption to the analysis of datasets drawn from socio-economic surveys of 44,918 Thai households conducted in 2006, 43,055 Thai households in 2007, 43,844 Thai households in 2009, and 42,083 Thai households in 2011. Thai households consumed tobacco at a rate of 40.79, 33.84, 33.52, and 23.92 percent in 2006, 2007, 2009, and 2011, respectively. Note that within the focal period, the excise tax on cigarettes increased from 79 percent to 80 percent on 29 August 2006, and from 80 percent to 85 percent on 14 May 2009 (also the ceiling rate of the excise tax was raised from 80% to 90% on 14 May 2009). It is possible, therefore, that the overall reduction in tobacco consumption may be related to the higher excise tax (Chaloupka, Straif, & Leon, 2010; Kengganpanich, Termsirikulchai, & Benjakul, 2009; Thomson et al., 2004; Zhang, Cohen, Ferrence, & Rehm, 2006). However, the excise tax has almost hit the ceiling at 90 percent. Overall, in regard to both policy and programs put into effect with the goal of reducing tobacco consumption, it is necessary to directly target the household group(s) most likely to consume tobacco, as shown in this study.

We focused on finding the focal group of households with the highest likelihood of consuming tobacco and on analyzing trends and changes in terms of the relationship between household tobacco consumption and each predictor over the time period 2006–2011 with the exceptions of years 2008 and 2010, which were not included in the analysis. Note that our findings are subject to the limitation that household tobacco consumption was self-reported, which might have yielded prevalence estimates lower to some extent than is actually the case.

For all four years of the survey, TreeNet showed that the most important predictor of household tobacco consumption was household expenditure on alcohol consumed at home, followed by household expenditure on alcohol consumed away from home, the head of household's educational level, and household income. The TreeNet results suggested that the likelihood of household tobacco consumption was higher for households with higher household alcohol expenditure both consumed at home and away from home, a head of household with a lower educational level, with lower household income, located in the South or the Northeast, with a head of household who was male, and a head of household who worked for a private company.

Some trends were identified and some interesting observations can be made in regard to the age of the head of household. The TreeNet results show that from 2006 to 2011, the likelihood of household tobacco consumption changed such that during the years 2006–2007, households headed by an older person were more likely to consume tobacco than households headed by a younger person, whereas households headed by a person aged 20–25 years showed a greater increase in the likelihood of tobacco consumption compared to the increase shown by other age ranges in 2009. Moreover, households headed by young adults (aged 18–25 years) (Davis, Gilpin, Loken, Viswanath, & Wakefield, 2008) also showed the greatest likelihood of tobacco consumption in 2011.

It is interesting that the likelihood of consuming tobacco showed a relatively significant increase for the age range of 20–25 years from the beginning of the study period to the end of the study period. According to the WHO report on the global tobacco epidemic in 2013 (WHO report, 2013), there has been keen tobacco industry interest in the 18–25-year-old population. One of the main reasons is that this age range is a time of transition and experimentation (Benjamin, 2012; Biener & Albers, 2004; Davis et al., 2008; WHO report, 2013) and because most smokers stay with the brand they first use regularly (Henriksen, Flora, Feighery, & Fortmann, 2002; Pechmann & Knight, 2002).

Further, the tobacco industry is also increasingly targeting people in low- and middle-income countries (WHO report, 2013), to the extent that it has become adept at tailoring its advertising and promotion tactics to these populations (Lee, Ling, & Glantz, 2012). An example of a promotional strategy of this nature in Thailand is the use of young women to represent "ambassadors of smoking" (Nimpitakpong & Pittayakulmongkon, 2011).

According to the Global Adult Tobacco Survey (WHO, 2011a), in Thailand in 2011, 34.2 percent of people aged 15–24 years and 23.7 percent of those aged older than 24 years noticed marketing strategies deployed by the tobacco industry. In terms of advertisements for cigarettes at places that sell this product, 24.5 percent of people aged 15–24 years noticed advertisements in these places and 16.8 percent of those aged older than 24 years noticed them. It seems that the age range of young adults has more access to advertising than is the case for the other age ranges. Further, this access seems to have had an impact on young adults given that the overwhelming majority of independent, peer-reviewed studies show that tobacco advertising not only leads to an increase in consumption but that young people are greatly influenced by that advertising as stated in WHO report (2013). Importantly, advertising and promotional activities on the part of tobacco companies have been shown to cause the onset and continuation of smoking among adolescents and young adults (Benjamin, 2012).

These findings should be helpful to policy makers responsible for tailoring programs to households most dependent on tobacco in order to reduce tobacco consumption in Thailand. Also, attention should be paid to determining the tobacco industry strategies that seem to have the widespread effect of increasing the relative likelihood of tobacco smoking in young adults.

## Declaration of Conflicting Interests

The authors declare no potential conflicts of interest with respect to the research, authorship, or publication of this article.

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