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RESEARCH ARTICLE

Alcohol Consumption and Age in Thailand from 2006 to 2011: An Exploration of Non-Linear Relationships

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Abstract:

Background:

In this paper, we investigate how household alcohol consumption in Thailand relates to the age of the head of household.

Methods:

We use datasets drawn from socio-economic surveys of Thai households conducted during the period of 2006–2011, and we use Treenet, a data-mining technique, to investigate nonlinear relationships between response and predictors. Our study shows that households with a head of household aged between 25 and 30 years old were the most likely to consume alcohol at home and that this likelihood decreased after the age of 30.

Results:

Our results also reveal that the proportion of total household expenditure allocated to alcohol decreased over time, but in different ways for different age groups. Moreover, we find that the gaps in alcohol spending across the different age groups tend to become smaller over time. Our results suggest that Thai government policies seem to have been accompanied by a relative decrease in alcohol consumption by younger groups.

Keywords: Nonlinear relationships, Alcohol consumption, Alcohol spending, Treenet, Gradient boosting, Age.

INTRODUCTION

Alcohol is implicated in many social and economic problems. In Thailand, according to the report on alcohol consumption and its effects published in 2013 by the Center of Alcohol Studies in Thailand, alcohol is the most critical health-risk factor in Thailand (http://www.thaiantialcohol.com/uploads/files/content/download/51b56305406bf.pdf). Kasantikul *et al.* [1] studied the role of alcohol in motorcycle crashes in Thailand and established it as the most important causal factor. Thavorncharoensap *et al.* [2] reported that the total economic cost of alcohol consumption in Thailand constituted about 1.99% of the total Gross Domestic Product (GDP) in 2006. Furthermore, excessive alcohol consumption is related to leading causes of death in Thailand, among which are malignant neoplasm, heart disease, and hypertension with cerebrovascular disease [3].

In some studies, the population is categorized into subgroups in order to investigate specific socio-economic and or demographic profiles as they relate to alcohol consumption. Of these, some studies focus on age groups. For example, Assanangkornchai *et al.* [4] studied patterns of alcohol consumption in the Thai population based on age group and

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gender from national household survey in 2007 and the results showed that an important group to focus on in order to reduce alcohol consumption included males aged 20–24 and 25–44 years who were not married and lived in Bangkok. Meier [5] found that age affects such matters as preferences pertaining to alcoholic beverages, drinking location, price paid, price sensitivity, and tendency to substitute one alcoholic beverage for another. Meng *et al.* [6] showed that age, period, and birth cohort each have an effect on alcohol-consumption level and alcohol abstention in Great Britain, and found that 18-to 24-year-olds display the highest consumption level and the lowest abstention rate. Kerr *et al.* [7] decomposed trends in alcohol volume and heavy drinking days into age, period, cohort, and demographic effects. They found that although the mean values of drinking levels declined for those aged 26 and older, there was a substantial increase in alcohol volume among those aged 18-25 years. Studies of relationships between alcohol consumption and age provide several benefits; they notably help identify groups to target for alcohol reduction policies. However, previous studies have not explored nonlinear relationships between alcohol consumption and age; as will be shown here, more detailed investigations of these non-linear patterns allow for more flexibility than assuming linear relationships or constant relationships within defined age groups and alcohol consumption.

In this study, we provide a thorough analysis for the period of 2006–2011 of the relationships between the age of the head of household and (i) the likelihood of household alcohol consumption at home and (ii) the proportion of total household expenditure allocated to alcohol consumed at home. We used datasets drawn from socio-economic surveys of Thai households conducted in 2006, 2007, 2009, and 2011. Note that the years 2008 and 2010 are not included, as the datasets for those years are incomplete. To study these relationships, we relied on models that take into account the age of the head of household and other demographic factors as well as other predictors including expenditure on tobacco and expenditure on gambling. We applied Treenet (also referred to as gradient boosting [8]), a data-mining technique that reveals non-linear associations between response and predictors. This study provides an analysis based on a nonlinear model-that has never been used before in the literature-in order to provide results of models of both household alcohol consumption/non-consumption and of household expenditure on alcohol consumed at home. Moreover, our study has investigated the longitudinal trend in alcohol consumption in Thailand, and its variations with the age of the household head, hereby expanding the scope of the past work. Please note that the relationship between age of head of household and alcohol consumption uncovered in our study do not imply causal effects between them, since it is extremely difficult to infer causal effects from observational data.

The results from Treenet show that for the focal period, households with a head of household aged between 25 and 30 years old were the most likely to consume alcohol at home and that this likelihood decreased after the age of 30 for all the years of the study. Our results also show that the differences in the proportions of household expenditure spent on alcohol consumed at home among all age groups decreased over the years of study. Taken together, these results also suggest that some age groups reduced the proportion of their total household expenditure spent on alcohol relative to other age groups. Note that the reasons for this overall decrease and the trend whereby the differences in regard to the proportion of household expenditure spent on alcohol also decreased between the age groups might be related to alcohol-control policies activated during the study period, which we explore in our discussion and conclusion sections.

DATASETS AND METHODS

Datasets

In this study, we used 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. A stratified two-stage sampling was implemented for the survey. The primary sampling units were blocks for municipal areas and were villages for non-municipal areas. The secondary sampling units were private households. Note that 2008 and 2010 are not included, as the datasets for these years are incomplete. Based on the included surveys, 22.34%, 16.51%, 15.64%, and 8.03% of households consumed alcohol at home in 2006, 2007, 2009, and 2011, respectively. The average proportion of household expenditure spent on alcohol consumed at home was 1.587%, 0.839%, 0.866%, and 0.414% in 2006, 2007, 2009, and 2011 respectively. Note that the proportion of household expenditure spent on alcohol consumed at home is defined as the proportion of total household monthly expenditures devoted to alcoholic beverages consumed at home by all members of the household. This downward trend shows a reduction in both the percentage of households that consumed alcohol at home and the proportion of household expenditure spent on alcohol consumed at home. In this study, we take the further step of thoroughly synthesizing the trends pertaining to the age of the head of household and its relationship to both the likelihood of alcohol consumption at home and the proportion of household expenditure spent on alcohol consumed at home for the period of 2006 to 2011. To study the partial relationship between alcohol

and age, we used a model that incorporates the factors shown in Table **1**.

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

Method

In this study, we refine our understanding of alcohol consumption and spending on alcohol in the following way. Specifically, we apply data-mining models to capture non-linearities in the relationships between the response and the factors of interest. We employ Treenet models (also referred to as gradient boosting [8]) since the non-parametric approach adopted by Treenet models makes it possible to handle a response variable with a large number of zero values. All data analysis was performed using Salford Predictive Modeler version 8.0.

In this analysis, we provide a thorough analysis for the period of 2006–2011 of the association between (i) the likelihood of consuming alcohol at home and the age of the head of household extracted from the model with all the factors in Table **1** with the exception of the proportion of tobacco expenditure and the proportion of gambling expenditure and (ii) the proportion of household expenditure spent on alcohol consumed at home with the age of the head of household extracted from the model with all the factors in Table **1** with the exception of tobacco expenditure and gambling expenditure. Accordingly, we constructed two models that differ from each other in regard to response:

- Model 1: The response is whether or not the household consumed alcohol at home.
- Model 2: The response is the proportion of household expenditure spent on alcohol consumed at home.

Table 1. Factors of interest.

Predictor	Details for Each Categorical Variable
Region	Note: Region of household 1. Bangkok Metropolis (6.15%, 5.69%, 6.21%, 5.84%)[a], 2. Central (excluding Bangkok) (24.76%, 28.85%, 29.37%, 29,21%), 3. North (25.01%, 24.93%, 24.35%, 24.59%), 4. Northeast (26.38%, 26.40%, 25.66%, 25.92%), 5. South (13.74%, 14.13%, 14.41%, 14.44%)
Area	Note: Area of household 1. Municipal area (62.20%, 61.54%, 61.69%, 61.13%), 2. Non-municipal area (37.80%, 38.46%, 38.31%, 38.87%)
Number of household members	Note: Number of members in household (Mean = 3.26, 3.22, 3.18, 3.04)[b]
Income	Note: Average total monthly income per household (Thai Baht) (Mean =19754, 20160, 22388, 24290)
Sex	Note: Sex of head of household[c] 1. Male (66.96%, 66.58%, 64.84%, 63.63%), 2. Female (33.04%, 33.42%, 35.16%, 36.37%)
Marital status	Note: Marital status of head of household 1. Single (9.10%, 8.82%, 8.88%, 9.62%), 2. Married (69.94%, 69.76%, 68.45%, 66.64%), 3. Widowed (15.19%, 15.82%, 16.61%, 17.41%), 4. Other (5.77%, 5.60%, 6.06%, 6.33%)
Religion	Note: Religion of head of household 1. Buddhist (95.10%, 94.78%, 94.92%, 94.95%), 2. Islamic (4.14%, 4.43%, 4.33%, 4.51%), 3. Christian and other (0.76%, 0.79%, 0.75%, 0.54%)
Disability	Note: Whether head of household is disabled 0. No (97.46%, 97.23%, 97.50%, 97.31%), 1. Yes (2.54%, 2.77%, 2.50%, 2.69%)
Welfare	Note: Whether head of household receives welfare or medical services 0. No (3.04%, 2.73%, 2.03%, 1.61%), 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 (Thai Baht) (Mean = 137.0, 120.8, 160.5, 182.8)
Tobacco expenditure	Note: Average monthly expenditure on tobacco products per household (Thai Baht) (Mean = 131.11, 97.31, 112.2, 85.8)

(Table 1) contd.....

Predictor	Details for Each Categorical Variable
Amount debt	Note: Total debt at end of previous month (Mean = 154999, 149915, 154995, 159082)
Government fund	Note: Whether head of household borrowed money from a government fund 0. No (80.31%, 81.94%, 84.11%, 85.16%), 1. Yes (19.69%, 18.06%, 15.89%, 14.84%)
Education	Note: Educational level of head of household 1. Missing values (6.15%, 5.98%, 5.78%, 5.59%), 2. Primary (58.44%, 59.08%, 58.15%, 58.42%), 3. Lower secondary (10.20%, 10.11%, 9.98%, 10.09%), 4. Upper secondary (10.46%, 10.01%, 10.69%, 10.31%), 5. Post-secondary (3.56%, 3.63%, 3.69%, 3.59%), 6. Bachelor's degree (9.86%, 9.79%, 10.02%, 10.20%), 7. Master's degree (1.14%, 1.24%, 1.53%, 1.54%), 8. Doctoral degree (0.06%, 0.03%, 0.05%, 0.07%), 9. Other (0.13%, 0.13%, 0.12%, 0.19%)
Work status	Note: Work status of head of household 1. Employer (8.02%, 6.67%, 6.31%, 4.61%), 2. Own-account worker (35.94%, 37.02%, 36.88%, 36.90%), 3. Contributing family worker (2.10%, 2.24%, 2.33%, 2.03%), 4. Government employee (11.37%, 11.33%, 10.68%, 10.33%), 5. State enterprise employee (0.97%, 0.95%, 0.98%, 0.79%), 6. Private company employee (21.93%, 21.16%, 21.47%, 21.63%), 7. Member of producers' cooperative (0.03%, 0.04%, 0.03%, 0.03%), 8. Housewife (4.09%, 4.20%, 4.26%, 4.58%), 9. Student (0.74%, 0.71%, 0.72%, 0.73%), 10. Child or elderly person (10.90%, 11.39%, 12.24%, 13.82%), 11. Ill or disabled person (1.32%, 1.47%, 1.36%, 1.52%), 12. Looking for a job (0.08%, 0.11%, 0.10%, 0.09%), 13. Unemployed (0.53%, 0.53%, 0.39%, 0.44%), 14. Other (1.89%, 2.12%, 2.22%, 2.48%)
Proportion of tobacco expenditure	Note: Proportion of monthly expenditure on tobacco products per household by total monthly expenditure (Mean = 0.0134, 0.0073, 0.0077, 0.0057)
Proportion of gambling expenditure	Note: Proportion of monthly expenditure on lottery tickets and other kinds of gambling by total monthly expenditure (Mean = 0.0139, 0.0078, 0.0096, 0.0103)

[a] Numbers in the parenthesis represents proportions of that category in years 2006, 2007, 2009 and 2011, respectively. [b] Numbers in the parenthesis represents mean in years 2006, 2007, 2009 and 2011, respectively. [c] The head of household is the leader of the household, as selected by all household members.

RESULTS

Fig. (**1**) displays the partial effects (controlling for other factors) of the age of the head of household on the estimated response for Model 1, i.e., whether or not the household consumed alcohol at home in the four years covered in the present study. Fig. (**2**) displays the partial effects (controlling for other factors) of the age of the head of household on the estimated response for Model 2, i.e., the proportion of expenditure spent on alcohol consumed at home in the four years covered in the present study.

In Fig. (**1**), the plots show a downward curvilinear trend between the age of the head of household and the log odds of alcohol consumption at home for each of the four years. In most years, the plots show that the peak of the log odds is at about 25–30 years old. There is a slight drop in the log odds from age 30 to 40 years old for each of the four years. As the age of the head of household increases from 40 to 75 years old, the log odds decrease by about 0.2 units in 2006, by about 0.3 units in 2007 and 2009, and by about 0.25 in 2011. In 2006, we observe a continuing downward trend of log odds after age of 75 years old, which differs from the trend for the other three years of the study, each of which shows constant log odds for households headed by a person aged older than 75 years. For households headed by a person younger than 25 years old, the four years differ in regard to the curve shown; i.e., year 2006 shows an increasing slope, year 2007 shows constant log odds with a shift, and years 2009 and 2011 each shows quite constant log odds with some variation for households headed by a person younger than 20 years old. Given the slope from the peak point to the lowest point, year 2011 seems to have the gentlest slope compared to the four years of study.

Overall, the results suggest that the likelihood of consuming alcohol at home is highest for households headed by a person aged between 25 and 30 years old, after which the likelihood of a household consuming alcohol at home drops curvilinearly for each of the four years covered by the study. This means that the age of the head of household at which households are most likely to consume alcohol at home is between 25 to 30 years old and the likelihood decreases after
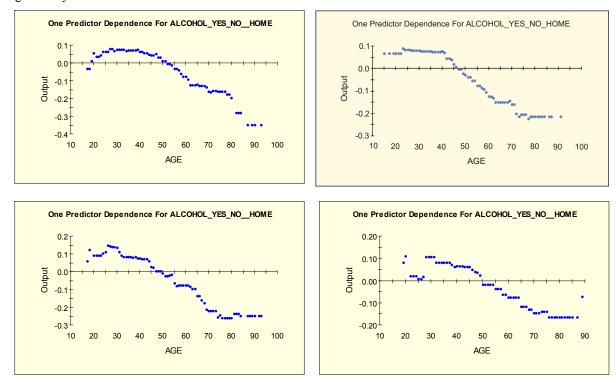
the age of 30 years.

Fig. (1). Age of head of household and log odds of alcohol consumption at home in 2006 (above left), 2007 (above right), 2009 (bottom left), and 2011 (bottom right). Partial effects.
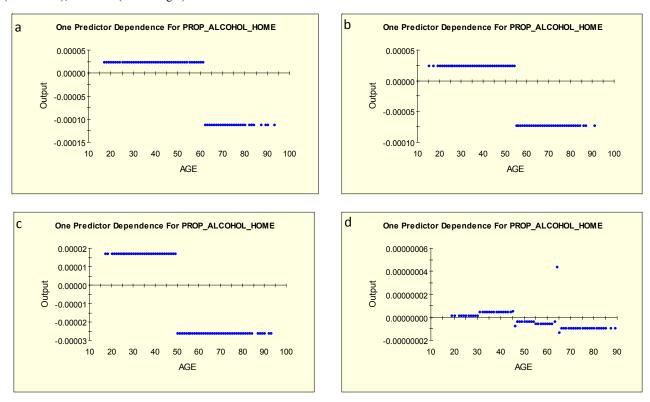

Fig. (2). Age of head of household and proportion of alcohol expenditure spent on alcohol consumed at home in 2006 (above left), 2007 (above right), 2009 (bottom left), and 2011 (bottom right). Partial effects.

As Fig. (**2a**) shows, the age of the head of household does not start to show an effect on the proportion of the

household's alcohol expenditure consumed at home until the head of household is aged about 62: at this age, the estimated proportion drops and then does not drop again as the age of the head of household increases. The result suggests that the age of the head of household at 62 and older is associated with a drop in the proportion of household expenditure spent on alcohol that was consumed at home of about 0.000125 in 2006. Figs. (**2b** and **2c**) show a pattern similar to that shown in (Fig. **2a**). In 2007, a drop of about 0.0001 units occurred at about the age of 55. In 2009, the drop, this time of 0.000045 units, occurs at about the age of 50. On the other hand, Fig. (**2d**) shows a step function whereby the first increase occurs at around the age of about 30, the first drop at the age of about 45, and the second drop at the age of about 65 years.

In all four years covered by the present study, the proportion of household expenditure on alcohol spent on alcohol consumed at home shows a decrease at several head of household ages: at age 62 in 2006, age 55 in 2007, age 50 in 2009, and age 45 in 2011. We note that the ages at which the proportions drop become progressively lower over the four years with a drop of 0.000125 in 2006, 0.0001 in 2007, 0.000045 in 2009, and 0.00000001 (for the first drop) in 2011. We also see from the plots that the differences in regard to the proportion of expenditure on alcohol spent on alcohol consumed at home among the age groups become progressively smaller over the four years of the study.

Moreover, the trend over the four years suggests that households headed by a person younger than 50 years of age consistently decreased the proportion of their household expenditure spent on alcohol over the study period ceteris paribus (when other factors are controlled for).

DISCUSSION AND CONCLUSION

In this study, for the period of 2006–2011, we thoroughly synthesized the relationships between the age of the household head and both the likelihood of households consuming alcohol and the proportion of household expenditure spent on alcohol. We performed our analysis using Treenet, a data-mining technique that explores nonlinear relationships between response and predictors. We used 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. Note that, although the use of household data enabled us to perform an analysis that has implications for government policy on alcohol taxes and consumption, etc., we realize that the fact that our dataset is at the household level constitutes a limitation. Due to the lack of data on alcohol consumption in Thailand at the individual level in recent years, our analyses cannot provide an interpretation and conclusions at the individual level, which is a more conventional unit of analysis. Also note that the household surveys utilized here provided data on alcohol consumed at home and alcohol consumed away from home separately. We investigated both types of consumption, i.e. at home and away from home. However, in the model of away-from-home consumption, the age of the household head was not an important factor after controlling for other factors. In consequence, combining both types of consumption would likely attenuate the age effects we uncovered for at home consumption. Therefore, this study focuses primarily on alcohol consumed at home.

In terms of the likelihood of consuming alcohol at home, the results from Treenet show that households headed by a person aged between 25 and 30 years old are most likely to do so. However, the likelihood of consuming alcohol at home drops curvilinearly for households headed by a person older than 30 years of age for all four years of the study. Note that 2011 is the year with the gentlest log odds slope, which represents the smallest gap in the likelihood of consuming alcohol at home between households with a head of household in the age group most likely to consume and those with a head of household in the age least likely to consume.

In terms of household spending on alcohol, our results show that the difference in the proportion of household expenditure spent on alcohol consumed at home among households headed by people in each age group decreased from the beginning to the end of study period. This result implies that households headed by people in some age groups decreased the proportion of their total expenditure spent on alcohol to a greater extent than households headed by people in other age groups did. In particular, households headed by a person younger than 50 years of age consistently lowered their proportion of household expenditure spent on alcohol over the study period.

It could be that the progressive decrease from year to year in the proportion of households consuming alcohol at home and the proportion of household expenditure on alcohol consumed at home is related to several policies in Thailand for alcohol control during the study period. One of the most important policies is the increase of the excise tax on various kinds of alcohol in Thailand, as shown in Table **2**. Note that many research studies have established taxation as one of the most effective ways to control alcohol consumption [9 - 12].

Table 2. Pattern of actual tax increases for eight alcoholic beverage categories from 2001 to 2012.

Type of alcoholic beverage	2001	2003	2005	2007	2009	2012
1. White spirits		70[a]		110	120	150
2. Mixed spirits	240			280	300	350
3. Special blended spirits	240		400			
4. Whisky						
* inexpensive	240		400			
* expensive	45%[b]	50%				
5. Brandy	30%	35%	40%	45%	48%	50%
6. Community-fermented beverages		70				
7. Beer	55%				60%	
8. Wine	60%					

Note: Numbers displayed in the table indicate years in which the tax rate changed [12]. [a] Numbers in the table are specific tax rates in Thai Bahts per liter of pure alcohol (THB/LPA). [b] Percents in the table are ad valorem rates.

It is also likely that excise tax is related to the shrinking gap across the age groups in terms of the proportion of household expenditure spent on alcohol consumed at home, as the increase in the excise tax affects beverages consumed in greater quantities by younger consumers, *e.g.*, white spirits, than by older consumers (see http://www.ias. org.uk/What-we-do/Publication-archive/The-Globe/Issue-2-2008/Newly-introduced-alcohol-marketing-strategies-Thai-experience.aspx). Further, a study by Chaloupka *et al.* [13] supports the position that the price of alcohol, which can be manipulated by excise tax policies, is an important factor in influencing alcohol consumption among youth and young adults. Moreover, they found that demand for distilled spirits is very sensitive to price.

Note that the other policies during the period covered herein include the Alcohol Control Act passed in 2008. This act includes a partial ban on alcohol advertising and prohibits both the sale and the consumption of alcohol in certain places, among which temples, government offices, and hospitals. The Alcohol Control Act might also be related to the reduction of alcohol consumption reported in the present study. As we could not establish the existence of causal relationships between the Thai government's alcohol-control policies and the reported decrease in alcohol consumption, it is important for future research to include a focus on studying causal relationships directly.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

HUMAN AND ANIMAL RIGHTS

No Animals/Humans were used for studies that are base of this research.

CONSENT FOR PUBLICATION

Not applicable.

CONFLICT OF INTEREST

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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