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Sociological Mechanisms Underlying Alcohol, Tobacco, and Gambling: A Causal Mediation Analysis

Pannapa Changpetch*[a] and Dominique Haughton[a][b][c]

[a] Department of Mathematical Sciences, Bentley University, 175 Forest Street, Waltham, MA 02452, USA.
[b] Université Paris 1, Paris, France.
[c] Université Toulouse 1, Toulouse, France.
*Corresponding author; e-mail: pchangpetch@bentley.edu

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Abstract

This paper employs a Directed Acyclic Graph (DAG) to investigate direct and indirect effects among the proportion of household expenditure spent on alcohol, the proportion of household expenditure on tobacco, the proportion of household expenditure on gambling, and fourteen demographic factors from a socio-economic survey of 43,844 Thai households conducted in 2009. Our results show that the proportion of household expenditure spent on alcohol has a direct effect on both the proportion of household expenditure on tobacco and the proportion of household expenditure on gambling. The geographical location of the household has a direct effect on all three household expenditures on alcohol, tobacco and gambling. The sex of the household head has a direct effect on both the proportions of household spending on alcohol and tobacco but not on that on gambling. The age of the household head has a direct effect on household spending on alcohol but not on tobacco and gambling. Overall, our paper sheds light on the sociological mechanisms underlying household expenditure on alcohol, tobacco, and gambling and demonstrates why a DAG is the key ingredient to these insights.

Keywords: Alcohol consumption, tobacco consumption, gambling, directed acyclic graph.

1. Introduction

It is no secret that in Thailand excessive alcohol consumption, tobacco consumption, and gambling constitute serious societal ills that are undermining the health of individuals and the economic well-being of society more generally. In terms of alcohol, the World Health Organization (WHO) puts Thailand first among ASEAN countries for alcohol consumption. Further, excessive alcohol consumption is a factor in the top causes of death (e.g., malignant neoplasm, heart disease, and hypertension with cerebrovascular disease) in Thailand (Kamsa-Ard et al. 2014). In terms of tobacco, 50,710 premature deaths a year for the period of 2006 to 2011 were attributed to major tobacco-related diseases (Lian and Dorotheo 2014). In regard to

the nation's economic well-being, in just one year (2009), Thailand's expenditure on medical care for tobacco-related diseases totaled 11.2 billion Bahts (0.37 billion USD). In terms of gambling, a paper from the Thai Center for Gambling Studies (2015) estimated that around 370 billion Bahts circulated for both legal and illegal gambling activities in Thailand during the period of October 2014 to September 2015 (Center for Gambling Studies, Thailand).

In the literature, studies of associations are typically performed using the following methods. In studies related to alcohol, tobacco, and gambling, commonly used methods are bivariate analysis, multiple linear regression, and logistic regression analysis (e.g., Stinchfield 2010, CDC 2011, Jackson et al. 2002, Wetzels et al. 2003, Hublet et al. 2006, Duhig et al. 2007, Aekplakorn et al. 2008, Barnes et al. 2009, Bonevski et al. 2014). For example, on the basis of a logistic regression approach to considering the relationship between alcohol consumption and tobacco consumption, Jackson et al. (2002) reported that prior alcohol use predicts tobacco use more strongly than vice-versa. However, using a similar approach, Wetzels et al. (2003) reported opposite results for several countries in Europe. However, in addition to bivariate analysis, multiple linear regression and logistic regression analysis, other techniques that have been used to explore relationships between alcohol consumption, tobacco consumption, and gambling consumption include Tobit models and Treenet models (www.salford-systems.com/treenet.html, Friedman, 2001). Tan et al. (2009) used a trivariate Tobit model with household expenditure data as the input to investigate the demand for tobacco, alcohol, and gambling in Malaysia, whereas Changpetch et al. (2016) used Treenet to investigate alcohol consumption in Thailand.

Another approach to exploring relationships is a directed acyclic graph (DAG), which has been used in many applications but not in the context of alcohol, tobacco and gambling. For example, Bessler (2003) used country level data and constructed a DAG to explore the direct and indirect associations between the poverty rate and numerous factors including the inequality index, the birth rate, the child mortality rate, the GDP per capita, international trade, and life expectancy. Haigh and Bessler (2004) used a DAG to establish a connection between commodity markets and transportation markets, and Awokuse (2006) used this approach to explore the causal relationship between real exports and GDP growth in Japan.

In one of the most spectacular examples of the effectiveness of a DAG as an aid to deriving conceptual models, Spirtes et al. (2000) used a DAG to explain publishing productivity among academic psychologists in reference to such factors as undergraduate performance, gender, the quality of the graduate program, the publication rate, the number of early publications, and the quality of the first job. The model they identified in a few seconds was almost identical to a model established after a long tedious period of sifting through considerable volumes of past literature.

In the present study, we employ data from a socio-economic survey of 43,844 Thai households conducted in 2009 to construct a DAG to investigate the direct and indirect effects between the proportion of household expenditure on alcohol, the proportion of household expenditure on tobacco, and the proportion of household expenditure on gambling, and 14 demographic factors. DAG—a technique that has never been used in this context before—allows connections to be made between all the variables without any restrictions. Our results show that the proportion of household expenditure on alcohol has a direct effect on both the proportion of household expenditure on tobacco and the proportion of expenditure on gambling. We find that the impact of religion on the proportion of household expenditure on alcohol and the proportion of expenditure on tobacco operates indirectly by way of the geographical location or region of

the household, but that the religion of the household head has a direct effect on the proportion of household expenditure on gambling. The sex of the household head has a direct effect on both the proportion of household expenditure on alcohol and the proportion of household expenditure on tobacco. The age of the household head has a direct effect on the proportion of household expenditure on alcohol and has an indirect effect on it via household size and the marital status of the head. The educational level of the household head does not have a direct effect on household expenditure on either alcohol, tobacco, or gambling. However, this variable does have an indirect effect through several paths, including household income and the region of the household.

2. Methodology

2.1. Dataset

For this study, we used a dataset collected via a socio-economic survey of Thai households conducted in 2009. The factors included in our analyses are displayed in Table 1 with summary statistics.

Table 1 Factors of interest

Predictor	Details for each categorical variable
region	Note: Region of household 1. Bangkok Metropolis (6.2%), 2. Central (excluding Bangkok) (29.4%), 3. North (24.4%), 4. Northeast (25.7%), 5. South (14.4%)
area	Note: Area of household 1. Municipal area (61.7%), 2. Non-municipal area (38.3%)
no_household	Note: Number of members in household min = 1, median = 3, max = 17, mean = 3.18, standard deviation = 1.63
income	Note: Average monthly total income per household (Thai Baht) min = -103,988, median = 14,420, max = 2,821,572, mean = 22,388, standard deviation = 38,058
sex	Note: Sex of head of household 1. Male (64.8%), 2. Female (35.2%)
age	Note: Age of head of household (years) min = 9, median = 51, max = 99, mean = 51.69, standard deviation = 14.77
marital_status	Note: Marital status of head of household 1. Single (8.9%), 2. Married (68.4%), 3. Widowed (16.6%), 4. Other (6.1%)
religion	Note: Religion of head of household 1. Buddhist (94.9%), 2. Islamic (4.3%), 3. Christian and other (0.8%)

Table 1 (Continued)

Predictor	Details for each categorical variable
disability	Note: Whether head of household is disabled 0. No (97.5%), 1. Yes (2.5%)
welfare	Note: Whether head of household receives welfare or medical services 0. No (2.0%), 1. Yes (98%)
amount_debt	Note: Total debt at end of previous month min = 0, median = 10,000, max = 57,000,000, mean = 154,995, standard deviation = 616,876
government_fund	Note: Whether head of household borrowed money from a government fund 0. No (84.1%), 1. Yes (15.9%)
education	Note: Educational level of head of household 1. Missing values (5.8%), 2. Primary (58.2%), 3. Lower secondary (10.0%), 4. Upper secondary (10.7%), 5. Post-secondary (3.7%), 6. Bachelor's degree (10%), 7. Master's degree (1.5%), 8. Doctoral degree (0.05%), 9. Other (0.12%)
work_status	Note: Work status of head of household 1. Employer (6.3%), 2. Own-account worker (36.9%), 3. Contributing family worker (2.3%), 4. Government employee (10.7%), 5. State enterprise employee (1.0%), 6. Private company employee (21.5%), 7. Member of producers' cooperative (0.03%), 8. Housewife (4.3%), 9. Student (0.7%), 10. Child or elderly person (12.2%), 11. Ill or disabled person (1.4%), 12. Looking for a job (0.1%), 13. Unemployed (0.4%), 14. Other (2.2%)
prop_tobacco	Note: Proportion of monthly expenditure on tobacco products per household by total monthly expenditure min = 0, median = 0, max = 0.2907, mean = 0.0077, standard deviation = 0.0194
prop_gambling	Note: Proportion of monthly expenditure on lottery tickets and other kinds of gambling by total monthly expenditure min = 0, median = 0, max = 0.6195, mean = 0.0096, standard deviation = 0.0218
prop_alcohol_home	Note: Proportion of monthly expenditure on alcohol consumed at home per household by total monthly expenditure min = 0, median = 0, max = 0.5738, mean = 0.0087, standard deviation = 0.0280
prop_alcohol_away	Note: Proportion of monthly expenditure on alcohol consumed away from home per household by total monthly expenditure min = 0, median = 0, max = 0.4740, mean = 0.0059, standard deviation = 0.0242

Table 1 (Continued)

Predictor	Details for each categorical variable
prop_alcohol_total	Note: Proportion of monthly expenditure on alcohol consumed both at home and away from home per household by total monthly expenditure min = 0, median = 0, max = 0.6135, mean = 0.0145, standard deviation = 0.0376

Note that the Thai exchange rate in 2009 ranged from 30.35 to 35.22 bahts to the US dollar. Note, too, that our household data separated alcohol into that consumed at home and that consumed away from home, whereas neither tobacco consumption nor gambling were separated into these or any other categories.

2.2. Directed acyclic graph (DAG)

In this section, we construct a directed acyclic graph (DAG) (also referred to as a Bayesian network) to help unravel the direct and indirect effects of household characteristics on household expenditure on alcohol, tobacco and gambling. The importance of these techniques, highlighted by the Turing prize awarded to Judea Pearl in 2011, has been growing, along with the debate among researchers in regard to whether traditional statistical models used in many applications provide enough evidence to warrant policy recommendations. The issue of causality is, of course, at stake here, and there is no claim to a conclusive answer (Spirtes et al. 2000 and Pearl 2009). A number of algorithms exist for constructing DAGs, falling essentially into two categories: Constraint-based algorithms, such as the PC (Partial correlation) or GS (Greedy Search; package bnlearn in R, see Scutari 2010) algorithms and Score based algorithms (Conrady and Jouffe 2015).

We employ an algorithm implemented by the Bayesialab software (http://www.bayesia.com). Note that all variables are discretized in the Bayesialab implementation. We employ a Taboo search algorithm (a greedy score-based algorithm). It allows for temporarily iterating to less optimal solutions with a smaller score in order to avoid being stuck near a local optimum in the search space.

In Figure 1, the proportions of household expenditure on alcohol, tobacco, and gambling are shown to be closely linked. The proportion of household expenditure on alcohol has a direct effect on both the proportion of household expenditure on tobacco and the proportion of household expenditure on gambling. If we force the proportion of household expenditure on alcohol to be at a higher level (Figure 2), the proportion of household expenditure on gambling and the proportion of household expenditure on tobacco will be higher as well.

The region of the household has a direct effect on household expenditure on alcohol, tobacco, and gambling. The religion of the household head connects to household expenditure on alcohol (consumed at home) and on household expenditure on tobacco only via the region of the household, which suggests that the impact of religion on both of these operates via the geographical location of the household. On the other hand, the religion of the household head has a direct effect on household expenditure on gambling.

The sex of the household head has a direct effect on both household expenditure on alcohol and on tobacco, but this variable does not have a direct effect on household expenditure on gambling. The age of the household head has a direct effect on household expenditure on alcohol;

moreover, through a different path, the age of the household head connects to household expenditure on alcohol via household size and the marital status of the household head, which suggests that the effect of the age of the household head on household expenditure on alcohol operates via two factors, namely whether the household head is single, married, or widowed and the number of people who live in the household.

The area of the household, i.e., whether municipal or non-municipal, connects to household expenditure on alcohol (consumed at home), household expenditure on tobacco, and household gambling only via the geographical region of the household. The educational level of the household head does not have a direct effect on household expenditure on alcohol, tobacco, or gambling. However, this variable does have an indirect effect through several paths, including via household income and the geographical region of the household.

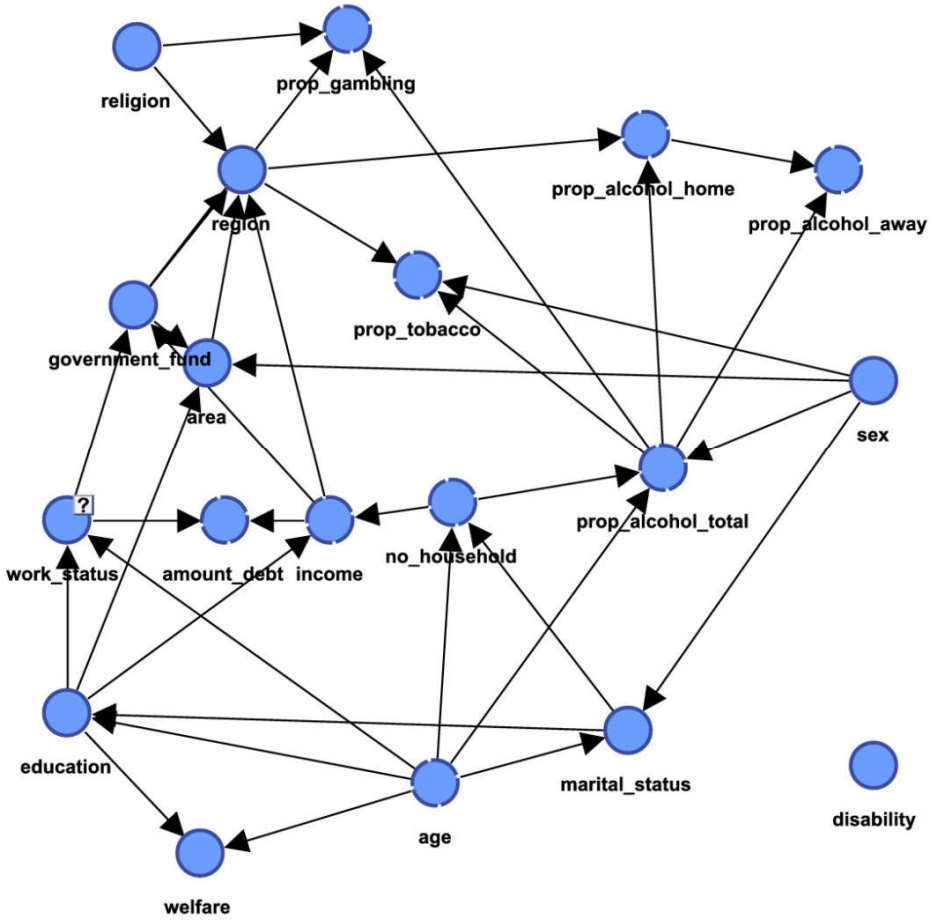

Figure 1 Directed acyclic graph

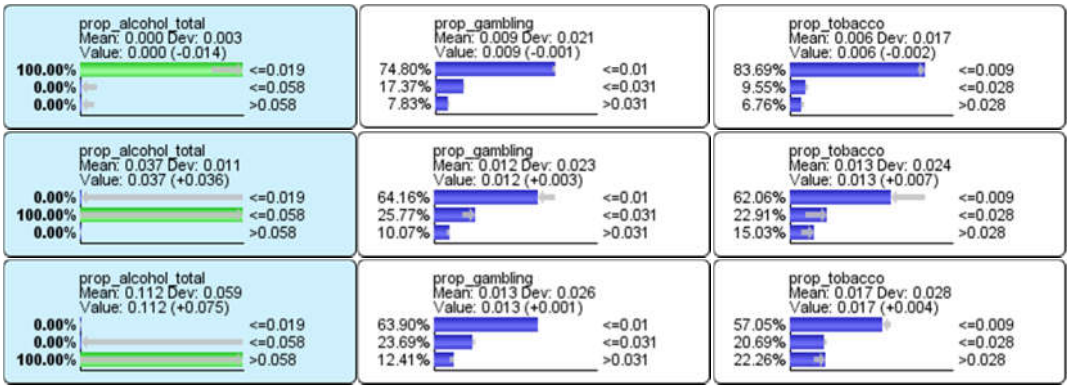

Figure 2 Impact of the different levels of proportions of household expenditure on alcohol on the proportion spent on gambling and the proportion spent on tobacco

3. Conclusions

In this study, a directed acyclic graph (DAG) was used to investigate direct and indirect effects among the proportion of household expenditure spent on alcohol, the proportion of household expenditure on tobacco, and the proportion of household expenditure on gambling, and 14 demographic factors from a socio-economic survey of 43,844 Thai households conducted in 2009. Beyond bivariate analyses, multiple linear and logistic regression analyses used in past work related to the study of alcohol consumption (e.g., Stinchfield 2010, Jackson et al. 2002, Wetzels et al. 2003, Duhig et al. 2007, Aekplakorn et al. 2008, Barnes et al. 2009, Bonevski et al. 2014), we implemented a new method that had never been used in this context before, i.e., a directed acyclic graph (DAG).

Our study thus illuminates the mechanisms that underlie alcohol, tobacco and gambling consumption beyond our past understanding of these phenomena. In a previous study where we used a Treenet model to explore the relationships among the same set of variables (Changpetch et al. 2016), we found that variables that are important for predicting the proportion of household expenditure on alcohol at home and away from home include the proportion of household expenditure on tobacco, the proportion of household expenditure on gambling, sex of the head of household, age of the head of household, region of the household, religion of the household, and work status of the household head. In that study, one variable on alcohol consumption was singled out as a target, and all predictors were on the same pedestal.

We now are in a position to comprehend which predictors might lead to other predictors which in turn might lead to alcohol, tobacco and gambling consumption, and indeed whether these three modes of consumption tend to be related directionally. In that manner, our paper has shed light on the sociological mechanisms underlying household expenditure on alcohol, tobacco, and gambling and has demonstrated why a DAG is the key ingredient to these insights.

References

Aekplakorn W, Hogan MC, Tiptaradol S, Wibulpolprasert S, Punyaratabandhu P, Lim SS. Tobacco and hazardous or harmful alcohol use in Thailand: Joint prevalence and associations with socioeconomic factors. Addict Behav. 2008; 33(4): 503-514.

Awokuse TO. Export-led growth and the Japanese economy: evidence from VAR and directed acyclic graphs. Appl. Econ. 2006; 38(5): 593-602.

Barnes GM, Welte JW, Hoffman JH, Tidwell MC. Gambling, alcohol, and other substance use among youth in the United States. J. Stud. Alcohol Drugs. 2009; 70(1):134-142.

Bessler DA. On world poverty: its causes and effects. Rome: Research Bulletin; 2003.

Bonevski B, Regan T, Paul C, Baker AL, Bisquera A. Associations between alcohol, smoking, socioeconomic status and comorbidities: evidence from the 45 and up study. Drug Alcohol Rev. 2014; 33(2): 169-176.

Center for Gambling Studies, Thailand. Available from: www.gamblingstudy-th.org. http://www.gamblingstudy-th.org/imgadmins/book_file/PPT-survey-58-final.pdf [accessed January 6, 2017]

Centers for Disease Control and Prevention (CDC). Vital signs: current cigarette smoking among adults aged ≥ 18 years-United States, 2005-2010. Morbidity and mortality weekly report. 2011; 60: 1207-1212.

Changpetch P, Haughton D, Le MT, Ly S, Nguyen P, Thach TT. Alcohol consumption in Thailand: a study of the associations between alcohol, tobacco, gambling, and demographic factors. Asian J. Soc. Sci. Humanit. 2016; 5(4): 53-67.

Conrady S, Jouffe L. Bayesian networks and BayesiaLab: a practical introduction for researchers. Franklin: Bayesia USA; 2015.

Duhig AM, Maciejewski PK, Desai RA, Krishnan-Sarin S, Potenza MN. Characteristics of adolescent past-year gamblers and non-gamblers in relation to alcohol drinking. Addict Behav. 2007; 32(1): 80-89.

Friedman JH. Greedy function approximation: a gradient boosting machine. Ann. Stat. 2001; 29(5): 1189-1232.

Haigh MS, Bessler DA. Causality and price discovery: an application of directed acyclic graphs. J. Bus. 2004; 77(4): 1099-1121.

Hublet A, De Bacquer D, Valimaa R, Godeau E, Schmid H, Rahav G, Maes L. Smoking trends among adolescents from 1990 to 2002 in ten European countries and Canada. BMC Publ. Health. 2006; 6: 280-287.

Jackson KM, Sher KJ, Cooper ML, Wood PK. Adolescent alcohol and tobacco use: onset, persistence and trajectories of use across two samples. Addiction. 2002; 97(5): 517-531.

Kamsa-Ard S, Promthet S, Lewington S, Burrett JA, Sherliker P, Kamsa-Ard S, Suwanrungruang K, Parkin DM. Alcohol consumption and mortality: the Khon Kaen cohort study, Thailand. J. Epidemiol. 2014; 24(2): 154-160.

Lian TY, Dorotheo U. The ASEAN tobacco control atlas (2nd ed.). Bangkok: Southeast Asia Tobacco Control Alliance (SEATCA); 2014.

Scutari M. Learning Bayesian networks with the bnlearn R package. J. Stat. Software. 2010; 35(3): 1-22.

Stinchfield RA. A critical review of adolescent problem gambling assessment instruments. Int J Adolesc. Med. Health. 2010; 22(1): 77-93.

Pearl J. Causal inference in statistics: An overview. Stat. Surv. 2009; 3: 96-146.

Spirtes P, Glymour CN, Scheines R. Causation, prediction, and search. MIT press; 2000.

Tan AK, Yen ST, Nayga RM. The demand for vices in Malaysia: an ethnic comparison using household expenditure data. Atl. Econ. J. 2009; 37: 367-382.

Wetzels JJ, Kremers SP, Vitoria PD, De Vries H. The alcohol-tobacco relationship: a prospective study among adolescents in six European countries. Addiction. 2003; 98(12): 1755-1763.