

MODELING FOR DEMOGRAPHIC AND REGIONAL PREVALENCE AND TRENDS OF SMOKING IN THAI MALES

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Abstract. This study aimed to describe using national survey data the demographic and regional prevalence and trends of smoking in Thai males during the past 25 years. Data from eight national surveys conducted by the National Statistics Office from 1986 to 2011 were used to examine the prevalence of smoking. Males aged 15 and older were included in this study. Logistic regression was used to model smoking patterns, according to year of survey, age group, urbanization, and Public Health Area (PHA). The prevalence of smoking among males aged 15 years and older in 2011 was 38.4%. Sharply increasing smoking prevalence was found in the 15-24 years-old age group in all surveys. Before survey year 1999, the prevalence of smoking started to level off near retirement age, and subsequently, it leveled off after 40 years of age. The prevalence of smoking in all age groups decreased after 1986 except in the 15-19 years-old age group. Higher prevalence of smoking was found in rural areas. Males from the Northeast and the lower South regions had the highest prevalence. More effective anti-smoking policies should focus on males aged below 25 years to reduce the increasing prevalence of smoking in this group.

Keywords: smoking modeling, smoking prevalence, smoking trends, Thai males

INTRODUCTION

Cigarette smoking is a primary cause of preventable illness and premature death; estimated to cause almost 6 million deaths each year worldwide. It is expected to reach 8 million deaths annually by year 2030 (WHO, 2008). More than 80% of these deaths occur in low- or middle-income countries. Globally, males smoke more than females by a factor of 5 (Guindon and

Boisclair, 2003). However the prevalence of smoking among males and females varies substantially across countries. In developed countries, the prevalence in females is almost the same as for males, but females smoke much less than males in developing countries, especially in Southeast Asia, with rates ten times lower than males (WHO, 2008). It has been estimated that one billion males in the world smoke with 35% in developed countries and 50% in developing countries (Mackay and Eriksen, 2002; Warner, 2006).

A study of smoking prevalence and cigarette consumption in 187 countries from years 1980 to 2012 indicated that the estimated prevalence of daily smoking for

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both sexes declined after 1980. The greatest reduction was between 1996 and 2006, especially among males, but subsequently followed by slower reduction at the global level (Ng *et al*, 2014).

In Thailand, data from the Global Adult Tobacco Survey (GATS) in 2009 show that males smoke 15 times more than females (46.5% against 3.1%), with 12.5 million (23.7%) current smokers (WHO SEARO, 2009). This survey also found the highest prevalence of smoking in the South and the lowest in Bangkok, and varying according to demographic factors, region and year of survey. Since 1976, the Thai National Statistical Office has collected information on smoking behavior as part of its Health and Welfare Survey, conducted every 5 years.

In 1999, a survey of smoking behavior was conducted. Subsequently, smoking and drinking behavior surveys were combined in 2004 and conducted every three years (National Statistical Office, 2014). Two studies gathered information on smoking behavior from these surveys and used statistical analysis to examine prevalence and trends of smoking (Sangthong *et al*, 2011, 2012). These studies found that a large decline in smoking prevalence occurred from 1986 to 2004, with a smaller decline after 2004. However, a rising trend in tobacco consumption among youths was found from surveys in 2007 and 2009. A higher prevalence of smoking was found in (a) males aged 21-60 years, (b) persons with low education and income levels, and (c) rural residents (Sangthong *et al*, 2012).

The analysis of smoking survey data using appropriate statistical methods provides valuable information on smoking prevalence and trends in Thailand, and consequently, supports policy makers in evidence-based decision making. The study conducted by Sangthong *et al* (2011)

applied an age-period-cohort model for analyzing these datasets. However, fitting this model to data has an identifiability problem because period equals year of birth plus age (Rutherford *et al*, 2010).

Our study fitted a simple logistic regression model with smoking status as the outcome and age, gender, year of survey, and location as determinants. The results can also provide cohort effects by subtraction of age and survey year effects. Given that smoking rates for females and males under 15 years of age are substantially lower than for older males, we restricted our study to males aged 15 or more.

MATERIALS AND METHODS

Data sources

Three sources of survey data from the National Statistical Office of Thailand (NSO) were used for this study; namely, the Health and Welfare Survey (HWS), the Smoking Behavior Survey (SBS), and the Smoking and Drinking Behavior of the Population Survey (SDBPS). Data from five Health and Welfare surveys conducted in years 1986, 1991, 1996, 2001, and 2003; one Smoking Behavior Survey in 1999; and two Smoking and Drinking Behavior Surveys conducted in years 2007 and 2011 were used for statistical analysis.

A stratified two-stage sampling method was used for data collection in each survey. The first stage selected every province with two areas: municipal and non-municipal, with primary sampling unit enumeration areas (EAs) and villages. EAs and villages were sampled using systematic random sampling proportional to household. The second stratum comprised households sampled using systematic random sampling with 15-16 households in each EA for municipal areas and 10-12 households in each village for

non-municipal areas.

Every member from a selected household aged 11 years and older was interviewed for smoking behavior using a structured questionnaire. Those who responded as regular or occasional smokers were considered as smokers. Smoking prevalence among Thai females is not common with only 1.7% for those aged 11 and above reported in year 2007 (Sangthong *et al*, 2012). Only males aged 15 and above were included in our study. Age, area, province, smoking status, and year of survey were selected as factors of interest.

Error checking was performed and data cleaned before analysis. Data from the eight surveys were combined resulting in 352,433 subjects. Age was classified into 5-year age groups from 15-19 to 75-79 and 80 or older. Provinces were grouped into 13 Public Health Areas (PHAs). The Central Region consists of PHAs 1 to 4, the Northeast consists of PHAs 5 and 6, the North consists of PHAs 8 to 10, and the South consists of PHAs 11 and 12. Bangkok is PHA 13 and is entirely municipal. For statistical analysis, two combined variables were generated as follows. Survey year was combined with age group to form a year-age group variable with 112 categories (8 years \times 14 age groups). Area and PHA were combined to form a regional variable with 25 categories (2 areas \times 12 PHAs + Bangkok). These two variables were considered as factor determinants. The data were stored as a frequency table with 2,800 (112 \times 25) records. The outcome for this study is smoking status (smoke or not smoke).

Statistical analysis

Logistic regression was used to create a model for the prevalence of smoking. This model formulates the logit of the

probability that a person is a smoker as an additive linear function of the determinant factors and is formulated as

$$\ln(p_{ij}) - \ln(1 - p_{ij}) = \mu + \alpha_i + \beta_j.$$

Here, p_{ij} is the probability of being a smoker in year-age group i and area-PHA group j , μ is a constant, α_i are the coefficients for year-age group i , and β_j are the coefficients for area-PHA j . Crude percentages of smokers classified by survey year-age group, and area-PHA are graphed as dot plots. However, such plots can be misleading when risk factors are mutually correlated, so these graphs also show 95% confidence intervals for adjusted percentages based on the regression model. A method for making this adjustment is described in Tongkumchum and McNeil (2009). We also used weighted sum contrasts (Venables and Ripley, 2002) instead of more commonly used treatment contrasts to facilitate comparison with the overall mean rather than with an arbitrarily chosen reference level.

R statistical software was used for statistical data analysis and graphical presentation (R Development Core Team, 2013).

RESULTS

The prevalence of smoking among males aged ≥ 15 years and older from the eight surveys ranged from 38.4% to 56.4%. The highest percentage of smoking was in the year 1991, and the lowest was in the year 2011. Higher percentages of smoking were found in males living in non-municipal areas for all surveys. A decreasing trend of smoking was seen in both in non-municipal and municipal areas from 1991 to 2011 (Table 1).

The goodness of fit of logistic model with two determinants (year-age group

Table 1
Smoking percentage by survey year and area.

Survey year	Total	Percent of smokers		
		Rural	Urban	Overall
1986	25,681	63.2	50.4	55.3
1991	32,563	64.9	50.7	56.4
1996	27,176	59.8	46.6	52.7
1999	30,310	54.3	43.7	47.3
2001	77,796	52.4	42.1	46.2
2003	15,786	50.6	40.0	44.4
2007	77,428	44.8	35.3	39.2
2011	65,691	44.1	34.3	38.4

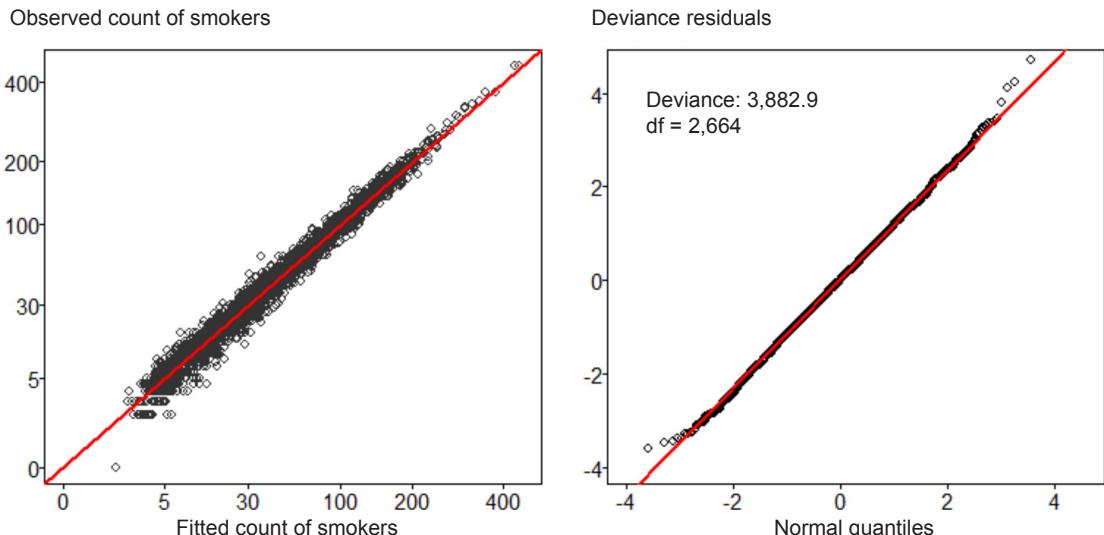


Fig-1 Plot of observed against fitted counts of smoker (left panel) and deviance residuals plotted against normal quantiles (right panel).

and area-PHA group) was evaluated by plotting observed against fitted counts of smokers (left panel) and deviance residuals against normal quantiles (right panel) (Fig 1). Observed and fitted counts are plotted on both axes in cube root scales. The figure shows the agreement of observed and fitted counts. The residuals plot provides a good fit with most of the residuals lined along the diagonal, indicating that model is plausible.

Adjusted percentages of smoking with 95% confidence intervals from the logistic model with year-age and area-PHA as determinants are shown in Figs 2 and 3. Crude percentages of smoking are illustrated as dots in the same plot. The overall percentage of smoking for all eight surveys was 45.3 as shown by the horizontal line. The lowest prevalence

TRENDS OF SMOKING IN THAI MALES

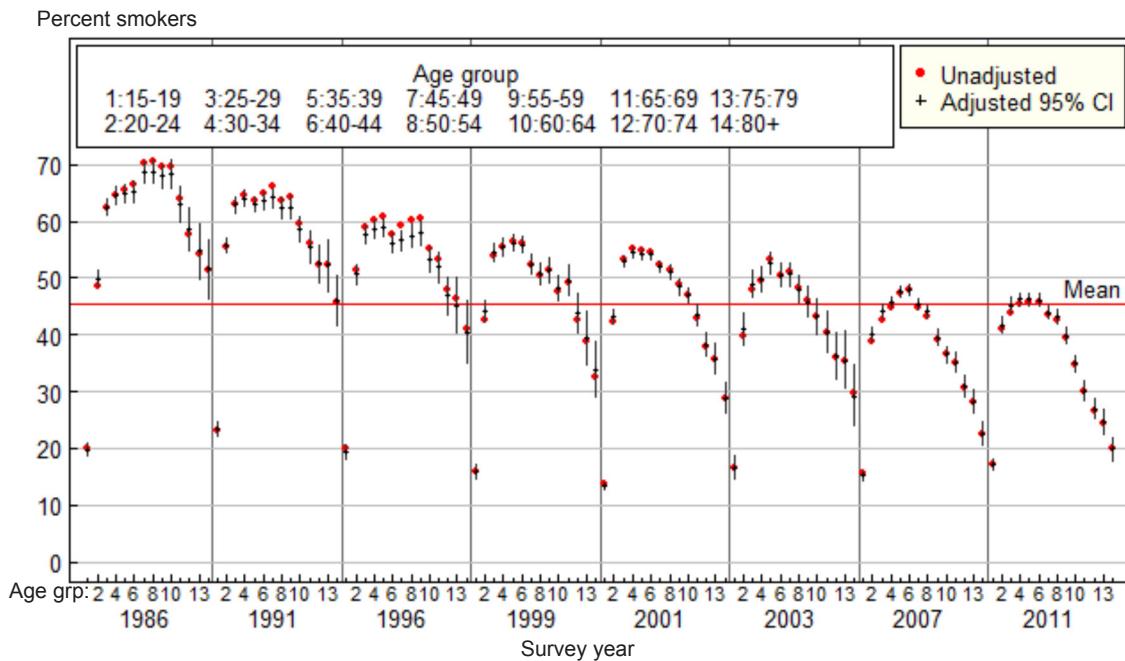


Fig 2—Crude percent of smoking and adjusted with 95% confidence intervals of smoking by year-age group.

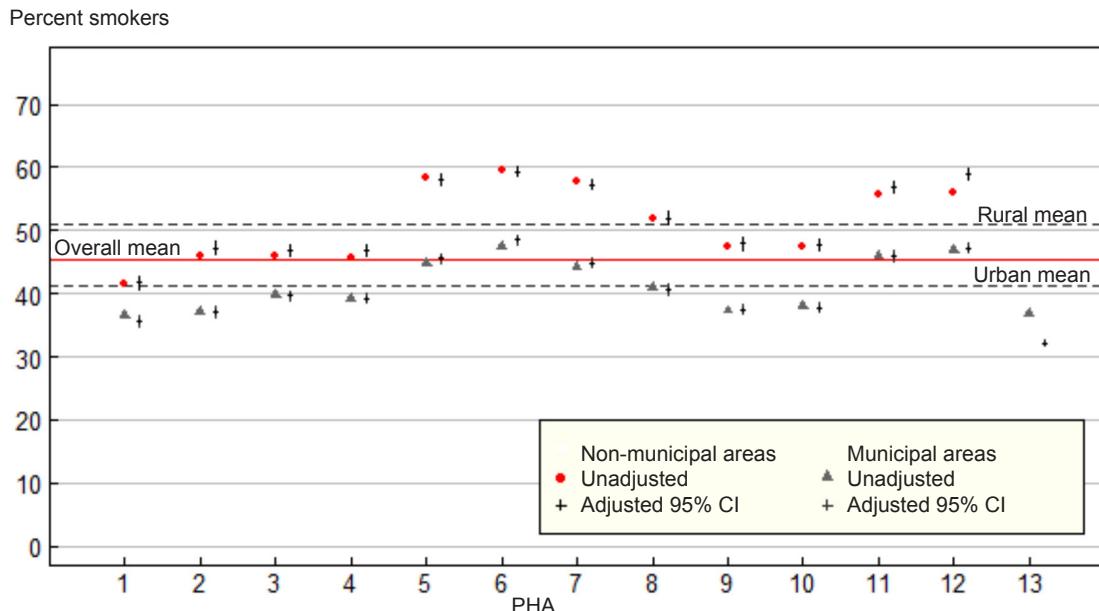


Fig 3—Crude percent of smoking and adjusted with 95% confidence intervals of smoking by area-PHA. PHA, public health areas.

of smoking for all surveys was found in age group 15-19 years old. The highest prevalence of smoking was found in age

group 45-64 years for surveys in 1986, age group 25-59 for 1991 and 1996, age group 25-44 for 1999 and 2001, age group 35-39

for 2003, age group 35-44 for 2007, and age group 30-44 for 2011.

The prevalence of smoking in year 1986 started to fall at age ≥ 60 , and fell at age ≥ 55 in years 1991 and 1996; whereas it started to level off at age ≥ 40 for the five surveys from the years 1999 to 2011. A sharply increasing smoking prevalence appeared in age group 15- 29 after surveys in years 1986-2003. Subsequently, a sharply increasing trend was found only in age group 15-24 for surveys in 2007 and 2011. The prevalence of smoking in all age groups decreased after the survey in year 1986 except in age group 15-19 years. The prevalence of smoking in age group 15-19 decreased after survey year 1991 until year 2001. Subsequently, the prevalence in this age group increased after the surveys in years 2007 to 2011.

A decreasing trend of smoking in males aged 20-24 occurred in 1991 until 2007, and then the prevalence in 2011 increased. The prevalence of smoking among males aged ≥ 20 , 20-79, 20-69, 25-69 and 25-54 from surveys in years 1986, 1991, 1996, 1999, 2001, 2003 and 2007, respectively, were higher than average. The prevalence of smoking was lower than average in age group 15-19 from three surveys in years 1986, 1991 and 1996, in age group 15-19 and ≥ 75 in year 1999, in age group 15-19 and ≥ 65 from two surveys in years 2001 and 2003, in age group 15-19 and ≥ 55 in year 2007, and in age group 15-19 and ≥ 45 in year 2011. Overall, decreasing trends in all age groups were found, except in the two youngest age groups. In each survey year, age-specific prevalence had an asymmetric U shape with peak near age 40 and decreasing rapidly thereafter.

The dashed line in Fig 3 shows the average smoking prevalence in non-municipal (upper line) and municipal (lower line) area. The prevalence of smoking

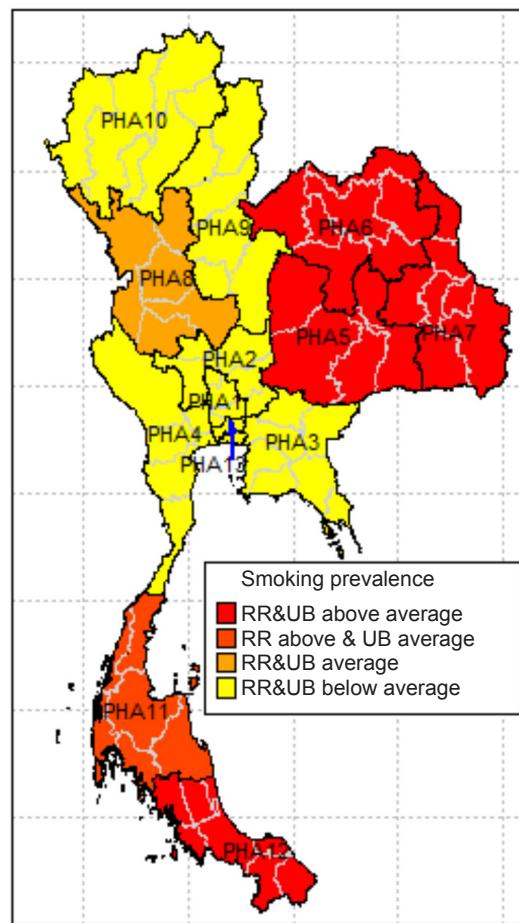


Fig 4-Thematic map of smoking prevalence in each PHA. RR, rural areas; UB, urban areas; PHA, public health areas.

from non-municipal area in all PHAs was significantly higher than average, except for PHA 1 where it was significantly lower than average, as shown in Fig 3. The highest prevalence of smoking was in the Northeast and the South. In municipal areas, the prevalence of smoking in PHA 6 (upper Northeast) and PHA 12 (lower South) was significantly higher than average. PHA 1- 4 (Central), 8-10 (North) and 13 (Bangkok) had lower than average prevalence of smoking.

A thematic map illustrates the prevalence of smoking in each PHA area as

shown in Fig 4. It shows that the prevalence of smoking in all non-municipal areas was higher than the overall mean except for PHA 1. The prevalence of smoking in rural areas in all PHAs in the Central region and two PHAs in the North (PHA 9 and 10) were lower than the rural mean, except that PHA 8 in the North was not different from the rural mean. All PHAs in the South and the Northeast were higher than the rural mean. The same patterns were found in urban areas. Confounding bias clearly occurred in PHA 13 because the crude and adjusted percentages are substantially different.

DISCUSSION

The National Statistical Office using different types of national surveys has collected the smoking behavior of residents in every province in Thailand. Applying statistical methods for analyzing such large datasets illustrates the pattern of smoking prevalence and trends over this period. In this study, we analyzed the combined smoking data from eight surveys in the past 25 years using a logistic regression model with year-age and area-PHA variables as the determinants. Smokers aged <15 years were excluded from our study, as this group had relatively small numbers of smokers. The study conducted by Sangthong *et al* (2011) showed disproportionately large standard errors because age group 11-15 years was taken as the reference group.

The result from the model indicates that the prevalence of smoking among Thai males in the past 25 years decreased from 1986 to 2011. A slightly decreasing trend appeared during 2007 to 2011. The decreasing trend was also found by Sangthong *et al* (2011). Although the crude percentage of smoking prevalence

between year 1986 and 1991 increased from 55.3% to 56.4%, the trend from multivariate analysis showed that a decreasing trend occurred among those aged 45 years and older; whereas, males aged younger than 25 years had an increasing trend of smoking in the same period.

The difference between crude and adjusted prevalence is due to the confounding effect of lower sample size at higher ages and could be eliminated by ensuring that samples were balanced with respect to age group. The increasing smoking trend among males aged younger than 25 years from 1986 to 1991 may be due to allowing foreign tobacco firms to advertise their product after 1988 (Vateesatokit *et al*, 2000).

A decreasing trend of smoking during the period of 1991 to 2006 was also reported by Levy *et al* (2008). They applied the SimSmoke simulation model to the Health and Welfare Survey data in order to estimate change in smoking rates and resulting lives saved by tobacco control policies implemented from 1991 to 2006. Their results suggested that smoking prevalence decreased by 25%, mostly as a result of higher taxes and marketing ban policies. The same method was also applied to survey data in Korea between 1995 and 2007 (Levy *et al*, 2010), and the result showed a decreasing trend of smoking in Korea but with a slower rate of decrease than that of Thailand. Moreover, decreasing trends of smoking were also reported in many countries, including the United States (Nelson *et al*, 2006; Dwyer-Lindgren *et al*, 2014), as well as Canada, Iceland, Norway, and Mexico (Ng *et al*, 2014).

Our study indicated that a decreasing smoking rate in all age groups occurred from 1991 to 2001. Subsequently, the smoking rate among males aged 15-19

had an increasing trend from 2001 to 2003 and was constant until 2007, followed by an increasing rate in 2011. The increasing rate of smoking also appeared in age group 20-24 years during years 2007 to 2011; whereas, a slightly decreasing trend continued in the older age groups. This suggests that the existing tobacco control policies might not have had much effect on males aged less than 25 years. Although Thailand announced the policy of a smoking ban, both indoors and outdoors in establishments open to the public such as restaurants, bars, and open-air markets, by 2008, there was little effect on young males.

Our model indicated that males living in rural areas had much higher smoking rates than those living in urban areas. The differences ranged from 10% to 14%. Similar results have been reported in several other studies (Merchant *et al*, 1998; Aekplakorn *et al*, 2008; Sangthong *et al*, 2012; Lim *et al*, 2013). The possible explanation is that those who live in urban areas are more likely to have better knowledge of the harmful effect of smoking on health, greater enforcement of smoking ban policies, and a more entrenched social norm of anti-smoking in public areas. People who live in rural areas tend to have lower socio-economic status and higher current smoking prevalence (WHO, 2009).

PHA 1 (Central) region had a lower smoking prevalence than average for males living in both rural and urban areas. This area surrounds Bangkok, which has the lowest smoking prevalence. Thus, lifestyle and socio-economic status are similar to Bangkok, and the smoke-free law is also well enforced in these areas.

Smoking among males from the lower South (PHA 12) and the Northeast (PHA 5, 6, and 7) were higher than average for

those living in rural and urban areas. Our study supports the findings stated in the Global Adult Tobacco Survey (GATS) report by WHO (2009). This report indicated that the highest current smoking rate was in the South, followed by the Northeast, and the cessation rate was lowest in the South. In the past 20 years, the South had lower smoking rates than the North and Northeast regions of Thailand. Further study is needed to investigate the reasons for different decreasing trends of smoking in each region.

The prevalence of smoking among Thai males had a decreasing trend possibly resulting from anti-smoking policies. Further research should focus on males aged less than 25 years, those who live in rural areas and in the lower South and the Northeast of Thailand.

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