RESEARCH ARTICLE

Association between Smoking and Mortality: Khon Kaen Cohort Study, Thailand

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Abstract

Background: Despite anti-smoking campaigns, smoking prevalence among Thai males aged 30 or older is high, at around 50%. The purpose of this study was to determine the relationship between smoking and mortality in a rural Thai community. Materials and Methods: Subjects enrolled into the Khon Kaen cohort study between 1990 and 2001 were followed up for their vital status until 16th March 2012. The death resource was from the Bureau of Policy and Strategy, Ministry of Interior, Thailand. A Cox proportional hazards model was used to analyse the association between smoking and death, controlling for age, education level and alcohol drinking, and confidence intervals were calculated using the floating risk method. Results: The study recruited 5,962 male subjects, of whom 1,396 died during a median 13.5 years of follow-up. Current smokers were more likely to die than never smokers after controlling for age, education level and alcohol drinking (HR, 95%CI: 1.41, 1.32-1.51), and the excess mortality was greatest for lung cancer (HR, 95%CI: 3.51, 2.65-4.66). However, there was no increased risk with increasing dose of tobacco, and no difference in risk between smokers of yamuan (hand-rolled cigarettes) and manufactured tobacco. Conclusion: Mortality from cancer, particularly lung cancer, and from all causes combined is dependent on smoking status among men in rural Thailand, but the relative risks are lower than have been reported from studies in high income countries, where the tobacco epidemic is more established.

Keywords: Smoking - mortality - health behaviour - rural population - Thai males

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Introduction

There have been many prospective cohort studies of the association between smoking and all-cause mortality (Thun et al., 1996; Doll et al., 2004; Hozawa et al., 2004) including at least 34 in the Asia-Pacific region (Barzi et al., 2008). These studies all show smokers are more likely to die than non smokers, and that heavy smokers have a higher risk of death than light smokers. However, this is the first community-based cohort study with a long follow-up period to be reported from Thailand, and the first in an entirely rural population in Asia.

Despite anti-smoking advertisement campaigns on television in Thailand (Tobacco Control Laws, 2012), the prevalence of smoking has remained high among men (but not women). In 2001, 2004 and 2007, the smoking prevalence among males aged 30 or older was 54%, 48% and 45%, respectively (4%, 3% and 3% among females: the percentage of smokers among Thai females is small because it not acceptable in Thai culture for women to smoke) (National Statistical Office Thailand, 2004; 2007; Vathesatogkit, 2012).

The Khon Kaen Cohort Study was started in 1990 and recruited 25,000 subjects from a rural population in North-East Thailand (Sriamporn et al., 2005). Here we investigate the association between smoking and mortality separately by type of cigarette and dose. The major tobacco products used in this population are hand-rolled cigarettes (yamuan) and manufactured cigarettes (Sarunya et al., 2012) and this study provides an opportunity to examine any variations in risk associated with these different types of cigarette.

Materials and Methods

Study population

Enrollment into the cohort took place between 1990 and 2001. The target population was males and females aged 30-69 years, randomly selected from two sub-districts. In the present study subjects were excluded if they were under 30 years or 70 years or above (n=944) at the time of enrollment, they had no national identification number (n=3,723), smoking status was unknown (n=741), or dose of cigarettes was unknown (n=129). Of the 24,528

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participants, 18,991 remained in the study.

Measurement

All participants were interviewed for demographic data, alcohol consumption and smoking by trained staff, and height, weight and blood pressure were measured. Approximately one week after the enrollment date, a blood sample was taken to test the blood sugar level after fasting for at least 8 hours. All participants were informed about the project and signed a consent form.

Cigarettes were separated into two types: yamuan (hand-rolled cigarettes using locally grown tobacco) and manufactured cigarettes (both filter and non filter). The following smoking status categories used were: never smoker (lifetime never smoker or had smoked for less than one year before the enrollment date or smoked fewer than one cigarette per day), ex-smoker (smoked for at least one year and smoked at least one cigarette per day and had quit for at least one year before the enrollment date) and current smoker (smoked for at least one year and smoked at least one cigarette per day and either never quit or quit less than one year before the enrollment date). Dose (cigarettes per day) was calculated by dividing the number of cigarettes smoked in a week by 7, in a month by 30 and in a period longer than one month by 35. Yamuan dose was multiplied by 1.5 owing to their longer length compared with a regular cigarette (Sriamporn et al., 2002). Smokers were then divided into three groups: less than 10, 10-15 and more than 15 cigarettes per day.

Mortality follow-up

Length of follow-up was calculated as the time between the enrollment date and date of death or until 16th March 2012. The information on death in Thailand was collected from the death certificate through the Bureau of Policy and Strategy, Office of the Permanent Secretary, Ministry of the Interior (Kijsanayotin, 2011). The national identification number was used as the key to link the study data with that from the mortality database. A member of staff at Srinagarind Hospital, Khon Kaen University transcribed the cause of death text into ICD-10 codes. All-cause and cause-specific mortality including malignant neoplasms (C00-C97), malignant neoplasm of bronchus and lung (C34), other malignant neoplasms (excluding C34), diseases of circulatory system (I00-I99), disease of the respiratory system (J00-J99), symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (R00-R99) and other causes (excluding C00-C97, I00-I99, J00-J99 and R00-R99) were analysed.

Statistical analysis

Cox proportional hazards models were used to estimate hazard ratios for the association between smoking and all-cause mortality and cause-specific mortality, controlling for age, education level and alcohol drinking. The resulting hazard ratios (HR) are presented as floating absolute risks. In this way, the value of the HR is unaltered but an appropriate 95%CI is ascribed to the log of the HR of every group (including the reference group, with HR 1) (Easton et al., 1991; Plummer, 2004).

Ethnical consideration

This study was approved by the Khon Kaen University Ethics Committee for Human Research [Reference No HE541374].

Results

A total of 24,528 participants were recruited into the cohort, of whom 18,991 (5,962 males and 13,029 females aged 30-69 years) were included in the analyses. Because of the very low smoking prevalence among females (0.8%), the main analyses reported here are for males only. Smoking prevalence was found to decrease with age in males (30-39 years, 62%; 40-49 years, 60%; 50-59 years, 57%; 60-69 years, 53%).

There was little difference in age between never smokers and current smokers (mean 50.5 versus 50.9) while ex-smokers were approximately three years older (Table 1). The proportion educated to second primary or higher (≥5 years) was four-fold higher in those who

Table 1. Baseline Characteristics of Males by Smoking Category (n=5,962)

Baseline characteristics	Never smokers (n=1,409)	Ex-smokers (n=1,132)	Current smokers						
			Any tobacco (n=3,421)	Yamuan only (n=2,121)	Manufactured tobacco only (n=644)	Yamuan & manufactured tobacco (n=656)	<10* (n=1,118)	10-15* (n=1,137)	>15* (n=1,166)
Mean (SD)									
Age, years (n=5,962)	50.5 (8.7)	53.4 (7.9)	50.9 (8.4)	51.5 (8.5)	49.3 (8.5)	50.3 (7.7)	52.2 (8.7)	51.0 (8.3)	49.5 (8.1)
BMI, kg/m² (n=4,201)	23.4 (3.2)	23.3 (3.2)	22.0 (3.0)	21.7 (2.8)	22.6 (3.0)	22.5 (3.1)	22.0 (2.9)	22.0 (2.9)	22.1 (3.0)
SBP, mm Hg (n=4,100)	119.6 (15.4)	120.1 (14.1)	117.0 (14.3)	117.0 (13.7)	117.5 (15.5)	116.7 (14.6)	117.0 (14.4)	117.0 (13.8)	117.0 (14.6)
DBP, mmHg (n=4,100)	78.7 (10.4)	79.0 (9.5)	76.7 (10.3)	76.9 (10.0)	76.5 (10.9)	76.6 (10.6)	76.6 (10.5)	76.8 (10.0)	76.8 (10.5)
Blood sugar, mg/dl (n=2,708)	98.2 (30.9)	98.5 (31.0)	96.0 (27.8)	96.2 (27.0)	100.3 (36.1)	92.7 (22.9)	96.3 (26.4)	96.8 (31.7)	95.1 (25.5)
Resident (n=5,962): municipal area, n (%)	296.0 (21.0)	237 (20.9)	652 (19.1)	387 (18.3)	136 (21.1)	129 (19.7)	244 (21.8)	186.0 (16.4)	222 (19.0)
Education (n=5,828): second primary school or higher, n (%)	242.0 (17.7)	171 (15.4)	378 (11.3)	135 (6.5)	174 (27.3)	69 (10.8)	133 (12.1)	117.0 (10.5)	128 (11.2)
Alcohol (n=5,774)									
Never drinkers, n (%)	602.0 (44.1)	216 (19.4)	612 (18.6)	414 (20.5)	103 (16.4)	95 (14.6)	223 (20.6)	205.0 (19.0)	184 (16.3)
Ex-drinkers, n (%)	60.0 (4.4)	238 (21.4)	233 (7.1)	156 (7.7)	46 (7.3)	31 (4.8)	88 (8.1)	69 (6.4)	76.0 (6.7)
Current drinkers, n (%)	702.0 (51.5)	658 (59.2)	2,453 (74.4)	1,446 (71.7)	480 (76.3)	527 (80.7)	774 (71.3)	807.0 (74.7)	872 (77.0)

*Cigarettes/day

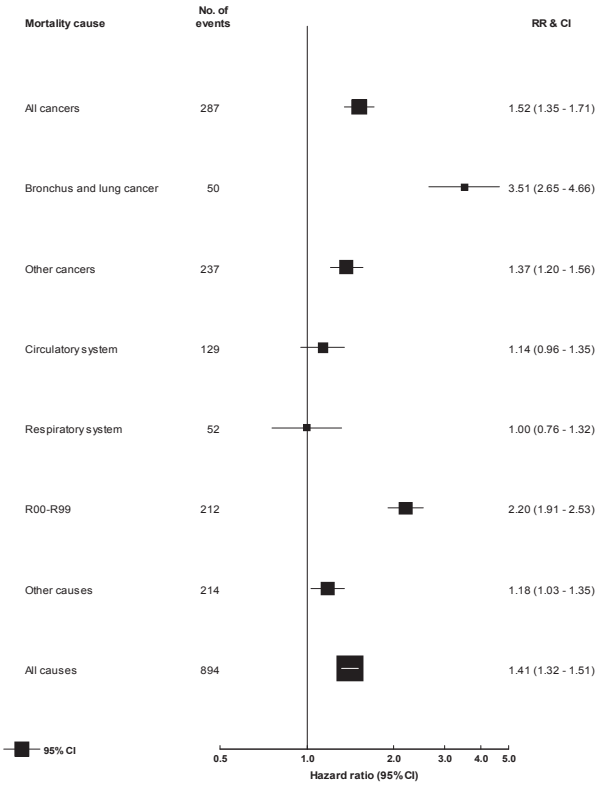

Figure 1. Hazard Ratios (with 95% confidence limits) of Specific and All Cause Mortality for Current Smokers Compared with Never Smokers, Controlling for Age, Education Level and Alcohol Drinking (n=5,962)

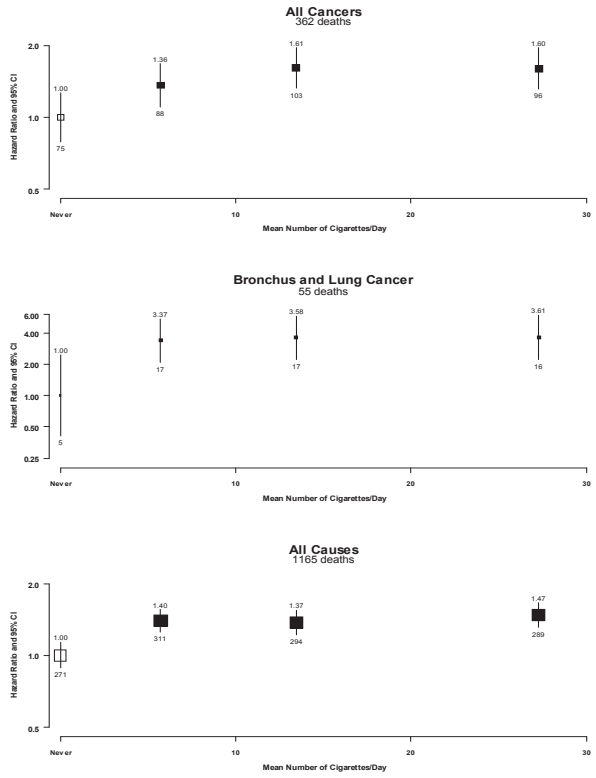

Figure 2. Hazard Ratios of Specific and All Cause Mortality for Dosage of Tobacco Smoking Compared with Never Smokers, Controlling for Age, Education Level and Alcohol Drinking (n=5,962). Mean number of cigarettes/day of who those smoked fewer than 10 cigarettes was 5.7, 10-15 cigarettes was 13.5 and greater than 15 cigarettes was 27.3. 1 yamuan = 1.5 manufactured

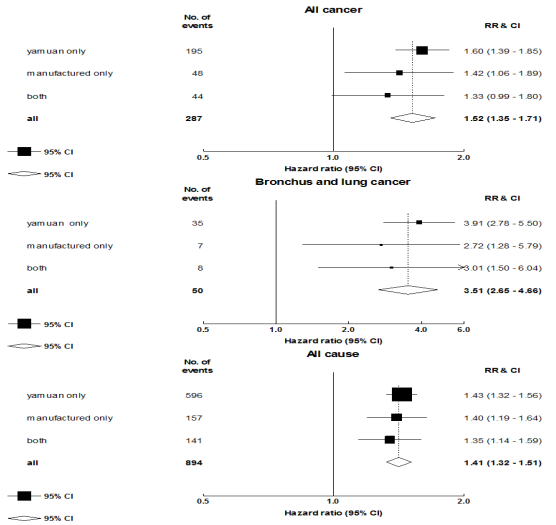

Figure 3. Hazard Ratios of Specific and All Cause Mortality for Smokers of Different Tobacco Products Compared with Never Smokers, Controlling for Age, Education Level and Alcohol Drinking (n=5,962)

smoked manufactured tobacco than in yamuan smokers (27% and 6.5%, respectively) and in-between for non-smokers (18%). The highest percentage of alcohol abstainers was found in the never smoker group (44%), with about twice the proportion of the other smoking groups.

After a median follow-up time of 13.6 years (minimum 0.02 years and maximum 22.2 years), there were 3,203 deaths: 1,396 in males and 1,807 in females. The leading causes of death were malignant neoplasms (417 male, 411 female), diseases of the circulatory system (220 male, 281 female) and respiratory system (92 male, 96 female).

After adjustment for education level and alcohol consumption there was a moderate association between smoking and all-cause mortality (HR, 95%CI: 1.41, 1.32-1.51: Figure 1). Smoking was associated with all cancers combined (1.52, 1.35-1.71), but particularly with lung cancer (3.51, 2.65-4.66). However, there was no evidence of associations between smoking and diseases of the circulatory (1.14, 0.96-1.35) or respiratory (1.00, 0.76-1.32) systems. Furthermore, among smokers no significant trend was found in risk of death from cancer, or from all causes with increasing number of cigarettes (Figure 2) and there was no statistically significant difference between the hazard ratios for yamuan and manufactured cigarettes (Figure 3).

Discussion

This is the first community-based cohort study with a long follow-up period from Thailand reporting on the association between smoking and mortality. The median follow-up period of this study was 13.5 years. About 94% of the original cohort had data for smoking, and the baseline characteristics of subjects with unknown smoking status were similar to those of the subjects in the analyses, aside from residential area (but this variable did not affect the association between smoking and mortality). Data on deaths are available from a national mortality database

compiled by the Ministry of the Interior. The cause of death was certified by a physician in approximately 70% of cases. The results showed an association between smoking and mortality, even after controlling for age, education level and alcohol drinking. There was a strong association between smoking and bronchus and lung cancer, with a high dose presenting a higher risk of death than a light dose. Yamuan and manufactured tobacco was found to be equally harmful to health, except in the case of bronchial and lung cancer. Surprisingly, there was no association between smoking and diseases of the circulatory and respiratory systems.

The strength of the association between smoking and mortality can be considered moderate when compared with that between consuming raw and undercooked fish and risk of cancer of the liver and intrahepatic bile ducts (the leading cause of death in Khon Kaen) (Poomphakwaen et al., 2009; Songserm et al., 2012), although it is similar to that observed in males in a combined analysis of cohort studies in East and South Asia 1.37 (95%CI: 1.23-1.53) (Barzi et al., 2008). Our results are also consistent with the pooled Asian studies with respect to all cancer (HR of 1.52 versus 1.44) (Barzi et al., 2008) and cancer of the lung (HR of 3.51 versus 3.54) (Nakamura et al., 2009). These hazards are generally much smaller than those observed in high income countries (Cancer Research UK, 2009; World Health Organization and International Agency for Research on Cancer, 2004), which relates to the more recent exposure to tobacco smoking in Thailand.

There are many chemicals in cigarettes which are toxic in the human body, so that the hazard associated with smoking generally increases as the cigarette exposure increases (Prescott et al., 1998; Hozawa et al., 2004; World Health Organization and International Agency for Research on Cancer, 2004).

All-cause mortality was not associated with type of tobacco in our study, although a previous study found that the relative risk for hand rolled tobacco compared with manufactured tobacco was 1.29 (95%CI: 1.12-1.49) for lung cancer (Lee et al., 2012).

In conclusion, There is an association between smoking and mortality, particularly in the case of malignant neoplasm of the bronchus and lung. With current mortality rates in Thailand (Lopez et al., 1999), a male smoker will on average die 5 years earlier than a non smoker. Although Thailand's tobacco control measures are relatively strong and comply well with the WHO Framework Convention on Tobacco Control (Sangthong et al., 2012), the relatively high prevalence of smoking among men shows that significant challenges remain.

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