STROKE INCIDENCES AND RELATED FACTORS AMONG EMPLOYEES WORKING AT THE CENTRAL OFFICE OF THE ELECTRICITY GENERATING AUTHORITY OF THAILAND (EGAT): A PROSPECTIVE-DESCRIPTIVE STUDY

Worakorn Mai-um[1, *], Narin Hiransuthikul[1], Piyamit Srithara[2], Supot Tunlayadechanont[2]

[1] Department of Preventive and Social Medicine, Faculty of Medicine, Chulalongkorn University, Bangkok 10330, Thailand
[2] Department of Medicine, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok 10400, Thailand

ABSTRACT: Several studies in Thailand, mostly hospital-based, have assessed the prevalence of stroke and its related factors. We reported the incidence rate of stroke and the distribution of related factors among the community-based cohort of the employees of the Electricity Generating Authority of Thailand (EGAT) who were working at the central office in Nonthaburi, a neighboring province of Bangkok. This prospective-descriptive study was done by using database of 3,360 EGAT's employees, 39,564 person-years of follow up, who enrolled in the Ramathibodi Hospital's cardiovascular disease project during from 1985 to 1997. Data were collected by questionnaire interviews and reviews of physical examination records, laboratory and brain imaging reports, as well as death certificates. The study revealed that the median age of the participants was 42 years old, 77.2% male. The prevalence of hypertension and diabetes were 19.5% and 2.7 %. About 27.3% of the participants had dyslipidemia. About half, two-thirds, and one-fifth were current smokers, alcohol drinkers, and had sedentary lifestyle. The incidence rate of all types of stroke, i.e., ischemic stroke, hemorrhagic stroke and other types of stroke were 85.94, 25.28, 53.08, and 7.58 per 100,000 person–years. High incidence of stroke was found in participants who were currently taking antihypertensive drugs with systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg. Regarding serum lipids, we found the highest incidence of stroke in participants with serum total cholesterol 240 mg/dl or higher and serum triglyceride 200 mg/dl or higher. Regarding risk behaviors, the highest incidences of stroke were found in participants with ever-drinking and ever-smoking. High incidences of stroke among smokers, with highest incidence in former-smokers and alcoholic drinkers, with highest incidence in former-drinkers were found. In conclusion, the stroke incidence rate among employees at the central office of the EGAT is similar to that in the developed countries in Asia. Hemorrhagic stroke was more frequently found than ischemic stroke. Upon enrolment in the project, the studied population was mostly from the upper middle class of Thailand; they were in their middle age. They had relatively high systolic and diastolic blood pressures, diabetes mellitus, serum total cholesterol, serum triglyceride, smoking and alcohol drinking habits, and incidences of stroke either hemorrhagic or ischemic.

Keywords: Stroke incidence, related factors, Electricity Generating Authority of Thailand, Employee

INTRODUCTION

In 2008, the World Health Organization (WHO) reported that non–communicable diseases (NCD) were the major causes of death; 80% of all NCD deaths occurred in low and middle – income countries. The largest proportion of NCD deaths was caused by cardiovascular diseases; one among them was myocardial infraction and its subsequent stroke [1]. Nowadays, stroke remains the second

* *Correspondence to: Worakorn Mai-um*
E-mail: maium1504@gmail.com

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leading cause of deaths in Thailand [2] and the second leading cause of deaths worldwide[1]. So far, Thailand is similar to other countries encountering the epidemic expansion of heart diseases and cardiovascular diseases especially stroke. Cerebrovascular diseases (CVD) are also one of the major causes for burden of diseases in Thailand. The admission rate of CVD is high as 216.58 times per year [2] leading to death, permanent disability and financial burdens for the family members. Admission fee averaged 34,000 baht, while OPD visit was calculated at 1,400 baht per visit and total health expenditures, excluding other costs, related to this group of diseases was estimated to be 14,500 – 21,700 million baht per year [3]. The 4th National Health Examination conducted in Thailand in 2008 – 2009, revealed that the Thai populations were at high risk of developing CVD, due in part to increasing trends of high blood pressure, high fasting blood sugar, high lipid content, smoking, alcohol consumption, sedentary lifestyles and obesity. Also, Thai age structure had been changing, the entire population is aging [4]. This change has also triggered increased CVD incidences in Thailand.

As an institute specializing in CVD management, the Institute of Neurology in Thailand, has warned the public, particularly those between 50 – 60 years old, to be aware of this debilitating diseases. Additionally, CVD has been diagnosed at increased rates among lower age groups in developing countries, as compared to the developed countries, for the last several years.

In 1988, 1996, and 2006, the prevalence of CVD in the 35-64 years of age among an urban community of Thailand was 11.1% [5], the prevalence of stroke in the elderly population from the four regions of the country (community – based) was 1.1% [6] and the prevalence of stroke in the 45 – 80 years of age among Thai population was 1.8% [7]. However, most prevalence studies conducted in Thailand are hospital-based; hence, they had limitations for generalization [8]. The study aimed to characterize stroke incidences and related factors among EGAT Central Office employees, Thailand. The findings should be helpful for primary prevention plans for disease control among risk groups in the community-based of urban upper-middle class populations.

METERAILS AND METHODS

Study Population

This study utilizes data from 3,499 workers in the head office of EGAT (2,702 male and 797 female) aged 35 – 55 years old who participated in the 1985 annual health check-up program of the organization. One hundred and thirty-nine subjects were, however, excluded: 17 did not have their identification number; 66 only gave a self-reported history of stroke or cardiovascular disease without physical confirmation; and 56 had no dates of birth. Therefore, 3,360 participants were enrolled into this study. Their health records in the Bureau of Medical and Sanitation, EGAT and Ministry of Public Health were reviewed 12 years later for analysis and follow up (Figure 1).

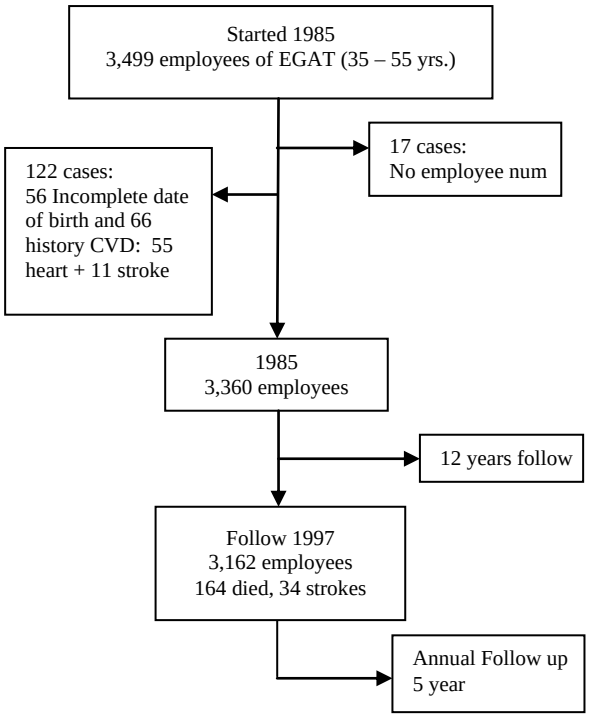

Figure 1 Flow chart of study population

All subjects also provided written informed consents prior to data collection. Participants were interviewed by trained interviewers using a questionnaire containing questions on demographic data, CVD related factors and laboratory tests; blood pressure measurement, fasting plasma glucose, and serum lipid levels. Measurement of blood pressure was done twice: in sitting position after urination and five–minute rest. The research team measured the height and weight of each participant, and calculated body mass index (= weight (kg) / height $(m)^2$). After that, a thorough physical examination was performed by a cardiologist to confirm that cardiovascular disease and cerebrovascular disease were absent. Finally, participants were defined as follows:

Definitions of hypertension, diabetes mellitus, and dyslipidemia in the study:

a. Hypertension is defined based on the WHO's criteria [9]: "normal or high risk" if systolic blood pressure is lower than 140 mm Hg or diastolic blood pressure is lower than 90 mm Hg and "hypertension" if systolic blood pressure is equal to or greater than 140 mm Hg or diastolic blood pressure is equal to or greater than 90 mm Hg. or the subject is taking antihypertensive drug(s) at baseline.
b. Diabetes mellitus is defined, based on the criteria of the American Diabetes Association [10]: "normal or high normal" if fasting plasma glucose is lower than 126 mg/dl and "high" if fasting plasma glucose is equal to or greater than 126 mg/dl; or the subject is taking DM drug(s) at baseline.
c. Dyslipidemia is defined based on the National Cholesterol Education Program – NCEP [11]: "high" if 1) LDL is equal to or greater than 160mg/dl; 2) HDL is lower than 40 or 50 mg/dl in male or in female; 3) total cholesterol is equal to or greater than 240 mg/dl and; 4) triglyceride is equal to or greater than 200 mg/dl. Lastly, hypercholesterolemia is defined as at least 3/4 types of serum cholesterol levels were highly, or the subject is taking anti – lipid drug(s) at baseline.
d. Personal behaviors.
e. "Smokers" are defined as those who have been smoking for at least 5 cartons or over 100 cigarettes throughout their life [12]; "smoking status" is classified as never-smoker, former-smoker, and current smoker.
f. "Drinking status" is classified as never-drinker, former-drinker, and current drinker.
g. "Physical activity" is classified as: 1) "Adequate Physical Activity," for those who have physical activity for thirty minute per day and is equal to or greater than 3 days a week; 2) "Sedentary Life Style," for those who have physical activity lower than thirty minute per day or lower than 3 days a week.

Stroke events

Stroke is classified as: 1) intra-cerebral hemorrhage without subarachnoid hemorrhage; and, 2) ischemic stroke, either with known or unknown cause(s), without transient ischemic attack (TIA). The incidence of stroke is defined as the first event of stroke as diagnosed by a physician in outpatient or inpatient medical records reviewed by the investigator or having compatible imaging characteristic(s) from CT-SCAN or MRI within 28 days after clinical onset of stroke [13, 14].

We defined death caused by stroke as follows: 1) it must occur within one month after diagnosis of stroke confirmed by positive CT-SCAN or MRI findings, or 2) autopsy results indicating death from stroke. In case of death that happened outside of hospital without history or imaging results of stroke, we reviewed the registered records from various sources such as the Medication and Sanitation sector of EGAT, Ministry of Interior, and Department of Central Accounting in order to identify all possible causes of death and related illness of the subjects.

Verification of stroke incidences

Potential cerebrovascular events were identified based on vital status confirmed and twelve years survey by physical examination of the subjects, interviews, questionnaires and telephone interviews were also conducted. In case of uncertainty, a board of three neurologists determined the nature of the illness, wherein at least 2/3 of the specialists had to agree with each other.

Covariates

At baseline, information on demographics, underling diseases and personal behaviors was collected from the project database. The covariates of interest were age; gender; education level; income per month; body mass index (BMI); systolic blood pressure; diastolic blood pressure; combined blood pressure; fasting plasma glucose; categories of dyslipidemia according to serum cholesterol level, serum triglyceride level, and serum HDL level; smoking and drinking history; and physical exercise level.

STATISTICAL METHODS

Crude and category – age specific incidence rates were calculated. Descriptive statistics (means, standard deviation and proportions) were used to determine the study population baseline characteristics and covariates.

RESULTS

Three thousand three hundred and sixty EGAT's employees who were staff of the central office were enrolled in the study. Table 1 shows baseline characteristics of the studied participants. The median age was 42 years with 77.2 % male. Most participants graduated high school level

Table 1 Baseline characteristics in EGAT's employees at the central office.

Baseline characteristics	**(N=3,360)**
Median age, yrs. (IQR)	42 (38, 47)
Male	42
Female	41
Age group, %	
Group 1, 35 – 44 yrs.	63.9
Group 2, 45 – 54 yrs.	35.4
Group 3, 55 – 64 yrs.	0.7
Gender, %	
Male	77.2
Female	22.8
Education level, %	
Secondary school or lower	38.4
Bachelor's degree or lower	56.8
Master's degree or higher	4.8
Income per month, %	
≤ 5,000 baht	19.7
≥ 5,001 – 20,000 baht	74.7
≥ 20,001 baht	5.6
Overweight or Obese, %	24.0
Mean Body Mass Index (SD)	23.03 (3.12)
Mean Systolic Blood Pressure (SD), mmHg.	120.61 (16.10)
Mean Diastolic Blood Pressure (SD), mmHg.	75.20 (11.03)
Hypertension, %	19.5
Systolic Blood Pressure ≥ 140 or taking medications, %	15.4
Diastolic Blood Pressure ≥ 90 or taking medications, %	14.2
Mean fasting plasma glucose, (SD), mg/dl	89.65 (18.37)
Diabetes mellitus, %	2.7
Dyslipidemia (SD), mg/dl	
Mean total cholesterol	222.67 (42.93)
Mean HDL: Male / HDL: Female	45.48 (11.77) / 52.58 (11.73)
Mean LDL	145.96 (41.66)
Mean triglyceride	149.37 (92.98)
Dyslipidemia, %	27.3
Total cholesterol ≥ 240 mg/dl, %	32.1
HDL: Male < 40 mg/dl and Female < 50 mg/dl, %	33.7
LDL ≥ 160 mg/dl, %	34.5
Triglyceride ≥ 200 mg/dl, %	19.4
Personal behaviors	
Physical Activity	
Adequate physical activity: ≥ 30 min per day and ≥ 3 days per week, %	81.5
Sedentary life style: < 30 min per day and < 3 days per week, %	18.6
Drinking status, never/former/current, %	29.7/5.1/65.3
Smoking status, never/former/current, %	42.4/14.0/43.7

(38.4%). Their work positions were mostly officer (44.1%) and 74.7% had income 5,001 - 20,000 baht per month. About one – fourth were overweight or obese. The mean systolic blood pressure was 120.61 mmHg.

We found that 15.4 and 14.2% had systolic hypertension and diastolic hypertension respectively. The prevalence of diabetes mellitus was 2.7%. The prevalence of total cholesterol level 240 mg/dl or higher was 32.1%, serum triglyceride level 200mg/dl or higher was 19.4%, serum HDL level in male < 40 mg/dl and in female < 50 mg/dl were 33.7% and serum LDL level 160 mg/dl or higher was 34.5%. The prevalence of current smoking and alcohol intake were 43.7% and 65.3%, respectively. 18.6% of employees had a sedentary life style.

From our study, the overall incidences of all stroke types, ischemic stroke, hemorrhagic stroke and other types were 34, 10, 21 and 3 cases. All patients with ischemic stroke were alive at the time of diagnosis. On the contrary, there were 18 deaths (85.7%) among individuals with hemorrhagic stroke.

Table 2 Baseline data and incidence rates of stroke types in the employees of EGAT

Baseline data		**Ischemic stroke**		**Hemorrhagic stroke**		**All types**	
Variables	**Person-years**	**Events**	**Incidence rate***	**Events**	**Incidence rate***	**Events**	**Incidence rate***
Age specific at events							
35 – 44	10,152	0	0.00	0	0.00	0	0.00
45 – 54	21,509	5	23.25	9	41.84	15	69.74
55 – 64	7,694	4	51.99	10	129.97	16	207.95
65+	209	1	478.47	2	956.94	3	1,435.41
Total	39,564	10	25.28	21	53.08	34	85.94
Gender							
Female	9,113	1	10.97	1	10.97	2	21.95
Male	30,451	9	29.56	20	65.68	32	105.09
Education							
≤ High school	15,013	1	6.66	11	73.27	14	93.25
≤ Bachelor's degree	22,618	8	35.37	10	44.21	19	84.00
≥ Master's degree	1,933	1	51.73	0	0	1	51.73
Income per month							
≤ 5,000 baht	7,700	0	0	4	51.95	4	51.95
≥5,001–20,000Bath	29,437	7	23.78	15	50.96	25	84.93
≥20,001 bath	2,216	3	135.38	0	0	3	135.38
Body Mass Index							
Normal	30,081	7	23.27	11	36.57	21	69.81
Overweight or Obese	9,462	3	31.71	10	105.69	13	137.39
Blood Pressure							
Systolic blood pressure							
<140 mmHg	33,580	5	14.89	11	32.76	18	53.6
≥140 mmHg or taking medication	5,960	5	83.89	10	167.79	16	268.46
Diastolic blood pressure							
< 90 mmHg	33,994	6	17.65	13	38.24	20	58.83
≥ 90 mmHg or taking medication	5,546	4	72.12	8	144.25	14	252.43
Hypertension							
Systolic <140 and Diastolic<90 mmHg	31,956	5	15.65	11	34.42	17	53.2
Systolic ≥140 or Diastolic≥90 mmHg or taking medication	7,584	5	65.93	10	131.86	17	224.16
Diabetes Mellitus							
FPG <126 mg/dl	38,541	8	20.76	19	49.3	29	75.24
FPG ≥126 mg/dl or taking medication	987	2	202.63	2	202.63	5	506.59
Dyslipidemia							
Total cholesterol							
<240 mg/dl	26,892	5	18.59	11	40.9	18	66.93
≥240 mg/dl	12,636	5	39.57	10	79.14	16	126.36
HDL Cholesterol							
Male≥ 40 or Female≥50mg/dl	26,244	6	22.86	12	45.72	21	80.02
Male<40 or Female<50mg/dl	13,284	4	30.11	9	67.75	13	97.86
LDL Cholesterol							
<160 mg/dl	25,873	6	23.19	12	46.38	21	81.17
≥160 mg/dl	13,607	4	29.40	9	66.14	13	95.54
Triglyceride							
<200 mg/dl	31,916	6	18.80	11	34.47	20	62.66
≥200 mg/dl	7,612	4	52.55	10	131.37	14	183.92

Table 2 Baseline data and incidence rates of stroke types in the employees of EGAT (Cont.)

Baseline Data		Ischemic stroke		Hemorrhagic stroke		All types	
Variables	**Person-years**	**Events**	**Incidence rate***	**Events**	**Incidence rate***	**Events**	**Incidence rate***
Personal Behaviors							
Physical activity							
≥3days/week	32,222	7	21.72	14	43.45	24	74.48
<3days/week	7,318	3	40.99	7	95.65	10	136.65
Drinking status							
Never drinkers	11,799	2	16.95	3	25.43	5	42.38
former - drinkers	1,974	1	50.66	3	151.98	4	202.63
Current drinkers	25,755	7	27.18	15	58.24	25	97.07
Smoking status							
Never smokers	16,895	2	11.84	5	29.59	8	47.35
former- smokers	5,508	2	36.31	6	108.93	8	145.24
Current smokers	17,161	6	34.96	10	58.27	18	104.89

* Incidence rate per 100,000 person-years

Table 2, shows category-specific stroke incidence rates (ischemic stroke, hemorrhagic stroke and all stroke types). The incidence rate of hemorrhagic stroke in our study was about double that of ischemic stroke. According to age specific groups of incidence rate of stroke, we found that stroke increased with age; those who were over 65 years of age had highest incidences for all stroke types followed by age group 55 – 64, age group 45 – 54 and age group 35 – 44 years.

Other demographic factors which affected the incidence rates of stroke were age and gender (male had high risk greater than female), education level and income per month. However, these socio – economic status presented an opposite in the trend of incidence rates in ischemic stroke and hemorrhagic stroke. The last which affected the incidence rates of stroke was overweight or obesity.

We found much higher incidences rates of ischemic stroke, hemorrhagic stroke and all stroke types in subjects with hypertension the incidence rates of all stroke types, ischemic stroke and hemorrhage stroke were 83.89, 167.79 and 268.46 per 100,000 person – years by systolic blood pressure ≥ 140 mm Hg or current use of antihypertensive medication; 72.12, 144.25 and 252.43 per 100,000 person – years by diastolic blood pressure ≥ 90 mm Hg or current use of antihypertensive medication; 65.93, 131.86 and 224.16 mmHg per 100,000 person – years by systolic blood pressure ≥ 140 or diastolic blood pressure ≥ 90 mm Hg or current use of antihypertensive medication.

The overall diabetes prevalence was 2.7% and it also correlated with the incidence rates of ischemic stroke and hemorrhage stroke (202.63 per 100,000 person – years). However, diabetes highly affected the incidence rate of all stroke types (506.59 per 100,000 person – years).

It was also found that subjects with high plasma total cholesterol level (≥ 240 mg/dl) had about two double incidence rates of ischemic stroke, hemorrhagic stroke and all stroke types as compared to those with normal plasma total cholesterol level. Subjects with low plasma HDL cholesterol level (<40 mg/dl in male or <50 mg/dl in female) had higher incidence rates of ischemic stroke, hemorrhagic stroke and all stroke types compared to those with normal plasma HDL level. On the contrary, subjects with high plasma LDL cholesterol level (≥ 160 mg/dl or high plasma triglyceride level ≥ 200 mg/dl had higher incidence rates of ischemic stroke, hemorrhagic stroke and all stroke types as shown in Table 2.

Considering health behaviors, the highest incidences of stroke were found in subjects with sedentary life style (physical activity less than 3 days per week 136.65 per 100,000 person – years), ever drinkers (former - drinkers and current drinkers 202.63 and 97.07 per 100,000 person – years) and ever smokers (former - smokers and current smokers 145.24 and 104.89 per 100,000 person – years).

We observed a distinct increasing time trend in stroke incidence. Specifically, age-specific and overall incidences of all stroke types were considerably higher during 1992 – 1997 than during 1985 – 1991 (Table 3).

DISCUSSION

Our study shows similar incidence rate of stroke as in the developed countries in Asia. However, hemorrhagic stroke has higher incidence

Table 3 Age-specific stroke incidence rates during 1985-1991 and 1992-1997

Trend of stroke incidence rates by age - group per 100,000 person-years									
		Ischemic stroke		Hemorrhagic stroke		Other types		All types	
Age	Person-years	Events	Incidence rate*	Events	Incidence rate*	Events	Incidence rate*	Events	Incidence rate*
Period 1985-1991									
35-44	8,913	0	0.00	0	0.00	0	0.00	0	0.00
45-54	9,583	2	20.87	2	20.87	0	0.00	4	41.74
55-64	1,540	0	0.00	3	194.81	0	0.00	3	194.81
Total	20,036	2	9.98	5	24.96	0	0.00	7	34.94
Period 1992-1997									
35-44	1,239	0	0.00	0	0.00	0	0.00	0	0.00
45-54	11,926	3	25.16	7	58.70	0	0.00	10	83.85
55-64	6,154	4	65.00	7	113.75	3	48.75	14	227.49
65-74	209	1	478.47	2	956.94	0	0.00	3	1435.41
Total	19,528	8	40.97	16	81.93	3	15.36	27	138.26

*Incidence rate per 100,000 person-years

rate among employees of EGAT who were staff at the central office. Surprisingly, it shows early incidence of stroke among younger age group, i.e. 45 – 54 years old, educated, upper-middle class urban workers. Baseline factors related to the findings include hypertension, both in patients who could manage to control or not as well as those who failed to realized their hypertensive condition: diabetic conditions: those with fasting blood sugar in normal and high-normal ranges or taking diabetic medication or failed to realize their high blood sugar: dyslipidemia; smoking and alcohol drinking habits. The incidence rate is high in former-smokers and former-drinkers. We also found substantially higher stroke incidence during 1992 – 1997 than 1985 – 1991.

At baseline our community-based long-term prospective descriptive study of EGAT's employees working at the central office revealed high incidence of stroke. This could well because they have 3 major health risks such as median of age, mean of systolic blood pressure ≥ 115 mmHg and prevalence of hypertension, diabetes mellitus and dyslipidemia. We also found high incidence of stroke in older age group, male gender and individuals with risky behaviors including alcoholic drinking, smoking and sedentary life style. When compared to the Ohasama Project [15], a rural Japanese community cohort study, and a population-based prospective study in central Spain (NEDICES), they also had relatively higher incidence rates of stroke than our study [16]. Also, the WHO's MONICA Project reported that the incidence rate of all stroke types in China in men and women were 99 and 98 per 100,000 person – years [17].

Our subjects had higher incidence of hemorrhagic stroke than ischemic stroke which was different from the of TOTAST study [10, 15]. Reasons for this finding may include the following:

1) Patients with hemorrhagic stroke in our study were more severe than individuals with ischemic stroke. The accurate diagnosis of stroke depends on clinical manifestation and CT–scan or MRI particularly in cases of ischemic stroke. There were shortages of neurologists and brain imaging facilities in many hospitals in Thailand during the time of our study. Therefore ischemic stroke was probably more likely to be underdiagnosed than hemorrhagic stroke.
2) Before 2002, the coverage of health service utilization data base in Thailand was low particularly in private hospitals or clinics. The patients with ischemic stroke who had mild symptoms might visit the private health services more often than those with hemorrhagic stroke.
3) Most of ischemic stroke occurred after transient ischemic attacks (TIAs) [13]. Once having TIA the patients may have received medical care or changed their lifestyles resulting in interruption of progression to ischemic stroke.

We found the first event occurred in age-specific incidences of ischemic and hemorrhagic strokes were among employees 45-54 year of age. These are consistent with a study conducted by Prasat Neurological Institute [3]. Therefore, screening for risk factors of stroke should be encouraged among Thai people younger than 45 years old.

In our study, we identify health risks: hypertension, diabetes mellitus, and dyslipidemia) for all types of stroke. We found that hypertension and diabetes mellitus were strongly associated with increased incidences of ischemic and hemorrhagic stroke. As for dyslipidemia, high total cholesterol was related to ischemic and hemorrhagic stroke. Our result is similar to the study by Goldstein et al. [18] but different from the study by et Arisen et al. and Jared al. [19, 20] which showed inverse relationships between total cholesterol levels and stroke incidence rates. Whether high total cholesterol prevents the occurrence of hemorrhagic stroke is still inconclusive. We found that current and former smoking, as well as current and former alcohol drinking habits, were also risk factors for stroke.

A strength of our study was that it has no loss of record of the subjects, in spite of the long duration of 12-year follow up. In addition, the diagnosis of stroke in most cases was verified by brain imaging and/or pathological reports from autopsy. In case of uncertain diagnosis due to no imaging or pathological reports available, consensus by a committee of neurologists was obtained.

Subjects were not randomly sampled in this study. Also, covariates were measured only once, at baseline. Within-subject changes in levels of these variables could have changed during follow-up (time-dependent variables), and thereby affected our analytical results. In addition, bias due to the healthy worker effect might be present in our study. Finally, participants in our cohort were employees at the central office of a state enterprise. Most were middle age males and had relatively high socio- economic status as compared to other Thai people. Therefore, generalizability of our result is limited. Future study should be expanded nationwide to cover the entire Thai population.

Finally, the observed increasing time trend in stroke incidence could reflect true increases in stroke risk over time, increasing thoroughness and accuracy of diagnosis, or a combination of both. Further research is required to explain this finding in the study population and in Thailand as a whole.

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