Outbreak, Surveillance and Investigation Reports
Field Epidemiology Training Program, Bureau of Epidemiology
Department of Disease Control, Ministry of Public Health, Thailand
Tel: +6625901734-5, Fax: +6625918581, Email: osireditor@osirjournal.net, http://www.osirjournal.net

Population Attributable Fraction of Stroke Risk Factors in Thailand: Utilization of Non-communicable Disease Surveillance Systems

Darin Areechokchai[1,*], Kamolthip Vijitsoonthornkul[2], Sarinya Pongpan[1], Sasithan Maeakhian[1]

1 Bureau of Epidemiology, Department of Disease Control, Ministry of Public Health, Thailand

2 Bureau of Non-communicable Diseases, Department of Disease Control, Ministry of Public Health, Thailand

*Corresponding author, email address: rinfetp@gmail.com

Abstract

In Thailand, stroke is the third leading cause of death. The objective of this study was to measure the impacts of behavioral risk and underlying disease factors on stroke. The study design was a case-cohort study comparing prevalence of demographic characteristics and risk factors between stroke patients and general population. We obtained data of stroke patients and risk factors in general population of 12 provinces from two non-communicable disease surveillance systems to calculate population-attributable fraction: the national health information system for morbidity and mortality surveillance, and the behavioral risk factor surveillance system. Multiple logistic regression, based on weighted data and adjusted for clustering effect in each province, was carried out. It was found that approximately 41.6% of stroke in Thai population was related to hypertension. From an age group-specific model, among those aged 15-34 years, smoking carried the highest population attributable fraction of stroke, 32.7% (95% CI = 3.9-40.4). This study demonstrates that impact measurement of stroke risk factors could help devise stroke prevention and control strategies to tackle influential factors. In Thailand, hypertension control program should be a priority in middle and old age groups whereas smoking prevention should be emphasized in young people.

Keywords: stroke, Thailand, population attributable fraction, risk factor, behavioral impact

Introduction

Stroke is the major consequence of cerebrovascular disease. It is the second most common cause of mortality worldwide.[1] According to the World Health Organization (WHO), stroke is the second leading cause of death for people above 60 years old, and the fifth leading cause in people aged 15 to 59 years old. It is estimated that about 6.2 million people worldwide die from stroke each year, and one in six people worldwide will have a stroke in their lifetime.[2] In Thailand, stroke is the third leading cause of death. During 2014, the country annual morbidity and mortality from stroke were 352.3 and 38.7 per 100,000 population respectively.[3]

Risk factors of stroke include non-modifiable and modifiable factors. Age is the single most important non-modifiable risk factor whereas multiple risk factors can be changed, treated, or controlled such as high blood pressure, diabetes mellitus, dyslipidemia, cigarette smoking, unhealthy diet and physical inactivity.[4-7] Less well-documented risk factors include alcohol consumption, drug abuse and socioeconomic factors.[8-9] Understanding attributions of various risk factors, including behaviors and underlying diseases, is important to help prioritizing stroke prevention and control strategies.

Non-communicable disease (NCD) surveillance systems in Thailand include morbidity and mortality surveillance system for major NCDs (hypertension, diabetes mellitus, renal diseases, ischemic heart diseases and cerebrovascular diseases) and behavioral risk factor surveillance system (BRFSS). The morbidity and mortality surveillance system uses data from the national health information system (NHIS), an electronic database collecting patients' data from all government hospitals to monitor public health indicators, to determine burden of diseases and epidemiological characteristics of NCD patients.[10] The BRFSS is conducted among Thai population aged 15-75 years old every three years in sentinel provinces following the guideline of United States

Centers for Disease Control and Prevention (US CDC)[11] and STEPwise approach to chronic disease risk factor surveillance (STEPS) of WHO.[12]

Although multiple risk factors of stroke have been documented worldwide including Thailand[13-14], to the best of our knowledge, impacts of those known risk factors on stroke in Thailand have never been assessed quantitatively. The objective of this study was to measure the impacts of behavioral risk and underlying disease factors on stroke using the data of patients from NHIS and general population recruited in BRFSS to calculate population attributable fraction (PAF).

Methods

This study was conducted as a case-cohort study based on the secondary data. The first database was information on stroke patients included in surveillance evaluation of NHIS in 2014 conducted by local surveillance team[15]. The second database was the general population from BRFSS conducted by the Bureau of Non-communicable Diseases, Department of Disease Control in 2015, exploring lifetime behavioral risk factors of NCDs. Since the two databases were anonymous, de-identified and unlinked, the ethical approval was not applied.

The study areas were 12 provinces throughout Thailand where BRFSS was conducted (Figure 1). The study populations were Thai residents aged 15-79 years old from the two surveillance systems.

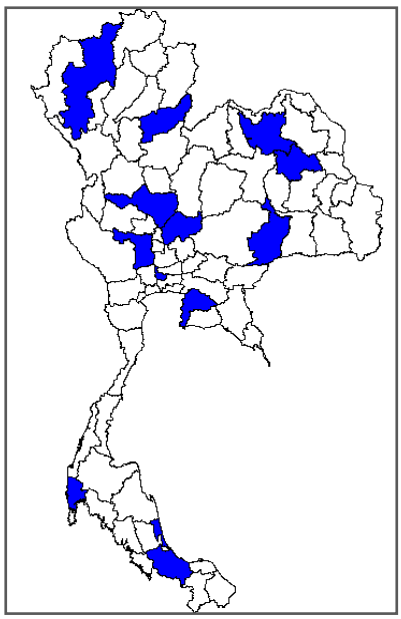

Figure 1. Geographical distribution of 12 provinces in Thailand covered in this study

Stroke patients' data were collected from NHIS by selecting ICD-10 of I60-69. Additional information was also extracted from the findings of surveillance evaluation. Variables included residential province, age, gender, year of stroke diagnosis, history of tobacco consumption and underlying diseases such as hypertension and diabetes mellitus. Information of behavioral risk factors and underlying diseases among general population were obtained from BRFSS. Tobacco smokers were defined as persons who had history of regular smoking documented in NHIS or reported smoking at least 100 cigarettes in their lifetime to BRFSS.[16]

Demographic characteristics and prevalence of risk factors were described and compared between stroke patients and general population. Since complex survey designs with different sampling fractions were used in the original databases of the two surveillance systems, weighted prevalence calculation using size of stroke patients and total population was performed to obtain overall estimates of 12 provinces. In bi-variate analysis, chi-square test was used for comparing patients and population characteristics. In multivariable analysis, multiple logistic regression based on the weighted data and adjusted for clustering effect in each province was carried out to determine exposure odds ratios (OR) and PAFs, including 95% confidence intervals. PAFs were calculated using the following formula:[17]

$$PAF = (\text{Exposure prevalence among cases}) \times (RR - 1)/RR$$

where RR is risk ratio. Since OR from the case-cohort design could be used to estimate RR,[18] RR in the formula was replaced with OR when calculating PAFs in this study.

Overall, age group-specific multivariable models were developed and factors included in the models were known risk factors of stroke based on the previous literature. STATA version 14 was used for all data analyses.

Results

There were 3,041 stroke patients reported in NHIS. About 59.6% were male and 57.2% were 60 years or older. Their demographic characteristics were significantly different from those of general population in BRFSS database, in which 48.3% were male and mostly aged 35-59 years old. Prevalence of hypertension and diabetes mellitus in stroke patients were higher than those among general population while prevalence of hypertension was particularly higher than 50% among stroke patients. Overall, there was no significant difference of tobacco smoking between two groups (Table 1).

Table 1. Characteristics and risk factors of stroke patients and general population in 12 provinces of Thailand, 2014-2015

Characteristic and risk factor	Weighted proportion (Percent)		P-value
	Stroke patients[a] (n = 3,041)	General population[b] (n = 10,752)	
Male	59.6	48.3	< 0.001
Age group (years)			< 0.001
15-34	2.8	35.6	
35-59	40.0	47.8	
60 or more	57.2	16.5	
Underlying diseases			
Hypertension	57.8	16.9	< 0.001
Diabetes mellitus	23.5	8.5	< 0.001
Tobacco smoking	33.2	26.9	0.22

[a] Weighted by number of total stroke patients in the national health information system

[b] Weighted by number of total population 2014, mid-year population statistics 2014, Civil Registration, Ministry of Interior

In case-cohort comparison, multiple logistic regression, which was weighted and adjusted for clustering effects, showed that male and age were baseline risk factors. Males had about 2-fold higher risk of stroke than female. OR of 35-59 years age group and 60 years or more, compared with those 15-34 years old, were 3.4 (95% CI = 2.5-4.6) and 8.5 (95% CI = 6.0-12.1) respectively. For modifiable risk factors, hypertension carried the highest OR, 3.6 (95% CI = 2.6-5.0) whereas tobacco smoking was not identified as a significant risk in the data analysis. The greatest PAF of stroke among Thai population was 41.6% for hypertension (Table 2).

Age group-specific multivariable model estimating PAF of stroke for hypertension, diabetes mellitus and tobacco smoking showed that hypertension carried the highest PAF of stroke among Thai population aged 35-59 years and 60 years or more, 44.0% (95% CI = 39.6-47.1) and 32.4% (95% CI = 17.7-43.1) respectively. While there was no statistically significant association between tobacco smoking and the disease in the overall model (Table 2), different finding was found in the age group-specific model. Among those aged 15-34 years, OR of tobacco smoking were 4.1 (95% CI = 1.1-15.0) (Table 3).

As shown in the figure 2, this significant association led tobacco smoking to being the most influent risk factor with highest PAF of stroke, 32.7% (95% CI = 3.9-40.4) in this youngest age group, instead of hypertension, which PAF was 22.9% (95% CI = 19.8-23.8).

Discussion

Even though risk factors of stroke have been clearly identified in many populations worldwide which help guiding appropriate prevention and control strategies,[19-20] Thailand should determine the impacts of various risk factors on stroke among populations to adapt prevention and control policies that are relevant to the national context especially when

Table 2. Multiple logistic regression, weighted[a] and adjusted for clustering effects[b], of stroke risk factors between patients and general population (case-cohort comparison) and population attributable fraction in 12 provinces of Thailand, 2014-2015

Risk factor	Prevalence among stroke patients (%)	Adjusted OR (95% CI)	PAF percent
Male	59.6	2.04 (1.59-2.65)	-
Age group (years)			
15-34	2.8	reference	-
35-59	40.0	3.38 (2.47-4.61)	-
60 or more	57.2	8.53 (6.01-12.12)	-
Hypertension	57.8	3.56 (2.55-4.97)	41.6
Diabetes mellitus	23.5	1.68 (1.29-2.27)	9.5
Tobacco smoking	33.2	1.26 (0.61-2.60)	6.9

[a] Weighted by number of total stroke patients in the national health information system and number of total population 2014, mid-year population statistics 2014, Civil Registration Section, Ministry of Interior

[b] Adjusted for clustering effect in each province

Table 3. Age group-specific multiple logistic regression, weighted[a] and adjusted for clustering effect[b], of stroke risk factors between patients and general population (case-cohort comparison) and population attributable fraction in 12 provinces of Thailand, 2014-2015

Risk factor	Adjusted odds ratio of age in years (95% CI)		
	15- 34	35- 59	60 or more
Male	0.79 (0.31-2.03)	2.29 (1.62-3.24)	1.82 (1.46-2.29)
Hypertension	16.84 (5.44-52.18)	5.31 (3.73-7.56)	2.13 (1.37-3.29)
Diabetes mellitus	3.77 (0.31-46.23)	1.65 (1.20-2.28)	1.65 (1.15-2.37)
Tobacco smoking	4.14 (1.14-15.04)	1.39 (0.68-2.84)	0.99 (0.42-2.35)

[a] Weighted by number of total stroke patients in the national health information system and number of total population 2014, mid-year population statistics 2014, Civil Registration Section, Ministry of Interior

[b] Adjusted for clustering effect in each province

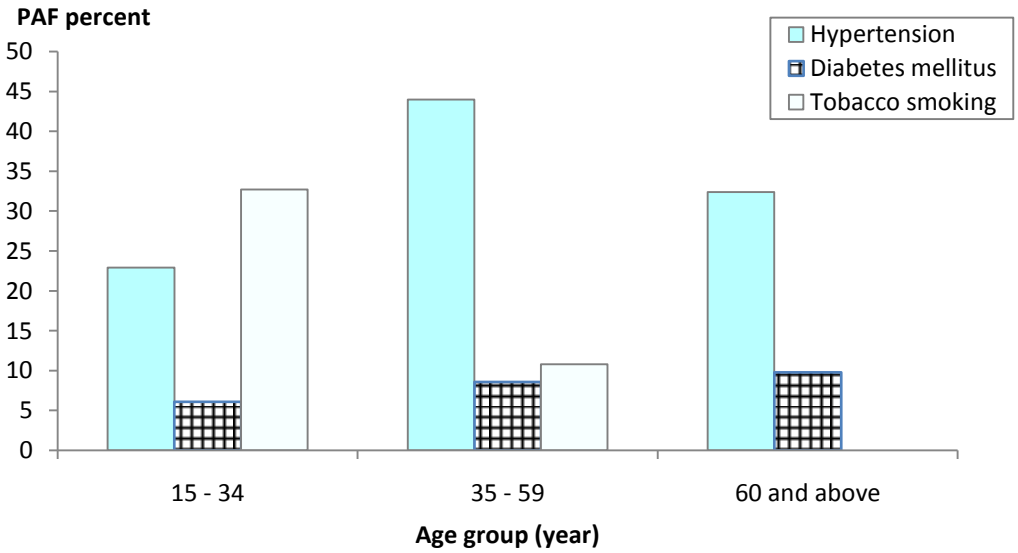

Figure 2. Population-attributable fraction of stroke risk factors by age group in 12 provinces, Thailand, 2014-2015

resources are limited. In our study, male and increasing age were important non-modifiable risk factors. As Thailand is becoming an aging society[21], burden of stroke and its related health care costs would be increasing consequentially. Therefore, stroke primary prevention should be emphasized and directed to appropriate target populations.

Similar to other studies in Asia, Middle East and North Africa,[7,22] hypertension was a major modifiable risk factor of stroke. The prevalence of hypertension among stroke patients was about 3-fold higher than general population. Furthermore, in this case-cohort comparison, hypertension also played a major role to stroke. Approximately 41.6% of stroke in Thai population was related to hypertension and PAF for hypertension was even more prominent in middle-aged group of 35-59 years, 44.0%. Since the prevalence of hypertension in Thailand was 21.4% from the national health examination survey 2009 or more than 13 million of Thai people were living with high blood pressure[23]. Hypertension prevention and control programs should be seriously promoted, particularly in middle-aged group.

While there was no statistically significant association between tobacco smoking and the disease in the overall model, opposite finding was observed in the age group-specific model. Among those aged 15-34 years, smoking carried the highest PAF of stroke, 32.7%. Additionally, the annual incidence of stroke among Thai population aged 15-39 years was about three per 100,000 population.[24] Thus, if Thailand could implement successful smoking prevention and cessation interventions in young people, annual incidence of stroke in the young generation would be significantly reduced.

This study also showed a significant association between diabetes mellitus and stroke. The similar finding was documented in South-East Asia and Western Pacific regions of WHO.[8] However, in age group-specific multivariable model, PAFs were less than 10% for diabetes mellitus in all groups. Effects

of diabetic control could reduce risk of stroke in all age groups similarly.

This study has several limitations. Firstly, since the BRFSS was conducted in purposively selected provinces and we obtained stroke patients data of the same provinces from the NHIS 2014, there might be a concern about statistical representativeness of the national picture. However, 12 selected provinces are geographically distributed throughout Thailand, which could reflect diversity of the disease and its risk factors among regions in the country. Secondly, the use of secondary data from NHIS 2014 could have resulted in selection bias as stroke patients who had not visited any hospitals would not have been captured in the database. Selection bias could also occur among BRFSS samples because the surveillance recruited only people who were alive. Lack of risk factor information among deaths may lead to underestimated prevalence of risk factors in general population. Thirdly, several risk factors such as dyslipidemia, obesity and physical inactivity were not recorded in NHIS properly, so we could not evaluate the prevalence and impact of these factors.

Conclusion

This study demonstrates that measuring the impacts of stroke risk factors can help researchers devise stroke prevention and control strategies to tackle influential factors and pinpoint appropriate populations. In Thailand, hypertension control program should be a priority in middle and old age groups whereas smoking prevention and cessation interventions should be emphasized in young people.

Acknowledgements

The authors thank the staff from Center of Information and Communication Technology, Ministry of Public Health, for providing NHIS data to serve the national NCD surveillance system. We also thank the staff from Bureau of Non-communicable Diseases, Department of Disease Control for supporting BRFSS data. Lastly, we thank public health officers in the Regional Offices of Disease Prevention and Control and the Bureau of Epidemiology, Department of Disease Control for conducting NCD surveillance evaluation to improve quality of NCD surveillance data.

Suggested Citation

Areechokchai D, Vijitsoonthornkul K, Pongpan S, Maeakhian S. Population attributable fraction of stroke risk factors in Thailand: utilization of non-communicable disease surveillance systems. OSIR. 2017 Mar;10(1):1-6.

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