Combined Effects of Hypertension and Diabetes Mellitus with Stroke among Thais in the Central Region of Thailand: a cross-sectional study

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Objective: To determine associations of individual and combined effects of hypertension and diabetes with stroke among Thais aged 55 years and older.

Material and Method: Cross-sectional data from national screening program for metabolic syndrome in Thailand for the year 2010 among participants who lived in central region of Thailand were used. The number of participants was 13,268 in the analysis.

Results: The prevalence of stroke was 0.9%. Associations between hypertension and diabetes found among participants who had hypertension only, diabetes only, and both hypertension and diabetes were: 8.99 (95%CI: 6.63-17.41), 3.72 (95%CI: 1.03-13.37), 10.48 (95% CI: 4.54-24.20) among males and 5.16 (95% CI: 2.29-11.53), 6.55 (95%CI 2.19-19.55), and 9.29 (95%CI 3.81-22.68) among females, respectively.

Conclusion: The present study suggested dramatically the strong effects of the association of combined hypertension and diabetes with stroke. Strengthening health promotion programs for the prevention of hypertension, diabetes, especially having both diseases after screening, is important among Thai population.

Keywords: Hypertension, Diabetes mellitus, Stroke, National screening program, Thais

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The incidence of stroke is usually high in many counties all over the world, especially in developing countries. In Thailand, morbidity and mortality of stroke increased from 216.58 per 1,000 to 307.93 per 1,000, and from 276.83 per 1,000 to 397.24 per 1,000 between 2008 and 2010, respectively(3). Stroke is known to be a disease of blood vessels in the brain, and usually occurs in association with other chronic conditions, such as hypertension, diabetes, high cholesterol levels and heart diseases(13,14). Having hypertension for a long period of time can strain and damage the blood vessels of heart and brain and become a strong risk factor for stroke, especially in the subject with high diastolic blood pressure(15). Diabetes, most being ischemic stroke events in diabetes patients, are due to the occlusion of paramedial penetration of arteries. The occlusion causes small infarcts within the white matter of brain. Diabetic neuropathy may contribute to the development of these cerebrovascular disease(16).

Hypertension and type II diabetes are commonly known as associated conditions(3). Both hypertension and diabetes are 2 among 5 important components of in metabolic syndrome. The cluster of metabolic abnormalities, occurring in the same person, appears to confer a substantial, additional cerebrovascular risk over and above the sum of the risk associated with each abnormality (15). Prospective study among Finnish subjects reported hypertension and type 2 diabetes increased stroke risk independently, and their combination increases the risk dramatically(16). Moreover, the highest risk of an occurrence of stroke event was found within the subjects who had had both hypertension and diabetes with an elevated level of inflammation(9,10).

Hypertension and diabetes are already known to be important risk factors for all types of stroke among Thais(4,11). Many Thais adults and the elderly have...
both hypertension and diabetes type 2 at the same
time, but there was a rare number of studies to assess
individual and combined effects of hypertension and
diabetes to stroke occurrence, not only cardiovascular
diseases, among Thais.

This analysis aimed to persuade in assessing
strength of associations of hypertension and diabetes,
both independent and combined of their effects
regarding stroke morbidity by using cross-sectional
data from screening programs among Thais who lived
in the central region of Thailand.

Materials and Method

Study population

The present study is based on cross-sectional
data from National Screening program for metabolic
syndrome by the National Health Security Office
(NHSO) of the Ministry of Public Health, Thailand. The
screening program was conducted from October 1, 2009
to July 31, 2010 among Thais who reached the age of 15
and above. There were 673,950 participants within 21
provinces of the central region of Thailand. Some
30,303 participants met inclusion criteria for analysis of
these studies by the age of 55 to 75 years, and having
plausible and complete data. Participants were
randomly selected by using a computer program with
simple random sampling in 40% of which 13,268 were
included in the analysis.

Methods of data collection

Data collection in National Screening program
for metabolic syndrome was performed mainly by
trained health officers at primary care units of health
care centers and health promotion hospital in the
villages, under the supervision of provincial health
officers.

Interviewing

A questionnaire was used for interviewing
those diagnosed or taking drugs through a physician
for important chronic diseases, with variable outcomes
such as "stroke", heart disease, and
hypercholesterolemia. Other lifestyle habits such as
cigarette smoking, alcohol drinking, and daily exercise
were also in interviewing.

Blood test

Blood sample was taken from vein of the
subject in the morning after at least 8 hours overnight
fasting for fasting plasma glucose (FPG) level, which
was measured by standardized enzymatic method.

Physical examination

Blood pressure was measured by using
sphygmomanometer or digital blood pressure monitor
(Omron). Each participant was asked to stop smoking,
drinking alcohol, or drinking caffeine substances and
exercises for at least 30 minutes before the measurement.
Blood pressure was measured in a sitting position for
three times at 1-2 minutes apart, and the average of the
three readings was recorded. Body weight was
measured by using a balanced beam scale, while the
height was measured without wearing shoes, using a
wall-mounted stadiometer. Body mass index (BMI)
was calculated in weight in kilograms, divided by height
in meters squared (kg/m²)²².

Definition of terms

When the level of FPG was ≥126 mg/dl, the
result confirmed having diabetes¹⁹. The cutoff point
for having hypertension was when systolic and
diastolic blood pressure were greater than 140 and 90
mmHg respectively or a current use of antihypertensive
medication¹⁹. The BMI for Asian people was used to
classify participants as underweight if BMI was <18.5,
as normal if BMI was 18.5-22.9, as overweight if BMI
was 23.0-24.9, as obese I if BMI was 25.0-29.9, and as
obese II if BMI was ≥30⁰¹⁰.

Statistical analysis

Multiple logistic regression analysis was used
when stratified by gender because of the heterogeneity
of the results between genders. There was significant
interaction term by additive model between
hypertension and diabetes on stroke risk (but not
significant of multiplicative term of
hypertension*diabetes). So hypertension and diabetes
were combined and created into four categories, 1) no
hypertension and no diabetes, 2) having diabetes only,
3) having hypertension only, and 4) having both
hypertension and diabetes. Adjusted odds ratio and
95% confidence interval (OR: 95% CI) for strength of
associations between hypertension and diabetes and
other existing chronic conditions with stroke were
calculated with additional adjustment for effect of
covariates simultaneously. The dependent variable was
having stroke (yes/no), and independent variables were
no hypertension and no diabetes (yes/no), having
diabetes only (yes/no), having hypertension only (yes/
no), having both hypertension and diabetes (yes/no),
having heart disease (yes/no), and having high
cholesterol (yes/no). The covariates were age in years,
cigarette smoking (only in male participants), alcohol
drinking, exercise, and body mass index. Detection of collinearity between variables was performed before putting in the model with the method of enter? with the level of significance at 0.05.

Results
Characteristics and lifestyle of study population
Total study population included in analysis was 13,268 (Males = 5,265, females = 8,003). They had age between 55 years to 75 years, and average age was 63.3 ± 5.8 years. By lifestyle factors, the prevalence of current and former smokers was the same which were 21.1% and 9.0% among males, and quite rare in 2.2% and 0.6% among females, respectively. The prevalence of current and former alcohol drinkers among males were 21.1% and 5.9% and among females were 3.7% and 2.4%, respectively. The prevalence of those, who never exercise were 22.7% and 25.1% among males and females, respectively. In addition, the prevalence of those who usually had exercised more than 3 times a week and every day were 11.4% and 11.0% among males and 10.1% and 9.6% among females, which were quite low. The prevalence of overweight and obesity among these groups of study population was 20.1% and 26% among males, and 19.4% and 37.5% among females (Table 1).

Prevalence of hypertension, type 2 diabetes, and stroke
The overall prevalence of stroke by self-report and diagnosed by a physician among this group of study population was 0.9%, while the prevalence of stroke among male participants was 1.4%, and that of female participants was 0.6% (Table 2). The prevalence of having hypertension only, diabetes only, and both hypertension and diabetes among male participants were 16.5%, 3.5%, and 5.2%, and among female participants were 21.5%, 4.9% and 8.4%, respectively. The prevalence of heart disease, and hypercholesterolemia, were 2.7% and 6.2% among male participants, and 4.2% and 10.4%, respectively (Table 2).

Associations between hypertension, diabetes with stroke
Results from multiple logistic regression stratified by gender demonstrated significant associations between hypertension and diabetes with stroke in both genders (model fitness by p-value from Hosmer and Lemeshow Test = 0.255 and 0.055, respectively). The significant effects among male participants, who had hypertension only, had diabetes only, had both hypertension and diabetes were 8.99 (95% CI 4.63-17.43, p-value < 0.001), 3.72 (95% CI 1.03-13.37, p-value = 0.044), and 10.48 (95% CI 4.54-24.20, p-value = 0.001), respectively, when compared to those who did not have both hypertension and diabetes (Table 3). While the significant effects among female participants, who had hypertension only, had diabetes only, had both hypertension and diabetes, were 5.16 (95% CI 2.29-11.53, p-value < 0.001), 6.55 (95% CI 2.19-19.55, p-value = 0.001), and 9.28 (95% CI 3.81-22.68, p-value < 0.001) when it was compared to those who did not have both hypertension and diabetes (Table 4). Besides, there was significant association of having heart disease with stroke (Adjusted OR = 2.82, 95% CI 1.30-6.11, p-value = 0.009) among male participants, but not among female participants, when compared to those, who did not have a heart disease (Table 3).

Discussion
This cross-sectional study suggested additive interaction in combined effect of hypertension and diabetes to stroke risk, which was consistent with that of the cohort study of the impact of hypertension and diabetes to the incidence of stroke in Finnish study. The present study also confirmed significantly high effects of hypertension to stroke risk among non-diabetes and diabetes participants from a screening program as indicated in a study among Thailand diabetes registry projects concerning risk factors of stroke among Thai diabetes patients.

Although, treatment of hypertension is known to reduce risk of stroke for long periods of time, there have been studies that demonstrated the use of some drugs in the treatment of hypertension for reducing cardiovascular events appeared to increase the risk of subsequent development of diabetes by its effect on insulin sensitivity. However, it was still inconsistent with the limitation for conclusion, and needs a longer term study.

In Thailand, costs of medications for treatments for chronic non-communicable diseases, especially treatment for vascular diseases of hypertension and diabetes that the Thai government had to pay yearly was quite high, but incidence of stroke still increased. It was known that to decrease the incidence of stroke is to decrease incidence of hypertension and diabetes. Physician should focus on standard guidelines for treatments, and patients should follow strictly what physicians prescribe and order. Improvement of patient’s knowledge about prevention and treatment of hypertension and diabetes.

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Table 1. Demographic characteristics of study population

<table>
<thead>
<tr>
<th>Variables</th>
<th>All (n=13,268)</th>
<th>Males (n=5,265)</th>
<th>Females (n=8,003)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55-65</td>
<td>8,468 (63.8%)</td>
<td>3,295 (62.6%)</td>
<td>5,173 (64.6%)</td>
<td>0.008*</td>
</tr>
<tr>
<td>66-75</td>
<td>4,800 (36.2%)</td>
<td>1,970 (37.4%)</td>
<td>2,830 (35.4%)</td>
<td></td>
</tr>
<tr>
<td>Mean of age</td>
<td>63.3±5.8</td>
<td>63.4±5.9</td>
<td>63.3±5.8</td>
<td></td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>11,533 (87.6%)</td>
<td>3,817 (73.0%)</td>
<td>7,716 (97.2%)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Current</td>
<td>1,275 (9.7%)</td>
<td>1104 (21.1%)</td>
<td>171 (2.2%)</td>
<td></td>
</tr>
<tr>
<td>Ever</td>
<td>361 (2.7%)</td>
<td>307 (5.9%)</td>
<td>54 (0.6%)</td>
<td></td>
</tr>
<tr>
<td>Alcohol drinking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>11,157 (84.7%)</td>
<td>3,696 (70.6%)</td>
<td>7,461 (93.9%)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Current</td>
<td>1,358 (10.3%)</td>
<td>1,066 (20.4%)</td>
<td>292 (3.7%)</td>
<td></td>
</tr>
<tr>
<td>Ex</td>
<td>665 (5.0%)</td>
<td>472 (9.0%)</td>
<td>93 (2.4%)</td>
<td></td>
</tr>
<tr>
<td>Exercise</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>3,166 (24.1%)</td>
<td>1,178 (22.7%)</td>
<td>1,988 (25.1%)</td>
<td>0.001*</td>
</tr>
<tr>
<td>&lt; 3 times a day</td>
<td>4,768 (36.4%)</td>
<td>1,872 (36.0%)</td>
<td>2,896 (36.6%)</td>
<td></td>
</tr>
<tr>
<td>≥ 3 times a day</td>
<td>2,453 (18.7%)</td>
<td>984 (18.9%)</td>
<td>1,469 (18.6%)</td>
<td></td>
</tr>
<tr>
<td>&gt; 3 times a day</td>
<td>1,389 (10.6%)</td>
<td>591 (11.4%)</td>
<td>798 (10.1%)</td>
<td></td>
</tr>
<tr>
<td>Everyday</td>
<td>1,336 (10.2%)</td>
<td>573 (11.0%)</td>
<td>763 (9.6%)</td>
<td></td>
</tr>
<tr>
<td>Body mass index</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>5,204 (40.1%)</td>
<td>2,329 (45.2%)</td>
<td>2,875 (36.8%)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Underweight</td>
<td>949 (7.3%)</td>
<td>454 (8.8%)</td>
<td>495 (6.3%)</td>
<td></td>
</tr>
<tr>
<td>Overweight</td>
<td>2,553 (19.7%)</td>
<td>1,035 (20.1%)</td>
<td>1,518 (19.4%)</td>
<td></td>
</tr>
<tr>
<td>Obese I</td>
<td>3,417 (26.3%)</td>
<td>1,138 (22.1%)</td>
<td>2,279 (29.2%)</td>
<td></td>
</tr>
<tr>
<td>Obese II</td>
<td>853 (6.6%)</td>
<td>202 (3.9%)</td>
<td>651 (8.3%)</td>
<td></td>
</tr>
</tbody>
</table>

* = Statistically significant

Table 2. Prevalence of hypertension, diabetes type 2 and stroke by gender

<table>
<thead>
<tr>
<th>Chronic diseases</th>
<th>All (n=13,268)</th>
<th>Males (n=5,265)</th>
<th>Females (n=8,003)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Stroke</td>
<td>122</td>
<td>0.9</td>
<td>73</td>
</tr>
<tr>
<td>Hypertension only</td>
<td>2,587</td>
<td>19.5</td>
<td>870</td>
</tr>
<tr>
<td>Diabetes type 2 only</td>
<td>576</td>
<td>4.3</td>
<td>185</td>
</tr>
<tr>
<td>Both hypertension and diabetes</td>
<td>676</td>
<td>7.1</td>
<td>272</td>
</tr>
<tr>
<td>Heart diseases</td>
<td>447</td>
<td>3.6</td>
<td>133</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>1,160</td>
<td>8.8</td>
<td>327</td>
</tr>
</tbody>
</table>

during the course of life are extremely necessary. Lifestyle change through health promotion programs after screening program for Thais should be strengthened and evaluated yearly.

The result from this analysis also found a significant association between heart disease and stroke but only among male participants. Study demonstrated that arteriosclerosis, atrial fibrillation of heart disease showed its role as important risk factor of ischemic stroke, but there were a few studies with inclusive results of heart diseases in hemorrhagic stroke, and still needed further clarification(44).

However, the main limitation of the present study was the nature of cross-sectional data, which produced association, not the causation. Data from this population-based survey may have some bias in measuring stroke outcome that was assessed by self-reporting and diagnosed by a physician. However, data from screening programs should be used regularly to evaluate effectiveness of national screening and health promotion programs. Further prospective study in subgroups of population who have annual health
Table 3. Crude and adjusted association (OR: 95%CI) between diabetes mellitus, hypertension, heart diseases and stroke among male participants

<table>
<thead>
<tr>
<th>Variables</th>
<th>Stroke (n%)</th>
<th>Non stroke (n%)</th>
<th>Crude Odds ratio (95% CI)</th>
<th>Adjusted* Odds ratio (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension and diabetes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No hypertension and no</td>
<td>17 (23.3)</td>
<td>3,905 (75.2)</td>
<td>1**</td>
<td>1**</td>
<td>&lt;0.001***</td>
</tr>
<tr>
<td>diabetes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension without</td>
<td>36 (49.3)</td>
<td>834 (16.4)</td>
<td>9.91 (5.54-17.73)</td>
<td>8.99 (4.63-17.43)</td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>4 (5.5)</td>
<td>181 (3.5)</td>
<td>5.07 (1.69-15.24)</td>
<td>3.72 (1.03-13.37)</td>
<td>0.044***</td>
</tr>
<tr>
<td>Hypertension and diabetes</td>
<td>15 (20.5)</td>
<td>257 (4.9)</td>
<td>15.31 (1.91-122.52)</td>
<td>10.48 (4.54-24.20)</td>
<td>&lt;0.001***</td>
</tr>
<tr>
<td>Having heart diseases</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>53 (84.1)</td>
<td>4752 (97.5)</td>
<td>1**</td>
<td>1**</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>10 (15.9)</td>
<td>123 (2.5)</td>
<td>7.28 (3.62-14.66)</td>
<td>2.82 (1.30-6.11)</td>
<td>0.009***</td>
</tr>
<tr>
<td>Having high cholesterol</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>45 (61.6)</td>
<td>4541 (87.6)</td>
<td>1**</td>
<td>1**</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>16 (21.9)</td>
<td>311 (6.0)</td>
<td>5.19 (2.90-9.29)</td>
<td>1.78 (0.90-3.50)</td>
<td>0.095***</td>
</tr>
</tbody>
</table>

* = Adjusted by all variables in table and age in years, smoking, alcohol drinking, exercise, and body mass index.  
** = Reference group  
*** = Statistically significant

Table 4. Adjusted association (OR: 95%CI) between diabetes mellitus, hypertension, heart diseases and stroke among female participants

<table>
<thead>
<tr>
<th>Variables</th>
<th>Stroke (n%)</th>
<th>Non stroke (n%)</th>
<th>Crude Odds ratio (95% CI)</th>
<th>Adjusted* Odds ratio (95% CI)*</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension and diabetes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No hypertension and no</td>
<td>11 (22.4)</td>
<td>5193 (65.3)</td>
<td>1**</td>
<td>1**</td>
<td></td>
</tr>
<tr>
<td>diabetes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension without</td>
<td>19 (38.8)</td>
<td>1698 (21.3)</td>
<td>5.28 (2.50-11.12)</td>
<td>5.16 (2.29-11.53)</td>
<td>&lt;</td>
</tr>
<tr>
<td>diabetes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension and diabetes</td>
<td>5 (10.2)</td>
<td>386 (4.9)</td>
<td>6.11 (2.11-17.68)</td>
<td>6.55 (2.19-19.55)</td>
<td>0.001***</td>
</tr>
<tr>
<td>Having heart diseases</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>42 (87.5)</td>
<td>7200 (95.9)</td>
<td>1**</td>
<td>1**</td>
<td>&lt;0.001***</td>
</tr>
<tr>
<td>Yes</td>
<td>6 (12.5)</td>
<td>308 (4.1)</td>
<td>3.34 (1.40-7.91)</td>
<td>1.69 (0.68-4.16)</td>
<td>0.254</td>
</tr>
<tr>
<td>Having high cholesterol</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>34 (69.4)</td>
<td>6659 (83.9)</td>
<td>1**</td>
<td>1**</td>
<td>0.293</td>
</tr>
<tr>
<td>Yes</td>
<td>14 (28.6)</td>
<td>819 (10.3)</td>
<td>3.34 (1.78-6.26)</td>
<td>1.45 (0.72-2.95)</td>
<td></td>
</tr>
</tbody>
</table>

* = Adjusted by all variables in table and age in years, smoking, alcohol drinking, exercise, and body mass index.  
** = Reference group  
*** = Statistically significant
examinations is suggested to be analyzed not only to confirmed results, but also to identify the interrelationship between hypertension and diabetes which cannot be found in secondary hypertension, including the treatment effect of hypertension among Thai's.

Conclusion
The present study points out the high, independent effects of the association of hypertension with stroke than with diabetes. The higher effects were found among participants who had both hypertension and diabetes in both genders.

Acknowledgement
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Potential conflicts of interest
None.

References


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อิทธิพลรวมของการมีโรคความดันโลหิตสูงและเบาหวานต่อการเกิดโรคหลอดเลือดสมองในประชากรภาคกลางของประเทศไทย: การศึกษานาคตัดช่วง

ภูณิยา นาคสวัสดิ์, ศุลิต สุขวิทยานุ, ภานุวัฒน์ ปานเกษร

วัตถุประสงค์: ศึกษาความสัมพันธ์เชิงสถิติและความสัมพันธ์รวมของการมีโรคความดันโลหิตสูงและโรคเบาหวานต่อการเกิดโรคหลอดเลือดสมองในประชากรภาคกลางของประเทศไทยอายุ 55 ปีขึ้นไป

วิธีการและวิธีการ: วิเคราะห์ข้อมูลด้วยสถิติจากการสำรวจข้อมูลความเสี่ยงในกลุ่มภาวะโรคหลอดเลือดสมองที่ดำเนินการในปี พ.ศ. 2553 จำนวน 13,286 คน

ผลการศึกษา: พบความสัมพันธ์ของการมีโรคหลอดเลือดสมองระยะ 0.9 ความสัมพันธ์ระหว่างการเป็นโรคความดันโลหิตสูงอย่างต่อเนื่อง การเป็นโรคเบาหวานอย่างต่อเนื่อง และการเป็นโรคความดันโลหิตสูงและโรคเบาหวานกับการเกิดโรคหลอดเลือดสมอง เท่ากับ 8.99 เท่า (95% CI 4.63-17.43), 3.72 เท่า (95% CI 1.03-13.37), และ 10.48 เท่า (95% CI 4.54-24.20) ในประชากรเพศหญิง และ 5.16 เท่า (95% CI 2.29-11.53), 6.55 เท่า (95% CI 2.19-19.55), และ 9.29 เท่า (95% CI 3.81-22.68) ในประชากรเพศผู้ชายตามลำดับ

สรุป: ผลการศึกษาแสดงข้อมูลความสัมพันธ์รวมของการเป็นโรคความดันโลหิตสูงและโรคเบาหวานต่อการเกิดโรคหลอดเลือดสมองที่สูงกว่าการไม่มีโรคใดโรคหนึ่ง การแก้ไขเหตุที่มีปัญหาการสร้างเสริมสุขภาพหลังการคลอดจรรยาความสัมพันธ์ในกลุ่มภาวะโรคหลอดเลือดสมองที่มีอยู่ความสำคัญที่ควรต้องใส่ความสำคัญและให้ความสนับสนุนในมิติความเชื่อมโยงเรื่องอื่นในการดำเนินการและการเข้าร่วมกิจกรรมของประชาชนตลอดจนการประเมินผลที่ต่อเนื่องและเป็นระบบ