THE IMPACT OF SOCIODEMOGRAPHIC VARIABLES ON RISK FACTORS ASSOCIATED WITH ISCHAEMIC STROKE PATIENTS BY AGE GROUP

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ABSTRACT

This study aims to identify the relevant risk factors based on different sociodemographic backgrounds among ischaemic stroke patients in relation to age. We included all adult ischaemic stroke patients from 1st January 2013 to 31st December 2019 who presented to Hospital Seberang Jaya. The study utilized data that were collected from medical records and were presented with descriptive and inferential statistics. Hypertension was common in male ($p=0.009$), female ($p<0.001$), Chinese ($p<0.001$), married ($p=0.006$), or single ($p=0.006$) ischaemic stroke patients with advancing age. Ischaemic stroke patients in their 50s who were female ($p=0.043$) or Indian ($p=0.005$) and Chinese patients ≥60 ($p=0.025$) more often presented with diabetes. Dyslipidaemia was predominant in ischaemic stroke patients who were male between 50 and 59 ($p=0.017$) or Chinese ≥60 ($p=0.041$). Male ($p=0.037$), female ($p=0.005$), Chinese ($p<0.001$), Indian ($p=0.022$), or married ($p=0.037$) ischaemic stroke patients with advancing age were more likely to be associated with at least two risk factors. There was a declining proportion of fewer than two risk factors among ischaemic stroke patients with the same sociodemographic background in progressing age. Risk factors had a specific age and sociodemographic distribution pattern in ischaemic stroke patients. Public health preventive programmes targeting certain age groups with different sociodemographic backgrounds could be useful to reduce the burden of stroke.

Keywords: impact, sociodemographic, variables, risk factors, ischaemic stroke, patients, age, stroke

1. INTRODUCTION

A 6-year stroke study conducted at Hospital Seberang Jaya, Penang showed that nearly 82% of the patients were ischaemic stroke (IS) patients.(1) There are modifiable and non-modifiable risk factors (RFs) associated with IS. Non-modifiable RFs include age, sex, ethnicity, and genetic factors. While these non-modifiable RFs cannot be altered, they still serve as imperative identifiers of stroke-risk patients.(2) On top of that, modifiable RFs such as hypertension, atrial fibrillation (AF), and ischaemic heart disease (IHD) may further influence the aetiology and outcomes of stroke.(3) As evidenced in the literature, the substantial impact of these RFs varied in combination with other variables such as sex and age.(4) Identification of these precipitating factors is essential in order to implement preventive measures that target patients at increased risk for stroke. Because RFs are frequently interrelated, clustering patterns of several RFs should be investigated. Understanding the association might be useful in creating interventions that target

numerous regularly co-occurring RFs in certain population groups.[5]

There were several studies in the past such as the Framingham Heart Study,[6] the Atherosclerosis Risk in Communities study,[7] and the Cardiovascular Health Study[8] that identified the RFs for stroke. Despite the fact that there have been stroke epidemiological studies worldwide, sometimes with inconsistent results, there are no studies done locally in Malaysia to identify the RFs of stroke. The RFs among different socioeconomic groups have also not been extensively studied. The lack of Malaysian stroke-related data is hampering evidence-based efforts to improve patient care and to provide and plan for a better healthcare policy. Therefore, we performed this 7-year observational study at a local stroke-ready hospital in order to identify the relevant RFs and to determine disparities in the co-occurrence of these various RFs based on sociodemographic backgrounds among IS patients in relation to age.

2. METHODS

This single-centre, hospital-based study was registered with the local National Medical Research Register (NMRR-20-1476-55732) and obtained ethical approval from the Medical Research and Ethics Committee, Ministry of Health Malaysia.

Hospital Seberang Jaya (HSJ) has an acute stroke care facility that provides 24/7 intravenous thrombolysis service to patients from Penang and nearby states.[9] We included all adult patients (above 18 years old) from 1st January 2013 to 31st December 2019 who presented to HSJ within 14 days of IS symptoms onset. Based on stroke subtypes as defined by the World Health Organization classification system, patients with other types of strokes, such as intracerebral haemorrhage, and subarachnoid haemorrhage, were excluded from this study.[10] The identification of stroke cases was based on clinical assessment by a neurologist and confirmed using computed tomography or magnetic resonance imaging of the brain. We collected relevant data from medical case notes obtained from the medical record office. The information was verified by a neurology stroke expert prior to data extraction and analysis.

Variables for analysis that were retrieved include the IS patients' sociodemographic data (age, sex, ethnicity, and marital status), and five major RFs (hypertension, diabetes, dyslipidaemia, IHD, and AF) that were identified via medical records. Hypertension was demarcated as a mean systolic blood pressure of ≥140 mmHg or a mean diastolic blood pressure of ≥90 mmHg in repeated measures, or use of antihypertensive medications, as documented in medical records.[11] Diabetes was demarcated as a fasting plasma glucose level ≥7 mmol/L or being prescribed with oral hypoglycaemic agents or an insulin regiment, as documented in medical records.[12] Hyperlipidaemia was defined as total cholesterol >5.2 mmol/L, high-density-lipoprotein cholesterol <1.0 mmol/L for male, and <1.2 mmol/L for female, triglyceride >1.7 mmol/L, and low-density-lipoprotein cholesterol >2.6 mmol/L with cardiac RFs or currently on statins, as documented in medical records.[13] IHD was demarcated as a self-reported physician diagnosis for angina pectoris or myocardial infarction, or with a history of angioplasty, stenting procedures or coronary artery bypass graft surgery.[4] AF was demarcated as a self-reported physician diagnosis with abnormal electrocardiogram findings, history of antiarrhythmic drugs or with anticoagulant therapy, as documented in medical records.[14]

All data analyses were performed using the Statistical Package of Social Sciences software, version 20.0. Descriptive statistics were employed for all variables in the study. The chi-square test or Fisher's exact test was used to assess the major RFs and the number of RFs by different age groups in the overall sample, in both male and female, in Malay, Chinese, and Indian, as well as in married and single patients. All probability values are two-sided, and a level of significance (p-value < 0.05) was considered statistically significant.

3. RESULTS

3.1 Ischaemic Stroke by Overall Sample

We included 1,280 IS patients with the mean age (SD) of 62.3 (12.1) years. Our study showed that hypertension was the most common RF of IS, followed by diabetes, dyslipidaemia, IHD, and AF. The five major RFs of IS was stratified into different age groups, ranging from 20 to ≥60 years

old. Overall, we found statistically significant association for all five major RFs, namely hypertension (p<0.001), diabetes (p=0.025), dyslipidaemia (p=0.006), IHD (p=0.040) and AF (p=0.006) with age. Hypertension was the most frequent RF across all age groups, present in 50% to 80% of the patients with IS. AF was the least common RF, hardly seen in patients aged below 60. (Figure 1A; Table 1)

We found significant association between number of RFs and age (p<0.001). Of the five major RFs assessed, 473 (37.0%) patients had two RFs, 20% to 30% of the patients had either no or one RF. The least number of patients, 31 (2.4%), had four RFs. In the youngest age group of 20 to 29 years, half had a single RF and the other half of them developed IS without having any RFs. As the age increased, the proportion of patients with either no or only one RF declined while the number of patients with two or more RFs of IS became greater. (Figure 2A; Table 2)

3.2 Ischaemic Stroke by Sex

Among the 815 (63.7%) male patients, association between age and hypertension (p=0.009) as well as dyslipidaemia (p=0.017) were found to be statistically significant (Table 1). The proportion of hypertension declined slightly in patients aged 40 to 49 years and rose thereafter in the subsequent elder age groups. Dyslipidaemia was found most often in male patients aged 50 to 59 years (18.2%), and least often in those aged 30 to 39 years (3.3%) (Figure 1B). In the female group, one patient aged between 20 and 29 with young IS had hypertension. The proportion of diabetes increased up to the age of 50s and declined thereafter (Figure 1C).

There was a statistically significant association between number of RFs and age in both male (p<0.037) and female (p=0.005) patients (Table 2). In male patients aged 30 to 39 years, a majority of them (46.7%) had only one RF whereas most of the females (66.7%) in the same age group did not have any RFs. The proportion of patients with at least two RFs increased steadily from age 30 to ≥60 in both male and female patients. More than 50% of the male and female patients who were ≥60 years had at least two RFs (Figures 2B and 2C).

3.3 Ischaemic Stroke by Ethnic Group

Although Malays accounted for more than half of the patients, we did not observe significant association between RFs and age (Table 1; Figure 1D). Among 405 (31.6%) Chinese patients, three major RFs, hypertension (p<0.001), diabetes (p=0.025) and dyslipidaemia (p=0.041) were significantly associated with increasing age (Table 1). Starting at the age of 30, both the proportion of hypertension and diabetes were seen in advancing age. The proportion of hypertension in Chinese patients aged ≥60 almost tripled as compared to younger patients in their 30s. There was also a marked increase in the proportion of dyslipidaemia from 4% to more than 20% as the age increased from 40 to ≥60 (Figure 1E). Meanwhile in the Indian group (14.9%), diabetes was the only RF showing significant association with varying age groups (p=0.005) (Table 1). A 10% decrease was first observed in the younger age group in the proportion of diabetes. However, it rose to approximately 60% as the age increased to ≥50 years (Figure 1F).

Statistically significant association was observed between the number of RFs and age in Chinese (p<0.001) and Indian (p=0.022) patients (Table 2). All Chinese patients aged below 40 years had either no or only one RF. As the age increased, patients with at least two RFs gradually predominated in the population (Figure 2E). Most Indian patients aged ≥60 had two RFs, whereas approximately 40% of those aged below 50 years had only one RF (Figure 2F).

3.4 Ischaemic Stroke by Marital Status

We found a statistically significant association between hypertension and age in both married (p=0.006) and single (p=0.006) patients (Table 1). Proportion of hypertension in married patients varied across all age groups, being highest in the 20 to 29 age group and lowest in the 30 to 39 age group (Figure 1G). Among patients who were single, the proportion of hypertension increased progressively from the age of 30 to ≥60 (Figure 1H). In patients aged below 60, hypertension was more often reported by those who were married in comparison with those who were single (Figures 1G and IH).

There was a significant association between the number of RFs and age in married

patients (p=0.037) (Table 2). In married patients aged 30 to 39 years, 25% had at least two RFs and the frequency then increased to about 40% in the ≥60 age group (Figure 2G).

The association between the number of RFs and age in single patients was not statistically significant (Figure 2H).

Table 1: Prevalence of major risk factors by different age groups (in overall sample; in male and female; in Malay, Chinese, and Indian; in married and single patients)

Major risk factors	Age groups (years)					Total	P-value
	20-29	30-39	40-49	50-59	≥ 60		
Overall sample, n (%)							
Hypertension	1 (50.0)	23 (54.8)	90 (62.9)	236 (67.0)	571 (77.1)	921 (72.0)	< 0.001
Diabetes	0 (0.0)	13 (31.0)	59 (41.3)	168 (47.7)	372 (50.2)	612 (47.8)	0.025
Dyslipidaemia	0 (0.0)	1 (2.4)	16 (11.2)	60 (17.0)	142 (19.2)	219 (17.1)	0.006
Ischaemic heart disease	0 (0.0)	0 (0.0)	14 (9.8)	27 (7.7)	85 (11.5)	126 (9.8)	0.040
Atrial fibrillation	0 (0.0)	0 (0.0)	1 (0.7)	3 (0.9)	31 (4.2)	35 (2.7)	0.006
Sex, n (%)							
a) Male (n=815, 63.7%)	**n = 1**	**n = 30**	**n = 107**	**n = 242**	**n = 435**	**n = 815**	
Hypertension	0 (0.0)	19 (63.3)	62 (57.9)	164 (67.8)	319 (73.3)	564 (69.2)	0.009
Diabetes	0 (0.0)	11 (36.7)	43 (40.2)	105 (43.4)	218 (50.1)	377 (46.3)	0.115
Dyslipidaemia	0 (0.0)	1 (3.3)	8 (7.5)	44 (18.2)	72 (16.6)	125 (15.3)	0.017
Ischaemic heart disease	0 (0.0)	0 (0.0)	14 (13.1)	20 (8.3)	55 (12.6)	89 (10.9)	0.075
Atrial fibrillation	0 (0.0)	0 (0.0)	1 (0.9)	2 (0.8)	14 (3.2)	17 (2.1)	0.185
b) Female (n=465, 36.3%)	**n = 1**	**n = 12**	**n = 36**	**n = 110**	**n = 306**	**n = 465**	
Hypertension	1 (100.0)	4 (33.3)	28 (77.8)	72 (65.5)	252 (82.4)	357 (76.8)	< 0.001
Diabetes	0 (0.0)	2 (16.7)	16 (44.4)	63 (57.3)	154 (50.3)	235 (50.5)	0.043
Dyslipidaemia	0 (0.0)	0 (0.0)	8 (22.2)	16 (14.5)	70 (22.9)	94 (20.2)	0.117
Ischaemic heart disease	0 (0.0)	0 (0.0)	0 (0.0)	7 (6.4)	30 (9.8)	37 (8.0)	0.201
Atrial fibrillation	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.9)	17 (5.6)	18 (3.9)	0.132
Ethnic group, n (%)							
a) Malay (n=684, 53.4%)	**n = 0**	**n = 19**	**n = 95**	**n = 185**	**n = 385**	**n = 684**	
Hypertension	0 (0.0)	13 (68.4)	65 (68.4)	131 (70.8)	295 (76.6)	504 (73.7)	0.248

Diabetes	0 (0.0)	8 (42.1)	46 (48.4)	88 (47.6)	195 (50.6)	337 (49.3)	0.819
Dyslipidaemia	0 (0.0)	1 (5.3)	13 (13.7)	30 (16.2)	64 (16.6)	108 (15.8)	0.547
Ischemic heart disease	0 (0.0)	0 (0.0)	11 (11.6)	13 (7.0)	41 (10.6)	65 (9.5)	0.243
Atrial fibrillation	0 (0.0)	0 (0.0)	0 (0.0)	3 (1.6)	14 (3.6)	17 (2.5)	0.191
b) Chinese (n=405, 31.6%)	**n = 2**	**n = 11**	**n = 27**	**n = 97**	**n = 268**	**n = 405**	
Hypertension	1 (50.0)	3 (27.3)	12 (44.4)	59 (60.8)	205 (76.5)	280 (69.1)	< 0.001
Diabetes	0 (0.0)	1 (9.1)	8 (29.6)	37 (38.1)	124 (46.3)	170 (42.0)	0.025
Dyslipidaemia	0 (0.0)	0 (0.0)	1 (3.7)	19 (19.6)	62 (23.1)	82 (20.2)	0.041
Ischaemic heart disease	0 (0.0)	0 (0.0)	2 (7.4)	6 (6.2)	31 (11.6)	39 (9.6)	0.500
Atrial fibrillation	0 (0.0)	0 (0.0)	1 (3.7)	0 (0.0)	15 (5.6)	16 (4.0)	0.100
c) Indian (n=191, 14.9%)	**n = 0**	**n = 12**	**n = 21**	**n = 70**	**n = 88**	**n = 191**	
Hypertension	0 (0.0)	7 (58.3)	13 (61.9)	46 (65.7)	71 (80.7)	137 (71.7)	0.079
Diabetes	0 (0.0)	4 (33.3)	5 (23.8)	43 (61.4)	53 (60.2)	105 (55.0)	0.005
Dyslipidaemia	0 (0.0)	0 (0.0)	2 (9.5)	11 (15.7)	16 (18.2)	29 (15.2)	0.443
Ischaemic heart disease	0 (0.0)	0 (0.0)	1 (4.8)	8 (11.4)	13 (14.8)	22 (11.5)	0.475
Atrial fibrillation	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (2.3)	2 (1.0)	0.661
Marital status, n (%)							
a) Married (n=620, 78.2%)	**n = 1**	**n = 16**	**n = 61**	**n = 158**	**n = 384**	**n = 620**	
Hypertension	1 (100.0)	8 (50.0)	43 (70.5)	101 (63.9)	294 (76.6)	447 (72.1)	0.006
Diabetes	0 (0.0)	6 (37.5)	25 (41.0)	78 (49.4)	200 (52.1)	309 (49.8)	0.301
Dyslipidaemia	0 (0.0)	1 (6.3)	8 (13.1)	27 (17.1)	79 (20.6)	115 (18.5)	0.424
Ischaemic heart disease	0 (0.0)	0 (0.0)	3 (4.9)	13 (8.2)	52 (13.5)	68 (11.0)	0.087
Atrial fibrillation	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.6)	18 (4.7)	19 (3.1)	0.060
b) Single (n=173, 21.8%)	**n = 0**	**n = 11**	**n = 25**	**n = 55**	**n = 82**	**n = 173**	
Hypertension	0 (0.0)	4 (36.4)	12 (48.0)	34 (61.8)	63 (76.8)	113 (65.3)	0.006
Diabetes	0 (0.0)	2 (18.2)	8 (32.0)	25 (45.5)	37 (45.1)	72 (41.6)	0.242

Dyslipidaemia	0 (0.0)	0 (0.0)	3 (12.0)	7 (12.7)	15 (18.3)	25 (14.5)	0.469
Ischaemic heart disease	0 (0.0)	0 (0.0)	1 (4.0)	2 (3.6)	10 (12.2)	13 (7.5)	0.248
Atrial fibrillation	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.2)	1 (0.6)	1.000

4. DISCUSSION

Generally, our data are comparable to Asian countries including developed countries such as Taiwan[15], Japan[16], Singapore[17], and South Korea[18] as well as developing countries such as China[19], India[20], Thailand[21], and Kuwait[22]. A previous study suggested that the average age of stroke patients in developing countries was younger than in the developed countries.[23] Compared to the four developing Asian countries mentioned above, our mean (SD) age of 62.3 (12.1) was the second highest after China, with an average age of 65. This likely means that the local burden of stroke contributed by young stroke patients may not be as significant, but further study is necessary to confirm this observation. Male IS patients are predominant in our setting and among all these countries. Males are reported to have more IS but females had more infarctions affecting the anterior circulation and more subarachnoid haemorrhages.[24, 25] In the general population, hypertension is the most significant RF for stroke and diabetes is second to hypertension as an RF for IS.[26, 27] Although AF was the least common RF, a study showed that there is a 5-fold increased risk of stroke for those with AF.[28]

4.1 Ischaemic Stroke by Overall Sample

The proportion of each RF increased with age, similar to previous studies. A hospital-based cohort in Taiwan showed that hypertension and diabetes were more common in older IS patients.[29] Furthermore, a China study indicated that classic vascular RFs such as IHD and AF were more common in elderly patients.[30] The proportion of at least two RFs increased with advancing age too. Aging is usually accompanied by other co-morbidities such as hypertension, diabetes, etc., which are also RFs for stroke, further contributing to the number of stroke and its aftermath.[31] We noticed that the proportion of hypertension in the younger age group i.e., 30-39 years old reaches 54.8%, which is significant and unexpected. This calls for more intensive hypertension screening, including young adults, to examine whether the hypertension is essential or secondary. This measure helps patients to receive the appropriate treatment as early as possible, particularly young adults, in order to prevent or reduce the incidence of stroke events. In contrast with our finding, a past study found that dyslipidaemia was more common in the younger group.[32] Dyslipidaemia is common and plays a role in the development of atherosclerosis and cerebrovascular disease.[33] Given that the proportion of dyslipidaemia rises with age and that it is one of the five major modifiable RFs for cerebrovascular disease, it appears prudent to strive for more consistent and long-term monitoring and treatment of these frequent RF disorders.

4.2 Ischaemic Stroke by Sex

Studies have shown that the stroke rate doubles every 10 years after the age of 55 in both males and females.[34] A similar age pattern can be seen in our study with more than half of the IS patients in both sexes aged ≥60. On top of being the most prominent RF overall, the proportion of hypertension increased with age in both male and female IS patients. This indicates that the influence of hypertension on the risk of IS is the same in males and females. Previous study showed that males had somewhat higher rates of hypertension until they were around 50 years old, after which, between 50 and 70 years old, the incidence of hypertension was the same in both sexes. However, the number declined in both sexes between 70 and 80 years of age with a slightly steeper decrease in males.[35] It should be noted that the study was conducted in Denmark and the outcome could be affected by its local regional and socioeconomic differences. We also observed a disparity between the sexes. As the age of the patient progressed, the proportion of dyslipidaemia increased in males while the proportion of diabetes escalated in females.

Therefore, gender-specific approaches for optimal lipid or blood sugar management may be beneficial, but future studies are required to confirm the results. In addition, both RFs in males and females peaked when the patients were in their 50s with a slight decline thereafter, which may be due to mortality displacement in the elderly group. It is common to associate aging with at least two chronic illnesses.[36] Knowing the increased proportion of clustering of at least two RFs in both sexes with age in our stroke cohort, further study is warranted to investigate whether they function synergistically and enhance one another or whether they are just additive RFs for IS. The issue should be studied with consideration for hormonal, lifestyle, health behaviour, and other differences between males and females.

4.3 Ischaemic Stroke by Ethnic Group

Based on our study, the proportion of IS was the highest in Malay (53.4%) followed by Chinese (31.6%) and Indian (14.9%) patients. Despite the fact that more than half of the IS patients are Malay, only Chinese and Indian patients showed associations between RFs and age. Currently, there are only a few studies on ethnic variations in the Asian stroke population, mostly in Singapore, which has a more homogeneous population ethnically compared to Malaysia.[37, 38] Our study is the first that investigates RFs with ethnicity in relation to age among Malay, Chinese, and Indian IS patients. Even though our findings might not be definitive, socioeconomic, dietary patterns and lifestyles, as well as some hereditary variations are the factors to consider with the increased proportion of hypertension, and dyslipidaemia in Chinese and diabetes in both Chinese and Indian with age. Of note, one in two Chinese IS patients have hypertension in their 20s. Considering that younger stroke patients have a significantly higher risk of mortality than the general population, prompt treatment of stroke RFs, such as hypertension, particularly in the younger generation is critical.[39] We also observed that the proportion of Indian diabetic IS patients peaked in the 50s age range with a trivial drop afterwards. This may be due to mortality displacement which warrants further study to confirm. Another finding revealed that both Chinese and Indian IS patients had at least two RFs as they became older, with Indians having a younger predisposition to multiple RFs, as early as in their 30s. The primary treatment approach for decreasing stroke-related morbidity and mortality is prevention.[40, 41] Given that the first-ever stroke was expected to occur under the age of 40 and the risk of stroke increased with having more RFs, it could be an advantage to target these RFs among young Indians. However, more evidence is needed to warrant the recommendation.

4.4 Ischaemic Stroke by Marital Status

Marriage as a way of life is not linked to a decreased risk of stroke in all studies.[42, 43] Our study also indicated that more than 75% of IS patients were married. It has been suggested that the association between marital status and risk of stroke were largely influenced by socioeconomic factors, unhealthy lifestyle behaviours and reduced social support.[44, 45] We also observed a similar age pattern in both married and single IS patients with hypertension. While the youngest single IS patients were in their 30s, it is noteworthy that the married IS patient with hypertension was in the 20s age range. According to a Chinese study, young IS patients with psychological symptoms had a greater proportion of married status, hypertension, infarct size, and family dysfunction when compared to those without psychological symptoms.[46] Young people's mental health may be unaffected, if not negatively affected, by early marriage, which is non-normative both statistically and culturally.[47] Lastly, our study showed that married IS patients have up to four RFs with increasing age. While marital status cannot be changed by medical intervention or therapy, knowing the mechanism may help in discovering potential strategies to lower the risk, a topic for future study. This also suggests early identification of RFs so that measures can be taken to increase awareness and public education about them which could, in the long run, reduce the prevalence of IS. Patients with hypertension had a 1.5 to 5.0 times higher risk of death or dependency/deterioration.[48] The proportion of both married and single IS patients with hypertension in their 60s was about the same (76%) in our study. Since previous research showed that individuals who live alone are more likely to die after a stroke,[49] elderly stroke

survivors who are single and living alone, particularly those with disabilities, may require extra attention for better post-stroke care management and long-term outcome.

5. LIMITATION

The study only represents a hospital-based study and may not represent the population in the whole of Malaysia. However, with over a thousand patients and general demographic variables that are comparable to both Malaysia and other Asian countries, our findings may provide insights that are relevant to a regional or international population. Our findings are exclusively based on marital status at the time of the stroke. The impact of changes in marital status on the risk of stroke is not taken into account in this study. Besides, we did not further investigate the type of hypertension (essential or secondary) among the patients. It is worthwhile to explore, especially among the group of patients 30-39 years old, if the high blood pressure is identified as essential or secondary hypertension. This is crucial since these findings could be attributed to metabolic syndrome, which is prevalent in our community and could become more common among the younger age group. All of these warrant future studies so that more efficient public health measures can be introduced to target such communities. Lastly, this study is an observational retrospective study based on medical records, which may be subject to selection and information bias.

6. CONCLUSION

Young stroke is on the rise and the burden of IS is common in the elderly, with elderly stroke patients accounting for roughly a third of all healthcare visits with high mortality rates.[50, 51] The rising incidence of individuals with multiple RFs is also a serious public health problem that has gotten a lot of attention in recent years.[52] Our stroke study shows IS patients with different sociodemographic variables may have different RFs that vary in relation to age. The identification of these associations assists in developing more focused stroke prevention initiatives. Tailored public health preventive programmes targeting certain age groups with different sociodemographic backgrounds could be useful to reduce the burden of stroke.

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Supplement:

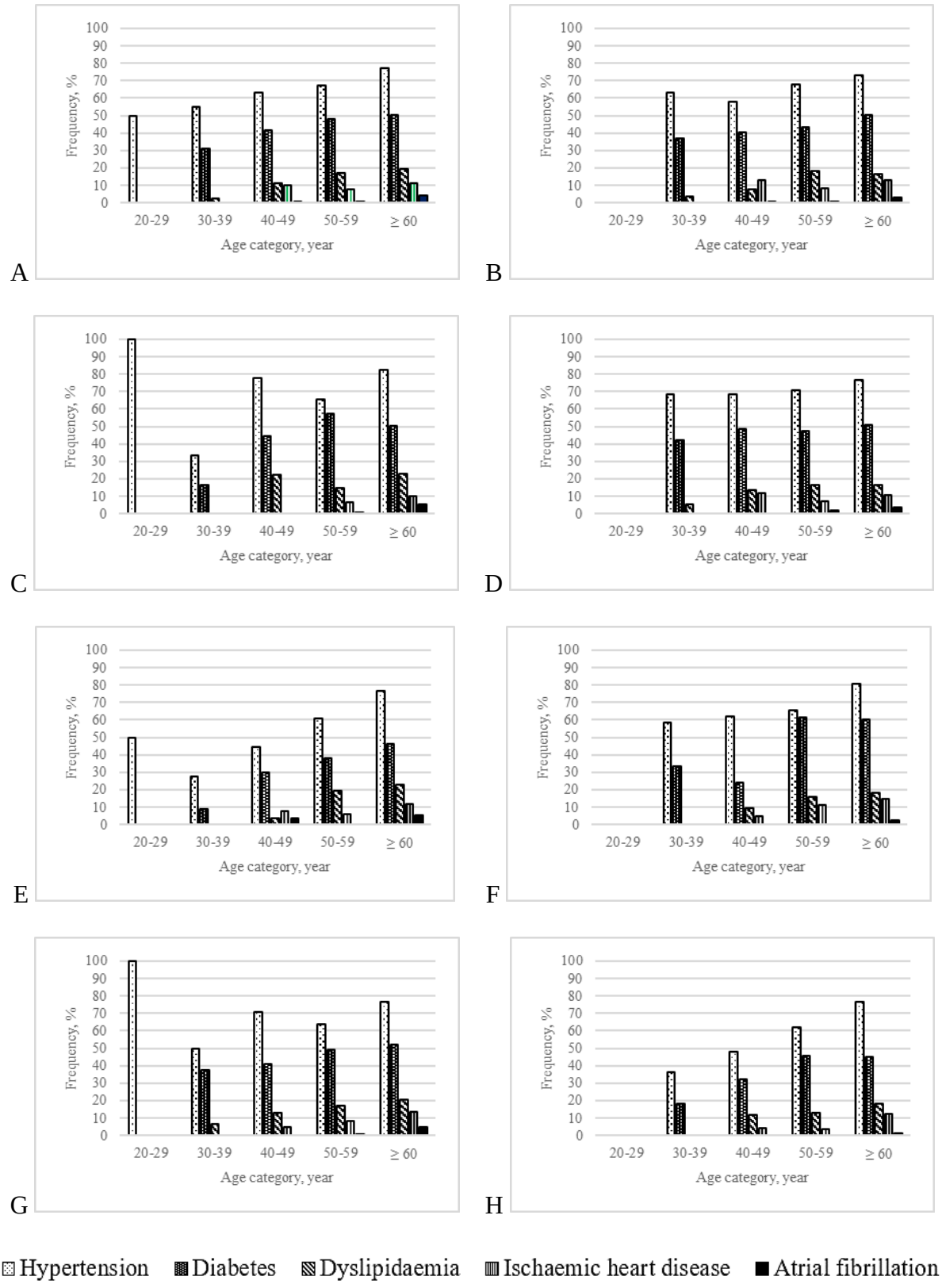

Figure 1: The five major RFs according to age group: (A) overall, (B) male, (C) female, (D) Malay, (E) Chinese, (F) Indian, (G) married, and (H) single.

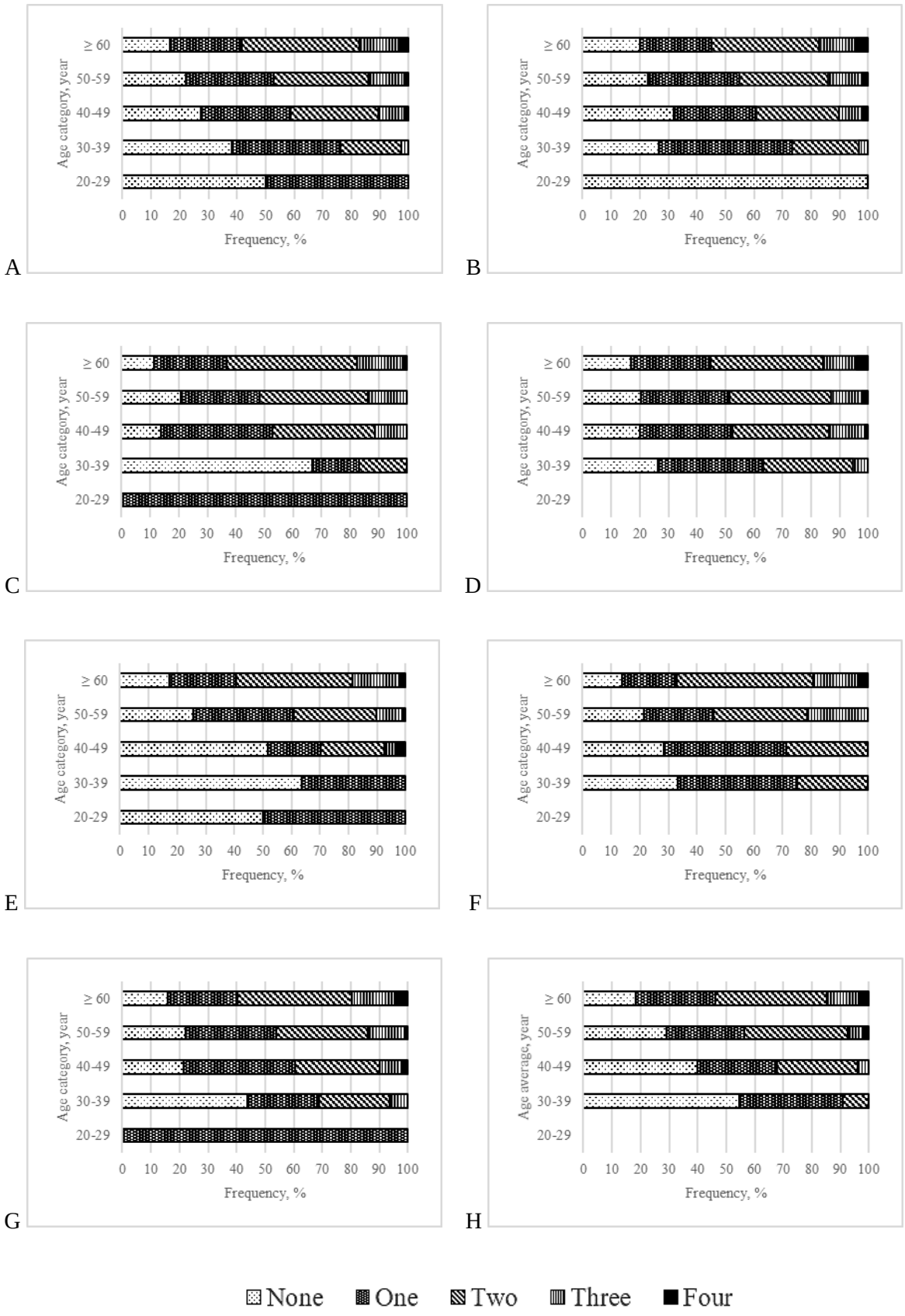

Figure 2: The number of five major RFs according to age group: (A) overall, (B) male, (C) female, (D) Malay, (E) Chinese, (F) Indian, (G) married, and (H) single.

Table 2: Prevalence of number of risk factors by different age groups (in overall sample; in male and female; in Malay, Chinese, and Indian; in married and single patients)

Characteristics	Age groups (years)					Total	P-value
	20-29	30-39	40-49	50-59	≥ 60		
Overall sample, n (%)	**n = 2**	**n = 42**	**n = 143**	**n = 352**	**n = 741**	**1280**	
None	1 (50.0)	16 (38.1)	39 (27.3)	78 (22.2)	123 (16.6)	257 (20.1)	< 0.001
One	1 (50.0)	16 (38.1)	45 (31.5)	108 (30.7)	187 (25.2)	357 (27.9)	
Two	0 (0.0)	9 (21.4)	44 (30.8)	117 (33.2)	303 (40.9)	473 (37.0)	
Three	0 (0.0)	1 (2.4)	13 (9.1)	44 (12.5)	104 (14.0)	162 (12.7)	
Four	0 (0.0)	0 (0.0)	2 (1.4)	5 (1.4)	24 (3.2)	31 (2.4)	
Sex, n (%)							
a) Male (n=815, 63.7%)	**n = 1**	**n = 30**	**n = 107**	**n = 242**	**n = 435**	**n = 815**	
None	1 (100.0)	8 (26.7)	34 (31.8)	55 (22.7)	88 (20.2)	186 (22.8)	< 0.037
One	0 (0.0)	14 (46.7)	31 (29.0)	78 (32.2)	109 (25.1)	232 (28.5)	
Two	0 (0.0)	7 (23.3)	31 (29.0)	75 (31.0)	164 (37.7)	277 (34.0)	
Three	0 (0.0)	1 (3.3)	9 (8.4)	29 (12.0)	55 (12.6)	94 (11.5)	
Four	0 (0.0)	0 (0.0)	2 (1.9)	5 (2.1)	19 (4.4)	26 (3.2)	
b) Female (n=465, 36.3%)	**n = 1**	**n = 12**	**n = 36**	**n = 110**	**n = 306**	**n = 465**	
None	0 (0.0)	8 (66.7)	5 (13.9)	23 (20.9)	35 (11.4)	71 (15.3)	0.005
One	1 (100.0)	2 (16.7)	14 (38.9)	30 (27.3)	78 (25.5)	125 (26.9)	
Two	0 (0.0)	2 (16.7)	13 (36.1)	42 (38.2)	139 (45.4)	196 (42.2)	
Three	0 (0.0)	0 (0.0)	4 (11.1)	15 (13.6)	49 (16.0)	68 (14.6)	
Four	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	5 (1.6)	5 (1.1)	
Ethnic group, n (%)							
a) Malay (n=684, 53.4%)	**n = 0**	**n = 19**	**n = 95**	**n = 185**	**n = 385**	**n = 684**	
None	0 (0.0)	5 (26.3)	19 (20.0)	38 (20.5)	65 (16.9)	127 (18.6)	0.845
One	0 (0.0)	7 (36.8)	31 (32.6)	57 (30.8)	107 (27.8)	202 (29.5)	
Two	0 (0.0)	6 (31.6)	32 (33.7)	66 (35.7)	152 (39.5)	256 (37.4)	
Three	0 (0.0)	1 (5.3)	12 (12.6)	20 (10.8)	46 (11.9)	79 (11.5)	
Four	0 (0.0)	0 (0.0)	1 (1.1)	4 (2.2)	15 (3.9)	20 (2.9)	
b) Chinese (n=405, 31.6%)	**n = 2**	**n = 11**	**n = 27**	**n = 97**	**n = 268**	**n = 405**	
None	1 (50.0)	7 (63.6)	14 (51.9)	25 (25.8)	46 (17.2)	93 (23.0)	< 0.001
One	1 (50.0)	4 (36.4)	5 (18.5)	34 (35.1)	63 (23.5)	107 (26.4)	
Two	0 (0.0)	0 (0.0)	6 (22.2)	28 (28.9)	109 (40.7)	143 (35.3)	
Three	0 (0.0)	0 (0.0)	1 (3.7)	9 (9.3)	44 (16.4)	54 (13.3)	
Four	0 (0.0)	0 (0.0)	1 (3.7)	1 (1.0)	6 (2.2)	8 (2.0)	
c) Indian (n=191, 14.9%)	**n = 0**	**n = 12**	**n = 21**	**n = 70**	**n = 88**	**n = 191**	
None	0 (0.0)	4 (33.3)	6 (28.6)	15 (21.4)	12 (13.6)	37 (19.4)	0.022
One	0 (0.0)	5 (41.7)	9 (42.9)	17 (24.3)	17 (19.3)	48 (25.1)	
Two	0 (0.0)	3 (25.0)	6 (28.6)	23 (32.9)	42 (47.7)	74 (38.7)	
Three	0 (0.0)	0 (0.0)	0 (0.0)	15 (21.4)	14 (15.9)	29 (15.2)	
Four	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (3.4)	3 (1.6)	
Marital status, n (%)							
a) Married (n=620, 78.2%)	**n = 1**	**n = 16**	**n = 61**	**n = 158**	**n = 384**	**n = 620**	
None	0 (0.0)	7 (43.8)	13 (21.3)	35 (22.2)	61 (15.9)	116 (18.7)	0.037
One	1 (100.0)	4 (25.0)	24 (39.3)	50 (31.6)	94 (24.5)	173 (27.9)	
Two	0 (0.0)	4 (25.0)	18 (29.5)	51 (32.3)	154 (40.1)	227 (36.6)	
Three	0 (0.0)	1 (6.3)	5 (8.2)	20 (12.7)	59 (15.4)	85 (13.7)	
Four	0 (0.0)	0 (0.0)	1 (1.6)	2 (1.3)	16 (4.2)	19 (3.1)	
b) Single (n=173, 21.8%)	**n = 0**	**n = 11**	**n = 25**	**n = 55**	**n = 82**	**n = 173**	
None	0 (0.0)	6 (54.5)	10 (40.0)	16 (29.1)	15 (18.3)	47 (27.2)	0.307
One	0 (0.0)	4 (36.4)	7 (28.0)	15 (27.3)	23 (28.0)	49 (28.3)	
Two	0 (0.0)	1 (9.1)	7 (28.0)	20 (36.4)	32 (39.0)	60 (34.7)	
Three	0 (0.0)	0 (0.0)	1 (4.0)	3 (5.5)	9 (11.0)	13 (7.5)	
Four	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.8)	3 (3.7)	4 (2.3)	

STATEMENTS

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Statement of Ethics
This study was registered at the National Medical Research Register and approved by the Medical Research and Ethics Committee, Ministry of Health Malaysia (NMRR-20-1476-55732) and the Committee waived the need for patient consent.

Conflict of Interest Statement
The authors have no conflicts of interest to declare.

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Author Contributions
All authors have approved the final article and authorship is limited to those who have contributed substantially to the work reported. Conceptualisation by HCL, JNK; writing and original draft preparation by HCL, JNK, SNLR; writing, review and editing by HCL, IL; supervision by IL; project administration by HCL.

Data Availability Statement
The data that support the findings of this study are available from the corresponding author upon reasonable request.