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Ischemic Stroke Subtypes: Socio-demographic Factors, Risk Factors, and Outcomes in Southern Sri Lanka

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Background: Stroke is a heterogeneous, catastrophic disease. A comprehensive clinical analysis of ischemic stroke (IS) risk factors and outcomes is crucial for optimum management in resource-poor settings.

Methods: A prospective cross-sectional study of acute cerebrovascular disease (ACVD) involving 592 patients was conducted in a tertiary care center in Sri Lanka from November 2018 to May 2019. We aimed to describe the ACVD subtypes and the relationship of IS subtypes and subtype-categories (as defined by the Oxfordshire Community Stroke Project clinical classification) with risk factors, severity, and outcome.

Results: The majority (63.3%) had IS. Partial anterior circulation syndromes (PACS), total anterior circulation syndrome (TACS), posterior circulation syndromes (POCS), and lacunar syndromes (LACS) accounted for 102 (29.7%), 58 (16.9%), 88 (25.7%) and 95 (27.7%) of the cases, respectively. The most common PACS sub-category was higher-cerebral-dysfunction-with-homonymous-hemianopia (HCD+HH,39 cases;38.2%). Cerebellar-signs-without-long-tract-signs (CS-LTS) sub-category constituted the highest among POCS (47 cases; 53.4%). The leading sub-category within LACS was pure-motor (PM) strokes (43 cases; 45.3%).

Patients aged ≥50 years (adjusted-OR [AOR]2.439; 95%CI,1.163-5.116;P=.018), IHD(AOR 2.520; 95%CI,1.347-4.713; P=.004) and BMI>23kg/m^2(AOR 2.607; 95% CI,1.420-4.784; P=.002) were 2.5 times more likely to associate with TACS. Patients with a history of TIA (AOR 1.910; 95%CI,1.036-3.524; P=.038) and arrhythmias (AOR 5.933; 95%CI,3.294-10.684; P<.001) were 1.9 and 5.9 times more likely to be associated with POCS respectively. Those with hypertension were 2.3 times more likely to associate with LACS (AOR 2.233; 95%CI,1.270-3.926; P=.005).

NIHSS(P<.001), mRS on admission (P=.001) and in 3 months (P<.001), deaths during hospital stay (P=.003) and within 28 days (P<.001) had a stronger relationship with individual stroke subtypes.

Conclusion: The comparative risk of different IS subtypes depends on different risk factors. The findings of this study demonstrate that sub-categories within each stroke subtype may behave independently with regard to risk factors and outcomes, thus warranting the need for individual assessment. *Ethn Dis*. 2021;31(4):509-518; doi:10.18865/ed.31.4.509

Keywords: Stroke Subtypes; OCSP Classification; Hospital-based

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Introduction

Stroke is a heterogeneous disease, which could be catastrophic.[1] Stroke is Sri Lanka's sixth most common cause of mortality and the fifth most common cause of disability-adjusted life years lost. While the exact stroke prevalence in Sri Lanka is not yet known, two community studies have demonstrated a prevalence rate of 10 per 1000 people studied.[2] Resource allocation for stroke prevention and rehabilitation should be based on a scientific representation of up-to-date local data.[3,4]

A comprehensive clinical analysis of socio-demographic and risk factors of ischemic stroke (IS) subtypes and subtype categories is essential for effective utilization of available resources. Although the risk factors of IS are already established, the impact and association of risk factors within each IS subtype and subtype categories are limited.[5] However, risk factors and outcome analysis could reveal unidentified associations within IS subtypes and subtype categories, warranting further analysis.

While studies on lacunar strokes have demonstrated a difference in risk factor association in comparison to non-lacunar strokes, the association of risk factors and outcomes within each lacunar syndrome, to

our knowledge, is yet to be studied.[6] Moreover, studies focused on non-lacunar subtypes are needed.

The outcomes of stroke subtypes have been studied mostly according to the etiological classification of stroke.[7] There are only a few hospital-based studies on the outcomes of stroke subtypes in recent past.[8] To our knowledge, this is the first study that compares outcomes within each stroke subtype category.

The aim of our current study was to describe acute cerebrovascular disease subtypes and the relationship of IS subtypes and subtype categories with risk factors, severity, and outcome…

The aim of our current study was to describe acute cerebrovascular disease (ACVD) subtypes and the relationship of IS subtypes and subtype categories with risk factors, severity, and outcome, based on data from Sri Lanka, a lower-to-middle income country.

Methods

Study Design and Setting

A prospective cross-sectional study was conducted in the Teaching Hospital Karapitiya (THK), the main tertiary care center in the southern Province of Sri Lanka (SL).

Study Participants, Materials and Processes

All adults admitted with ACVD from November 2018 to May 2019 were identified as the study population. Those fulfilling the inclusion criteria with expressed written consent for participation were recruited. Patients with past strokes or disabling neurological conditions were excluded. The study participants were assessed on admission, at 28 days and at 3 months.

We used an interviewer-administered questionnaire in Sinhala, Tamil, and English to gather information on demographics and risk factors. The type of ACVD, transient ischemic attack (TIA), intracerebral hemorrhage (ICH), subarachnoid hemorrhage (SAH), and IS were determined via clinical evaluation and computed tomography (CT) and/or magnetic resonant imaging (MRI) of brain. The Oxfordshire Community Stroke Project (OCSP) clinical classification was used to further classify IS into subtypes as total anterior circulation syndrome (TACS), partial anterior circulation syndromes (PACS), posterior circulation syndromes (POCS) and lacunar syndromes (LACS) as well as to identify categories within each subtype.

The severity assessment of stroke was based on the National Institute of Health Stroke Scale (NIHSS) and Glasgow Coma Scale (GCS). The post-stroke outcomes were assessed via the Modified-Rankin-Scale (mRS) on admission and at 3 months after providing standard care for acute stroke, secondary prevention, and risk factor management according to the Ceylon College of Physicians (CCP) stroke guidelines 2017.[9] Information regarding the outcome was gathered on admission and at 28 days. The questionnaire developed for this study covered all these components.

Socio-demographic factors (age, sex, ethnicity and income), risk factors, including past TIA, hypertension, diabetes mellitus (DM), dyslipidemia, ischemic heart disease (IHD), arrhythmias, smoking, family history of stroke, body mass index (BMI)>23kg/m^2 (South Asian cut off for overweight), severity and outcomes within IS subtypes and subtype categories were analyzed to evaluate specific relationships among variables.

All procedures were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all participants included in the study.

Statistical Analysis

IBM SPSS Statistics, version 23, was used for analysis. Measures of central tendency (mean ± standard deviation or median with interquartile range [IQR], and range) were used to describe continuous variables. Categorical variables were summarized using frequencies and percentages. Statistical tests for evaluation of relationships between variables were selected based on the features of independent and dependent variables. Continuous variables were compared using the ANOVA test. The risk factors of each stroke subtype were evaluated

Table 1. Sociodemographic factors, risk factors, assessment and outcome of ischemic stroke

Variable	N	%
Demographic factors		
Dexterity		
Right	246	71.7
Left	97	28.3
Sex		
Male	203	59.2
Female	140	40.8
Age (years)		
20-29	7	2.0
30-39	9	2.6
40-49	40	11.7
50-59	82	23.9
60-69	134	39.1
70-79	53	15.5
80+	18	5.2
Income		
Low	138	40.2
Middle	151	44.0
High	54	15.7
Ethnicity		
Sinhala	226	65.9
Tamil	69	20.1
Muslim	48	14.0
Risk factors		
Past TIA	67	19.5
Hypertension	228	66.5
Diabetes mellitus	159	46.4
Dyslipidemia	148	43.1
Ischemic heart disease	129	37.6
Arrhythmias	67	19.6
Atrial fibrillation	38	11.1
Other arrhythmias	29	8.5
Smoking	111	32.4
Family history	109	31.8
Body mass index (kg/m^2)		
Overweight or obese(> 23)	143	41.7
Normal or underweight(≤23)	200	58.3
Other risk factors		
Polycythemia	6	1.7
SLE and APLS	2	0.6

Variable	N	%
Assessment		
NIHSS		
1-4, (minor stroke)	38	11.1
5-15, (Moderate stroke)	263	76.7
16-20 (Moderate to severe stroke)	3	.9
21-42, (Severe stroke)	39	11.4
GCS		
13-15(Mild)	234	68.2
9-12(Moderate)	68	19.8
3-8(Severe)	41	12.0
Outcome		
Hospital deaths	14	4.1
Death in 28 days	10	2.9
mRS on admission		
0-2	56	16.3
3	84	24.5
4-6	203	59.2
mRS in 3 months		
0-2	199	58.0
3	108	31.5
4-6	22	6.4

TIA, transient ischemic attack; NIHSS, National Institute of Health Stroke Scale; GCS, Glasgow Coma Scale; mRS, Modified Rankin Scale; SLE and APLS, systemic lupus erythematosus and antiphospholipid syndrome

via odds ratio (OR) and the Pearson Chi-square test. For factors that were found to be risk factors (with OR>1 and 95% CI) and not overlapping the null value (OR=1) in univariate analysis, adjusted-ORs were calculated via a multinomial logistic regression model (multivariable analysis) to adjust for confounders. Multicollinearity between independent variables was explored through the Chi-square test; no significant relationships between variables were found. The comparison of NIHSS, GCS, and mRS in each stroke subtypes was analyzed using the Kruskal-Wallis Test. Fisher's Exact Test was used to compare deaths among each IS subtype.

Risk factors and deaths in each stroke subtype category were analyzed via Pearson Chi-square and Fisher's

Exact tests (when n<5). The Kruskal-Wallis Test was used to analyze clinical assessment (NIHSS and GCS) and outcomes (mRS) of categories of each IS subtype. During the statistical analysis of the individual ischemic stroke subtypes with variables and outcomes, all patients with ischemic stroke not belonging to that particular subtype were taken as the reference group. The analysis was supervised by an experienced statistician in the national epidemiology unit.

Results

Baseline Characteristics

Five-hundred-and-ninety-two patients with ACVD were recruited; of these, 50 (8.4%) had TIA. Of the 542 stroke patients, 343(63.3%), 175 (32.3%), and 24 (4.4%) had IS, ICH and SAH, respectively. The mean age of the IS population was 62.0 years (SD±11.6) and 203 (59.2%) were males. The majority were aged >50 years (n=287;83.7%) and most were Sinhalese (65.9%) and right-handed patients (71.7%). IS was more common among the low- and middle-income population (84.3%) (Table 1).

Among IS patients, PACS was the most common subtype (n=102; 29.7%) while TACS, POCS and LACS accounted for 58(16.9%), 88(25.7%) and 95(27.7%), respectively. Higher cerebral dysfunction with homonymous hemianopia (HCC+HH) was identified as the most common PACS category with 39 (38%) patients, followed by 32 (31%) patients diagnosed with unilateral motor sensory deficit or both affecting at least two of face, arm and leg with homonymous hemianopia (UMS+HH) and 31 (30%) with unilateral motor sensory deficit or both affecting at least two of face arm and leg with higher cerebral dysfunction (UMS+HCD). Among the patients with POCS, 47 (53%) patients had cerebellar signs without long tract signs(CS-LTS), while 22 (25%) patients had brainstem signs or bilateral motor and/or sensory signs (BS/BMS) and 19 (22%) had isolated hemianopia or cortical blindness (IH/CB). Among LACS patients, the most common category was pure motor (PM) with 43 patients, while the least common was dysarthria clumsy hand syndrome (DCHS) found among only 4 patients. (Table 2).

Socio-demographic and Risk Factors, Clinical Severity and Outcome Assessment in IS Subtypes

With regard to risk factors, hypertension (66.5%) was the leading modifiable risk factor, followed

Table 2. Baseline characteristics of the population: Frequencies of types of ACVD, IS subtypes and IS subtype categories

Subtype of acute cerebrovascular disease	n	% (n/N)
Transient ischemic attack (TIA)	50	8.4(50/592)
Stroke patients	542	91.6(542/592)
Intracerebral hemorrhage (ICH)	175	32.3(175/542)
Subarachnoid hemorrhage (SAH)	24	4.4(24/542)
Ischemic strokes (IS)	343	63.3(343/542)
Total anterior circulation syndromes (TACS)	58	16.9(58/343)
Partial anterior circulation syndromes (PACS)	102	29.7(102/343)
1. Unilateral motor, sensory deficit or both affecting at least two of face, arm and leg + higher cerebral dysfunction (UMS+HCD)	31	30.4(31/102)
2. Unilateral motor, sensory deficit or both affecting at least two of face, arm and leg + homonymous hemianopia (UMS+HH)	32	31.4(32/102)
3. Higher cerebral dysfunction + Homonymous hemianopia (HCD+HH)	39	38.2(39/102)
Posterior circulation syndromes (POCS)	88	25.7(88/343)
1. Cerebellar signs without long tract signs (CS-LTS)	47	53.4(47/88)
2. Brain stem signs or bilateral motor and/or sensory signs (BS/BMS)	22	25.0(22/88)
3. Isolated hemianopia or cortical blindness (IH/CB)	19	21.6(19/88)
Lacunar syndromes (LACS)	95	27.7(95/343)
1. Pure motor (PM)	43	45.3(43/95)
2. Pure sensory (PS)	16	16.8(16/95)
3. Mixed sensory motor (MSM)	23	24.2(23/95)
4. Ataxic hemiparesis (AH)	9	9.5(9/95)
5. Dysarthria clumsy hand syndrome (DCHS)	4	4.2(4/95)

Table 3. Relationship of risk factors with ischemic stroke subtype

Risk factor	Stroke subtype										
	TACS, n=58			PACS (n=102)		POCS (n=88)			LACS (n=95)		
	n(%)	OR, P	AOR (CI) P	n(%)	OR, P	n(%)	OR, P	AOR (CI) P	n(%)	OR, P	AOR (CI) P
Sex											
Male	31(53.4)	.754, .33		60(58.8)	.979, .93	47(53.4)	.727,.201		65(68.4)	1.727, .031	1.669 (1.003-2.780) .049
Female	27(46.6)			42(41.2)		41(46.6)			30(31.6)		
Aged ≥50 years	43(74.1)	2.076, .031	2.439 (1.163-5.116) .018	84(82.4)	1.145, .667	71(80.7)	1.326, .379		89(93.7)	1.173, .002	3.502 (1.433-8.558) .006
Past TIA	11(19.0)	.957, .95		17(16.7)	.764, .384	26(29.5)	2.189, .006	1.910 (1.036-3.524) .038	13(13.7)	.570, .091	
HTN	34(58.6)	.665, .165		67(65.7)	.951, .841	52(59.1)	.648, .089		75(78.9)	2.328, .002	2.233 (1.270-3.926) .005
DM	28(48.3)	1.097, .748		53(52.0)	1.378, .176	42(47.7)	1.077, .765		36(37.9)	.620, .052	
DL	32(55.2)	1.793, .043	1.447 (.760-2.756) .261	37(36.3)	.667, .094	46(52.3)	1.643, .045	1.231 (.722-2.098) .445	33(34.7)	.616, .052	
IHD	33(56.9)	2.599, .001	2.520 (1.347-4.713) .004	32(31.4)	.679, .121	34(38.6)	1.060, .818		30(31.6)	.695, .154	
Arrhythmias	12(20.7)	1.091, .808		10(9.8)	.351, .003	39(44.3)	6.453, <.001	5.933 (3.294-10.684) <.001	6(6.3)	.207, <.001	
Smoking	18(31.0)	.929, .813		34(33.3)	1.065, .802	22(17.0)	.622, .087		37(38.9)	1.500, .107	
BMI >23 kg/m^2	36(62.1)	2.722, .001	2.607 (1.420-4.784) .002	35(34.3)	.643, .071	36(40.9)	.958, .863		36(37.9)	.804, .377	
Family history	25(43.1)	1.813, .042	1.199 (.639-2.247) .572	25(24.5)	.607, .06	27(30.7)	.934, .798		32(33.7)	1.128, .639	

TACS, total anterior circulation syndrome; PACS, partial anterior circulation syndromes; POCS, posterior circulation syndromes; LACS, lacunar syndromes; TIA, transient ischemic attacks; HTN, hypertension; DM, diabetes mellitus; DL, dyslipidemia; IHD, ischemic heart disease; BMI, body mass index; CI, confidence Interval; OR, odds ratio; AOR, adjusted odds ratio.

by DM (46.4%), dyslipidemia (43.1%), BMI>23kg/m^2(41.7%), and IHD (37.6%). Of the patients, 111 (32.4%) were smokers while 109 (31.8%) had a family history of stroke. Six patients had polycythemia while 2 had systemic lupus erythematosus and antiphospholipid syndrome (Table 2). One hundred and twenty nine (23.8%) patients were already on aspirin or Clopidogrel, or both, while 47(8.6%) were

Table 4. Sociodemographic factors, assessment and outcome in stroke subtypes

Socio-demographic factors	Classification				Total, N=343	X^2 value (P)
	TACS, n=58	PACS, n=102	POCS, n=88	LACS, n=95		
	n(%)	n(%)	n(%)	n(%)	N (%)	
Income						18.752(.004)
High	12 (20.7)	14 (13.7)	10 (11.4)	18 (18.9)	54 (15.7)	
Middle	33 (56.9)	34 (33.3)	38 (43.2)	46 (48.4)	151 (44.0)	
Low	13 (22.4)	54 (52.9)	40 (45.5)	31 (32.6)	138 (40.2)	
Ethnicity						32.429(<.001)
Sinhala	37 (63.8)	82 (80.4)	41(46.6)	66 (69.5)	226 (65.9)	
Tamil	13 (22.4)	12 (11.8)	22 (25.0)	22 (23.2)	69 (20.1)	
Muslim	8 (13.8)	8 (7.8)	25 (28.4)	7 (7.4)	48 (14.0)	
Assessment and outcome						P
NIHSS on admission median; 1st-3rd quartile	14;13,24	11;8,13	7;7,21	6;1,6		<.001[a]
GCS on admission median; 1st-3rd quartile	14;5,14	14;11,14	11;7,15	15;15,15		<.001[a]
mRS						.001[a]
0-2	(0)	5 (4.9)	31 (35.2)	20 (21.1)		
3	18 (31.0)	38 (37.3)	11 (12.5)	17 (17.9)		
4-5	40 (69.0)	59 (57.8)	46 (52.3)	58 (61.1)		
	TACS, n=53 n(%)	PACS, n=100 n(%)	POCS, n=81 n(%)	LACS, n=95 n(%)		
mRS in 3 months						<.001[a]
0-2	7 (13.2)	63 (63.0)	51 (63.0)	78 (82.1)		
3	35 (66.0)	37 (37.0)	19 (23.5)	17 (17.9)		
4-5	11 (20.8)	0 (0)	11 (13.6)	0 (0)		
	TACS, n=58 n(%)	PACS, n=102 n(%)	POCS, n=88 n(%)	LACS, n=95 n(%)	Fisher's Exact Test value, P	
Hospital deaths	5 (8.6)	2 (2.0)	7 (8.0)	0 (0)	11.953, .003	
	TACS, n=53 n(%)	PACS, n=100 n(%)	POCS, n=81 n(%)	LACS, n=95 n(%)		
Death within 28 days	6 (11.3)	0 (0)	4 (4.8)	0 (0)	16.107, <.001	

a. P value calculated through Kruskal-Wallis Test.
X^2 value, Chi square value; TACS, total anterior circulation syndrome; PACS, partial anterior circulation syndromes; POCS, posterior circulation syndromes; LACS, lacunar syndromes; NIHSS, National Institute of Health Stroke Scale; GCS, Glasgow Coma Scale; mRS, Modified Rankin Scale.

on anticoagulants (data not shown).

Based on the initial analysis, patients ≥50 years (OR 2.076; P=.031), dyslipidemia (OR 1.793; 95%CI,1.015-3.167; P=.043), IHD (OR 2.599; P=.001), BMI≥23kg/m^2(OR 2.722; P=.001) and a family history (OR, 1.813; P=.042) demonstrated a relationship in the events of TACS. However, following multivariate analysis using a multiple logistic regression model (adjusted-OR [AOR]), it was found that only patients ≥50 years (AOR 2.439; 95%CI,1.163-5.116; P=.018), IHD (AOR 2.520; 95%CI,1.347-4.713; P=.004) and BMI≥23kg/m^2 (AOR 2.607; 95%CI,1.420-4.784; P=.002) were approximately 2.5 times likely to suffer from TACS than patients aged <50 years with a BMI <23kg/m^2 without a history of IHD (Table 3).

A relationship in the incidence of POCS was observed among patients with a past TIA (OR, 2.189; P=.006), dyslipidemia (OR 1.643; P=.045) and arrhythmias (OR 6.453; P<.001). Adjusted-OR following multiple logistic regression model revealed that patients with a history of TIA (AOR 1.910; 95% CI,1.036-3.524; P=.038) and arrhythmias (AOR 5.933; 95% CI,3.294-10.684; P<.001) are 1.9 times and 5.9 times more likely to be associated with POCS, respectively, than patients without (Table 3).

Male sex (OR 1.727, P=.031), aged ≥50 years (OR 1.173; P=.002) and hypertension (OR 2.328;

P=.002) were identified as risk factors in patients with LACS. A multiple logistic regression model confirmed that patients with these risk factors were more prone to get LACS than their counterparts. However, hypertension was the only modifiable risk factor, with a risk of 2.3 fold for LACS than a patient without (AOR 2.233; 95%CI,1.270-3.926; P=.005) (Table 3). None of the other risk factors were found to have a relationship with PACS. Interestingly, among socio-demographic factors, income (P=.004) and ethnicity (P<.001) demonstrated a strong relationship within stroke subtypes (Table 4). There was no affiliation of mean age of occurrence in-between each stroke subtype (P=.64).

With regard to the severity assessment, the majority (76.7%) had moderate strokes (NIHSS= 5-15) while 39(11.4%) had severe strokes (NIHSS= 21-42). Assessment of consciousness revealed that 234 (68.2%) had only mild (13-15) GCS impairment while 41(12%) had severe (3-8) GCS impairment (Table 2).

NIHSS values in TACS (median14; IQR 12), PACS (median11; IQR 6), POCS (median 7; IQR 15), and LACS (median 6; IQR 6) were tested using Kruskal-Wallis Test and a strong relationship with NIHSS (P<.001) across different subtypes of IS was evident. GCS in TACS (median14; IQR7), PACS (median14; IQR 4), POCS (median11; IQR9), and LACS (median15; IQR 0) also demonstrated a strong relationship between subtypes of IS (P<.001) (Table 4).

On admission, 203 (59.2%) patients had a mRS of 4-5 and by 3 months, only 22 (6.4%) remained in the mRS 4-6 category (Table 4). Both on admission mRS (P=.001) and 3 month mRS (P<.001) had an affiliation with the stroke subtype (Table 4).

Fourteen (4.1%) patients died during the initial hospital stay (acute period), while another 10 (2.9%) deaths were reported within 28 days (Table 4). Deaths during the hospital stay (P=.003) and within 28 days (P<.001) had a relationship across the stroke subtype, as analyzed via Fisher's Exact Test (Table 4). Deaths during the acute period were similar among patients with TACS (5;8.6%) and POCS (7;8%). Only the TACS(6,11.3%) and POCS(4, 4.8%) subtypes reported deaths after the acute period, but within 28 days. No deaths were reported in the LACS subtype.

On analysis of PACS categories (HCD+HH, UMS+HH and UMS+HCD), events within PACS subtype categories denoted a relationship among smokers (P=.021) and patients with BMI >23kg/m^2 (P=.034). Moreover, both NIHSS and GCS on admission displayed a robust relationship with PACS categories (P<.001). Being aged ≥50 years (P<.001), ethnicity (P=.004), history of TIA(P<.001), hypertension (P<.001), DM (P=.004), BMI>23kg/m^2 (P=.031) and arrhythmias (P<.001) had an association within POCS categories (CS-LTS, BS/BMS and IH/CB). Both NIHSS and GCS in POCS categories revealed a strong relationship (P<.001) with each category. mRS on admission also demonstrated a relationship with each POCS category (P=.036), while mRS in 3 months did not (P=.063). Deaths during the acute period of stroke within hospital stay (P=.012) and within 28 days (P=.004) were found to have a relationship within POCS categories.

The occurrence of different LACS categories (PM, PS, MSM, AH and DCHS) showed an association across age groups (P=.043) and income groups (P<.001). NIHSS and mRS on admission and mRS in 3 months had a robust affiliation within LACS categories (P<.001). Less than 5% of missing values were observed in the items and they were missing at random. The missing values were handled with mean substitution.

Discussion

This study was conducted in the only tertiary care center (Teaching Hospital Karapitiya, THK) in southern Sri Lanka (SL). Acute thrombolysis is the standard treatment for hyperacute IS at THK, while mechanical thrombectomy is yet to be established. THK follows the Ceylon College of Physicians (CCP) stroke guidelines for management of stroke and secondary prevention, together with an excellent rehabilitation program with the support of local and island-wide rehabilitation centers.[9] The Sri Lankan government provides free health care for all Sri Lankan citizens. Stroke management and risk factor modifications are conducted for all patients based on local guidelines. In southern SL, the mean monthly income per person is approximately 82USD and the majority are Sinhalese (95%).[10,11] Economic growth in Sri Lanka following the end of the civil war, along with remarkable improvement in stroke awareness

through various media, and the improvement in overall stroke care can be described as major differences influencing the current study findings compared with 2001, when the stroke subtypes were first studied in SL.[12]

To our knowledge, this is the first Sri Lankan study analyzing TIAs among other types of strokes. Out of all ACVD patients, 8.4% were found to have TIAs. IS accounted for 63.3%, which is less than the findings of similar regional studies.[13] In our study, the majority were found to be anterior circulation strokes (46.6%), while LACS accounted for 27%. This is different from the findings of previous regional studies, where the most common subtype was LACS.[13,14] In the current study, detailed neurological examinations were performed solely by more experienced neurologists and senior registrars in neurology. Moreover, correlation of clinical assessment with imaging was not done, in keeping with the study methodology. These factors may have contributed to a relatively low proportion of LACS compared with other studies.

Regarding overall risk factors, similarly to global data, hypertension was the leading modifiable risk factor.[15]

Regarding overall risk factors, similarly to global data, hypertension was the leading modifiable risk factor.[15] This is the only study in SL to include past TIA as a risk factor without combining it with past stroke. In our study, 19.5% had past TIA. Arrhythmias were identified in 19.6% and this included patients with previously documented uncontrolled arrhythmias as well as patients diagnosed on admission. As arrhythmias may occur either as an etiological factor or as a consequence of stroke, the identification of arrhythmia as a risk factor is challenging.[16,17] In our study, 31.8% had a family history of stroke, making it an area of interest for further evaluation.

In POCS, past history of TIA and arrhythmias had a statistically significant difference. Further analysis of the nature or the involved territory is required to assess whether it involved the same territory as the subsequent stroke. Focused studies regarding the etiology of POCS are needed to postulate a relationship between preceding TIA and POCS.

Based on previous studies, arrhythmias were predictive of anterior circulation strokes.[18] As arrhythmias may occur as a consequence of the stroke as well, it is difficult to draw a conclusion on the etiological relationship. Previous studies have demonstrated a marginal excess of hypertension as a risk factor within LACS when compared with non-LACS, which is consistent with our findings.[19] To our knowledge, risk factors among each subtype categories have not been studied previously. Smoking and BMI>23kg/m^2 within PACS categories, aged ≥50 years, ethnicity, past history of TIA, hypertension, DM, BMI>23kg/m^2 and arrhythmias within POCS categories, and aged ≥50 years and income within LACS categories demonstrated a strong relationship. Further studies are warranted to analyze the exact association of risk factors within each subtype-category.

According to the severity assessment, the majority had moderate strokes (NIHSS 5-15). Large volume infarcts (TACS) and small volume infarcts involving the brainstem and thalami in POCS are shown to be more severe with a poor outcome.[20] This study revealed that LACS are less severe compared with non-LACS, TACS are more severe compared with PACS and the severity of POCS may be highly variable. On analysis of mRS on admission, 58% belonged to the mRS 4-5 category, indicating that LACS, too, may cause significant disability/dependence irrespective of the volume of stroke. Assessment of mRS after 3 months demonstrated an improvement in PACS and LACS patients, compared with TACS and POCS. Within LACS categories, a higher degree of disability was observed in patients who had motor involvement. Studies with a larger number of patients within each category of LACS are required to further explain this observation. In our study, deaths were seen only in non-LACS. Moreover, TACS and POCS subtypes are more vulnerable to death than PACS. Findings regarding subtype categories, risk factors and outcomes warrant further multicenter studies focused on subtype categories.

The most recent studies on strokes are mostly etiology based, involving various forms of advanced imaging, genetics, and other expensive investigations. With that background,

this study is unique as it focuses on proper clinical assessment, which is crucial in a low-resource setting such as ours, where advanced imaging techniques may not be readily available. Findings of this study would be helpful in effective resource allocation for prevention of stroke, rehabilitation, and social services.

Study Limitations

This study mainly focuses on clinical parameters, hence a correlation with imaging was not considered. This describes the risk factors of stroke and subtypes, but not the etiologies. Although THK maintains records on socio-demographic factors, diagnosis and outcome of all admissions, the relationship between different socio-demographic factors and the IS subtypes and outcomes were not analyzed in the current study, as per the study methodology. Although several associations were identified among risk factors and outcomes within stroke subtype categories, the directions of those associations were not studied.

Conclusion

Income and ethnicity demonstrated a strong relationship within stroke subtypes among this patient population from southern SL. Hypertension was identified as the leading overall risk factor. The most common risk factors for TACS were advanced age, IHD, and being overweight or obese, while the most common risk factors for POCS were past TIAs and arrhythmias. Hypertension was found to be the only modifiable risk factor for LACS. Severity and disability assessment demonstrated that NIHSS and mRS scores have a statistically significant difference with the stroke subtypes. Deaths were more common with TACS and POCS. While the analysis of subtype categories identified relationships with a variety of risk factors, further assessment by multi-center local and international studies is required. The current study findings signify that the sub-categories within each stroke subtype may behave independently with regard to risk factors and outcomes in the population of SL, thus warranting a need for further individual assessment.

Conflict of Interest

No conflicts of interest to report.

Author Contributions

Research concept and design: Ambawatte, Weerathunga, Dissanayake, Somaratne, Athukorala, Wijewickrama; Acquisition of data: Ambawatte, Weerathunga; Data analysis and interpretation: Ambawatte, Athukorala, Wijewickrama; Manuscript draft: Ambawatte, Weerathunga, Dissanayake, Somaratne, Wijewickrama; Statistical expertise: Ambawatte, Athukorala, Wijewickrama; Administrative: Ambawatte, Weerathunga, Dissanayake, Athukorala, Wijewickrama; Supervision: Ambawatte, Dissanayake, Somaratne

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