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Research Paper

Evaluation of Homocysteine, Folate, Vitamin B_{12} and Some Haematological Parameters in Stroke Patients Among Ogonis, Rivers State, Nigeria

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ABSTRACT
Stroke is a problematic health concern that induces a dramatic change in the lives of not only individuals afflicted with the disease but also leaves a lasting impact on family members and caregivers. Level of vitamin B_{12} and folate can influence homocysteine levels, therefore, the study was aimed at evaluating homocysteine, folate, vitamin B_{12} and some haematological parameters as a risk factor of stroke among Ogonis in Rivers State. This was a case-control and cross-sectional study carried out among indigenes of Ogoni. A total of 48 subjects within the age of 30 and 60 years were recruited for the study; 24 subjects were first-ever stroke subjects (7 females; 17 males), while 24 subjects were apparently healthy control subjects (7 females; 17 males). Four (4) milliliters of blood were collected using a standard venipuncture technique from each subject. Full blood count was analysed using SYSMEX auto-analyser. Homocysteine, vitamin B_{12} and folate were analysed using ELISA technique. Data generated were analysed using Graph-Pad Prism 8.0.2 version, $p < 0.05$ was considered statistically significant. This study revealed a statistically significant higher mean homocysteine level in cases of stroke as compared to controls. However, there were no statistically significant difference in the mean values of vitamin B_{12} and folate level. The study revealed significant increase in red blood cell count in stroke group as compared to control subjects. There was no statistically significant difference in the mean values of haemoglobin concentration, packed cell volume (PCV), mean cell volume (MCV), mean cell haemoglobin concentration (MCHC), mean cell haemoglobin, total white blood cell count and platelet count ($p > 0.05$). This study also revealed that there was no correlation between homocysteine and Vitamin B_{12}; and vitamin B_{12} and folate. This study demonstrated that higher level of homocysteine is significantly associated with stroke and hyperhomocysteinemia is an independent risk factor of stroke.

KEYWORDS: *Stroke, Homocysteine, Folate, Vitamin B_{12}, Ogoni*

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I. INTRODUCTION

The term ‘stroke’ was coined and introduced to medicine by William Cole in the late 17th century [1], and has remained a generic definition since. Physiologically, stroke is an acute, focal injury of the central nervous system (CNS) of a vascular origin, contributing to a local or systemic neurological insult [2]. Technological advances have proved beneficial in terms of identifying the origins of the injury and determining whether it is a cerebral infarct, subarachnoid haemorrhage or intracerebral bleeding [3]. However, despite these improvements, the definition of stroke remains inconsistent [4].

Stroke is the second-leading single cause of disease in the world, closely behind ischaemic heart disease, and the fourth in the UK, with first-time stroke occurring worldwide every two seconds [5]. It is also

one of the largest causes of disability: half of all stroke survivors have a disability and over one-third are dependent on care givers [6].

Stroke is defined as being a fast development of localized or total signs of cerebral dysfunction with symptoms lasting more than 24 hours, being able to lead to death, without other apparent cause than a vascular one [7]. According to the World Health Organization (WHO), 2016 one person in the world is affected by a stroke every 6 seconds. It is a pandemic whose world incidence projection is nearly 23 million cases in 2030 against 16 million in 2005 [8]. Strokes are, in the industrialized countries, the third cause of mortality after cancers and cardiovascular diseases [9]. In Nigeria, mortality rates are very high with a range of 21% – 45% [10]. 9.3% in Ivory Coast [9]. Stroke constitutes one of the first causes of disability [11] and lasting handicap for the third of survivors [12]. In fact, the occurrence of stroke is at the origin of the motor with issues involving cognitive after-effects, with a decrease in the capacity to make effort, because of the motor deficit whose main causes are confinement, immobility and the breakdown of functional capacities [13].

Stroke is classified broadly into two categories; ischemic stroke and haemorrhagic stroke. Ischemic stroke occurs due to blockage of blood vessel which limits the blood supply to the brain [14], whereas haemorrhagic stroke occurs due to rupture of blood vessel leading to spillage of blood in the intracranial cavity [15]. Depending on the site of blood spillage the haemorrhagic stroke could be classified as intracerebral haemorrhage or subarachnoid haemorrhage. Approximately 60–80% of all strokes is ischemic [16].

Epidemiological studies have identified risk factors for stroke for some years. These are classified into the non-modifiable and the modifiable risk factors. Non-modifiable risk factors for stroke include age, gender, race and familial history [17]. Modifiable risk factors are divided into two groups as definite and indefinite risk factors. Definite risk factors include hypertension, smoking, diabetes mellitus, coronary artery disease, atrial fibrillation, asymptomatic carotis stenosis, sickle cell anaemia, dyslipidemia, postmenopausal hormone treatment and obesity [17]. Indefinite risk factors include metabolic syndrome, alcohol consumption, hyperhomocysteinemia, drug use and dependence, hypercoagulability and use of oral contraceptives [17].

Besides, sociodemographic factors, other biochemical factors such as: rising plasma homocysteine, folate deficiency, vitamin B12 deficiency, including genetic disorders of folate metabolism (677CT polymorphism in MTHFR gene) are being implicated in the possible aetio-pathogenesis of stroke [18].

The evidence for a causal link between homocysteine and stroke has also been strengthened by a meta- analytic study based on the principle of Mendelian randomization [19]. Homocysteine has a multifactorial origin including genetic, nutritional, and metabolic factors [20]. Genetic causes include methylenetetrahydrofolate reductase (MTHFR) gene polymorphism and cystathionine beta synthase, but these remain inherently nonmodifiable, at least in the current era. Nutritional factors of homocysteine include mainly the deficiency of Vitamin B_{12} and also of folate and pyridoxine. Vitamin B_{12} deficiency, by virtue of causing an increase in serum homocysteine levels, may thus also be implicated as a risk factor for stroke. This potentially holds significance as an acquired risk factor for stroke, which is also easily modifiable [20].

Among numerous risk factors for stroke, only two thirds of all strokes can be attributed to known causal risk factors [21]. One of them is elevated serum homocysteine concentration resulting from its metabolic enzyme deficiencies or deficiencies of vitamin B_6, vitamin B_{12} [22]. A number of epidemiological studies have linked folate deficiency and resultant elevated plasma total homocysteine levels with an increased risk of cardiovascular disease and ischemic stroke [23].

Folate and vitamin B_{12}, play an essential role in the metabolism of homocysteine. Insufficient levels of either of these vitamins can lead to increased blood levels of total homocysteine, which has been epidemiologically linked to increased risk of cardiovascular disease [24].

Nearly all the cellular elements in the blood are involved in the pathogenesis of stroke [25]. Regarding white blood cell subtypes, monocytes, lymphocytes and neutrophils have been proposed as potentially better predictors of stroke risk than total white blood cell alone [26]. As for red blood cell count, associations of haematocrit, mean corpuscular volume (MCV) and red blood cell distribution width (RDW) with stroke risk have been reported in a variety of populations [27]. Red blood cell distribution width, a measure of the variability in size of circulating red blood cell commonly used for the diagnosis of anaemia, has recently drawn increased attention as a potential biomarker of stroke risk [28]. Platelets play a crucial role in the pathogenesis of stroke and its treatment through prevention is possible through antiplatelet agents [29]. Antiplatelet agents can suppress the platelet activation and aggregation, thereby eliminating the high atherosclerosis risk of stroke patients. In the event of antiplatelet therapy ceasing, the risk of stroke may rise in high-risk patients [29]. On the other hand, the activation of platelets occurs via vascular subendothelium, collagen, fibrin, tissue factor and shear stress which are stimulants in the blood circulation [29]. Platelets can be affected by various conditions in the circulation and such variations can trigger the cascade of thrombus processes [29]. Platelets generate microparticles which upon activation exhibit various pathophysiologic functions like the initiation and exacerbation of stroke [29].

Most studies focused on patient populations with pre-existing stroke or looked at mortality rather than incidence of stroke. Therefore, more well-characterised and powered studies are needed to help clarify the potential role of blood count components as an inexpensive and routinely assessed set of biomarkers of stroke risk in previously healthy populations. This study seeks to establish possible relationship between serum homocysteine level, folate, vitamin B_{12} and haematological parameters as a risk factor for stroke.

II. MATERIALS AND METHOD

2.1 Study Design

Case-control and cross-sectional study design was adopted on subjects that are "Pure-breed Ogonis" whose maternal and paternal origins are Ogoni. A convenient sample size was used.

2.2 Study Area

The Ogoni ethnic group is found in Rivers State. It comprises majorly of individuals from Khana, Gokana, Tai and Eleme Local Government Areas. In 2001, they were estimated to be 500,000 in population. Ogoni land is located in an area along the Niger Delta Eastern edge, and to the north-east of the Imo Rivers and Port Harcourt city. Ogoni land covers about 1036 Sq Km and borders the Bay of Guinea. It is a land of aggressive oil exploration that has resulted to severe environmental pollution. Bori is the traditional headquarters of Ogoni, the administrative headquarters of Khana local government area and sample collection was carried out in Bori.

2.3 Study Population

This study was carried out among adults of Ogoni ethnic group. A total of 48 subjects were recruited for the study. Twenty-four (24) subjects were first ever stroke subjects (9 females and 17 males) of age between 30 and 60 years and 24 were apparently healthy control subjects of age between 30 and 60 years.

2.4 Collection of Blood Samples, Storage and Transportation

A total of 4 mls of venous blood was drawn from antecubital fossa of the subject with the use of vacutainer. Two millitres was collected into a glass vacutainer sample bottle that contains 0.5ml of 1.2mg/ml dipotassium ethylene diamine tetra-acetic acid (EDTA) and was mixed thoroughly for the estimation of full blood count. Two milliliters of the venous blood was also drawn into a plastic non-anticoagulated (plain) sample bottle for the analysis of homocysteine, folate and vitamin B_{12}. Blood samples collected in dipotassium ethylene diamine tetra-acetic acid were analysed within 24 hours of collection for the estimation of full blood count. Blood samples that were collected in plain non-anticoagulated vacutainer bottles were allowed to clot over time, the serum was obtained by centrifugal separation and introduced into another sterile clean plain bottle and stored at freezing temperature for the analysis of homocysteine, folate and vitamin B_{12}. Blood samples collected were all transported under cold chain from Bori (site of collection) to Port Harcourt where the samples were analysed.

2.5 Methodologies

2.5.1 Determination of Full Blood Count Using SYSMEX Kx-21n Automated Analyser, Kobe, Japan.

The procedure is such that the sample for analysis is mixed using vortex mixer. The lid of the sample container is opened and the sample fed into the Sysmex auto-analyser via a probe. On board of the analyzer, the sample is agitated to evenly distribute the cells, then diluted and partitioned into two channels, one of which is to count red blood cells and platelets, the other to count white blood cells and determine the haemoglobin concentration. The cells are suspended in a fluid stream and their properties are measured as they flow past sensors in a technique known as cytometry. The sensors count and identify the cells in the sample using two main principles: electrical impedance and light scattering. The results of the analysis are displayed at the read-out screen which can be printed out.

2.5.2 Determination of homocysteine, vitamin B12, and folate using homocysteine, vitamin B_{12} and folate ELISA kits

Homocysteine, vitamin B_{12} and folate were analysed using ELISA machine (STAT FAX-2100 Awareness Technology Inc) using vitamin B_{12}, folate ELISA kit by Calbiotech, El Cajon, CA 92020 U.S.A. and homocyeteine ELISA kit by Junjiang Inter, Shanghai, China. All the ELISA kits utilized sandwich-ELISA methodology.

2.6 Statistical analysis

The generated data were analyzed using Graph-pad prism 8.0.2.263 version. A p-value of <0.05 were considered to be statistically significant. Results were presented in tables as means ± standard deviation (M±SD).

III. RESULTS

A total of 48 individuals (24 individuals diagnosed with stroke, and 24 individuals that were apparently healthy, and without stroke), were recruited for the study. The age range for individuals with stroke was between 30years and 60years, while the age range of those used as control and without stroke was between 30years to 60years. For individuals with stroke, females were 7 while males were 17. Those without stroke were made up of 7 females and 17 males. Majority of stroke patients were males (71%). Details of the demographic characteristics of the study population are shown in Table 1

Table 2 showed the comparison of (Mean ± SD) of vitamin B_{12}, folate, homocysteine and some haematological parameters of subjects with stroke and apparently healthy control subjects. There were no statistically significant difference in the mean values of vitamin B_{12}, folate, haemoglobin concentration, packed cell volume (PCV), mean cell volume (MCV), mean cell haemoglobin concentration (MCHC), mean cell haemoglobin (MCH), total white blood cell count (TWBC), and platelet count. Whereas there was statistically significant difference in the mean values of homocysteine and red blood cell count when stroke subjects were compared against the control subjects.

Table 3 highlighted comparison of (Mean ± SD) of folate, vitamin B12, homocysteine and some haematological parameters in female stroke subjects and apparently female control subjects using student t-test. There was significant difference in some of the parameters analysed, which includes, homocysteine with p-value of 0.0035 and red blood cell with p-value of 0.0050 and they were considered to be very significant. Packed cell volume with p-value of 0.0148, haemoglobin concentration with p-value of 0.0331 and white blood cell with p-value of 0.0298 which were considered to be statistically significant. There was no statistically significant difference in the mean values of vitamin B_{12}, folate, mean cell volume, mean cell haemoglobin concentration, mean cell haemoglobin and platelet in stoke female patients all with p-value > 0.05.

Table 4 showed comparison of (Mean ± SD) of folate, vitamin B12, homocysteine and haematological parameters in male stroke subjects and apparently healthy male control subjects using student t-test. There were no statistically significant difference in all the parameters analyzed in stoke male patients and male control group all with p-value > 0.05.

Table 5 highlighted correlation between homocysteine and the other parameters (folate and vitamin B12). tudy revealed that there was no correlation between homocysteine and the other parameters (folate and vitamin B12).

Table 1: Demographic Details of Participants in the Study

Parameters	Stroke Group (N=24)	Control Group (N=24)
Number of Females	7	7
Number of Males	17	17
Age Range (Years)	30-60	30-60

Table 2: Comparison of (Mean ± SD) of Vitamin B_{12}, Folate, Homocysteine and some Haematological Parameters in the Study Population.

Parameters (Units)	Test (M ± SD)	Control (M ± SD)	p-value	Remark
Vitamin B_{12} (pg/ml)	224.9 ± 178.7	210.8 ± 121.7	0.7383	NS
Folate (ng/ml)	6.9 ± 6.6	9.1 ± 6.4	0.2298	NS
Homocysteine (nmol/ml)	21.8 ± 7.5	16.3 ± 9.2	0.0220	S
RBC ($x10^{12}$)	4.8 ± 0.5	4.5 ± 0.5	0.0135	S
PCV (%)	39.4 ± 3.3	37.5 ± 4.2	0.0936	NS
HB (g/dl)	12.5 ± 1.0	11.9 ± 1.6	0.1406	NS
MCHC (g/dl)	31.7 ± 1.2	31.6 ± 2.1	0.8191	NS
MCH (pg)	30.1 ± 3.3	28.3 ± 3.9	0.0745	NS
MCV (fl)	81.2 ± 5.1	83.5 ± 4.4	0.0864	NS
WBC ($x10^9$)	8.1 ± 8.0	6.0 ± 1.9	0.1757	NS
Platelets ($x10^9$)	182.4 ± 46.4	200.8 ± 98.6	0.4067	NS

Key: M= Mean; SD= Standard Deviation; S=Significant; NS= Non Significant

Table 3: Comparison of (Mean ± SD) Vitamin B_{12}, Folate, Homocysteine and Some Haematological Parameters in Female Stroke Subjects and Apparently Healthy Female Control Subjects.

Parameters (Units)	Test (M ± SD)	Control (M ± SD)	p-value	Remark
Vitamin B_{12} (pg/ml)	218.2 ± 149.5	262.6 ± 101.5	0.4622	NS
Folate (ng/ml)	11.2 ± 10.7	9.8 ± 6.6	0.7296	NS
Homocysteine (nmol/ml)	22.4 ± 5.4	12.0 ± 7.5	0.0035	VS
RBC ($x10^{12}$)	4.9 ± 0.4	4.2 ± 0.4	0.0050	VS
PCV (%)	40.0 ± 3.6	36.0 ± 2.5	0.0148	S
HB (g/dl)	12.6 ± 1.2	11.4 ± 1.0	0.0331	S
MCHC (g/dl)	31.6 ± 0.8	31.7 ± 2.2	0.9637	NS

MCH (pg)	25.5 ± 2.4	26.89 ± 2.4	0.2828	NS
MCV (fl)	80.6 ± 6.3	84.7 ± 3.4	0.0882	NS
WBC ($x10^9$)	7.3 ± 2.3	5.1 ± 1.5	0.0298	S
Platelets ($x10^9$)	180.1 ± 14.1	146.4 ± 49.6	0.1016	NS

Key: M= Mean; SD= Standard Deviation; S=Significant; NS= Non Significant; Very Significant

Table 4: Comparison of (Mean ± SD) Vitamin B_{12}, Folate, Homocysteine and Some Haematological Parameters in Male Stroke Subjects and Apparently Healthy Male Control Subjects.

Parameters (Units)	Test (M ± SD)	Control (M ± SD)	p-value	Remark
Vitamin B_{12} (pg/ml)	227.7 ± 193.6	142.9 ± 120.1	0.1346	NS
Folate (ng/ml)	5.2 ± 2.9	6.5 ± 4.2	0.2788	NS
Homocysteine (nmol/ml)	18.0 ± 9.4	22.3 ± 8.6	0.1781	NS
RBC ($x10^{12}$)	4.8 ± 0.5	4.7 ± 0.4	0.6510	NS
PCV (%)	39.5 ± 3.2	39.6 ± 3.0	0.9872	NS
HB (g/dl)	12.6 ± 1.0	12.8 ± 1.0	0.5833	NS
MCHC (g/dl)	31.9 ± 1.4	32.3 ± 1.2	0.3089	NS
MCH (pg)	31.9 ± 1.4	31.8 ± 1.8	0.8692	NS
MCV (fl)	81.8 ± 4.7	83.0 ± 4.4	0.4437	NS
WBC ($x10^9$)	8.4 ± 9.4	6.1 ± 2.0	0.3186	NS
Platelets ($x10^9$)	178.4 ± 52.8	205.6 ± 55.2	0.1527	NS

Key: M= Mean; SD= Standard Deviation; NS= Non Significant

Table 5 Correlation of Homocysteine, Folate and Vitamin B12 in Stroke Subjects.

Parameters	Correlation	Correlation
Homocysteine	Homocysteine/Vitamin B_{12}	Homocysteine/Folate
	r = 0.028; p-value = 0.897	r = 0.215; p-value = 0.313
Vitamin B_{12}	Vitamin B_{12}/ Homocysteine	Vitamin B_{12}/Folate
	r = 0.028; p-value = 0.897	r = 0.088; p-value = 0.684
Folate	Folate/Vitamin B_{12}	Folate/Homocysteine
	r = 0.088; p-value = 0.684	r = 0.215; p-value = 0.313

IV. DISCUSSION

This study was carried out on stroke subjects who had recovered but are still being managed by a Physician and apparently healthy subjects which served as controls. This study revealed a statistically significant higher mean ± SD homocysteine level in cases of stroke as compared to controls with mean values of homocysteine. Elevated level of homocysteine observed in stroke patients may be as a result of high dietary intake of diet rich in methionine, impaired homocysteine metabolism or defect in crucial co-factors (vitamin B_{12} and folate) that participate in homocysteine metabolism. This result supported the work of Kumawat *et al.* [30] in which there was significant difference in serum homocysteine in stroke patients as against the control. This work is also in agreement with that of Ashjazadeh *et al.* [31] This finding is also in agreement with the work by Narang *et al.* [32]; Biswas *et al.* [33]. The work of Rahman, *et al.* [34] opposed this result as it did not show statistically significant differences between stroke patients and control group.

Some studies suggest that vitamin B_{12} plays an important role in reducing homocysteine level He *et al.* [35]. This work revealed that there was no statistically significant difference in the mean values of vitamin B_{12}. This result is in agreement with the work of Osunkalu *et al.* [36] in which the mean value of serum vitamin B_{12} was higher in patients with stroke than in the normal subjects but not in agreement with the work of Suleiman *et al.* [37] in which the means of serum vitamin B_{12} in cases was significantly lower than that of their age-matched controls from the same population. The study carried out by Kocer *et al.* [38] also opposed the result of this study since there is statistical difference in serum level of vitamin B_{12} in stroke patient and the control group. Several other studies have also demonstrated the low levels of vitamin B_{12} in stroke patients (Van Oijen *et al.* [39]; Weikert *et al.* [40]).

Serum folate level from the study showed no significant differences between case and control group. Several studies have demonstrated the low levels of serum folate in stroke patient as compared with the control and the work of Hasan *et al.* [41] opposed this. The work of Jyothi *et al.* [42] also showed a statistically significant difference between the stroke patients and control. The work of Mehdi *et al.* [43] was not also in agreement with the result of this work. Their work has mean serum level of folate in stroke cases significantly lower than the controls.

It was demonstrated in this study that red blood cell count level was significantly increased in stroke group as compared to control subjects. A significant increase in red blood cells can thicken the blood and make it clot quickly, this raises the risk for stroke. This finding is in agreement with the recent work of Sharif *et al.*

[44] but not in agreement with the work of Christian *et al.* [45] where they concluded that there was no significant difference in red blood cell count of stroke patients and the control group.

Packed cell volume is one of the most important determinants of whole blood viscosity and increased blood viscosity has been reported to contribute immensely to blood pressure increase which is a major risk factor for most cardiovascular diseases Strand *et al.* [46]. In this study, it was observed that packed cell volume showed no significant difference between the stroke group and the control group. The values in both groups were within the normal range of individuals in the locality of study and this may be as a result of their dietary intake and the haematinic medications they were placed on. This finding is in agreement with the work of Christian *et al.* [45] but in contrast to the work of Akinola and Asaolu, [47] which showed that there was a significant difference in packed cell volume of the stroke patients and the control group.

The haemoglobin levels in stroke group were within the normal range and there was no statistically significant difference in the values of those in the control group upon comparison. The normal levels of haemoglobin in stroke group observed may be as a result of the haematinics most of them have been taking; as the medication is usually included in their prescribed drugs. The findings agree with a study by Christian *et al.* [45] but disagrees with that that of Sharif *et al.* [44].

From this study there was no significant difference in red blood cell indices which include mean cell volume, mean cell haemoglobin concentration and mean cell haemoglobin. The values of the results in both groups were all within the normal ranges and this is because none of the patients were anaemic from the clinical diagnosis seen during their recruitment into the study. This result is in agreement with the work of Christian *et al.* [45] but not in agreement with the work of Sharif *et al*. [44].

It was demonstrated in this study that there was no significant difference between white blood cell count of stroke patients and control group. This is in agreement with the work of Bakhshayesh-Eghbali *et al.* [48]; Christian *et al.* [45] but in contrast with the work by Furlan *et al.* [49]; Kazmierski *et al.* [50] and Sharif *et al.* [44] where statistical significant difference were recorded in stroke patients when compare with the control group.

This study reported no significant difference in Platelet count in stroke patients compared to the control group. This is in agreement with the work of Fujii *et al.* [51] which showed significant difference in platelet count of stroke patients as compared to the control group. This contradicts however the findings of Sharif *et al.* [44] and that of Akinola and Asaolu [47] which revealed significant differences between the platelet count of stroke patients as compared with the control group.

The comparison of homocysteine, folate, vitamin B_{12} and haematological parameters in male patients versus male control group; and female patients versus female control group in this study revealed a statistically significant increase in mean homocysteine levels of female with no significant difference in homocysteine level of male stroke subjects as compared to male control group. A previous study by (Bostom *et al.* 1999) had shown no significant difference in sex prevalence of homocysteinaemia. Red blood cell count, packed cell volume, haemoglobin and white blood cell count in female stroke patients and female control group showed a significant difference as opposed to the male stroke patients which revealed no significant differences when compared with male control group. The significant differences in haematological parameters in females was as a result of the normal differences observed in the reference ranges in these parameters for healthy population.

The comparison of folate, vitamin B_{12}, in both female and male stroke patients revealed that there was no statistically significant difference in folate and vitamin B_{12} when compared with female and male control groups respectively. Also, the comparison of mean cell volume, mean cell haemoglobin concentration, mean cell haemoglobin and platelet count in both female and male stroke patients showed no statistically significant difference in these parameters. The values of the results in both female and male stroke patients were all within the normal range and this is because none of the subjects were anaemic. This is in agreement with the work of Christian *et al.* [45].

The result of this work showed that serum homocysteine had insignificant correlation with vitamin B_{12} and folate. This finding is in contrast to work of Jyothi *et al.* [42] which demonstrated a strong correlation among the three parameters. This may be due to their dietary intake and the medication they were placed on.

V. CONCLUSION

This study demonstrated that higher level of homocysteine is significantly associated with stroke and hyperhomocysteinemia is an independent risk factor of stroke. Homocysteine which manifested as an elevated plasma level of homocysteine can therefore be recognized as risk factor for stroke. However, this view needs to be supported by prospective studies investigating the relation between homocysteine, folate, vitamin B_{12} levels, haematological parameters and risk of stroke to assess if serum levels of homocysteine, folate, vitamin B_{12} and haematological indices can be used as a predictor or risk marker for stroke.

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