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Carotid atherosclerosis in a sample of Egyptian patients with or without ischemic vascular events

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Abstract

Background Ethnic-racial factors are related to the development of extra- and intracranial atherosclerosis. There are extensive data about carotid atherosclerosis from American, European and Asian population. However, data from Egyptian ethnics are extremely rare. We aimed to examine the frequency and determine the predictors of carotid atherosclerosis in a sample of Egyptian patients. In a cross-sectional observational study, we prospectively recruited consecutive patients, with or without ischemic vascular events, either ischemic stroke or transient ischemic attack, who received neurovascular ultrasound in a tertiary hospital. We assessed the presence of carotid plaques and the degree of stenosis according to the hemodynamic North American Symptomatic Carotid Endarterectomy Trial (NASCET) criteria.

Results A total of 668 carotid arteries in 334 patients with a mean (IQR) age of 61 (55–70) years were examined; 69.5% presented with and 30.5% without ischemic vascular events. We found carotid plaques in 208 (31.1%) arteries among 147 (44%) patients; 32% of the patients showed non-hemodynamically significant plaques, whereas 3.6% showed 20–40% internal carotid artery (ICA) stenosis and 8.4% showed $\geq$ 50% ICA stenosis. In patients with ischemic vascular events and at least one risk factor, we detected carotid atherosclerosis, 20–40% ICA stenosis and $\geq$ 50% ICA stenosis in 40.4%, 3% and 9.1% among patients $\leq$ 60 years as well as in 64.8%, 5.5% and 13% among patients > 60 years, respectively. In an age and sex adjusted binary logistic regression model, the following factors predicted carotid atherosclerosis: age > 60 years (OR 3.33, 95% CI 1.99–5.57, $p < 0.001$), hypertension (OR 2.3, 95% CI 1.32–4.02, $p = 0.003$), current smoking (OR 2.27, 95% CI 1.13–4.55, $p = 0.02$), diabetes mellitus (OR 2.15, 95% CI 1.27–3.64, $p = 0.004$) and ischemic vascular events (OR 1.8, 95% CI 1.01–3.19, $p = 0.046$).

Conclusions Among Egyptians, the frequency of carotid atherosclerosis seems to be low. Further multiethnic studies are warranted to compare the prevalence of carotid atherosclerosis among Egyptians with Whites and Chinese populations. Older age, hypertension, smoking, diabetes mellitus and ischemic vascular events are predictors of carotid atherosclerosis.

Keywords Carotid plaque, Carotid stenosis, Ischemic stroke, Transient ischemic attack, Epidemiology

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Introduction

Carotid artery disease is the underlying etiology of a significant proportion of stroke patients [1–3]. The prevalence of carotid atherosclerosis differs among different races [4]. Epidemiological studies revealed that the incidence of stroke is higher among blacks [5–7] and Hispanics [7] than among whites. Moreover, intracranial atherosclerosis is higher among blacks [8, 9] and Asians

[9]. Conversely, several studies reported that carotid atherosclerosis is more common among whites than among blacks [10–12] and even more severe stenotic grades are more predominant among whites [11, 12]. Data from Egypt in this regard are scarce [13].

Screening for carotid atherosclerosis is not recommended in the general population [14]. However, screening for carotid atherosclerosis was found to be cost-effective to reduce the stroke burden in special populations with a prevalence of ≥ 20% for significant carotid stenosis [15]. Specifically, the society of vascular surgery (SVS) recommends ultrasound carotid screening for elderly asymptomatic patients with cardiovascular risk factors [16].

In a prospective observational study, we aimed to examine the frequency and predictors of carotid atherosclerosis in a sample of Egyptian patients.

Methods

We conducted a cross-sectional single center observational study according to the STROBE guidelines [17]. Data were prospectively collected from all patients who received qualified neurovascular ultrasound examination in the period from September 2020 to August 2022 for any indication in the department of Neurology, University Hospital of Alexandria and affiliated hospitals. We excluded patients with insufficient assessment, for example due to excessive motility or the presence of central venous line hindering accurate visualization of the carotid arteries.

Patients presented to our ultrasound laboratory for the following indications: 1. Ischemic stroke (n = 216, 64.7%), 2. TIA (n = 16, 4.8%), 3. Dizziness and/or vertigo (n = 49, 14.7%), 4. Suspicion of vasculitis (n = 23, 6.9%), 5. Headache (n = 7, 2.1%), 6. Syncope or drop attacks (n = 6, 1.8%), 7. Dementia or confusion (n = 5, 1.5%), 8. Pulsatile tinnitus (n = 2, 0.6%), 9. Subarachnoid hemorrhage (n = 2, 0.6%), 10. Suspicion of subclavian steal (n = 2, 0.6%), 11. Suspicion of carotid dissection (n = 1, 0.3%), 12. Advanced cerebral microangiopathy (n = 1, 0.3%), 13. Gait disturbance of unclear etiology (n = 1, 0.3%), 14. Unclear neurological deficits (n = 1, 0.3%), 15. Assessment for large atrial septal defect (n = 1, 0.3%) and 16. Subjective feeling of weakness (n = 1, 0.3%).

We conducted ultrasound examination of proximal and distal common carotid artery, proximal external carotid artery as well as proximal and distal internal carotid artery (ICA) in the B-mode followed by color-coded mode. We used the following ultrasound machines: GE Vivid T8 (GE Healthcare, Chicago, Illinois, USA) using a 3.5–10 MHz linear array probe, GE Vivid S6 (GE Healthcare, Chicago, Illinois, USA) using a 4–13 MHz linear array probe and Philips ClearVue 350 (Philips HealthCare, Best, Netherlands) using 4–12 MHz linear array probe.

The plaque was defined according to the Mannheim Carotid Intima–Media Thickness and Plaque Consensus as a focal structure in the vessel wall of at least 1.5 mm thickness with protrusion into the vascular lumen [18]. The degree of stenosis was calculated using the hemodynamic North American Symptomatic Carotid Endarterectomy Trial (NASCET) criteria [19].

Ischemic vascular events were defined as the presence of either ischemic stroke or transient ischemic attack (TIA). We diagnosed ischemic stroke according to the criteria of the American Heart Association/American Stroke Association (AHA/ASA); acute onset focal neurological deficits with evidence of acute brain infarction in the neuroimaging [20]. Hypertension was defined as persistent elevation of blood pressure ≥ 140/90 mmHg or current use of antihypertensive medications [21]. Diabetes was diagnosed according to the following criteria: 1) Hemoglobin A1c ≥ 6.5%, 2) Fasting blood sugar ≥ 126 mg/dl, or 3) current use of antidiabetic medications [22]. Patients were classified as current smokers if they regularly smoked within the previous 12 months.

We conducted a test of normality using the Shapiro–Wilk test and histograms. To describe quantitative data, we used the median and interquartile range. For qualitative data, we used absolute values and percentages. Categorial data were statistically analyzed using the $\chi 2$ test, while continuous data were expressed using the Mann–Whitney-U-test. We conducted a univariate binary logistic regression analysis to test for the strength of association between our variables and the development of atherosclerosis as an outcome. Variables with $p < 0.1$ in the univariate regression analysis were further included in an age and sex adjusted multivariate regression analysis. To test our model for the goodness of fit, we used the Hosmer–Lemeshow test. P-values < 0.05 were considered statistically significant. Data were analyzed using SPSS software version 25.

Results

A total of 668 carotid arteries in 334 patients were examined. The baseline characteristics of patients with or without atherosclerosis are shown in Table 1. Atherosclerosis was observed in 208 (31.14%) arteries in 147 (44%) patients; 158 (23.7%) arteries showed non-hemodynamically significant carotid plaques, whereas 14 arteries (2.1%) showed 20–40% ICA stenosis, 4 (0.6%) with 50% ICA stenosis, 2 (0.3%) with 60% ICA stenosis, 5 (0.7%) with 70% ICA stenosis, 4 (0.6%) with 80% ICA stenosis, 10 (1.5%) with 90% ICA stenosis and 7 (1%) with ICA occlusion. Three patients showed atherosclerosis in the external carotid artery and one patient had already

Table 1 Baseline characteristics of patients with or without atherosclerosis

	Atherosclerosis (n = 147, 44%)	No atherosclerosis (n = 187, 56%)	Total (n = 334)	p-value
Age, median (IQR)	66 (60–73)	58 (45–65)	61 (55–70)	< 0.001*
Male sex, n (%)	88 (59.5%)	107 (57.5%)	195 (58.4%)	0.72
Diabetes mellitus, n (%)	82 (55.8%)	58 (31.5%)	140 (42.3%)	< 0.001*
Hypertension	115 (78.2%)	93 (50.5%)	208 (62.8%)	< 0.001*
Current smoking	59 (43.4%)	63 (35.8%)	122 (39.1%)	0.17
Diagnosis				
Ischemic vascular events	118 (79.7%)	114 (61.3%)	232 (69.5%)	
Dizziness and/or vertigo	17 (11.5%)	32 (17.2%)	49 (14.7%)	0.04*†
Headache or suspected vasculitis	8 (5.4%)	22 (11.8%)	30 (9%)	0.01*†
Others††	5 (3.4%)	18 (9.7%)	23 (6.9%)	0.008*†

* Statistically significant results

† Statistical analysis in comparison to ischemic vascular events

†† Other diagnoses were syncope or drop attacks, dementia or confusion, pulsatile tinnitus, subarachnoid hemorrhage, suspicion of subclavian steal, suspicion of carotid dissection, advanced cerebral microangiopathy, gait disturbance of unclear etiology, unclear neurological deficits, assessment for large atrial septal defect, subjective feeling of weakness

stenting of the ICA following atherosclerotic stenosis before the inclusion in our study.

Patients with atherosclerosis were older in age; median (IQR) 66 (60–73) years versus 58 (45–65) in non-atherosclerotic patients, p < 0.001. In patients ≤ 60 years without any risk factors (hypertension, diabetes mellitus, current smoking or ischemic vascular events), carotid atherosclerosis was present among 3/27 of the patients (11.1%); of those 3 patients, only one (3.7%) had 70% ICA stenosis. In absence of ischemic vascular events and the presence of at least one of the aforementioned risk factors, we found non-hemodynamically significant carotid atherosclerosis, 20–40% ICA stenosis and ≥ 50% ICA stenosis in 3/24 (12.5%), 0/24 (0%) and 1/24 (4.2%) among patients ≤ 60 years as well as in 19/41 (46.3%), 0/41 (0%) and 2/41 (4.9%) among patients > 60 years, respectively.

Table 2 Baseline characteristics of patients with or without ischemic vascular events

	Ischemic vascular events (n = 232)	No ischemic vascular events (n = 102)	Total (n = 334)	p-value
Age, median (IQR)	62 (56–70)	60 (48–69)	61 (55–70)	0.06
Male sex, n (%)	145 (62.5%)	50 (49%)	195 (58.4%)	0.02*
Diabetes mellitus, n (%)	109 (47.2%)	31 (31%)	140 (42.3%)	0.006*
Hypertension	159 (68.8%)	49 (49%)	208 (62.8%)	0.001*
Current smoking	98 (45.6%)	24 (24.7%)	122 (39.1%)	< 0.001*
Atherosclerosis	118 (50.9%)	30 (29.4%)	148 (44.3%)	< 0.001*
Degree of stenosis (more stenotic side)				0.001*
10%	83 (35.8%)	24 (23.5%)	107 (32%)	
20–40%	12 (5.2%)	0	12 (3.6%)	
50%	4 (1.7%)	0	4 (1.2%)	
60%	1 (0.4%)	1 (1%)	2 (0.6%)	
70%	2 (0.9%)	2 (2%)	4 (1.2%)	
80%	2 (0.9%)	2 (2%)	4 (1.2%)	
90%	7 (3%)	0	7 (2.1%)	
Occlusion	7 (3%)	0	7 (2.1%)	

N.B. 3 patients had stenosis in the external carotid artery, those are included under the row of atherosclerosis but not under the degree of stenosis. Two patients had carotid dissection with stenosis of 50% in one of them and occlusion in the other one. Those patients were not included under the category of atherosclerosis

NASCET North American Symptomatic Carotid Endarterectomy Trial

* Statistically significant results

Table 3 Baseline characteristics of patients according to the age

	≤ 45 years (n = 47)		46–60 years (n = 117)		61–70 years (n = 97)		≥ 70 years (n = 73)	
	Isch (n = 24)	No Isch (n = 23)	Isch (n = 87)	No Isch (n = 30)	Isch (n = 68)	No Isch (n = 29)	Isch (n = 53)	No Isch (n = 20)
Age, median (IQR)	40 (35–42)	36 (28–42)	57 (53–60)	56 (51–58)	65 (63–68)	66 (63–69)	74 (73–77)	75 (72–77)
Male sex	13 (54.2%)	9 (39.1%)	59 (67.8%)	18 (60%)	43 (63.2%)	15 (51.7%)	30 (56.6%)	8 (40%)
Hypertension	8 (33.3%)	1 (4.3%)	61 (70.1%)	16 (55.2%)	52 (76.5%)	17 (58.6%)	38 (73.1%)	15 (78.9%)
Diabetes mellitus	7 (29.2%)	1 (4.3%)	48 (55.2%)	5 (17.2%)	28 (41.2%)	13 (44.8%)	26 (50%)	12 (63.2%)
Current smoking	10 (50%)	3 (13.6%)	42 (50.6%)	13 (42.3%)	30 (48.4%)	5 (19.2%)	16 (32%)	3 (15.8%)
Atherosclerosis	0	0	41 (47.1%)	7 (23.3%)	40 (58.8%)	12 (41.4%)	37 (69.8%)	11 (55%)
Degree of stenosis (more stenotic side)								
10%			28 (32.2%)	5 (16.7%)	30 (44.1%)	9 (31%)	25 (47.2%)	10 (50%)
20–40%			4 (4.6%)	0	3 (4.4%)	0	5 (9.4%)	0
50%	1 (4.2%) +		1 (1.1%)	0	1 (1.5%)	0	1 (1.9%)	0
60%			0	0	1 (1.5%)	1 (3.4%)	0	0
70%			0	2 (6.7%)	0	0	2 (3.8%)	0
80%			0	0	1 (1.5%)	1 (3.4%)	1 (1.9%)	1 (5%)
90%			1 (1.1%)	0	2 (2.9%)	0	4 (7.5%)	0
Occlusion	1 (4.2%)*		5 (5.7%)	0	1 (1.5%)	0	0	0

+ The patient with 50% stenosis had dissection in the internal carotid artery, *the patient with occlusion had probably embolic occlusion of the internal carotid artery without any evidence of atherosclerosis in the carotid arteries on both sides

Isch ischemic vascular events, *No Isch* no ischemic vascular events

In the presence of ischemic vascular events and at least one risk factor, non-hemodynamically significant carotid atherosclerosis, 20–40% ICA stenosis and ≥ 50% ICA stenosis were present in 28/99 (28.3%) and 3/99 (3%), 9/99 (9.1%) among patients ≤ 60 years and in 50/108 (46.3%), in 6/108 (5.6%) and 14/108 (13%) among patients > 60 years, respectively. The baseline characteristics of patients with or without ischemic vascular events are demonstrated in Table 2. The frequency of atherosclerosis according to the age is shown in Table 3. Atherosclerosis was present in 0% among patients ≤ 45 years (0/47), in 41% (48/117) among middle-aged patients 46–60 years, in 53.6% (52/97) among patients 61–70 years and 65.8% (48/73) among patients ≥ 70 years ($p < 0.001$).

In an age and sex adjusted binary logistic regression model, the following factors predicted atherosclerosis: age > 60 years (OR 3.33, 95% CI 1.99–5.57, $p < 0.001$), hypertension (OR 2.3, 95% CI 1.32–4.02, $p = 0.003$), current smoking (OR 2.27, 95% CI 1.13–4.55, $p = 0.02$), diabetes mellitus (OR 2.15, 95% CI 1.27–3.64, $p = 0.004$) and ischemic vascular events (OR 1.8, 95% CI 1.01–3.19, $p = 0.046$). This model is presented in Table 4.

Table 4 Factors related to the occurrence of carotid atherosclerosis in the binary logistic regression models

Characteristic	Univariate regression analysis			Multivariate regression analysis		
	OR	95% CI	P	OR	95% CI	P
Age > 60 years	3.45	2.19–5.44	< 0.001*	3.33	1.99–5.57	< 0.001*
Male sex	1.08	0.7–1.68	0.72	0.58	0.3–1.14	0.11
Hypertension	3.52	2.16–5.72	< 0.001*	2.3	1.32–4.02	0.003*
Diabetes mellitus	2.74	1.75–4.3	< 0.001*	2.15	1.27–3.64	0.004*
Current smoking	1.37	0.87–2.17	0.17	2.27	1.13–4.55	0.02*
Ischemic vascular events	2.48	1.51–4.09	< 0.001*	1.8	1.01–3.19	0.046*
H–L-Test†						0.78

CI confidence interval, *OR* odds ratio

* Statistically significant results

† Hosmer–Lemeshow "goodness-of-fit" test for the multivariate regression analysis showed a non-significant p-value (p = 0.29) for the difference between our observed results and the expected results. The non-significant p-value for this test means better fit of the model (the higher the value, the better the fit)

Discussion

We found atherosclerosis in 29.4% of all our asymptomatic patients without ischemic vascular events and in 46.9% of our elderly asymptomatic patients > 60 years without ischemic vascular events. These figures seem to be lower than previously published in Whites but higher than Chinese population. For example, a 30-year-old study demonstrated that the prevalence of carotid plaques in 45–64 year-old asymptomatic whites and blacks from the USA is 34% [10]. Later on, a British study reported a higher prevalence of carotid plaques; 57% and 58% in asymptomatic men and women aged 56–77 years, respectively [23]. Recently, with the advancement of ultrasound machines, the prevalence of carotid plaques in a 63–65-year-old Norwegian asymptomatic cohort was found to be as high as 87% [24]. In Chinese population, a systematic review found carotid plaques among 20.15% of the asymptomatic subjects aged 30–79 years [25]. The higher prevalence of carotid plaques among Whites and the lower prevalence of carotid plaques among Chinese population in comparison to the Egyptian population seems to be ethnic related.

Among our asymptomatic patients ≥ 60 years old (n = 49), 3 patients (6.1%) had ≥ 20% ICA stenosis (1 patient (2%) had 60% ICA stenosis and 2 patients (4.1%) had 80% ICA stenosis). In Sweden, the prevalence of ultrasound-detected ≥ 20% ICA stenosis (according to the NASCET criteria) was 1.3% (121 arteries out of 9493 arteries) among elderly patients (most of them were above 65 years old) undergoing screening for abdominal aortic aneurysm; 0.9% had 20–49% stenosis, 0.2% had 50–49% stenosis and 0.2% had 70–99% stenosis. In another study, Jacobowitz and colleagues conducted an ultrasound carotid screening program in the USA for 394 patients > 60 years [26]. Among patients without hypertension, cardiac disease, current smoking or hypercholesterolemia, the prevalence of significant carotid artery stenosis ≥ 50% (according to the University of Washington criteria) was 1.8%. The prevalence increased to 5.8% in the presence of one risk factor, 13.5% in the presence of two risk factors and 16.7% in the presence of three risk factors. Of note, the authors used the University of Washington criteria for graduation of the stenosis, which is obsolete and different from the NASCET criteria used in the current study; in the former criteria, the stenosis is graded as ≥ 50% in the presence of peak systolic velocity (PSV) of > 120 cm/s, which amounts to 20–40% stenosis according to the NASCET criteria [19]. The effect of the risk factors in our patients might explain the higher prevalence of asymptomatic ≥ 20% ICA stenosis in our patients in comparison to the Swedish Cohort and the more or less similar prevalence in comparison to the American cohort. In another cohort of asymptomatic Caucasian subjects aged 50–75 years in Netherlands, the prevalence of significant ICA stenosis was 2.8% in non-diabetics and in 8.7% in diabetic patients [27]. Again, the authors defined significant ICA stenosis as PSV > 125 cm/s. We found ICA stenosis ≥ 20% in 4.2% of our non-diabetic patients and in 6.4% of our patients with diabetes mellitus, which is more or less similar to the Dutch study. In a cohort from Sri Lanka, the prevalence of ICA stenosis ≥ 50% among patients with ischemic stroke was 4% [28]. We found higher frequency (9.9%) of ICA stenosis ≥ 50% among our patients with ischemic vascular events, which might be ethnic related. In a systematic review, the pooled prevalence of moderate asymptomatic ICA stenosis ≥ 50–69% was 4.2% [29]. The authors further noted that among subjects < 70 years, the prevalence was 4.8% in men and 2.2% in women, while among elderly subjects ≥ 70 years, the prevalence reached 12.5% in men and 6.9% in women. We found markedly lower figures for moderate stenosis; only 1% of our asymptomatic patients and 2.1% of our patients with ischemic vascular events were diagnosed with moderate stenosis, which could be explained by ethnic difference.

In line with our findings, older age, diabetes mellitus, hypertension and smoking were also shown in several studies to be related to the increased prevalence of carotid plaques [10, 23, 29, 30]. Similar to our results, the authors of the previously cited Norwegian study found that current smoking (OR = 1.5) and hypertension (OR = 1.3) are significantly related to carotid atherosclerosis and in contrast, they found no relation with diabetes mellitus [24]. We assume that the authors included well-controlled diabetic patients and we included poorly controlled diabetic patients. In addition, previous authors from the USA showed significant association between ICA stenosis > 60% and the following factors: age > 65 years (OR = 4.1), current smoking (OR = 2.0), coronary heart disease (OR = 2.4), and dyslipidemia (OR = 1.9) [31].

In Egypt, 15 years ago, Abd Allah and colleagues reported atherosclerotic carotid disease in 41% among Egyptian symptomatic and asymptomatic patients; 17.6% had increased intimal medial thickness, 20.8% had < 50% stenosis, 1.7% had 50–69% stenosis, 0.8% had ≥ 70% stenosis and 0.06% had ICA occlusion [32]. The authors have shown that, among symptomatic patients with stroke or TIA, the figures were further higher; 67.8%, 29.7%, 0.8%, 1.3% and 0.4%, respectively. We found more or less similar results for non-stenotic carotid plaques, yet markedly higher figures for more severe stenotic grades; among our patients with ischemic vascular events, 50–60% ICA stenosis, 70–90% ICA stenosis and carotid occlusion was found 2.1%, 4.8% and 3% of our patients, respectively (versus 0.8%, 1.3% and 0.4% of the cohort published by Abd Allah and colleagues). This difference might be attributed to the advancement of ultrasound machines allowing better detection of atherosclerosis. Another cohort from north Upper Egypt investigated the prevalence of ultrasound detected carotid atherosclerosis among patients with ischemic stroke [33]. The authors reported increased intimal medial thickness among 94/167 (56.3%), < 50% ICA stenosis among 22/167 (13.2%), ≥ 50% ICA stenosis among 4/167 (2.4%) and total occlusion among 2/167 (1.2%) of the patients. We found markedly higher figures in our cohort; < 50% ICA stenosis was detected among 41% and ≥ 50% ICA stenosis was found among 9.9% of our patients with ischemic vascular events. It might be postulated that the lower figures in the aforementioned cohort from Upper Egypt are attributed to ethnic difference from people in northern Egypt. In another recent cohort from Egypt, Shehata and colleagues found < 50% stenosis and 50–69% stenosis in 17% and 5% of a cohort of hypertensive asymptomatic patients aged 30–70 years. In the control group of the aforementioned study, none of the patients had ICA stenosis [13]. Shehata and colleagues excluded patients with cardiac disease, dyslipidemia, diabetes mellitus and smoking from their cohort, which can explain the lower figures in their cohort in comparison to ours. Furthermore, 38% of asymptomatic Egyptians with metabolic syndrome were found in a small cohort to have < 50% stenosis in comparison to 13% of their control group without metabolic syndrome [34], which is similar to our results. Similar to our results, the Abd Allah and colleagues found that age (OR = 1.08), diabetes mellitus (OR = 2.02), hypertension (OR = 1.54), smoking (OR = 1.84) and dyslipidemia (OR = 2.07) independently predicted carotid atherosclerosis [32].

We identified several limitations of our study. Patients with severe ischemic stroke were less likely to receive ultrasound and hence a significant proportion of such patients were not included in our study. Our sample size with 344 patients is relatively small. However, we present one of the largest available samples from Egypt so far and our study was meant to be an explorative one. Large epidemiological data from Egyptian population are needed. We also included both asymptomatic patients and patients with ischemic vascular events in our study. However, we preferred to publish the data of both groups because of the rarity of the Egyptian data.

Conclusions

The frequency of carotid atherosclerosis among Egyptians seems to be lower than among Whites and higher than among Asian population. Older age, hypertension, smoking, diabetes mellitus and ischemic vascular events predict carotid atherosclerosis. Large epidemiological data in this regard are needed.

Abbreviations

AHA/ASA	American Heart Association/American Stroke Association
CI	Confidence interval
H-L-Test	Hosmer–Lemeshow test
ICA	Internal carotid artery
IQR	Interquartile range
NASCET	North American Symptomatic Carotid Endarterectomy Trial
OR	Odds ratio
PSV	Peak systolic velocity
SVS	Society of vascular surgery
TIA	Transient ischemic attack

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Author contributions
All authors made a substantial contribution to the conception, design, and revision of the draft. AE conducted the statistical analysis and wrote the first draft. All authors were involved in the final approval of the version to be published.

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Availability of data and materials
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Data collected within the routine clinical care were used. The study was approved from the University Hospital of Alexandria Ethics Committee (Serial number 0304850) and patients or their next available kin provided their written informed consent to participate in the study. All the steps/methods were performed in accordance with the relevant guidelines and regulations.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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