Eur J Vasc Endovasc Surg **25**, 505–512 (2003)
doi:10.1053/ejvs.2002.1884, available online at http://www.sciencedirect.com on SCIENCE DIRECT®

REVIEW

Ethnicity and Peripheral Arterial Disease

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Introduction: *the prevalence of peripheral arterial disease (PAD) is relatively well defined for the Caucasian population. Given the susceptibility of Asians and Afro-Caribbeans to coronary heart disease and stroke respectively, and the high prevalence of cardiovascular risk factors in both groups, one would expect a high prevalence of peripheral arterial disease.*
Methods: *a search of MEDLINE (1966–2002) was undertaken for studies on the incidence and prevalence of PAD, abdominal aortic aneurysms (AAA) and cerebrovascular disease in different ethnic groups.*
Results: *there are very few population-based prevalence studies assessing PAD, AAA or cerebrovascular disease in non-Caucasians. A review of hospital-based series demonstrates different patterns of PAD between ethnic groups. Blacks and Asians have a tendency towards more distal occlusive disease and AAA appear to be predominantly a disease of Caucasians. It is not clear whether these studies provide a true representation of the prevalence of arterial disease in various ethnic groups or are the result of an unmet health care need.*
Conclusions: *further studies are required to establish the prevalence, natural history and response to treatment of PAD, AAA and cerebrovascular disease in non-Caucasians. Only when this has been achieved, can clinically and cost-effective health care be delivered to affected individuals from different ethnic groups.*

Key Words: Ethnicity; Peripheral arterial disease; Cerebrovascular disease; Abdominal aortic aneurysm.

Introduction

The epidemiology of peripheral arterial disease (PAD) in the Caucasian population, and the impact it has on the provision of health care services, are relatively well defined. By comparison, very little appears to be known about PAD in the non-Caucasian population. Further information about PAD in non-Caucasians is important because they make up an increasing proportion of Western populations, especially in inner city areas. For example, non-Caucasians make up 7% of the population of Great Britain and 28% of the population of London (1991 National Census data). In addition, a clear understanding of the epidemiology and natural history of any condition is a prerequisite for the planning and implementation of effective health care. The evidence-base for the treatment of PAD is founded almost exclusively on Caucasian patients. These treatments may be inappropriate, not cost effective, and even harmful in patients from other ethnic backgrounds.

Here we review what is known of the ethnic differences in PAD, including abdominal aortic aneurysms (AAA) and cerebrovascular disease, and explore the possible reasons for such differences, and propose strategies for further research in this important area. A MEDLINE literature search (1966–2002) was performed to identify articles relating to vascular disease in ethnic groups other than Caucasian. Search terms included "ethnic groups", "Asians" or "Blacks" combined with "peripheral vascular/arterial disease", "abdominal aortic aneurysm", "cerebrovascular disease", "stroke", "transient ischaemic attack" or "carotid endarterectomy". Cross-referencing from the reference lists of major relevant articles identified further papers. Highest priority was given to population-based studies and where these were not available hospital-based case series were studied.

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1078–5884/03/060505 + 08 $35.00/0

Table 1. 2001 U.K. National Census Ethnic Groupings.

White
British
Irish
Other white
Mixed
White and black Caribbean
White and black African
White and Asian
Other mixed background
Asian or Asian British
Indian
Pakistani
Bangladeshi
Other Asian background
Black or black British
Caribbean
African
Other black background
Chinese or other ethnic group
Chinese
Any other ethnic group
Not stated

Ethnicity

The term ethnicity implies a shared origin, background, culture, traditions, language and religion, leading to a sense of group identity. Ethnicity needs to be differentiated from race, which relates to the division of people on the basis of physical characteristics, for example skin colour.[1] In the U.K., although a wide range of different ethnic groups are recognised (Table 1), ethnic data are not, or incompletely, recorded by many government agencies, including the National Health Service (NHS). The same is probably true of most European countries and this lack of uniform ethnic coding greatly hampers understanding and research in this area.

Ethnic Differences in Vascular Risk Factors

It is well recognised that ethnicity has a major impact on the prevalence of coronary heart disease (CAD) and the major vascular risk factors. Indeed, South Asians aged 20–69 years, living in the U.K., have approximately a 40% higher mortality from CAD when compared to age and sex matched Caucasians.[2] This is often attributed to the less favourable vascular risk factor profile seen amongst South Asians. In the U.K., South Asians have a two fold higher prevalence of hypertension[3] and five fold higher prevalence of diabetes compared to Caucasians.[4] Despite having similar total cholesterol levels, South Asians have lower high-density lipoprotein levels and higher triglyceride levels.[4] Afro-Caribbeans also have an increased prevalence of hypertension and diabetes when compared to Caucasians,[5] however they seem more prone to stroke (ischaemic and haemorrhagic), rather than CAD.[6]

Disentangling the factors that lead to these observations is complicated by the need to consider ethnic sub-groups. In the same way that cardiovascular risk varies significantly between Caucasians living in different European countries, in the U.K., Bangladeshis have lower rates of CAD compared to Indians and Pakistanis.[4] This is despite the fact that the highest smoking rates are found in male Bangladeshis (61%) and the lowest smoking rates in male Indians (18%).[4] Paradoxically, although only 1–5% of Asian females smoke, they are almost twice as likely to suffer from CAD than Caucasian females.[4]

Lower Limb Arterial Disease

Epidemiology

Approximately 20% of the middle-aged (55–74 years) Caucasian population have an ankle-brachial pressure index (ABPI) <0.9.[7] Of these, one quarter (ca. 5% of the total population) is symptomatic with intermittent claudication, the commonest manifestation of PAD.[7,8] The prevalence of claudication increases until the age of 75 years, after which it appears to decline.[9] In the Framingham study, males were affected almost twice as often as females,[9] but in the Edinburgh Artery Study, men and women were affected almost equally.[7] Claudicants have an annual mortality of 5–10%, which is 3–4 times higher than that observed in an age and sex matched non-claudicant population.[8,10] This excess mortality is almost exclusively due to cardiac events, ischaemic stroke and other vascular catastrophes. By contrast, the risk of developing critical limb ischaemia appears to be small (1–2% per year).[11]

There are, by comparison, no large population-based studies assessing the prevalence of PAD in non-Caucasians. Those that do exist suggest that the prevalence of PAD is lower than that seen in Western series (Table 2). These studies however, are predominantly retrospective hospital-based case series and case control series, evaluating PAD in non-Caucasian diabetics. These highly selective populations make the extrapolation of data to the general population, and direct comparison with Caucasian populations difficult.

The anatomical distribution of PAD appears to vary with ethnic origin. A retrospective analysis of 1215 patients admitted under the vascular service of a South African hospital identified a similar distribution

Table 2. Prevalence of peripheral arterial disease (PAD) in different ethnic populations.

Study			Population			PAD Prevalence (%)
Author	Year	Country	Source (No.)	Sex (M:F)	Age	
Janka[60]	1980	Munich, Germany	Diabetics attending hospital diabetic clinic (623)	2:3	Not stated	15.9 *
Fernando[61]	1993	Sri Lanka	NIDDM attending hospital diabetic clinic (500)	3:2	52 ± 6.1	3.8 †
			Age and sex matched controls (250)	3:2	53 ± 6.1	1.3 †
Mohan[62]	1995	South India	NIDDM attending hospital diabetic clinic (3167)	Male	55–60 yrs ¶	3.2 ‡
			NIDDM attending hospital diabetic clinic (1174)	Female	55–60 yrs ¶	5.0 ‡
Bhuripanyo[63]	1992	Thailand	NIDDM attending hospital diabetic clinic (207)	1:3	56.8 ± 9.8	7.7 †
Bowlin[64]	1994	Israel	Population sample (10 059)	Male	40–65	2.7 *
Fowkes[7]	1991	Edinburgh, Scotland	Population sample (1592)	1:1	55–74	4.5 † 17 ‡ 24.6 §

NIDDM, non-insulin dependent diabetes mellitus.
* Ankle pressure >30 mmHg less than brachial pressure.
† WHO claudication questionnaire.
‡ Ankle:brachial pressure index <0.9.
§ ABPI<0.9 or reactive hyperaemia pressure reduction >20%.
¶ Approximate mean age.

of aorto-iliac occlusive disease among whites, Asians and blacks. In this group however, striking differences were observed between males and females (male: female ratio; whites 2:1; Asians 7:1; blacks 16:1).[12] This same series showed that the prevalence of femoral–popliteal and infra genicular disease was higher in blacks and Asians when compared to whites.[12] This apparent predisposition for infra-inguinal disease in black patients is supported by other hospital-based studies and persists even after adjusting for diabetes and other cardiovascular risk factors.[13,14]

The available literature on the pattern of PAD in Asians is very limited. As for blacks this is confined to small hospital-based case series. Shead examined the distribution of PAD in a South Indian hospital-based study of 112 non-diabetic males (mean age 45 ± 11.6 years) presenting with PAD. The distributional pattern in these cases was 23% aorto-iliac, 41% femoro-popliteal and 36% distal.[15] The mean age of the patients with distal disease was only 37 (±12.8) years, significantly younger than would be expected in a Caucasian cohort. Whilst the aorto-iliac and femoro-popliteal disease was thought on angiography to be predominantly (96 and 64%) atherosclerotic, the majority of the distal disease was felt to be consistent with thrombo-angiitis obliterans (TAO) (Buerger's disease).[15] Pathological studies in India confirm the high incidence of Buerger's disease amongst Asians. In a study of 115 limbs amputated for PAD, Buerger's disease was shown to be present in 32% of cases.[16] This is much higher than in the Western population.

Ethnic differences in the pathophysiology of atherosclerosis have been observed in post-mortem studies. It has been demonstrated that in adolescence and early adulthood, blacks have 1.5 times greater fatty streaking of their aortas compared to whites, a finding that was not associated with pre-mortem lipid levels, blood pressure or obesity. In later life however, whites develop more extensive raised lesions.[17] We do not know why the transition from fatty streak to advanced atherosclerotic lesion is different between blacks and whites; nonetheless, an understanding of this process in different ethnic groups may be key to our understanding of the different patterns of disease observed.

Surgical treatment

There are reliable data to indicate that the availability and outcome of surgical treatment of CAD,[18,19] and possibly lower limb PAD, varies with ethnic background. Of course, it is difficult to separate ethnicity from the socio-economic and other factors that may cause bias. The majority of the available PAD studies compare white and black Americans.[13,14,20] These studies show that African Americans appear more likely to undergo infra-inguinal than aorto-iliac bypass, thereby supporting the notion that blacks have a greater tendency to develop distal disease.[20,21] When compared to white males and females, respectively, American black men are 1.13, and black women 1.93 times more likely, to undergo femoral bypass.[20] There

was no mention in this study of angioplasty rates. These were however, examined by Tunis, who reviewed 7210 procedures performed for PAD in Maryland, U.S.A. After adjusting for age, sex, diabetes and hypertension, blacks were 1.6 times more likely than whites to have surgery, but 42% less likely to undergo angioplasty.[22]

Amputation

The general consensus from surgical series seems to be that while African-Americans with PAD are more likely to undergo surgery, they are more likely to receive amputation and less likely to have bypass surgery or angioplasty. This persists even after adjusting for the common risk factors[21–24] (Table 3).

Diabetes is one of the predominant risk factors for the development of lower limb ischaemia requiring bypass and has a higher incidence in African-Americans. However, even after adjusting for their increased prevalence of diabetes, diabetic African-Americans remain twice as likely to undergo above-knee or below-knee amputations and approximately 50% more likely to undergo toe/foot amputation than age and sex matched Caucasian diabetic Americans.[23,25–27] There are very few data from other countries, however, a single U.K. study did not show an excess of amputations in diabetic black patients.[28] They showed that women have equivalent rates of amputations in both ethnic groups and African Caribbean men have a third of the risk of European men. We must keep in mind that inequalities in healthcare in the U.S.A. and higher smoking rates may account for the differences seen.

The reduced revascularisation rates and higher rates of amputation for PAD observed in blacks may be attributed to either a different pattern of disease precluding successful revascularisation, or to more advanced disease at presentation. This is highlighted by the observation of Madiba *et al*. that 79% of black patients presenting with aorto-iliac disease had a threatened limb, whilst whites and Asians predominantly attended with claudication.[29] This suggests that black patients presented later to the health care services, possibly due to unequal access to adequate healthcare.

Abdominal Aortic Aneurysm (AAA)

AAA (defined as an aortic diameter > 3.0 cm) is present in ca. 5% of middle-aged (55–75 years) Caucasian males and is the commonest cause of non-cardiac sudden death in this group.[30,31] The incidence of AAAs appears to be on the increase, however it is unclear whether this reflects a true increase in the incidence, is due to more advanced diagnostic imaging techniques resulting in improved identification of cases, or is a consequence of the aging population.[32]

As for lower limb occlusive disease, there are no significant population-based studies estimating the prevalence of AAA in populations other than Caucasian. Indeed, population-based data do not exist for blacks and Asians. The literature that does exist suggests that there is a lower prevalence of AAA in ethnic communities compared to that described in Caucasians (Table 4). Surgical series from Western multi-ethnic countries suggest that AAA repair is largely confined to the Caucasian population. For example, large studies from America indicated a standardised rate for AAA repair of 0.33 for Black males,[20] and a retrospective operative series from the U.K. reported no episodes of AAA repair in the Asian population (14% of the local population) over a 7-year period.[33] There are scarcely any data on the relative balance of elective and emergency (ruptured) AAA repair with one study reporting similar rupture rates between whites (20%) and blacks (23%).[34]

As with lower limb revascularisation, to what extent these data reflect the true epidemiology of the condition, or simply an unmet health care need, is unclear. When AAAs are identified in Blacks they tend to occur at a significantly younger age[12,34,35] which may reflect a different underlying pathology or more aggressive disease. Interestingly, a similar prevalence was observed between black and white females.[34,36] This is in contrast to the pattern observed

Table 3. Differences in operative treatment for peripheral arterial disease (PAD) between whites and blacks.

Study	Amputations (%)		Bypass operation (%)		Angioplasty (%)		Ratio of amputation: revascularisation	
	Black	White	Black	White	Black	White	Black	White
Tunis 1993[22]	777 (41)	1113 (22)	954 (50)	3051 (59)	183 (9)	1002 (19)	0.69	0.28
Guadagnoli 1995[23]	1621 (57)	5386 (33)	1089 (38)	8984 (55)	135 (5)	2021 (12)	1.33	0.49
Huber 1999[21]	3956 (56)	11 473 (26)	3115 (44)	32 793 (74)		No data	1.27	0.35
Collins 2002[24]	892 (44)	2042 (23)	1146 (56)	6702 (76)		No data	0.79	0.30

Table 4. Prevalence of abdominal aortic aneurysms (AAA) in different ethnic populations.

Study			Population					AAA Prevalence * (%)
Author	Year	Country	Source		No.	Sex (M:F)	Age	
Adachi[65]	2000	Japan	Screened residents of a rural farming community		1591	2:3	68 ± 15	0.3
Johnson[36]	1985	North Carolina, U.S.A.	Autopsy series	Whites	1174	3:2	>50	2.9 †
			Incidental CT scan		356			
		North Carolina, U.S.A.	Autopsy series	Blacks	491	1.2:1	>50	1.5†
			Incidental CT scan		189			
Wilmimk[66]	1999	Huntingdon, U.K.	Screened population sample		7493	Male	≥50	5.2

* Aortic diameter ≥ 30 mm.
† Aneurysm size not defined.

Table 5. Incidence of stroke and stroke-subtypes in different ethnic populations.

Study						Stroke Subtype			
Author	Year	Type	Country	Ethnicity		All	CI	PICH	SAH
Balarajan[2]	1979–1983	Mortality rates (ages 20–69) *	England and Wales	Indian	Male	153			
					Female	125			
				Caribbean	Male	176			
					Female	210			
Wild[57]	1989–1992	Mortality rates (ages 20–69) *	England and Wales	South Asian	Male	155			
					Female	141			
				Caribbean	Male	168			
					Female	157			
Sudlow[42]	1984–1995	Annual incidence (45–84 year age groups) †	France	Predominantly			183	26	4
			England	Caucasian			312	39	17
			Sweden				349	49	12
Woo[54]	1990–1995	Incidence rate of first-ever ischaemic stroke †	Rochester, U.S.A.	White			147		
			Cincinnati, U.S.A.	Black			246		
Ayla[50]	1995–1998	Death rates (age >25 years) ‡	U.S.A.	White			73.7	13.2	3.8
				Black			95.8	22.5	5.7
				Asian/Pacific Islander			45.8	20.1	5.2

CI, cerebral infarction; PICH, primary intracerebral haemorrhage; SAH, subarachnoid haemorrhage.
* Standardised mortality ratios using England and Wales rates as standard.
† Age- and sex-standardised per 100 000.
‡ Age standardised per 100 000.

in Caucasians where, in screening studies, AAAs are six times more common in men compared to women.[37]

The pathogenesis of abdominal aortic aneurysm

The pathogenesis of AAAs appears to be different in the black population. In South Africa, 99% of aneurysms in Caucasians had features of atherosclerosis. However, in blacks, only 34% were atherosclerotic with the majority being due to non-specific aortoarteritis (64%) or tuberculosis (18%).[34] Infectious disease is now considered to be an important cause of aneurysm formation in developing countries. A study from Zimbabwe demonstrated that 52% (33/63) of aortic aneurysms affected the thoracic aorta with 48% of these patients having serologically confirmed syphilis.[38] More recently, the global rise in HIV infection, leading to immunosupression and opportunistic infection, has resulted in increasing number of reports of HIV-related AAAs.[39,40] These aneurysms were primarily thought to be associated with opportunistic infection, for example TB, however, it is now appreciated that HIV itself may lead to both occlusive and aneurysmal arterial disease, possibly through the development of a specific vasculitic process.[41]

Cerebrovascular Disease

In the European population, between 70 and 90% of all strokes are ischaemic[42] and, of these, approximately one half is believed to be due to athero-embolism from the carotid bifurcation. Across Europe, the incidence of ischaemic stroke varies almost two-fold from 183 per 100 000 in France to 349 per 100 000 in Sweden (Table 5).[42] Males are approximately 1.5 times more likely to be affected than females and the incidence increases with age.[43]

The incidence of transient ischaemic attacks (TIAs) in European populations is poorly established, with widely different rates reported, even from within the same country. This may be due to differences in methodology and sampling, and the difficulties surrounding making an accurate diagnosis.[44] Thus, annual incidence rates range from 50 per 100 000 in France[45] to 190 per 100 000 in the U.K.[44] to 310 per 100 000 in Italy.[46]

Afro-Caribbeans have a higher incidence of, and mortality rate from stroke but seem to have a lower incidence of TIAs when compared to Caucasians.[6,47–49] This increased mortality most likely reflects an excess of stroke from other causes, such as intracerebral haemorrhage and subarachnoid haemorrhage, which are more common among blacks.[50,51] Despite blacks also having a higher incidence of ischaemic stroke when compared to Caucasians, they are much less likely to undergo carotid endarterectomy (CEA).[49,52,53] This is probably due to the relatively higher proportion of cardioembolic and small vessel ischaemic stroke subtypes observed in blacks (Table 5).[52,54,55]

There are only a few studies that assess the epidemiology of cerebrovascular disease in Asians (Table 5).[2,50,56,57] Data suggest that the incidence of strokes in U.K. Asians is higher (standardised mortality ratio [SMR] 226 male, 246 female) than that seen in Caucasians but lower than Afro-Caribbeans (SMR 394 male, 463 female).[57] As with blacks, this difference is partially accounted for by the higher incidence and mortality from intracerebral haemorrhage and subarachnoid haemorrhage observed in Asians when compared to Caucasians.[50] Ischaemic stroke secondary to carotid atherosclerosis occurs at a lower frequency in Asians. A screening study from India using MRI angiography estimated that only 11% of ischaemic strokes were associated with carotid lesions suitable for carotid endarterectomy with the majority of vascular lesions being in an intracranial position.[58]

Summary

A thorough review of the literature indicates that surprisingly little indeed is known about the influence of ethnicity on the prevalence, distribution, natural history, treatment and outcome of PAD, including AAA and cerebrovascular disease. Although this may reflect a lack of interest on the part of researchers there is no doubt that this is a difficult, and potentially politically sensitive issue to study. However, without these data, it is impossible to plan and implement effective health care strategies within our increasingly multi-ethnic Western societies, or indeed in the "developing" world, where vascular disease is rapidly becoming a major cause of mortality as deaths from communicable diseases reduce and risk factors for vascular disease, especially tobacco consumption, increase.[59]

The vast majority of the published studies analysing the epidemiology of PAD in ethnic groups are limited by selection bias. Most of the studies are hospital-based series that are subject to the inherent biases found in these types of studies. Selection bias in hospital-based series means that the potential confounding factor of unequal access to health care for different ethnic groups is not addressed. Interpreting data is further hampered by the fact that ethnicity is not a particularly sound epidemiological tool. Specifically, ethnicity is not easily measured, and the boundaries of ethnicity are becoming increasingly indistinct. This results in difficulty testing aetiological hypotheses when different patterns of disease are encountered, and because of the ever-changing face of ethnicity, research results may quickly become out of date.[1] There are also difficulties in attempting to disentangle ethnicity, race, and life-style, which might be quite different between 1st, 2nd and 3rd generation immigrants.

The link between ethnicity, vascular risk factors and arterial disease remains unclear. Asians appear to have less atherosclerosis than Caucasians and yet suffer from a higher prevalence of coronary heart disease, whilst blacks appear to suffer from a predisposition for infra-genicular disease and intracranial atherosclerosis. AAA are a predominantly Caucasian disease, reinforcing the belief that AAAs are a result of a different aetiological process to arterial occlusive disease. The anatomical difference in the pattern of atherosclerotic disease is most likely to be a result of complex interplay of environmental, cultural, and probably, genetic factors.

An insight into the epidemiology of any condition is essential for the planning and delivery of clinically and cost-effective health care for affected individuals. There appears to be a need to acquire further knowledge of the epidemiology of PAD in the ethnic minority groups. This can only be realistically achieved by performing population-based, cross-sectional prevalence surveys and prospective longitudinal cohort studies and until this is done, the true prevalence of arterial disease in different ethnic groups will not be known.

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Accepted 20 January 2003