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Epidemiology of Macrovascular Complications of Diabetes in South Asians and Comparison with Other Ethnicities

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Abstract

South Asians have been shown to have increased abdominal adiposity, visceral fat, low muscle mass and subclinical inflammation, all of which make them prone to diabetes and its macrovascular complications. Diabetes is the most important risk factor for coronary artery disease (CAD) in South Asia and South Asians with diabetes have a higher prevalence of CAD than Caucasians. Similar trends have been seen with coronary mortality, stroke and cerebrovascular disease. Importantly peripheral vascular disease and diabetic foot disease occur less frequently in South Asians compared to Caucasians. In addition, erectile dysfunction is emerging as an important complication of diabetes in South Asians and its association with cardiovascular disease is being recognised increasingly.

Keywords: Diabetes, complications, marcrovascular, cardiovascular, cerebrovascular, diabetic foot, erectile dysfunction, South Asians

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Introduction

The world is facing a growing burden of type 2 diabetes mellitus (T2DM) and its complications. The problem is especially challenging for developing countries and South Asia in particular. The prevalence of cardiovascular disease and foot ulcers was 24.6 and 5.5 per cent respectively among 20,554 Asian Indians with diabetes in a recent international study [1]. There is a considerable economic impact of complications of diabetes for developing economies. The annual direct and indirect cost of diabetes treatment was estimated to range between 1,230 billion INR ($25.5 billion) to 1,837.3 billion INR ($38.0 billion) in 2010 [2]. In an economic analysis, the presence of 3 or more complications resulted in an 80% increase in the cost of ambulatory care and a 67% increase in the cost of hospitalization in India [3].

In the landmark UK Prospective Diabetes Study (UKPDS), Asian Indians were at greater risk for any diabetes-related end point (RR 1.18, 95% CI 1.07-1.29 [4]. The phenotypic characteristics of South Asians makes them prone to T2DM. South Asians have excess body fat, abdominal adiposity (both excess subcutaneous and intra-abdominal fat), hepatic fat, low muscle mass, and subclinical inflammation [5]. All these features contribute to insulin resistance, dyslipidemia, metabolic syndrome and early-onset diabetes [6,7]. Many of these factors may also contribute to macrovascular complications of diabetes.

There is considerable variation in the epidemiological data on various complications of diabetes available from South Asia. Some of these variables are the epidemiological setting (i.e. population based or clinic based), sample size, methodologies, definitions of various disease states and quality. A critical appraisal of the available literature is attempted in this review, and wherever possible, the strengths and weaknesses of the respective studies have been pointed out.

Search Methodology

The medical search engines, Pub med (National Library of Medicine, Bethesda MD), Google Scholar and Governmental

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websites of South Asian countries were used for literature search using the key words, "diabetes mellitus, complications, coronary artery disease, cerebrovascular disease, peripheral vascular disease, diabetic foot, erectile dysfunction, India, Pakistan, Srilanka, Nepal, Bangladesh, South Asians, and Asian Indians". The references included reports from international organizations, chapters from books, review articles, cross-sectional studies and prospective studies. For each complications, data are presented first for South Asians living in South Asia and then for migrant South Asians/Asian Indians. This review aims to be comprehensively descriptive analysis.

Coronary Artery Disease

Coronary artery disease (CAD) contributes to morbidity and mortality substantially in diabetes. Diabetes accounts for a considerable proportion of burden of CAD globally as well as in South Asia (Table 1) [8-18]. In a retrospective analysis of 279,256 patients undergoing percutaneous coronary intervention from 2004 to 2011 from the British Cardiovascular Intervention Society National database, South Asians had a much higher prevalence of diabetes than Caucasians (42% vs 15%, p<0.0001) [19]. In a study in a tertiary care centre in North India, patients with T2DM had significantly lower total and LDL cholesterol levels than those without T2DM; however they still had higher prevalence of angiographically defined CAD [20]. In the case control INTERHEART study in which risk factors for acute MI were analysed in 52 countries, diabetes was more prevalent in patients with MI from five South Asian countries than rest of the world (9.5% and 7.2%, respectively) [21]. South Asian stroke survivors had higher measurements of arterial stiffness (P<0.001) and impaired endothelial-dependent vascular function (p<0.001) than white Caucasians in West Birmingham Stroke Project and these were associated with glycemic status on multivariate regression analysis [22].

The prevalence of CAD was 13.7% in 20,653 people with diabetes in a multicentre study from several centres across India [23] In a population based study from Chennai, South India (n,1262), the prevalence rates of CAD were 9.1, 14.9 and 21.4% in people with normal glucose tolerance, impaired glucose tolerance and T2DM, respectively, however CAD was diagnosed by symptoms and electrocardiogram (ECG) [24]. Similarly, the prevalence of CAD as assessed by ECG was 32.3% in 130 patients with diabetes in rural Goa, South India [25]. In a recent retrospective analysis of 249 patients with T2DM at a tertiary care centre in Chennai, South India, the incidence of CAD was 5.6 cases/1000 person-years [26]. Clinic based studies from Pakistan have reported the prevalence of CAD to be 26.4% and 19.8% in Karachi and Rawalpindi respectively in patients with T2DM [27].

Studies in migrant South Asians/Asian Indians show a higher prevalence of CAD compared to other races. A recent meta-analysis of 9 studies showed that South Asians had a higher prevalence of CAD compared with white subjects (HR 1.35) [28]. In a study from Singapore, diabetes was found to be more strongly associated with CAD in Asian Indians than in Chinese (HR for diabetics vs. non-diabetics 6.4 in Asian Indians and 3.0 in Chinese) [29]. A study in New York found diabetes to be more common in South Asians with CAD than Caucasians with CAD (55% vs. 31.1%; P < .001) [30]. The association between carotid intima-media thickness and diabetes was found to be much stronger in Indians in rural Andhra Pradesh (South India)

Table 1. Prevalence of Diabetes in Patients with Coronary Artery Disease in South Asia

Author	Year	Place	Study population	Sample Size	Prevalence of Diabetes (%)
Nadeem et al[8]	2013	Wah, Pakistan	Patients <45 years of age admitted with classical symptoms of IHD and ECG changes	109	18
Selim et al[9]	2013	Dhaka, Bangladesh	Patients with ACS	200	23.5
Zahidullah et al[10]	2012	Peshawar, Pakistan	Patients undergoing CABG	104	35.5
Faisal et al[11]	2011	Lahore, Pakistan	Patients (16-45 years of age) with acute MI	100	28
Khan et al[12]	2010	Peshawar, Pakistan	Diagnosed CAD	200	44
Misiriya et al[13]	2009	Kottayam, South India	Acute coronary syndrome	1865	30.9
Kumar et al[14]	2008	Ludhiana, North India	Patients within 4 weeks of first acute MI	846	40.4
Mardikar et al[15]	2008	7 centres in India	Patients with angiographically proven CAD	350	Prediabetes 50.2% Diabetes 21.4%
Jafar et al[16]	2008	Karachi, Pakistan	Population based	Men 90 Women 63 (ECG changes)	Diabetes Men 33.3% Women 41.3%
Latheef et al[17]	2007	Tirupati, South India	Population based study (1519 people were screened for CAD)	192 patients with CAD	16.7
Tewari et al[18]	2005	Lucknow, North India	Patients with angiographically proven CAD	1971	30.5

IHD: Ischemic heart disease, ECG: Electrocardiogram, ACS: Acute coronary syndrome, CABG; Coronary artery bypass graft, CAD: Coronary artery disease, MI: Myocardial infarction

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than in white Caucasians in Perth, Australia [31]. A study in 120 asymptomatic patients with T2DM in the Netherlands found a significantly higher coronary artery calcium score in South Asians comapred to white Caucasians and a higher prevalence of significant CAD (41% vs. 28%, respectively, p = 0.008) [32].
The ACRE (Appropriateness of Coronary Revascularization) study assessed the success of revascularization over six years and found that South Asians in London, UK were less likely to experience long-term improvements in angina after revascularization compared to whites (OR 0.19 for percutaneous coronary intervention and 0.36 for coronary artery bypass graft) [33]. In another study of 2,897 patients from a tertiary care centre in Leicester, UK, diabetic South Asians had a higher 30 day mortality after coronary artery bypass grafting than diabetic Caucasians (3.8% VS. 1.4%, P=0.01), however mortality at 5 years was not different (p=0.77) [34].

Contrary to the earlier trend, some recent studies fail to show a higher prevalence of CAD in South Asians with diabetes. In the recent South London Diabetes Cohort study, South Asian patients with T2DM had lower prevalence of CAD at diagnosis compared to whites (7.3% vs. 12.7%, p <0.0001) [35]. The incidence rates of myocardial infarction (MI) were similar in South Asians and whites in the Kaiser Permanente Northern California Diabetes Registry (Adjusted incidence rate 5.9 per 1000 person-years for both) [36] In a population-based prospective study from British Columbia and Alberta, Canada, both whites and South Asians with diabetes had a similar prevalence of MI [37]. In another recent prospective study in Ontario, Canada the incidence of CAD was same in South Asians and Europeans (age and sex standardized incidence rate 13.8 and 13.7 per 1000 person years, respectively, p=0.8) [38]. In a study of 1,486 south Asian (SA) and 492 white European (WE) subjects with T2DM from 25 general practices in Coventry and Birmingham, UK, the risk of cardiovascular disease event or death from cardiovascular disease at 2 years was non-significantly greater in SA compared to WE (OR 1.4) [39]. Similarly, in an analysis of pooled data from three population-based cross-sectional studies conducted in Oslo between 2000 and 2002, the rate of cardiovascular disease in immigrants with diabetes from Srilanka and Pakistan was not significantly different from ethnic Norwegians with diabetes (p=0.364) [40]. The earlier finding of an increased prevalence of CAD in South Asians with diabetes compared to Caucasians has not been replicated in recent studies from North America and Europe. The reasons for this transition are not very clear. A more complete integration into the country of migration and acculturation might be responsible for levelling out of differences between different ethnic groups. Also, it is possible that South Asians with diabetes are receiving better healthcare and management of cardiovascular risk factors resulting in reduction in prevalence of CAD.

Cerebrovascular Disease

Cerebrovascular disease (CVD) is another major cause of morbidity and mortality in patients with T2DM. Diabetes is associated with worse outcomes and increased short term and long term mortality after stroke [41]. South Asia is the highest contributor to stroke mortality in the world, accounting for more than 40% of global stroke deaths [42]. Studies from India have reported the crude prevalence rate of stroke varying from 44 to 843 per 100,000 population [43]. The average annual incidence rate of stroke in India currently is 145 per 100,000 population [44], which is higher than developed countries. In India 10% to 15% of strokes occur in people aged below 40 years and about 80% of strokes are ischaemic [45] The problem is compounded by poor awareness about warning symptoms and risk factors of stroke amongst Indians [46]

Table 2 lists the studies reporting the prevalence of diabetes in people with stroke [47-62]. Most of these studies reveal diabetes to be an important risk factor for stroke. Diabetes was present in about half of stroke patients in a community based Stroke Registry in Trivandrum, South India [63]. However, one case control study with 201 subjects from a rural tertiary care hospital in Nagpur, central India did not find diabetes to be a statistically significant risk factor for ischemic stroke [64].

Studies from various parts of South Asia have reported the prevalence of stroke in people with diabetes to be 6-7% (Table 3). [25,65-67]. Duration of diabetes is seen as an important determinant of development of stroke.

Diabetes has also been shown to be an important risk factor for stroke in migrant South Asians. South Asians with T2DM had higher incidence of stroke than Europeans (HR 1.97, p=0.038) in the population based prospective 'Southall and Brent Revisited (SABRE)' study from Southall, London, UK [68] In a study of 9,731 patients from 20 general practices in South Africa, South Asians with stroke had a higher prevalence of diabetes than whites with stroke (26% vs. 8%, respectively) [69] Diabetes was also found to be more frequent in Asian Indian (52%) compared to Chinese (40%) patients with ischemic stroke in Singapore [70]. The mortality due to stroke is higher in migrant South Asians than in white Caucasians and glycemic status has been seen to be a predictor of long-term stroke mortality [71]. In a study of 242 South Asian patients with ischemic stroke in Birmingham, UK, diabetes was an independent predictor of five year mortality (OR 1.65, p=0.039) [72].

Similar to the trends with CAD, recent studies from North America have not shown an increased prevalence of stroke in South Asians with diabetes. In the Kaiser Permanente Northern California Diabetes Registry, South Asians and whites had a similar incidence of stroke (3.4 vs. 3.9 per 1000 person-years, respectively) [36]. Similar results were seen in a prospective study from Ontario, Canada (Age- and sex-standardized incidence rates 2.0 and 3.9 per 1000 person years in South Asians and Europeans, respectively, HR 0.82, p<0.004) [37]. Finally, the UKPDS study also found no association between Asian Indian ethnicity and stroke among 4,273 patients after 18 years of follow up [7].

Peripheral Vascular Disease

Peripheral vascular disease (PVD) is a manifestation of atherosclerosis in the arteries of lower limbs. It is a potentially serious complication of diabetes and can result in significant morbidity because of ischemic pain, diabetic foot, non-healing ulcers and amputation. Diabetes is an important cause of PVD. Of note, 30% of 99 patients undergoing aorto-bifemoral bypass in Vellore, South India had diabetes [73].

A population based study from Chennai, South India showed a prevalence of PVD to be 8.3%.75 Several clinic based studies

Table 2 Prevalence of Diabetes among patients with Stroke in South Asia

Author	Year	Setting	Place	Sample Size	Prevalence of diabetes/ OR for stroke
Kulshrestha et al [47]	2013	Tertiary care hospital	Bareilly, North India	157,stroke	DM alone:8.9% DM with hypertension:14.6% DM with smoking: 7.6%
Baskar et al [48]	2013	Hospital	Chennai, South India	150, stroke	33.3%
Shah et al [49]	2013	Case control study in tertiary care hospital	Peshawar, Pakistan	50, stroke cases, 100 controls	Diabetes had OR of 2.49 for stroke
Basharat et al [50]	2012	Tertiary care hospital	Islamabad, Pakistan	281, ischemic stroke	59.8%
Zahra et al [51]	2012	Tertiary care hospital	Karachi, Pakistan	250, stroke without pre-existing diabetes	20% newly diagnosed with diabetes
Maskey et al [52]	2011	Teaching hospital	Pokhara, Nepal	160, stroke	9.3%
Taj et al [53]	2010	Tertiary care hospital	Karachi, Pakistan	159, stroke	40.3%
Sridharan et al [54]	2009	Community based	Trivandrum, South India	Urban 431 Rural 110,Stroke	Urban 48.7% Rural 55.7%
Nagraja et al [55]	2009	3 tertiary care hospitals	Bangalore, South india	1174, stroke	23%
Kalita et al [56]	2009	Tertiary care hospital	Lucknow, North India	198,ischemic stroke	24.7%
Kamal et al [57]	2009	Community(urban slum)	Karachi, Pakistan	545, stroke	OR for stroke 1.76 for RBG >180mg/dL
Khan et al [58]	2009	Tertiary care hospital	Karachi, Pakistan	55, stroke	36.3%
De Silva et al [59]	2009	Teaching hospital	Nugegoda, Sri Lanka	41, stroke, age <45 years	5%
Devkota et al [60]	2006	Teaching hospital	Kathmandu, Nepal	72, stroke	11.1%
Jafar [61]	2006	Community	Karachi, Pakistan	24, stroke	33.3%
Pathak et al [62]	2006	Teaching hospital	Kathmandu, Nepal	72,stroke	8.0%

RBG; Random blood glucose.

have reported prevalences varying from 4-15%, the higher rates seen in patients with a longer disease duration (Table 4) [23,25,74-81]. Studies from Pakistan have shown a higher prevalence, however these studies used only low ankle brachial index (ABI<0.9) as the diagnostic criterion for PVD. In a multi-centric study done in clinics in India, Tanzania and Germany, the prevalence of PVD was seen to be lower among Indian patients with diabetic foot ulcers compared to German patients (13% vs. 48%, respectively) [79]. In a clinic based study (n = 597, newly diagnosed patients with diabetes) in the suburbs of the Colombo area 4.8% patients had intermittent claudication and 1.8% had lower extremity amputation (LEA) [82]. A statistically nonsignificant higher prevalence of PVD was reported in Asian Indians comapred to Malays (19.8% vs. 5.8%) in a study in people with diabetes from Kuala Lumpur, Malaysia [83].

Although macrovascular disease such as cardiovascular disease occurs earlier and in a more severe manner in South Asians comapred to white Caucasians, it appears that the prevalence of PVD is lower. Asian Indians had a lower risk of PVD (0.43, CI 0.23-0.82) compared to White Caucasians in the UKPDS study [7]. In a study in London UK, Indian Asians had lower femoral intima media thickness (IMT) comapred to Europeans for similar levels of coronary atheroma as quantified by coronary CT (p=0.05) [84]. In

Table 3. Prevalence of Stroke Among People with Diabetes in South Asia

Author	Year	Setting	Place	Sample Size	Duration of diabetes/relation With stroke	Prevalence
Masod et al [66]	2013	Hospital	Mirpur, Pakistan	318	6.7±5.4 years	Stroke 7.3% TIA 1.3%
Vaz et al [25]	2011	Community based	Rural Goa,South India	130	Newly diagnosed	Stroke 6.9%
Khuwaja et al [67]	2004	3 diabetes clinics	Karachi, Pakistan	672	OR of duration>5 years for stroke: 1.94	Stroke 6.8%
Hashim et al [68]	1999	Primary care centres	Rawalpindi, Pakistan	805	Stroke seen with duration>15 years	Stroke 6.2%

TIA: Transient ischemic attack

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Table 4. Prevalence of Peripheral Vascular Disease in Diabetes in South Asia

Author	Year	Place	Setting	Sample Size	Duration of diabetes	Prevalence
Pradeepa et al [74]	2014	Chennai, South India	Population based	1755	No PVD:4.7±5.4 years, PVD:7.4±6.6 years (p<0.001)	Known diabetics:8.6%, newly detected diabetics: 6.4%, overall 8.3%
Das et al [23]	2012	Pan India	885 centres across India	20653	*	7.0%
Ali et al [75]	2012	Karachi, Pakistan	Hospital	387	9.3±6.3 years	39.2%∞
Vaz et al [25]	2011	Rural Goa, South India	Community	130	Newly detected diabetes	11.5%□
Akram et al [76]	2011	8 centres across Pakistan	Hospital	830	Low ABI: 8.5±6.2 Normal ABI:9.4±6.4 (p=0.052)	31.6%*
Viswanathan et al77	2006	Chennai, South India (Rural and Urban)	Clinic	1377 Urban 1265 Rural	Urban 12.9±8.0 years Rural12.5±7.6 years	Urban 15% Rural 13%
Viswanathan et al [78]	2005	Multicentric Chennai, Madurai, Vellore, Delhi	Clinic	1329	6.9 ± 5.9 years	4.8%
Morbach et al [79]	2004	3 centres one each in Germany, Tanzania and India (Chennai)	Clinic based	613 patients with diabetic foot lesions	Mean duration Germany: 14 years India: 12 years Tanzania: 5 years	Germany 48% Tanzania 12% India 13%
Premlatha et al [80]	2000	Chennai, South India	Population based	1262 subjects underwent OGTT	*	6.3% in individuals with diabetes
Mohan et al [81]	1996	Chennai, South India	Clinic based	726	>25 years	15.4%

OGTT Oral Glucose Tolerance Test, ∞Peripheral Vascular Disease defined as ankle brachial index <0.9, □ Peripheral Vascular Disease defined as history of intermittent claudication/absent peripheral pulses/ulcer/amputation, *No data

an analysis of 25,308 amputations and 13,6215 revascularisations in England, South Asians had approximately half the risk of amputation both with and without a revascularisation than Whites despite much higher rates of known atherosclerotic risk factors [85]. The reason for this intriguing disparity is not known. It is possible that atherosclerosis in different vascular beds is governed by different factors. A lower rate of smoking in South Asians compared to white Caucasians [86] may be a contributing factor.

Diabetic Foot

Diabetic foot is a major complication of diabetes, accounting for nearly 35% of all hospital admissions. It is also the commonest cause of non-traumatic amputations of the lower limb. Due to the significant morbidity and mortality, patients with diabetic foot incur the highest economic burden of all the complications of diabetes. [87]. Certain practices such as barefoot walking are common in rural areas in South Asia [88] and contribute greatly to foot ulcerations [89] Unsafe foot wear practices were seen in 46.9% of 300 people with T2DM in Mumbai, India [90]. Wearing covered shoes was protective against development of ulcers in a study in 168 patients with DM in Sri Lanka (OR 0.003) [91] In a cross sectional study in seven states across India, 56.4% of the population in the urban area and 46.6% of the population in the rural area had knowledge of foot care in diabetes [92]. On the other hand, only 6% of patients with diabetes practised proper foot care in Islamabad, Pakistan [93]. The incidence of foot ulcer was 9% and 39.8% (p < 0.001) among patients with diabetes who practiced and who did not practice foot care respectively in a study from Kochi, South India [94]. The problem is compounded by the lack of preventive foot care services in large parts of South Asia. In the Delhi Diabetes Community (DEDICOM) survey, only 3% patients with diabetes had a foot examination in the preceding year [95]. Provision of foot care education was shown to lead to a significant decline in the incidence of ulcers in people with diabetic neuropathy in South India [96].

The prevalence of diabetic foot in South Asia varies from 4-9% with 20-25% of these patients needing amputation (Table 5) [97-106]. North India and Pakistan have reported higher amputation rates than South India. Rural areas have a higher rate of foot infection and amputation than urban areas. Importantly, recurrence has been reported in more than half the patients with diabetic foot ulcer.

The prevalence of diabetic foot is lower in migrant South Asians. In a multi-centric study conducted on subjects with diabetes

Table 5. Prevalence of Diabetic Foot and Amputation in South Asia

Author (Year)	Place	Sample Size	Results(%)		
			Ulcer/ Infection	Amputation	Recurrence of ulcer
Zubair et al (2011) [97]	Aligarh, North India	162,patients with DFU		28.4	
Ashraf et al (2011) [98]	Wah, Pakistan	115, patients with DFU	*	25	*
Aamir et al (2011) [99]	Peshawar, Pakistan	114, patients with DFU	*	Toe:17 Major: 6	*
Jayaprakash et al (2009) [100]	Chandigarh	1044 T2DM assessed for foot at risk 149 patients with foot at risk followed up for a mean of 9 months	9	20.2	3.4
Mehra et al (2008) [101]	Wardha (Western India)	500,DM	10.4	*	*
Viswanathan et al (2006) [102]	Chennai (Rural and Urban)	1377 Urban 1265 Rural ?DM	Urban 26 Rural 34	Urban 3 Rural 8	*
Viswanathan et al (2005) [103]	Chennai, Madurai, Vellore, Delhi	1329 T2DM	7.6	3	*
Khuwaja et al (2004) [104]	3 centres in Karachi, Pakistan	672,DM	3.9	*	*
Ali et al (2001) [105]	Karachi, Pakistan	100, patients with DFU	*	Toe:15 Below Knee: 6	*
Vijay et al (2000) [106]	Chennai, South India	374 patients with surgical procedure for foot infection	*	*	53

DM: Diabetes mellitus, T2DM: Type 2 diabetes mellitus, DFU: Diabetic foot ulcer. *No data

Table 6. Studies on Prevalence of Erectile Dysfunction in people with Diabetes in South Asia

Author	Year	Place	Setting	Sample Size	Duration of diabetes and relationship with ED	Prevalence of Erectile Dysfunction
Dan et al [115]	2014	Kolkata, Eastern India	Hospital	113 married men, mean age 42 years	Duration of treatment of diabetes 21.3±17.2 months	38.9%
Goyal et al [116]	2013	Ludhiana, North India	Teaching hospital	348 men, age 25-75 years	Duration significantly associated with severity of ED (p= 0.000034)	ED 77.2% Severe ED 14%
Ahmed et al [117]	2013	Peshawar, Pakistan	Hospital	217 married men, mean age 43 years	Increased prevalence with increased duration	ED 97.2% Severe ED 20.7%
Kuma [118]	2011	Kochi, South India	Tertiary care hospital	147 men, mean age 51 years	21±9 years	58%
Viswanathan et al [119]	2009	Chennai, South India	Tertiary care hospital	423 men	Duration of diabetes associated with severity of ED.	ED 44.4% Severe ED 8%
Meena et al [120]	2009	Bikaner, Western India	Teaching hospital	50 men	ED: 8.9±6.3 years No ED:2.8±1.9 years (p=0.003)	ED 78% Severe ED 36%
Malavige et al [121]	2008	Colombo, Sri Lanka	Clinic	253 men	ED associated with duration (OR 1.48)	ED 73.1% Severe ED 33.2%

Legend to table 6: ED: Erectile dysfunction

having undergone amputation in India, Tanzania and Bangladesh, the recurrence rates of ulcer were 9% and 11% in India and Bangladesh, respectively as opposed to 30% in Tanzania [107]. In a retrospective study of hospital discharge database of 44,917 hospitalized patients with diabetes in Singapore, Indians had lower rates of lower extremity amputation (LEA) comapred to Malays and Chinese (OR 0.784 for Indians vs. Chinese) [108]. Studies comparing migrant South Asians with white Caucasians in the UK have shown 3-fold lower rate of foot ulcer [109] and a 4-fold lower rate of amputation [110]. In the Kaiser Permanente Northern California Diabetes Registry, South Asians with T2DM had much lower rates of LEA compared to whites (OR 0.38) [36]. Similarly, in another population-based study in a cohort of 491,243 adults with newly diagnosed diabetes in Ontario, Canada who were followed for a median of 4.7 years, the incidence of LEA was lower in South Asians than Europeans (age

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and sex standardized incidence rate 0.2 and 0.7 per 1000 person years, respectively, HR 0.31, p<0.0001) [111]. This is despite the fact that preventive foot care practices are often not observed in South Asians as seen in a Canadian study in which 60% of recent immigrants from South Asia and China with diabetes never examined their feet [112]. Shorter height of South Asians may delay the onset of neuropathy which may protect against development of diabetic foot [113].

Erectile Dysfunction

Erectile dysfunction (ED) as a complication of diabetes often does not receive much attention. Several factors such as hesitation and embarrassment on the part of either patient or the physician, incorrect perception of ED being an age related 'normal' phenomenon and lack of understanding about the underlying serious disease are responsible for suboptimal identification and management of this disorder. ED has been shown to contribute to poorer quality of life in Asian Indians with diabetes [114].

The prevalence of ED in South Asian patients with diabetes has been reported to be between 38-97% (Table 6) [115-121]. The main factors associated with ED are age, duration of diabetes, glycemic control, presence of neuropathy and retinopathy.

There is limited information available on erectile dysfunction in migrant South Asians. In California men's health study on 78,445 men aged 45-69 years, Asian men were less likely to report severe ED relative to white men (OR 0.9) [122]. In a recent study of men with a mean age of 56 years from 25 general practitioners in UK, the prevalence of erectile dysfunction and reduced libido was similar in South Asians and Europoids (84.8% and 84.1%, respectively) with diabetes [123].

Conclusions and Future Perspectives

The epidemiology of macrovascular complications of diabetes in South Asians has unique features with a higher prevalence of coronary artery disease and cerebrovascular disease compared to individuals of other ethnicities. This poses a huge challenge for the developing economies in South Asia. Though the prevalence of peripheral vascular disease and diabetic foot is generally lower in South Asians than in other ethnicities, the sheer numbers of people affected by diabetic foot make this a huge challenge. There is a long pending need for robust population –based epidemiological data on various complications of diabetes from this part of the world, as the existing data is mostly clinic based, sparse and incomplete.

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Declarations of Interest

The authors declare no conflicts of interest.

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