Cardiovascular Disease Risk in Immigrants: What Is the Evidence and Where Are the Gaps?

Asia-Pacific Journal of Public Health
23(6) 882–895
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DOI: 10.1177/1010539509360572
http://aph.sagepub.com
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Abstract

Objectives: This study systematically reviewed the peer-reviewed literature to establish morbidity and mortality from myocardial infarction (MI) and stroke among immigrant populations. *Methods:* The review considered only studies published between 1986 and 2008 that provided data on MI or stroke morbidity/mortality among first-generation immigrants. A prespecified search strategy identified 58 studies for possible inclusion. Of these, 12 met the inclusion criteria. *Results:* Immigrant MI mortality and morbidity varied by host country with no consistent pattern from one country or region. However, there was an overall trend for increasing risk of MI among immigrants worldwide. Chinese and African immigrants had consistently higher stroke mortality. *Conclusion:* MI and stroke incidence and prevalence among first-generation immigrants are related to both genetic and environmental factors, but the relative contribution of each is unclear. Prospective studies are needed to identify genetic and behavioral characteristics associated with stroke among Chinese immigrant populations.

Keywords

immigrants, cardiovascular disease, culture difference

Introduction

Migration has led to rapid demographic changes across the globe, with the world's population likely to become increasingly integrated in the new millennium.[1] Population mobility is a central factor driving the expansion of globalization. The levels of immigration and travel, including the

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migration of skilled labor, are likely to remain at least at current levels or to increase rapidly.[2] In the past, migration was influenced by decolonization, refugee movements, civil disturbances, and political, social, and economic occurrences.[2] During the 20th century, reasons for migration have included war, poverty, politics, economic and religious factors, and the need for skilled labor.[2] Traditionally, migration has been predominantly from Europe to countries such as the United States, the United Kingdom, and Australia, but these patterns have changed over the past decade, with many immigrants now moving from Asia, Africa, Central and South America, and Middle East nations to the United States, Australia, the United Kingdom, and Canada.[3]

The growth in migration has stimulated attention to the epidemiological features of migrant health.[2] Those who emigrate from a country tend to be healthier than those who remain, but the health of immigrant populations also varies with a range of factors, including the country of origin, the receiving country, gender, and the age at migration.[2,4,5] On the other hand, challenging this healthy migrant effect is evidence of increasing prevalence of some diseases, especially cardiovascular diseases, in some of the countries of origin for immigrants. For many immigrant groups there are substantial changes in lifestyle in their new homeland, with greater modernization and mechanization and often a more sedentary and stressful lifestyle, and these changes may act to increase risk factors for cardiovascular disease (CVD).[6] Moreover, if immigrants' access to things such as education, employment, housing, transport, health care facilities, and social support—all social determinants of health—is marginal in their new country of residence, this also may be associated with increase in risk of CVD.[7]

Myocardial infarction (MI) and stroke comprise the majority of CVDs. Although these diseases are the single largest killers around the world[8] and there is some evidence that migrants are at a higher risk of having these diseases, there is no coherent picture of rates of morbidity and mortality from MI and stroke among different immigrant groups. Literature reviews on CVD among immigrants have adopted various approaches and looked at a range of immigrant groups located in various host countries. A review by Kernicki[9] in 1997 investigated differences in risk factors for CVD among major US immigrant groups. In 2004, Kuller[10] reviewed literature comparing arteriosclerosis, CVD, and lipid metabolism among the black African and the Hispanic white population in the United States, focusing on genetics, lifestyle, and environmental interactions and related deficits. The 4 British reviews, by McKeigue et al[11] in 1989, Dhawan[12] in 1991, Bopal[13] in 2000, and Jaumdally et al[14] in 2006, looked at literature on CVD in Britain's largest immigrant population, that from South Asia. In the Netherlands, Uitewaal et al[15] in 2004 reviewed risk factors and the prevalence of CVD among 2 of their country's largest immigrant subgroups, Turkish and Moroccan.

The existing literature reviews do not comprehensively demonstrate which immigrant groups are at increased risk compared with the host populations. There is also a lack of information on whether patterns of MI and stroke mortality and morbidity among immigrants have changed over recent years given the shift in immigration patterns that has occurred. The current literature review addresses these gaps. We have conducted a systematic review of the published peer-reviewed literature to establish the prevalence of MI and stroke morbidity and mortality among immigrant populations around the world, and whether being an immigrant is a risk factor for MI and stroke.

Methods

Study Selection

We searched PubMed, MEDLINE, EMBASE, PROQUEST, and CINAHAL for articles published in the peer-reviewed journals from 1985 to 2008, using the following search terms: migration, immigration, emigration, immigrant, emigrant, and country of birth, in combination with ischemic

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heart disease, acute myocardial infarction (AMI), myocardial infarction (MI), heart attack, coronary thrombosis, cerebrovascular disease, and stroke.

Reviews were included if they

- presented original data on the prevalence or incidence of MI and/or stroke in first-generation immigrants;
- used one of the following study designs—retrospective, prospective, case control, cross-sectional survey; and
- included a control group, comparing the immigrant population to either the host population or the country or region of origin.

Studies were excluded if they focused on people who emigrated specifically to do farming or agricultural work; returned migrants; or refugees and asylum seekers. Studies of second generation immigrants were not included, nor were opinion or review articles. Finally, studies which did not properly establish the country of birth of the immigrant groups were also excluded.

Extraction and Synthesizing Data

The information relating to MI and stroke was extracted and tabulated. The methodology of each study was evaluated, including the study population and selection methods (eg, simple method random vs nonrandom), sample size in relation to the size of the immigrant population under study, age distribution of the study group, and the methods used to identify patients and prevalence of morbidity and mortality.

Results

The search initially yielded 58 papers of potential interest. Of these 19 were selected based on title or abstracts, and 12 of these were reviewed: 6 studies that provided original data on MI morbidity and/or mortality (3 retrospective, 2 prospective, and 1 case-control study of MI); and 6 studies that provided data on stroke morbidity and mortality (4 retrospective and 2 prospective studies).

For the United States, a total of 6 studies were conducted: 3 retrospective[16-18] and 1 was a case-control.[19] For the United Kingdom,[20] Sweden,[21] and Israel,[22] 1 prospective and 1 retrospective[23] study was conducted, respectively. Australia[24] and Canada[25] each had only 1 retrospective study conducted in total. All the studies calculated the age-adjusted rates and rate ratio with 95% confidence intervals. All used the host population (those who were born in the receiving country) as a reference group.

Table 1 presents the general characteristics of the studies of MI morbidity and mortality. The majority of studies used hospital admission or MI records as a mode of data collection: 3 retrospective studies[16,24,26] and 1 prospective[20] study provided MI morbidity data based on hospital admission data; 1 study[23] collected MI mortality data prospectively; 1 used medical histories to identify a history of MI.[19] Findings indicated that studies from different countries in general targeted different single immigrant groups except Australian and Swedish studies. The Australian and Swedish studies targeted more than one immigrant groups for their studies. Moreover, majority of studies did not indicate any uniform system of the aggregation of countries of birth to regional groups. Nearly half of studies were collected their data 5 or more years ago.

Table 2 presents the general characteristics of the studies of stroke morbidity and mortality. One of the retrospective studies[18] presented stroke morbidity data based on hospital admission data, and 3 retrospective studies[17,25,27] collected mortality data from death certificates. One study[21] collected morbidity data prospectively through hospital admissions and another[22] collected

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Table 1. Characteristics of 6 Studies of MI Morbidity and Mortality Among Immigrants

First Author, Year, Country, and Study Design	Study Population	Age Range (Years)	Sample Size by Ethnic Group	Data Collection Method and Available Data
Rosamond et al,[16] 2001, USA, retrospective	Black (ethnicity not defined)	35-74	White 8387 M, 3686 F[a]; Black 1475 M, 1294 F	Hospital admission of AMI (incidence)
Fridman et al,[19] 2006, USA, prospective observational case control (2004-2005)	Former Soviet Union	20-74	Former Soviet Union 47 (M and F); American-born Caucasians 56	Self-reported history of MI (incidence)
Adler et al[20], 1998, UK, prospective	White (UK); South Asian; Afro-Caribbean	24-65	White 4974 (M and F); South Asian 490; Afro-Caribbean 383	Physician-reported fatal and nonfatal MI (incidence)
Dotevall et al,[26] 2000 Sweden, retrospective (1990-1996)	Swedish; Finnish; Balkans; Turkish; Middle Eastern; Central/East European; West European; North American; African	25-64+	Swedish 1740 (M and F); all immigrants 378	Population records of MI (incidence)
Taylor et al,[24] 1999 Australia, retrospective	Australian; New Zealand; UK and Ireland; Southern European; North West European; East European; Middle Eastern; Asian	35-74	Australian 18 597 M, 7799 F; New Zealand 217 M, 68 F; UK and Irish 2003 M, 761 F; Southern European 1912 M, 465 F; North West European 663 M, 195 F; East European 609 M, 271 F; Middle Eastern 774 M, 208 F; Asian 638 M, 234 F	Hospital admission of AMI (incidence)
Brodov et al,[23] 2002, Israel, prospective	Former Soviet Union	45-74	Israeli-born 836 M and F; Soviet Union 2684 M and F	Death records of MI

Abbreviations: MI, myocardial infarction; AMI, acute myocardial infarction; M, male; F, female.
[a]Hospital admission for myocardial infarction for both males and females.

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Table 2. Characteristics of 6 Studies of Stroke Morbidity and Mortality Among Immigrants

First Author, Year, Country, and Study Design	Study Population	Age Range (Years)	Sample Size by Ethnic Group	Data Collection Method and Available Data
Fang et al,[17] 1999, USA, retrospective	Chinese immigrants; Chinese living in China	25-65+	Chinese 245 M, 565 F; White 3165 M, 172 F	Death certificate (mortality)
Muennig et al,[18] 2004, USA, retrospective	NR	00-65+	Indian 1083 M, 8179 F[a]	Hospital admission (incidence)
Wild et al,[27] 1997, UK, retrospective	Scottish; Irish; East African; West African; Caribbean; South Asian	25-74	English 97 454[b] M and F; Scottish 1928; Irish 2663; East African 99; West African 69 952; Caribbean 886; South Asia 1347	Death record (population census)
Kahn et al,[21] 2004, Sweden (prospective)	Swedish; German; from former Yugoslavia; Chilean; Danish; Polish; Finnish; Norwegian; Romanian; Former Soviet Union; from former Czechoslovakia; Hungarian; Chinese/ Vietnamese	40-98	Swedish 813 574[c] (M and F); German 12 786; Yugoslavian 31 061; Chilean 2819; Danish 21 571; Polish 19 675; Finnish 11 751; Norwegian 3966; Romanian 3515; former Soviet Union 2409; former Czechoslovakia 3969; Hungarian 9801; Chinese/ Vietnamese 2374	Medical records (incidence)
Tanne et al,[22] 1998, Israel, prospective	North African; Middle Eastern; European; Asian; African	45+	Balkan 1688[c] M and F; Central European 1337; East European 1861; Israeli 1377; Middle Eastern 2291; North African 2291 (total 9734)	Medical records (mortality)
Sheth et al,[25] 1999, Canada, retrospective	European (Canadian); South Asian; Chinese; other immigrants	35-75	European (Canadian) 48 054[d] M and F; South Asian 409; Chinese 858; other immigrants 15 877	Death records (cerebrovascular disease; mortality)

Abbreviations: M, male; F, female; NR,
[a]Information from hospital admission billing records.
[b]Total number of deaths both periods (1970-1972 and 1989-1992).
[c]Total number of follow-ups.
[d]Total number of deaths.

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mortality data prospectively through medical records. In contrast to MI, stroke mortality data were collected largely through death records. The findings suggested that fewer studies have been conducted prospectively on stroke morbidity and mortality around the world. In contrast to MI, studies on stroke targeted more than one immigrant groups for their study population. Nearly half the studies targeted the elderly population as the reference study population. Also in contrast to MI, larger samples were included in the studies on strokes.

Table 3 presents the data from each study on prevalence and incidence of MI. One US study reported that age-adjusted hospitalization rates of MI from 1987 to 1996 were higher among black immigrants, both men (4.1%) and women (4.9%), compared with the US white men (0.95%) and women (0.5%) population.[16] Another US study found that the self-reported incidence rates of MI from 2004 to 2005 were significantly high among immigrants from the former Soviet Union (45%) compared with US Caucasian (20%) population.[19] A Swedish study reported that, from 1990 to 1996, hospital admission rates for MI, for all immigrants (21.7%; Middle East, Central/Eastern Europe, Western Europe, North America, Asia, Africa, and Finland) were higher than for the overall Swedish population but not significant.[26] A British study found physician-reported incidence rates of MI from 1997 to 1996 were significantly higher among South Asian male (20.8 per 1000) immigrants compared with the UK male (18.0 per 1000) population.[20] An Australian study based on a New South Wales hospital admission data for 1991-1992 to 1995-1996 found that the age-adjusted relative risk of AMI was consistently significantly higher among Middle Eastern male (1.42) and female (1.38) immigrants compared with the corresponding Australian-born population.[24] In contrast, an Israeli study found that mortality from MI based on death certificate during the period from 1990 to 1997 was lower among immigrants from the Soviet Union (age ≤55 years, 73.7%; age 56-65 years, 71.0%) compared with the Israel-born (aged ≤55 years, 76.9%; age 56-65 years, 74.8%).[23]

Although the findings of MI were inconsistent, there were general trend of increasing risk of MI among immigrant population around the world. In the United States, black male (4.1%) and female (4.9%) immigrants, and those from the former Soviet Union (45%) were found to be at a highest risk of MI compared with the host population. Other studies found that in the United Kingdom, South Asian male (20.8 per 1000) immigrants were at a higher risk, and in Australia, Middle Eastern male (1.42) and female (1.38) immigrants were at a higher risk, whereas in Israel, immigrants from the former Soviet Union (age ≤55 years, 73.7%; age 56-65 years, 71.0%) were found to be at a lower risk. Finally, in Sweden, all immigrants (21.7%) were found to be at high risk of MI.

The findings across these studies enable some interesting differences to be identified in levels of MI risk across immigrant groups from the same country or ethnic background, but residing in different host countries. Immigrants from the former Soviet Union who were living in the United States were at higher risk for MI than middle-aged Soviet Union immigrant who were living in Israel.

Table 4 presents the data on prevalence and incidence of stroke. The age-adjusted death rates for stroke for the period 1988 to 1992 were reported to be higher and among Chinese people who migrated to New York compared with the overall New York white population. Moreover, risk of stroke was substantially higher among Chinese male (115.9 per 1000 000) and female (116.7 per 1000 000) people living in mainland China compared with Chinese male (13.4 per 1000 000) and female (17.7 per 1000 000) people who migrated to New York.[17] Similarly, hospital admission rate ratios showed the incidence of stroke to be similar among Indian-born male (1.0) immigrants in the United States compared with the US male (1.0) population.[18] The Swedish study found that the age-adjusted incidence rate ratio of stroke reported through medical records for the period 1990 to 2000 was significantly higher for both men (1.34) and women (1.45) from Yugoslavia, men (1.45) from Hungary, and women (2.32) from China and Vietnam,

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Table 3. Data From 6 Studies of Prevalence and Incidence of MI Among International Immigrants

Study (Year)	Study Type and Period	Immigrant and Reference Groups	Percentages and Rates (95% CI)	
			Male	Female
Rosamond et al[16] (2001)	Hospital discharge of MI age-adjusted incident rates (%) with 95% CI; 1987-1996	Black	4.1% (0.7, 7.5)	4.9% (0.3, 9.6)[a]
		White (reference group)	0.9% (0.5, 1.7)	0.5% (1.2, 2.2)
Adler et al[20] (1998)	Age-standardized physician-reported MI incidence rates per 1000 with 95%CI; 1977-1996	South Asian	20.8 (14.0,29.3)[b]	2.7 (0.9, 6.6)
		Afro-Caribbean	5.6 (2.9, 9.8)	2.4 (0.9, 5.4)
		White (UK; (reference group)	18.0 (16.1, 19.9)	10.4 (8.7, 12.0)
Taylor et al[24] (1999)	Age-adjusted hospital admission of AMI relative risk with 95% CI; 1991/1992-1995/1996	New Zealand	0.76 (0.58, 1.00)	0.73 (0.52, 1.02)
		UK and Ireland	0.76 (0.70, 0.84)	0.85 (0.77, 0.95)
		Southern European	0.85 (0.78, 0.94)	0.77 (0.68, 0.88)
		North West European	0.86 (0.74, 1.00)	0.76 (0.62, 0.93)
		East European	0.85 (0.73, 1.00)	1.03 (0.86, 1.22)
		Middle Eastern	1.42 (1.23, 1.64)[b]	1.38 (1.14, 1.68)[b]
		Asian	0.66 (0.57, 0.78)	0.65 (0.54, 0.78)
		Australian (reference group)	1.00	1.00
Brodov et al[23] (2002)	Prevalence of MI in %; mortality; 1990 + 7-year follow-up	Former Soviet Union; Israeli (reference group)	Age (years)	Israeli / Former Soviet Union
			≤55	76.9 / 73.7[c]
			56-65	74.8 / 71.0
			≥66	70.7 / 70.7
Fridman et al[19] (2006)	Self-reported MI in %; incidence; 2004-2005	Former Soviet Union; US-born Caucasian (reference group)	45%[b,d]; 20%	
Dotevall et al[26] (2000)	Hospital admission MI in %; 1990-1996	All immigrant groups; Swedish born (reference group)	21.7%[b,d]	

Abbreviations: MI, myocardial infarction; AMI, acute myocardial infarction; 95% CI, 95% confidence interval.
[a]Age-adjusted annual percentage of MI (95% CI).
[b]$p < .05$ significance difference.
[c]Overall mortality percentage of MI.
[d]Overall incidence percentage of MI.

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Table 4. Data From 6 Studies of Prevalence and Incidence of Stroke Among International Immigrants

Study (Year)	Study Type and Period	Immigrant and Reference Groups	Rates and Rate Ratios (95% CI)	
			Male	Female
Fang et al[17] (1999)	Age-adjusted death rates per 100 000; 1988-1992	China (mainland)	115.9	116.7
		Chinese NYC	13.4	17.7
		US-born white (reference group)	12.9	14.9
Muennig et al[18] (2004)	Incidence rate ratios with 95% CI during year 2000	Indian born	0.75 (0.68, 0.83)	0.80 (0.73, 0.87)
		USA (reference group)	1.00 (0.98, 1.02)	0.99 (0.99, 1.01)
		Total Indian born	1.00 (0.99, 1.01)	
Kahn et al[21] (2004)	Age- and sex-adjusted rate ratio with 95% CI (1990-2000)	German	0.92 (0.64, 1.33)	1.08 (0.81, 1.4)
		Former Yugoslavian	1.34 (1.06, 1.70)[a]	1.51 (1.16, 1.96)
		Chilean	1.51 (0.68, 3.37)	0.26 (0.04, 1.8)
		Danish	1.07 (0.83, 1.38)	0.86 (0.66, 1.12)
		Polish	1.04 (0.75, 1.43)	1.05 (0.79, 1.39)
		Finnish	1.23 (0.80, 1.89)	1.04 (0.72, 1.51)
		Norwegian	1.18 (0.67, 2.1)	0.66 (0.34, 1.27)
		Romania	0.14 (0.02, 0.96)	0.16 (0.02, 1.1)
		From former Soviet Union	1.78 (0.99, 3.2)	1.31 (0.7, 2.4)
		From former Czechoslovakia	1.31 (0.74, 2.3)	0.57 (0.21, 1.5)
		Hungarian	1.45 (1.03, 2.0)[a]	1.30 (0.85, 2.0)
		Chinese/Vietnamese	1.1 (0.50, 2.5)	2.32 (1.32, 4.1)[a]
		Swedish (reference group)	1.00	1.00
Sheth et al[25] (1999)	Age standardized death rate ratios for cerebrovascular disease (1993-1997)	South Asian	47.0 (40.5, 53.5)	39.0 (33.4, 44.7)
		Chinese	45.8 (41.4, 50.3)	42.2 (38.3, 46.1)
		Other immigrants	52.1 (51.0, 53.3)	38.0 (37.1, 38.9)
		Canadian (reference group)	49.5 (48.9, 50.1)	34.8 (34.4, 35.3)
Wild[27] (1997)	Standardized mortality ratio per 10 000 with 95% CI cerebrovascular disease (1970-1972 and 1989-1992)	Male	1970-1972	1989-1992

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Table 4. (continued)

Study (Year)	Study Type and Period	Immigrant and Reference Groups	Rates and Rate Ratios (95% CI)	
			Male	Female
		Scottish	183 (68, 199)	125 (115, 136)
		Irish	234 (154, 166)	138 (128, 148)
		East African	NR	114 (86, 147)
		West African	NR	271 (210, 344)
		Caribbean	394 (338, 457)	168 (151, 186)
		South Asian	226 (198, 256)	155 (143, 168)
		English (reference group)	195 (191, 199)	100
		Female		
		Scottish	198 (180, 218)	125 (113, 137)
		Irish	235 (216, 254)	123 (113, 133)
		East African	NR	122 (88, 194)
		West African	NR	181 (118, 256)
		Caribbean	463 (389, 547)	157 (136, 179)
		South Asian	246 (210, 286)	141 (127, 157)
		English (reference group)	206 (202, 210)	100
Tanne et al[22] (1998)	Age-adjusted stroke mortality rates per 10 000; 21-year follow up	Balkan countries	11.3[b]	
		Central European	11.6	
		East European	12.4	
		Middle Eastern	17.1	
		North African	19.0	
		Israeli (reference group)	15.9	

Abbreviations: 95% CI, 95% confidence interval; NR, .
[a]$P < .05$ significance difference.
[b]Overall mortality rates of stroke per 10 000.

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compared with the overall Swedish population.[21] A UK study based on death records reported that mortality rates from of cerebrovascular disease from 1970 to 1992 were higher among men (394 per 10,000) and women (463 per 10,000) who had migrated from Caribbean compared with the UK men (195 per 10,000) and women (206 per 10,000) populations and between 1989 to 1992 were higher among men (271 per 10,000) and women (181 per 10,000) who had migrated from West Africa compared with the UK men (100 per 10,000) and women (100 per 10,000) populations.[27] Similarly, the Israeli study reported that the age-adjusted mortality rates from stroke, based on medical records, were higher during the 21-year follow-up among men who had migrated from North Africa (19.0 per 1000) and the Middle East (17.1 per 1000) compared with men (15.9 per 1000) born in Israel.[22] In contrast to the US and Swedish studies, the Canadian study, based on death records for the period 1997 to 1993, found that age-standardized death rates from stroke were higher among overall Canadian male (49.5 per 100,000) population compared with South Asian (47.0 per 100,000) and Chinese (45.8 per 100,000) immigrant men.[25] The findings across the stroke studies consistently suggested that Chinese and African immigrants have a higher death rate from stroke compared with all the other immigrant groups.

Discussion

To the best of our knowledge, this is the first review conducted on the prevalence of MI and stroke among immigrants across the world, looking at whether being an immigrant is a risk factor for MI and stroke. The review provides evidence of morbidity and mortality of MI and stroke among immigrants compared with host populations.

The evidence indicates that MI morbidity and mortality varies among immigrant groups from the same country of origin, who have immigrated to different host countries; and among immigrant groups from different countries of origin, living in the same host country. In the United States, black immigrants[16] and those from the former Soviet Union[19] are at higher risk for MI than their host populations. Furthermore, South Asian immigrants in the United Kingdom,[21] all immigrants in Sweden,[26] and Middle East immigrants in Australia[24] were reported to be at higher risk for MI compared with the host population. Patterns reported across the different studies vary from host country to host country, with no consistent patterns for immigrants from a given country or region. This suggests that the level of MI risk among immigrants is determined by a complex interaction of factors, both individual (including genetic) and environmental, and relating to both country of origin and host country.

With regard to stroke, Chinese-born[17] and Indian-born[18] immigrants in the United States were reported to be at high risk compared with the US-born population. Chinese and Vietnamese immigrants in Sweden, West African and Caribbean immigrants in the United Kingdom,[27] and North African[22] immigrants in Israel were reported to be at higher risk compared with the respective host populations. The available evidence consistently suggests that prevalence of stroke is higher among Chinese and African immigrant groups compared with host populations.

The prevalence and incidence of morbidity from MI among immigrants varied across host countries. In the United States, incidence was shown to be higher among black immigrants and former Soviet Union immigrants.[16,19,28] Incidence was also higher among South Asian immigrants in the United Kingdom[20] and among Middle Eastern immigrants in Australia.[24] In the Israeli study, MI mortality rates were reported to be higher among the host population.[23] The higher morbidity rates in the retrospective studies[16,24] and the cross-sectional survey[22] may be related to exposure to risk factors before immigration. Variations in rates across the studies may also reflect the different methods used to aggregate immigrants to regional subgroups.

Similarly, selection of an immigrant group to study may be determined variously by the size of different immigrant populations in the particular country, their risk profile, or other factors, all of which will vary from country to country. This means that comparability of studies will be very

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limited, and study results will be generalizable only to the particular population from which the sample was drawn.

As with MI, morbidity and mortality rates from stroke also vary from host country to host country. Although the intercountry variations are large, the evidence suggests that, compared with host populations, female Chinese immigrants are at higher risk for stroke morbidity[21] and Chinese male and female immigrants are at higher risk for stroke mortality.[17,25] Furthermore, the prevalence and incidence of stroke among the Chinese population living in China is also reported to be high.[17] Mortality rates for stroke are also consistently reported to be higher among African immigrants[22,27] compared with host populations.

The higher rates of stroke reported in the Chinese population suggest that genetic factors may contribute to the higher stroke mortality and morbidity seen in Chinese immigrant populations.[29] The change of environment may also lead to an increased stroke risk, particularly for women, because of changes in their traditional Asian culture and adjustment stress, which may be associated with increased hypertension.[6,30] Hypertension is a major predictor for stroke.[31] Within Africa, the high incidence of stroke has been explained by a high prevalence of hypertension.[32,33]. This high risk may be further elevated in African immigrant groups by the change of environment, urbanization and acculturation, with adoption of tobacco smoking habits, and increased food intake, including high intake of salt and saturated fats.[32,33]

Limitations

There were a number of methodological limitations in the studies included in this review and these limitations should be taken into account in interpreting the results. The majority of studies were retrospective, with only a small number conducted prospectively on MI[19,23] or stroke.[21,23] Data extracted retrospectively had been collected predominantly for administrative rather than research purposes, and data recording techniques, data entry personnel, and methods of disease classification may vary over time.[16-18,24] The majority of prospective studies did not establish the quality of data. Some studies collected the information through self-report;[19,28] however, there is debate about the accuracy of this method in estimating the true prevalence and incidence of MI or stroke, as people may either underestimate or overestimate when reporting their health conditions.[19] Sampling bias may also have affected the findings in some studies. The study findings, therefore, might be generalizable only to the community belonging to that sample. The Swedish prospective morbidity study, however, was of high methodological quality.[21] The mortality studies relied on death records of MI and stroke.[17,25,27] However, the quality of information based on death records has been widely questioned because of misclassification of the cause of death. In particular, multiple causes of death may be simplified in reporting to a single cause.[34] To draw valid conclusions, it is necessary to study these issues prospectively, across a combination of immigrant groups, rather than focusing on 1 or 2 immigrant groups.

There are 3 different study design methods frequently undertaken to examine particular health effects of migration.[35] First, studies may compare outcomes in a cohort of immigrants with those in the host population. In this review, only 3 studies each on MI[16,24,26] and stroke[17,25,27] fulfill this study design technique. Second, studies may follow up the migrant population to see a decline in health outcomes or characteristics over a period of time. In this review, only 3 studies of MI[19,20,23] and stroke[21,22] used this method. Finally, the effect of migration may be examined by comparing a group of immigrants who remain at their place of origin with nonimmigrant counterparts. In this review, only one study[17] on stroke used this method. Although it is a challenging and difficult task for a researcher to use this method, it does provide a very broad comparison within the study population regarding outcome of disease and condition, and consequently may allow better overall conclusions to be drawn.

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Research on immigrant groups is subject to a number of challenges and limitations. It is, for example, considerably easier to target large immigrant groups than smaller ones, and privacy concerns limit the ability to identify members of an immigrant group, and hence to define the study population. Defining a study population is further complicated by diversity within groups; for example, black Caribbean Africans and black Africans from the African continent. Communication and response rates are affected by both cultural and language differences.[36] In addition, nearly half the studies reviewed were conducted 5 or more years ago, and do not therefore reflect the substantial recent changes in migration patterns.[37,38]

Conclusion

It was apparent from the review that the evidence on immigrant health relates to both genetic and environmental factors; however, the relative contribution of each is unclear. Prospective studies are needed to create a database resource from which data on genetics and behavioral characteristics at individual and population level can be obtained. This will result in a better understanding of the patterns of immigrant health.

International migration will continue to increase during the next decade, and changing immigration patterns will be a major challenge for existing health policy and program frameworks. These challenges need to be addressed to improve public health practice and international health. This would be facilitated by access to health insurance data sets for medical research, as in the Israeli "Health Insurance Databases." Such access is particularly important in countries that receive large numbers of immigrants, such as the United States, Australia, Canada, and New Zealand. Establishment of a database, such as the Swedish "MigMed Research Database," in these countries would also provide an important resource for this research. Finally, international authorities responsible for immigrant health issues should establish a standard international classification system to aggregate immigrant subgroups for data collection and analysis process. However, prospective studies are needed to obtain data on genetics and behavioral characteristics associated with stroke among Chinese immigrant population, because the Chinese population is one of the fastest growing immigrant populations in the world.

Key Messages

- Being an immigrant increases the risk of MI and stroke.
- Genetic and environmental risk factors may interact to increase the risk of MI and stroke among immigrants. Further research is needed to clarify this.
- A linkage health database for public health research should be established in countries that receive large numbers of immigrants.
- An internationally accepted classification system for the aggregation of immigrant subgroups should be developed.
- No clear information is available on whether patterns of MI and stroke mortality and morbidity among immigrants have changed over recent years, with the shift in immigration patterns.

Acknowledgments

The authors wish to thank Dr Peter Swan for his valuable contribution. They also wish to thank Michael Cahill, Group Manger—Policy & Development Sector, Sports and Recreation Victoria, for his generous encouragement.

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Declaration of Conflicting Interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The authors disclosed receipt of the following financial support for the research and/or authorship of this article:

Department for Planning and Community Development.

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