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EVIDENCE-BASED MEDICINE, CLINICAL TRIALS AND THEIR INTERPRETATIONS (K. NASIR, SECTION EDITOR)

Understanding Immigration as a Social Determinant of Health: Cardiovascular Disease in Hispanics/Latinos and South Asians in the United States

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Abstract

Purpose of Review The main purpose of this review is to summarize the epidemiology of cardiovascular disease and its risk factors among two of the largest and most diverse immigrant groups in the United States (Hispanics/Latinos and South Asians).
Recent Findings While the migration process generates unique challenges for individuals, there is a wide heterogeneity in the characteristics of immigrant populations, both between and within regions of origin. Hispanic/Latino immigrants to the United States have lower levels of cardiovascular risk factors, prevalence, and mortality, but this assessment is limited by issues related to the "salmon bias." South Asian immigrants to the United States generally have higher levels of risk factors and higher mortality. In both cases, levels of risk factors and mortality generally increase with time of living in the United States (US).
Summary While immigration acts as a social determinant of health, associations between immigration and cardiovascular disease and its risk factors are complex and vary across subpopulations.

Keywords Cardiovascular disease · Health disparities · Immigrant health · Hispanics · Latinos · South Asia

Introduction

One in seven people living in the United States (US) are immigrants, and this number has tripled since 1970 [1•]. In this narrative review, we focus on immigrants to the US, a particularly vulnerable population in which many adverse social determinants of health (SDOH) often cluster [2]. Following *The Lancet* Commission on Migration and Health [2••], we

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define immigrants as any person who has moved away from his/her habitual place of residence into a different country. This process encompasses several challenges which may impact the health status of migrant populations [2••]. However, the wide heterogeneity of this population and the lack of detailed data on country of origin and/or migration status among many of the sources used to ascertain population health status complicate the understanding of the health consequences of migration.

Cardiovascular disease (CVD) is the main cause of mortality and morbidity worldwide and in the US [3]. CVD and its risk factors are not evenly distributed within and across populations, rather, there are marked disparities, with socially disadvantaged groups typically having a higher burden of disease [4–7]. Mechanisms leading to such disparities include (but are not restricted to) lack of access to healthcare, residential segregation leading to worsened physical and social neighborhood environments, lack of access to material resources, and discrimination [8–15]. Socially vulnerable populations include people of low socioeconomic status (SES), people with limited English proficiency, racial/ethnic minorities, and indigenous populations, among others [16].

Our objectives are three-fold: (a) to summarize the notion of migration as a social determinant of health, (b) to document the epidemiology of CVD among two of the largest and most diverse immigrant groups in the US, Hispanics/Latinos and South Asians, and (c) to identify methodological challenges relating to examining health disparities among immigrant populations. Findings from this review have major public health implications as CVD disparities may increase as immigrants endure social and structural factors that adversely influence their health as they age in the US, especially among disadvantaged populations that lack access to healthcare.

Immigration as a Social Determinant of Health

Immigrants, especially those who are undocumented but also those who lack US citizenship (noncitizens), experience legal discrimination, unequal labor protections, and increasingly suffer from law enforcement violence [2, 17]. As a result, immigrants are more likely to experience poverty, live in disenfranchised communities, and forgo critical health care services [18–20], all the while being systemically excluded from many social welfare programs available to other disadvantaged populations [21••]. These systemic exclusions, together with persistent anti-immigrant bias and rhetoric [21••], contribute to structural racism [22], or those "macrolevel systems, social forces, institutions, ideologies, and processes that generate and reinforce inequities among racial and ethnic groups," [23] endemic in the US. The slow-acting, long-term consequences of sustained structural racism on immigrant populations may result in an increased burden of SDOH associated with CVD and its risk factors.

Most of the systemic exclusions are related to a person's authorization to reside in the US, i.e., their *immigration status.* For instance, the 22 million noncitizens in the US [18] are more likely to experience discrimination and legal barriers to employment and labor protections [17]. Most of the 11 million undocumented immigrants in the US [24] are barred from any formal labor and excluded from social welfare programs [17, 24]. Furthermore, many undocumented immigrants are also under constant threat and fear of deportation. In comparison with citizens, noncitizens, especially undocumented immigrants, are more likely to live in poverty [18, 24] and to reside in low-income, segregated neighborhoods [19, 25, 26]. However, immigration status is dynamic, and losing or gaining citizenship, lawful permanent residence, or another visa status may impact cardiovascular outcomes, even among more affluent immigrants [27, 28].

One of the most notable exclusions immigrants experience is from the healthcare system. For example, undocumented immigrants often lack jobs that offer private insurance and are excluded from federal and state health insurance schemes [29, 30]. Lawful permanent residents (i.e., noncitizen green card holders) are also ineligible for federal public insurance for five years [29–31], a limitation that may be waived by states but that has been strengthened with the new Public Charge Rules [31, 32]. Policies designed to improve access to healthcare, including the Affordable Care Act's insurance subsidies and Medicaid expansion, still exclude certain noncitizens and may exacerbate disparities within immigrant populations [20, 33]. Even when eligible, newly enacted regulations (i.e., the expanded *Public Charge Rule*) may discourage immigrants and their families from applying to these benefits [32, 34]. As a result, 9% of nonelderly naturalized citizens are uninsured in comparison with 23% of lawful permanent residents and 45% undocumented immigrants [29, 30]. While most immigrants reach middle- and late-adulthood in the US [18], when their risk of CVD increases exponentially, one-third of noncitizens remain uninsured after twenty years in the country [35].

In general, it is difficult to aggregate immigrants into broad racial/ethnic categories considering their divergent experiences based on country of origin, and through the migration process, including reason for migration, SES before migration, and legal protections upon arrival. Racialized societal structures in the US may fuel some of these inequalities [36]. For example, White Hispanics/Latinos may have cardiovascular health advantages over Afro-Latinos due to differential socioeconomic opportunities afforded to those atop the racial/ethnic hierarchy [21••]. These issues are also salient among South Asians, where they intersect with other axes of oppression such as Islamophobia, especially among individuals of Pakistani origin [37]. Consequently, affluence varies across immigrant subpopulations. For instance, immigrants from India have higher

incomes and educational attainment than other South Asians, and Cubans and those born in South America have a more favorable SES profile than Hispanic/Latino immigrants from Mexico or Central America (see Table 1).

In the following two sections, we summarize evidence on disparities in CVD and its risk factors among two of the largest immigrant groups in the US: Hispanics/Latinos and South Asians.

CVD Among Hispanic/Latino Immigrants in the US

Hispanic/Latino Immigrants in the US

At sixty-million, including 19 million immigrants, the Hispanic/Latino population constitutes the largest racial/ethnic minority in the US. [18] This population has its origins in Mexico, the Caribbean, and Central and South America, as well as other Spanish-speaking countries, and, as we summarize in Table 1, is demographically diverse. Therefore, conflating all Hispanics/Latinos as a single group may result in an incomplete understanding of CVD and its risk factors in this population. For instance, immigrants from Mexico, Central America, and the Caribbean (65%) are more likely to lack citizenship than other Hispanic/Latino immigrants (44%). Immigrants from Mexico, Central America, and the Caribbean also have lower educational attainment and higher poverty rates than other Hispanic/Latino immigrants. A substantial number of Hispanic/Latino adults also self-identify as mixed race (34%), indigenous (25%), or Afro-Latino (24%) [39]. Despite this diversity, until recently limited information was available about CVD disparities within the Hispanic/Latino immigrant population.

CVD and CVD Risk Factors Among Hispanic/Latino Immigrants

CVD is the second leading cause of death among US-born and immigrant Hispanic/Latino adults [40, 41]. On average, Hispanic/Latino adults have a poor cardiovascular risk profile: less than 10% have a low-risk profile (i.e., absence of high cholesterol, hypertension, diabetes, obesity, or smoking) [42]. In the nationally representative National Health Interview Survey (NHIS), Hispanic/Latino immigrants have lower self-reported rates of high cholesterol, hypertension, diabetes, obesity, and smoking than their US-born counterparts (Fig. 1). However, as discussed above, Hispanics/Latinos in the US represent a very large, heterogeneous group, and there is a large variation in the within-group the burden of CVD and risk factors. However, few studies have examined the heterogeneity of CVD and its risk factors among Hispanics/Latinos.

The landmark Hispanic Community Health Study/Study of Latinos (HCHS/SOL), the largest epidemiologic cohort of Hispanic/Latino adults living in the US, has allowed for the identification of commonalities and has demonstrated significant disparities across subpopulations [43••]. In HCHS/SOL, US-born Hispanics/Latinos often had worse cardiovascular risk profiles than immigrants, especially those who have lived in the US for fewer years [42, 44]. This may be due to a consistent finding across studies, that a longer duration of residence in the US results in declines in physical activity,

Table 1 Sociodemographic characteristics of the Hispanic/Latino and South Asian immigrant populations in the US

	US born	Mexico	Cuba	Central Am. & other Caribbean	South America	Other Hispanic/ Latino	India	Pakistan	Bangladesh	Other South Asians
Number	279.2M	11.5M	1.4M	7M	3.5M	0.1M	2.7M	0.4M	0.3M	0.3M
% Aged < 18	25%	5%	5%	8%	7%	22%	7%	7%	9%	13%
% Aged 18–64	59%	85%	69%	79%	79%	67%	82%	83%	83%	79%
% Aged 65+	16%	10%	27%	13%	14%	11%	12%	10%	8%	8%
% Women	51%	48%	51%	52%	54%	47%	48%	48%	50%	49%
Median years living in the US	N/A	21	18	18	18	23	12	17	12	8
% Noncitizen (not naturalized)	N/A	66%	39%	50%	44%	22%	54%	31%	38%	60%
% Under poverty line	15%	19%	17%	18%	12%	11%	7%	17%	20%	15%
% < High school	7%	49%	16%	31%	11%	10%	5%	10%	14%	22%
% Completed high school	60%	44%	59%	53%	54%	63%	16%	36%	37%	35%
% Completed college or above	33%	7%	24%	16%	35%	28%	80%	54%	48%	43%
No health insurance	8%	36%	18%	27%	19%	11%	5%	12%	10%	13%

Data from the 2018 American Community Survey, obtained from the Integrated Public Use Microdata Series (IPUMS) project [38]. Other Hispanic/Latino include people self-identifying as Hispanic/Latino, and born outside of the US, Mexico, Central America & Caribbean, and South America. Other South Asians include people born in Nepal, Bhutan, Sri Lanka, and the Maldives

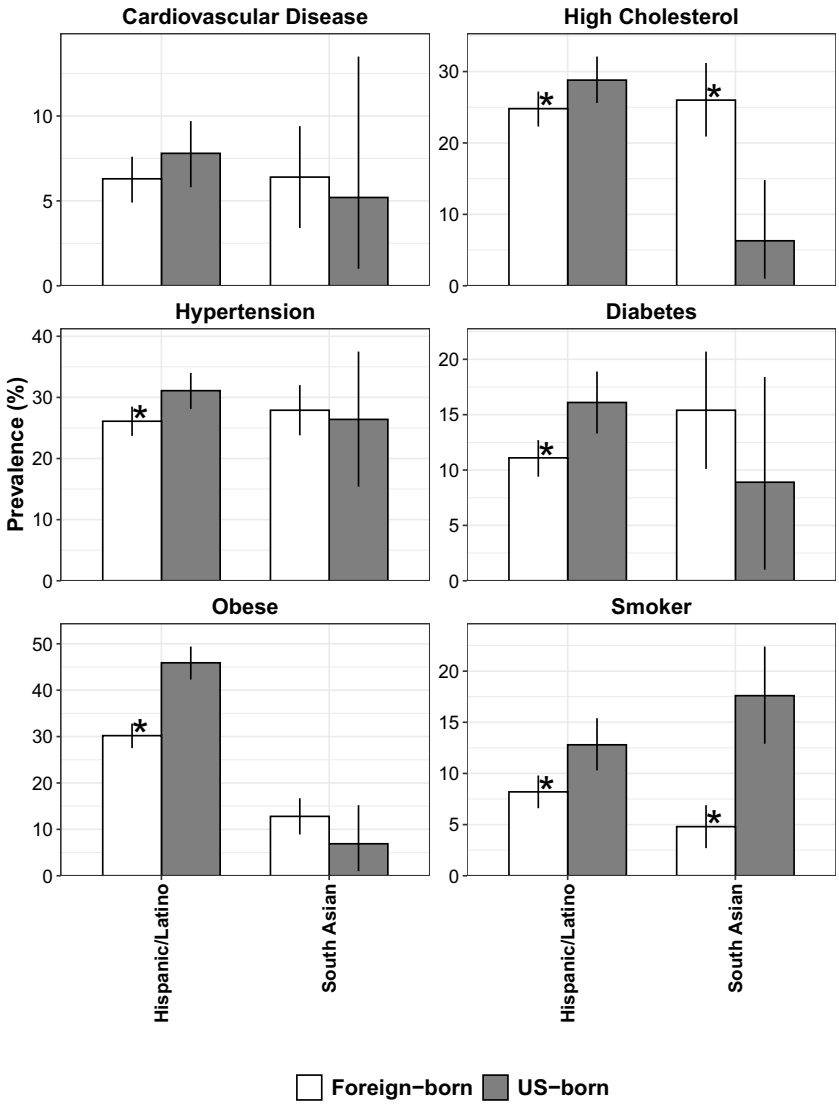

Fig. 1 Age-standardized prevalence of cardiovascular disease and its risk factors among adults in the US, by place of birth and race/ethnicity. Data from the National Health Interview Survey (NHIS, 2018), adults ≥ 20 years of age, as obtained from the IPUMS project [38]. Age-standardized prevalence estimates are weighted to account for sampling. Cardiovascular disease was defined as self-reported coronary heart disease, myocardial infarction, or stroke. Cardiovascular disease risk factors were self-reported. South Asian ancestry were those who self-identify as "Asian Indian" or were born in the Indian subcontinent. An asterisk next to a bar indicates a significant difference in prevalence in foreign-born vs US-born ($p < 0.05$)

increases in sedentary behaviors, and worsening diet quality among Hispanic/Latino immigrants [45, 46]. However, this link between nativity and duration of residence appears to vary by gender, where longer duration of residence is unrelated to cardiovascular risk among men but adversely associated with cardiovascular risk among women [42, 44]. The prevalence of CVD risk factors in HCHS/SOL also varied by country of origin or ancestry. For example, high cholesterol is common among all Hispanic/Latino groups, but the prevalence of hypertension and diabetes varies widely [43, 47, 48]. The age-adjusted prevalence of diabetes is around 18% among Mexicans, Central Americans, Dominicans, and Puerto Ricans, as compared with 13% in Cubans and 10% in South Americans [48]. For hypertension, age-adjusted prevalence is highest among Puerto Ricans, Cubans, and Dominicans, at around 29%, and lowest among Mexicans (13–21% depending on the site) and South Americans (12–20% depending on the site) [47]. Last, regardless of country of origin, Hispanic/Latino immigrants are less likely to be aware of risk factors, receive pharmacologic treatment, or achieve subsequent control than their US-born counterparts [27, 49–51].

Despite suboptimal management of CVD risk factors, Hispanic/Latino immigrants have a slightly lower self-reported prevalence of CVD (6.3% versus 7.8%) than their US-born counterparts in NHIS (Fig. 1). Similar findings were observed in HCHS/SOL, where Hispanic/Latino immigrants have a lower prevalence of self-reported CHD and stroke (1.3% and 0.7%, as compared with 2.1% and 1.8% for US-born Hispanics/Latinos) [43••]. Nonetheless, it is important to highlight that these data are based on self-report. Moreover, self-reported CVD varies by country of origin and SES. For example, rates of CHD and stroke are higher among Dominicans, especially men, than among other Hispanics/Latinos [43••]. In contrast, Mexican and Central American men and women, as well as South American men, have

considerably lower rates of CHD [43••]. However, awareness of prevalent CVD, especially for asymptomatic or milder events (e.g., silent ischemia or transient ischemic attack), may depend on adequate access to healthcare [52••] that immigrants often lack [29, 30]. Hispanics/Latinos, especially immigrants and those with limited English proficiency, are less likely to recognize the symptoms of these events and more likely to delay seeking care [53].

As a group, the Hispanic/Latino population in the US has paradoxically lower all-cause mortality rates and lower CVD prevalence than NHW [54, 55]. In terms of clinical and public health implications, this *Hispanic paradox* is problematic for the health of the Hispanic/Latino population because it perpetuates, with insufficient evidence, the idea that they are less susceptible to CVD [55••]. The notion of the Hispanic paradox also simplifies the diversity of the Hispanic/Latino population, as this potential health advantage may differ by age, gender, generational status, country of origin, and duration of residence in the US [52, 54–57]. Indeed, recent evidence using the mortality files from the National Center for Health Statistics suggests that Hispanic/Latino immigrants, regardless of their country of origin, have higher rates of CVD mortality than their US-born counterparts [55••]. Suboptimal management of risk factors [27, 49–51] and delays in seeking acute cardiovascular care [53], may explain why Hispanic/Latino immigrants, despite apparently lower rates of CVD, are at greater risk of death.

Importance of Psychosocial Factors, Acculturation, and Immigration Status for CVD and Its Risk Factors Among Hispanic/Latino Immigrants

Psychosocial factors such as social support and strong social/familial ties are hypothesized to moderate the adverse effect of chronic stress on CVD among Hispanics/Latinos in general [52, 58]. While the shared cultural values of *collectivism*, *familismo*, and *simpatía* are thought to strengthen these social bonds [58], further research is necessary to determine whether these factors confer resiliency against the development of CVD. Nonetheless, the potential protective impact of Hispanic/Latino culture may change over time as immigrants acculturate or adopt "American" cultural and behavioral traits [44]. Acculturation, especially when measured by the simple proxy of duration of residence in the US, has been associated with higher cardiovascular risk, including higher prevalence of CVD and its risk factors among Hispanic/Latino adults [43••]. However, as alluded to earlier, Hispanic/Latino immigrants, especially noncitizens, age in socioeconomic conditions [18, 24], which adversely influence their cardiovascular health [59]. Yet, it is unknown whether the effect of acculturation varies by the adverse socioeconomic conditions Hispanics/Latino immigrants endure. It stands to reason that disadvantaged immigrants, especially undocumented immigrants, acculturate differently than more affluent naturalized citizens.

Undocumented immigrants, have also less access to the necessary insurance coverage and preventative healthcare services [20, 29, 30], resulting in poor prevention and management of risk factors [27, 49–51]. Immigration status may also have a significant impact on a patient's decision to seek care due to language barriers and, in the case of undocumented immigrants, transportation barriers due to driver license restrictions or fear of referral to immigration authorities at healthcare facilities [17, 59], resulting in subsequent delays in seeking cardiovascular care [53]. Along with lower SES and residence in underserved, impoverished communities [19, 25, 26], undocumented immigrants likely experience chronic stress related to the stigma, discrimination, and uncertainty associated with their status [60], social determinants that may increase their risk of developing CVD.

CVD Among South Asian Immigrants to the US

South Asians Living in the US

South Asians are a heterogeneous group including individuals that trace their ancestry to India, Pakistan, Bangladesh, Nepal, Bhutan, Sri Lanka, and the Maldives, encompassing numerous linguistic, cultural, ethnic, and religious subgroups. Most South Asians in the US are of Indian origin (80%), followed by Pakistanis (10%), Bangladeshis (3.4%), Nepalese (2.5%), and Sri Lankans (1.1%) [61]. South Asians are now the fastest growing ethnic group in the US, experiencing a near tripling in population from 1.9 million in 2000 and to 5.4 million in 2017 [62]. Foreign-born South Asians represented 8.2% of the total number of migrants in the US in 2018 and has been one of the fastest growing immigrant populations in the US in the last few decades [1]. While a substantial proportion of South Asian immigrants are highly skilled professionals and have the highest median household income among all Asian American subgroups [61], nearly 472,000 (10%) of the South Asian population in the US lives in poverty, and the income gap between the most affluent and poorest has been reported to be the highest among Asian Americans [61]. For example, Nepali-Americans have the lowest median household income of all Asian American subgroups and have grown the most among all South Asian sub-groups in the last decade [18]. Moreover, there has recently been an increase in the number of undocumented South Asians living in the US, with a 72% increase in the number of undocumented Indian Americans between 2010-2017, reaching a total of 630,000 [63]. We summarize select demographic characteristics of South Asian immigrants in the US in Table 1.

CVD and CVD Risk Factors Among US South Asians

CVD is the leading cause of death among South Asians in the US [64–67]. As a group, South Asians tend to have a higher prevalence of cardiovascular risk factors when compared with other subgroups [65••]. However, few studies have examined CVD and its risk factors across South Asian immigrants specifically.

The notion of a significantly higher risk of coronary heart disease (CHD) among South Asians compared with most other racial/ethnic groups has been well-documented in the literature, with some of the first reports dating back to the late 1950s [68]. Since then, continued observations have reinforced the notion of increased risk in this group across the spectrum of CHD, ranging from more prevalent subclinical disease to a more severe atherosclerotic disease by coronary angiogram [69, 70]. A study of 10.5 million US death records between 2003 and 2010 reported a striking difference in the proportionate mortality ratio from ischemic heart disease among Indian Asians (1.12 for women, 1.43 for men) as compared with NHWs (0.92 for women, 1.08 for men). Furthermore, the proportionate mortality ratio from ischemic disease among Indians was the highest among the 5 other Asian subgroups studied [66•]. However, this study could not account for nativity and differentiate between foreign-born and US-born South Asians. In a subsequent study using similar data, Indians were found to have the highest years of life lost due to both ischemic heart disease and stroke [67]. While this study did not differentiate years of life lost between foreign- and US-born Indians, 91% of all deaths in Indians occurred among immigrants [67].

Considerable effort has been put forth towards uncovering novel risk factors that may drive this phenomenon. However, the evidence thus far suggests that while multifactorial, the pathobiology of ASCVD among South Asians may be essentially the same as in other groups [65••]; their increased risk is likely explained by a higher burden of traditional cardiovascular risk factors at premature ages [65••]. Nonetheless, South Asians seem to have a particularly high burden of risk factors such as abdominal obesity, the metabolic syndrome, and type 2 diabetes (T2DM) [65••]. The very high prevalence of these in South Asians has been linked both to impaired insulin secretion and function, governed by a complex interplay of beta cell dysfunction, low lean muscle mass, and a heightened propensity for both hepatic and intramyocellular fat accumulation [71]. Indeed, South Asians in the US have a more than 2-fold higher prevalence of T2DM compared with NHWs, and the highest age- and sex-adjusted prevalence compared with East and Southeast Asians [72•]. In Fig. 1, we show a comparison of the prevalence of CVD risk factors among foreign-born and US-born South Asians in NHIS, showing a lower prevalence of smoking among foreign-born South Asians and a higher prevalence of high cholesterol among foreign-born South Asians. However, this comparison is based on a small sample size (n = 402).

A substantive majority of the epidemiologic data regarding CVD and risk factors among the US South Asian population in the current era stems from the landmark Mediators of Atherosclerosis in South Asians Living in America (MASALA) study [73•]. While 98% of participants in MASALA are foreign-born, and a majority (83%) were born in India, there is wide heterogeneity in years of life lived in the US, allowing for an exploration of the effects of acculturation on cardiovascular risk [74•]. Adjusted for age and other confounders, South Asians who have spent a higher proportion of their lifetimes in the US have higher levels of coronary artery calcium burden, a robust marker of subclinical atherosclerotic disease [74•]. However, a key gap in this research is the lack of data on second-generation South Asians, a cohort consisting mostly of young adults born from South Asians who immigrated to the US predominantly in the late 1960s. For example, the vast majority of MASALA participants are first-generation migrants, and only 19 of its participants were born in the US.

Importance of Psychosocial Factors, Acculturation, and Immigration Status on CVD and Its Risk Factors Among South Asians in the US

As with Hispanic/Latino immigrants to the US, a longer duration of residence in the US among South Asians has been associated with higher cardiovascular risk [74•]. Specifically, a longer duration of residence, or higher proportion of life lived in the US, is associated with measures or subclinical atherosclerosis [74•]. However, this crude measure of acculturation does not take into consideration the different strategies immigrants adopt to acculturate. The MASALA study has explored acculturation strategies among US South Asians, including separation, assimilation, and integration [75]. These strategies are strongly associated with other socioeconomic factors and with CVD risk factors, as women in assimilation and integration categories have an improved cardiovascular risk profile [76]. One key outcome of acculturation is changes in dietary habits, where a westernization of dietary patterns (i.e., incorporation of red meat, saturated fats, and alcohol) is associated with longer duration of US residency among South Asian immigrants [77•]. These westernized dietary patterns are associated with increased insulin resistance, but also higher HDL cholesterol, when compared with a vegetarian pattern among South Asians [77•]. Furthermore, among those participants who remained vegetarian, the consumption of fried snack foods, high-fat dairy, and sugary sweets was high [77•]. On the other hand, limited acculturation and integration may increase psychosocial stressors, including depression, anxiety, and chronic stress, factors that have been linked to CVD [78]. In a study of the association between acculturation strategy and symptoms of

depression on South Asians in the US, lower levels of integration into US society were associated with more prevalent depressive symptoms, an association that was modified by the degree of perceived social support [75]. Anxiety and depression (in men) and chronic stress (in women) are also associated with subclinical atherosclerotic disease in South Asians in the US [79].

The consequences of immigration status for South Asians have not been thoroughly examined. As mentioned above, people of Indian origin represent one of the fastest growing undocumented migrant population in the US [63]. The consequences for health insurance status are unclear, as there is wide heterogeneity among South Asians in the US regarding health insurance status. While 92% of participants in the MASALA study are insured [73••], there is wide heterogeneity in the insurance status of different South Asian sub-groups. As shown in Table 1, around 5% of South Asians born in India do not have insurance, as compared with 10–13% of those born in other South Asian countries. Utilization of healthcare services is not fully understood among South Asians in the US. In an analysis using 2003–2005 data, South Asians from India were found to have higher rates of insurance compared with other foreign-born Asian-Americans [80]. Furthermore, the high use of statins among MASALA participants (even among non-diabetic individuals) may signal enhanced access to preventive care services, perhaps as a function of higher socioeconomic status and higher health risk awareness [81].

Methodological Issues in the Study of Health Disparities Among Immigrants and Future Directions

In this section, we highlight the three of the most common threats to validity in observational studies [82], selection bias, confounding, and measurement error, as they pertain to the study of immigrants, CVD, and its risk factors, and summarize potential ways of addressing these challenges. We also highlight the issue of heterogeneity within immigrant subgroups.

One of the key challenges in the study of immigrants is selection bias [83], one of the key mechanisms used to explain the "Hispanic paradox" mentioned above [84–89]. The process of differential exclusion, in this context, is usually known as "salmon bias," occurring when immigrants return to their country of origin for health-related reasons [88]. This process generates a similar type of bias as differential attrition in clinical trials or other cohort studies [90, 91], and is related to the incapacity to ascertain outcomes in the population that has re-emigrated back to their country of origin. For example, in a study using self-reported prevalence of CVD risk factors from surveys in Mexico and the US, researchers found that part, but not all, of the differences between immigrants and their US-born (or Mexico-born) counterparts were due to these selection processes [92], while another study using data from both sides of the US-Mexico border found that higher comorbidities were not associated with higher probability of return from the US to Mexico [93]. To minimize this threat to validity, key strategies include minimizing selection bias, by continuing to follow immigrants even after return to their countries of origin, and using some of the available methods to account for this differential attrition analytically [94]. This issue has been studied mostly with Mexican migrants to the US, but has also been the subject of research in other contexts, including South Asians in the UK [95].

A second threat to validity is confounding. The process leading to the decision to migrate, for economic, safety, or any other reason or combination of reasons, generates a lack of exchangeability [96] between and across immigrants and both the source and destination populations. People are not selected to migrate at random, and the factors that drive migration may also drive the distribution of cardiovascular outcomes in this population and its comparison groups. While strategies to analytically account for confounding are abundant, including regression adjustment or stratification, weighting, and matching [97], these may be challenging and require data collection on extensive sets of confounders. Alternatives to these approaches include leveraging natural experiments, including forced relocations due to natural disasters [98–100], or organized migration systems [101]. Moreover, there must be critical considerations of whether understanding the effects of migration itself is of interest, as opposed to the policies that affect migrants directly. Understanding the effects of interventions may create clearer causal questions that may lead to more policy-relevant answers [102, 103].

A third threat to validity is measurement error [104]. One key aspect, especially when using vital registration data to assess mortality differentials by race/ethnicity, is to understand the measurement of race and ethnicity in death certificates and population counts [89]. For example, it is estimated that there is a 3 to 5% inaccuracy in the assignment of ethnicity among Hispanic/Latino decedents as compared with their self-report [105], while other aspects such as cause of death influence racial coding in death certificates [106]. This issue is not exclusive to death certificates, and also affects population counts, as there is known undercounting of specific Hispanic/Latino [89, 107] and South Asian [62] subgroups in the US census.

A fourth challenge in the study of immigration and CVD among the Hispanic/Latino and South Asian populations is the wide heterogeneity, especially in SES, within these groups. For instance, as seen in Table 1, around 40–50% of immigrants from Mexico, Central America, and the Caribbean have not completed high school, as compared with 11% from South America, while 80% of immigrants from India have completed college or above. Income also varies widely, with

15-20% of immigrants from Bangladesh, Pakistan, Mexico, and Central America reporting income levels below the federal poverty line, as compared with 7% of immigrants from India (Table 1).

Conclusions

In this review, we summarized the importance of considering the immigration as a social determinant of health, and how the epidemiology of CVD varies for two of the largest and most diverse immigrant groups to the US: Hispanics/Latinos and South Asians. While Hispanics/Latinos as a group tend to have a worse CVD risk factor profile as compared with NHWs, this is heterogeneous by nativity, with foreign-born Hispanics/Latinos having a lower prevalence of most risk factors and prevalent CVD, but potentially higher CVD mortality rates. On the other hand, South Asian immigrants tend to have higher CVD mortality rates and levels of risk factors as compared with other groups, but these levels differ widely by ancestry and acculturation. These comparisons are complicated by a lack of data on second-generation South Asians, and by the wide socioeconomic heterogeneity within this group.

Notwithstanding, there are a number of common aspects of Hispanic/Latino and South Asian immigrants that may influence their risk of incidence and control of CVD and its risk factors, including psychosocial factors, acculturation, and immigration status. Research examining the health of Hispanic/Latino and South Asian immigrants has focused on individual, behavioral, and cultural explanations and, by doing so, has failed to capture the life-course, socio-ecological influence [108, 109] of poverty, segregation, and strong-armed anti-immigration policies. Broadening this line of questioning and applying a syndemic conceptual framework [110, 111] is critical to ensure clinicians and policymakers understand and target the root, structural causes of disparities.

Findings from this review have major public health implications as CVD disparities may only increase as immigrants endure social and structural factors that adversely influence their health as they age in the US, especially among disadvantaged populations that lack access to healthcare. Incorporating immigrants into existing CVD studies, measuring the specific processes that link migration to CVD, and understanding the methodological challenges inherent to studying migrants and health will pave the way for improved evidence that will inform future interventions to reduce CVD burden in this population.

Abbreviations US, United States of America; CVD, Cardiovascular disease; NHW, Non-Hispanic White; SDOH, Social determinants of health; SES, Socioeconomic status; NHIS, National Health Interview Survey; MASALA, Mediators of Atherosclerosis in South Asians Living in America; HCHS/SOL, Hispanic Community Health Study/Study of Latinos

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Declarations

Conflict of Interest The authors declare that they have no conflicts of interest relevant to the content of this manuscript.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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Papers of particular interest, published recently, have been highlighted as:
- • Of importance
- •• Of major importance

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