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Review article

Epidemiology, risk factors, and opportunities for prevention of cardiovascular disease in individuals of South Asian ethnicity living in Europe

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HIGHLIGHTS

- South Asian (SA) individuals represent a large, growing population in a number of European countries.
- SAs living in Europe are at increased risk of developing diabetes, atherogenic dyslipidaemia, and coronary heart disease.
- SA-specific cardiovascular health promotion and preventive interventions are currently scarce in most European countries.
- In this review, we aim to increase awareness within Europe of the public health importance of cardiovascular disease in SAs.
- We discuss potential opportunities for multi-level, targeted, tailored cardiovascular prevention strategies.

Keywords:
Cardiovascular disease
Coronary heart disease
Diabetes
Physical activity

ABSTRACT

South Asian (SA) individuals represent a large, growing population in a number of European countries. These individuals, particularly first-generation SA immigrants, are at higher risk of developing type 2 diabetes, atherogenic dyslipidaemia, and coronary heart disease than most other racial/ethnic groups living in Europe.

Abbreviations: AMI, acute myocardial infarction; CHD, coronary heart disease; ESC, European Society of Cardiology; NICE, National Institute for Health and Care Excellence; PURE, Prospective Urban Rural Epidemiology; SA, South Asian; SCORE, Systematic Coronary Risk Evaluation

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SAs also have an increased risk of stroke compared to European-born individuals. Despite a large body of conclusive evidence, SA-specific cardiovascular health promotion and preventive interventions are currently scarce in most European countries, as well as at the European Union level. In this narrative review, we aim to increase awareness among clinicians and healthcare authorities of the public health importance of cardiovascular disease among SAs living in Europe, as well as the need for tailored interventions targeting this group – particularly, in countries where SA immigration is a recent phenomenon. To this purpose, we review key studies on the epidemiology and risk factors of cardiovascular disease in SAs living in the United Kingdom, Italy, Spain, Denmark, Norway, Sweden, and other European countries. Building on these, we discuss potential opportunities for multi-level, targeted, tailored cardiovascular prevention strategies. Because lifestyle interventions often face important cultural barriers in SAs, particularly for first-generation immigrants; we also discuss features that may help maximise the effectiveness of those interventions. Finally, we evaluate knowledge gaps, currently available risk stratification tools such as QRISK-3, and future directions in this important field.

1. Introduction

According to the 2016 European Society of Cardiology (ESC) guidelines for cardiovascular disease (CVD) prevention, first-generation South Asian (SA) immigrants living in Europe should have their Systematic Coronary Risk Evaluation (SCORE) estimates multiplied by a 1.4 correction factor [1]. Similarly, the American College of Cardiology and American Heart Association list SA ethnicity as a “risk enhancer” for 10-year CVD risk estimations [2].

These recommendations are the result of a wealth of research studies published since the 1950s, conducted in South Asia as well as in groups of SA immigrants living across the globe, which have demonstrated a higher cardiovascular and particularly coronary heart disease (CHD) risk in SA individuals compared to most other racial/ethnic groups [3–25].

In Europe, SAs represent one of the largest, fastest growing minority groups in a number of countries, including the United Kingdom (UK), Italy, Germany, France, Spain, Greece, Switzerland, the Scandinavian countries, and the Netherlands [26]. Research in these countries has consistently described individuals of SA ethnicity as having a higher burden of type 2 diabetes (T2D) and CHD compared to other local racial/ethnic groups [11–25]. Some studies have also demonstrated a higher risk of stroke in SAs compared to local Whites [12–14,18,22]. Despite this large body of evidence and recent calls for action [27,28], SA-specific health promotion and preventive interventions are scarce in most European countries – as well as at the European Union level.

The aim of this narrative review is to increase awareness among clinicians and healthcare authorities of the importance of CVD in SA individuals living in Europe, as well as the need for aggressive preventive interventions targeting this group – particularly first-generation immigrants. For this purpose, we review European studies on the epidemiology of CVD in SAs, and discuss opportunities for prevention tailored to their unique risk profile. We also evaluate features that may maximise the effectiveness of those interventions in a context of cultural barriers. Finally, we evaluate knowledge gaps, currently available risk stratification tools such as QRISK-3, and future directions in this important field.

2. Demography of SA immigration to Europe

As of 2018, South Asia (i.e., India, Pakistan, Bangladesh, Sri Lanka, Nepal, Bhutan, and Maldives) accounted for 23% of the world's population – approximately 1,750 million men and women [29]. In addition, an estimated 20 million SAs live in other diaspora countries [30]. This includes large communities in the United States (US), Canada, the Middle East, Malaysia, South Africa, Australia, and several European countries, among others.

According to EuroStat, more than 2.5 million first-generation SA immigrants lived in Europe as of 2011 [26]. The UK currently hosts the largest SA population living in Europe, with approximately 1.85 million first-generation SA immigrants registered in the national census of November 2018, and more than 3 million people of SA ethnicity [31]. This is likely the consequence of longstanding colonial and post-colonial ties between the UK, India and Pakistan, together with the large diaspora that followed the partition of India in 1947.

Besides the UK, large groups of SAs, mostly first-generation immigrants, live in many other European regions (Fig. 1). India is the most frequent country of origin, followed by Pakistan (Fig. 2). In countries such as Italy and Spain, where SA immigration is a relatively recent phenomenon, SAs represent a young, mostly male group [15,18,32]. Conversely, in the UK, where this phenomenon has been occurring for almost a century, the SA population is closer to the local in terms of age/sex distribution [31].

Marked socioeconomic contrasts exist between individuals of Indian origin living in the UK, who have a high average household income [33] (similarly to what has been reported in the US [34]), and Pakistanis and Bangladeshis living in the UK and other European countries, such as Spain, who face more adverse conditions [32,33].

3. Epidemiology of CVD in SAs living in Europe

A large number of studies have evaluated the importance of CVD and particularly CHD in individuals of SA ancestry. These include studies in South Asia, which have shown higher event and mortality rates than those reported in Western countries [3,4]; multinational studies

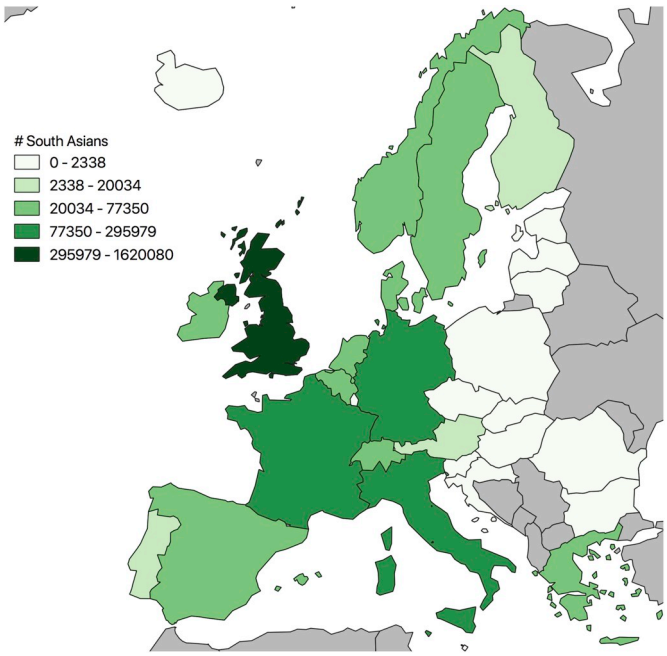

Fig. 1. First generation SA immigrants living in Europe as of 2011.
Source: EuroStats 2011.

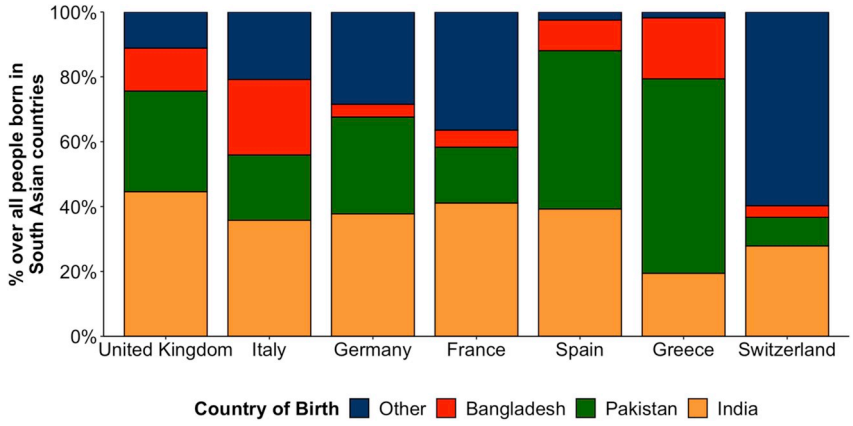

Fig. 2. National origin among large SA communities in Europe.
Source: EuroStats 2011.

such as INTERHEART or Prospective Urban Rural Epidemiology (PURE), in which SA countries lead the incidence of CHD events worldwide, occurring almost a decade earlier than in other world regions [5,6]; studies in non-European countries, where SA immigrants have higher CHD event rates and mortality than their local counterparts [7–10]; and research conducted in Europe [11–25].

A summary of some European cohort and population-based studies is presented in Table 1. For decades, the UK has led international research in this field. First-generation SA immigrants have the highest UK CHD death rates since the 1970s [11,12], with very high cerebrovascular death rates also reported in some subgroups, such as Bangladeshis [12]. Also, landmark cohort studies have shown individuals of SA ethnicity to have the highest incidence of CVD among all racial/ethnic groups in the UK, particularly Pakistanis and Bangladeshi women [13]. Importantly, in many of these studies such excess risk was independent of the established risk factors.

The second-largest European SA population lives in Italy [26]. In this country, SAs have the highest cardiovascular mortality rates [14], prevalence of CHD [15] and hospitalisation rates for acute myocardial infarction (AMI) [16]. SAs living in Italy also present a higher risk of stroke than the local population [14]. Similar observations have been reported in Spain [17,18], where SAs hospitalised for a first AMI are in average younger and have more severe coronary atherosclerosis than their local counterparts [19].

SA immigrants also lead the incidence of CHD/CVD in Denmark [20], Norway [21,22], and Sweden [23]. In addition, studies pooling data from several European countries, including France and the Netherlands, confirm a higher CVD mortality among SA immigrants compared to European-born individuals [24,25].

4. Why are SAs living in Europe at higher cardiovascular risk?

Although many epidemiological studies have considered SAs to be a single, homogeneous group, the SA ethnicity is actually highly heterogeneous [35]. This may explain why almost every known cardiovascular risk factor has been described as potentially relevant to SAs, as well as some inconsistent observations regarding the importance of specific risk factors across studies. Additional heterogeneity must also be recognised within Europe, the UK accumulating several generations of progressively acculturated SAs, while most SAs living in Mediterranean Europe are first-generation immigrants.

Despite this diversity, some factors have consistently been described as highly prevalent in almost all SA subgroups evaluated, particularly first-generation SA immigrants; both in Europe and elsewhere. Among them, glucose metabolism abnormalities and particularly T2D are almost ubiquitous [3,5–7,10,13,15,18,19,27,30,36,37]. Not only is T2D highly prevalent in SAs living in Europe, but once diagnosed, average glycosylated haemoglobin levels tend to be higher in first-generation SAs than in other groups [38,39]. Nonetheless, promising temporal trends have been reported in the UK in the management and outcomes of T2D in SAs [40], with appropriate treatment substantially attenuating SA's excess CVD risk [40]. Among SA national origins, Bangladeshis have the highest risk of developing T2D [41].

Several underlying mechanisms have been proposed for the T2D epidemic in SAs, including lifestyle features, epigenetic signalling related to impaired beta-cell function, and body composition: for a given body mass index [BMI], SAs have less lean tissue, and higher proportions of fat mass and fat in abdominal deposits, than Whites [40] – resulting in a higher prevalence of abdominal obesity and of T2D for a given BMI. This has led to the recommendation by the World Health Organization to use lower BMI thresholds to define overweight (BMI $\geq 23\ kg/m^2$) and obesity (BMI $\geq 27.5\ kg/m^2$) in Asians [42]. Among them, low levels of physical activity and low fitness [5,6,10,27,30,37,40,43] appear as key preventable risk factors. Frequent intake of sugar-rich snacks and drinks may also play a role, at least in some SA subgroups [44,45].

Other features proposed as potentially relevant to SAs' cardiovascular risk include additional dietary factors, such as intake of foods rich in saturated/trans fats (e.g., ghee, a type of clarified butter, although this practice is lessening in many SA communities) [27,39,40], high-heat food preparation [46], and reutilisation of cooking oil [46]; atherogenic dyslipidaemia, with low levels of high density lipoprotein cholesterol, hypertriglyceridemia, and small dense low density lipoprotein particles [3,7,13,19,27,30,36,47]; high levels of lipoprotein [a] [7,27,48]; obesity, particularly among women [18,49]; pro-thrombotic/pro-inflammatory states [7,27,36,48]; endothelial dysfunction [27,48]; and social factors, including low birth weight [50] and migration-associated stress; among others (Fig. 3) [27,30,48,51,52]. Importantly, none of these factors is directly captured in usual risk scores [1,13], and to what extent any of these, either in isolation or collectively, help explain the excess risk in SAs is currently not fully established, and future collaborative efforts are needed to examine these issues.

Regarding hypertension, published reports have yielded heterogeneous findings, likely due to differing risks in different SA subgroups [13,15,18,19,52–54]. For toxic substances, most European research has described tobacco smoking being less relevant to the risk profile of SA immigrants than to that of local populations [13,18,19,53], although this may not be true for some subgroups of Bangladeshi men [55]. Cocaine/substance abuse also seems more relevant as a risk factor for early AMI among some European populations, such as Spaniards, than in SAs [19,56]. Finally, whether other factors, such as blood vessel size/morphology [57,58] are also relevant to SAs' excess risk should be examined further.

Table 1
Example European studies on the epidemiology of CVD and CHD among SA immigrants.

Country	Author	Pub. year	Area	Study period	Main findings	Ref.
Mortality						
UK	McKeigue	1988	England, Wales	1970–1972	SA men and women had 50% higher CHD mortality than the national average	[11]
UK	Wild	2007	England, Wales	2001–2003	Standardised mortality rates for circulatory disease death in Bangladeshis were the highest of all 13 groups assessed. For CHD, men: local 96, Pakistani 162, Indian 131, Bangladeshi 175; women: 97, 174, 149 and 167	[12]
Italy	Fedeli	2015	Veneto	2008–2013	SAs had the highest SMRs (compared to Italians) for CHD death of all 7 immigrant groups assessed: 2.53 for men, 4.53 for women	[14]
Spain	Regidor	2009	National data	2001–2005	SA men had the highest age-adjusted CVD mortality across Spaniards and 9 immigrant groups. Compared to Spaniards, MRRs for CHD were 2.8 for SAs men; for CeVD, 3.6 for SA men and 2.2 for women	[17]
Various	Ikram	2016	–	1992–2007	Pooling data from Denmark, England & Wales, France, the Netherlands, Scotland, and Spain, SA immigrants had a higher CVD mortality compared to European-borns	[25]
Prevalence and Incidence						
UK	Hippisley-Cox	2017	England	1998–2015	Compared to local Whites, Pakistanis and Bangladeshi women had 70% higher CVD risk, Indians and Bangladeshi men 30% higher risk	[13]
Italy	Fedeli	2018	Veneto	2015	SAs had the highest risk of CHD compared to Italians and other immigrant groups	[15]
Spain	Cainzos-Achirica	2019	Catalonia	2017	SAs had the highest prevalence of CHD compared to Spaniards and other 4 immigrant groups. SA women ages 60–79 years had the highest prevalence of CeVD among women	[18]
Denmark	Hempler	2011	Capital, Central Regions	1997–2000	Pakistanis had a higher incidence of CVD and AMI than Danes, Turks, and Former Yugoslavians. Age- and socioeconomic status-adjusted RRs of CVD compared to Danes were 1.40 and 1.77 for Pakistani men and women, respectively	[20]
Norway	Rabanal	2015	National data	1994–2009	SAs had the highest risk of AMI/stroke hospitalisation compared to locals and 13 immigrant groups. AMI SERs in men: Norwegians 386, SAs 812; women: Norwegians 98, SAs 216	[22]
Sweden	Hedlund	2007	Stockholm County	1977–1996	Compared to Swedish-borns, age- and sex-adjusted RR of first AMI in SA was 1.50 for men, 2.06 for women	[23]

Abbreviations: AMI, acute myocardial infarction; CHD, coronary heart disease; CeVD, cerebrovascular disease; CVD, cardiovascular disease; MRR, mortality rate ratio; RR, relative risk; SA, South Asian; SER, standardised event rate; SMR, standardised mortality ratio; UK, United Kingdom.
Due to space limitations, this list is not exhaustive but rather presents a summary of cohort, population-based and mortality statistics studies from key European countries.

5. SAs in European CVD prevention guidelines

The size and growth of the SA population in some European regions represents a challenge for local healthcare systems which were designed for the care of lower-CVD-risk populations [1]. It is therefore crucial to develop tailored health promotion and preventive interventions focused specifically on these individuals. Such interventions are likely not only to have large health benefits, but also to contribute to the sustainability of local healthcare systems.

Nonetheless, SA-specific recommendations for CVD prevention, risk assessment and management included in key ESC prevention documents are currently very few [1,59,60]. These refer to 1) use of a crude 1.4 correction factor for SCORE risk estimations, and 2) tailored waist circumference thresholds (≥90 cm in men, ≥80 cm in women) when defining central obesity in SAs.

At the local level, although recommendations are also scarce in the National Institute for Health and Care Excellence (NICE) CVD prevention document [61], NICE guidelines for the management of specific cardiovascular risk factors, particularly T2D, include detailed guidance for individual- and group-level interventions targeting SAs [62]. Conversely, in other European countries, SA-specific recommendations are, to our knowledge, currently very limited. We believe such omissions need to be corrected.

6. Opportunities for tailored CVD prevention interventions for SAs in Europe

The current scarcity of available guidance highlights the need for further national- and European-level efforts. Below we discuss some proposed multi-level, tailored interventions (Fig. 3, in green). Although most of them are likely to be relevant to all racial/ethnic groups living in Europe, they may be particularly beneficial for SAs provided their unique risk profile. In a context of limited resources for public health interventions, governments may want to prioritise some of these interventions when designing SA-specific CVD prevention programs.

A first key intervention should be the aggressive, multi-level promotion of daily physical activity (Table 2), given its beneficial effects on fitness, prevention of T2D, lipid levels, blood pressure, and body weight [63–67]. Importantly, regular physical activity has been associated with a 50% lower risk of CHD events even among individuals at high genetic CHD risk [68], and is also highly beneficial in individuals with established T2D [69–71]. Sedentary jobs -such as shop clerks and car drivers-are very common among SA immigrant men [72], therefore, interventions promoting regular physical activity to travel to, or at the work place itself, may be particularly valuable.

Regarding diet, key sources of saturated fat (e.g., ghee) should be replaced with healthier fats. Low intake of sugar-rich foods should also be recommended, mirroring international recommendations for prediabetic and diabetic patients [70,71]. In Spain, a Mediterranean diet with high intake of extra virgin olive oil or nuts reduced the incidence of CVD and T2D compared to a low-fat diet with a higher proportion of carbohydrates [73,74]. In PURE, high carbohydrate intake was associated with higher CVD events and death, particularly in SAs [75].

Early detection of T2D and dyslipidaemia should also be a priority among SAs, with lower age and BMI thresholds considered for screening. Accurate risk stratification and optimal, personalised therapeutic management should be pursued as well, including appropriate use of statins and glucose-lowering medications [40,76]. For all these to happen, cardiovascular health information and other public health campaigns, improved access to care, and increased awareness within the medical community are likely to be key first steps to intervention.

7. Maximising the effectiveness of preventive efforts in SAs

Interventions may face important cultural barriers in SA communities, particularly among first-generation immigrants, and some

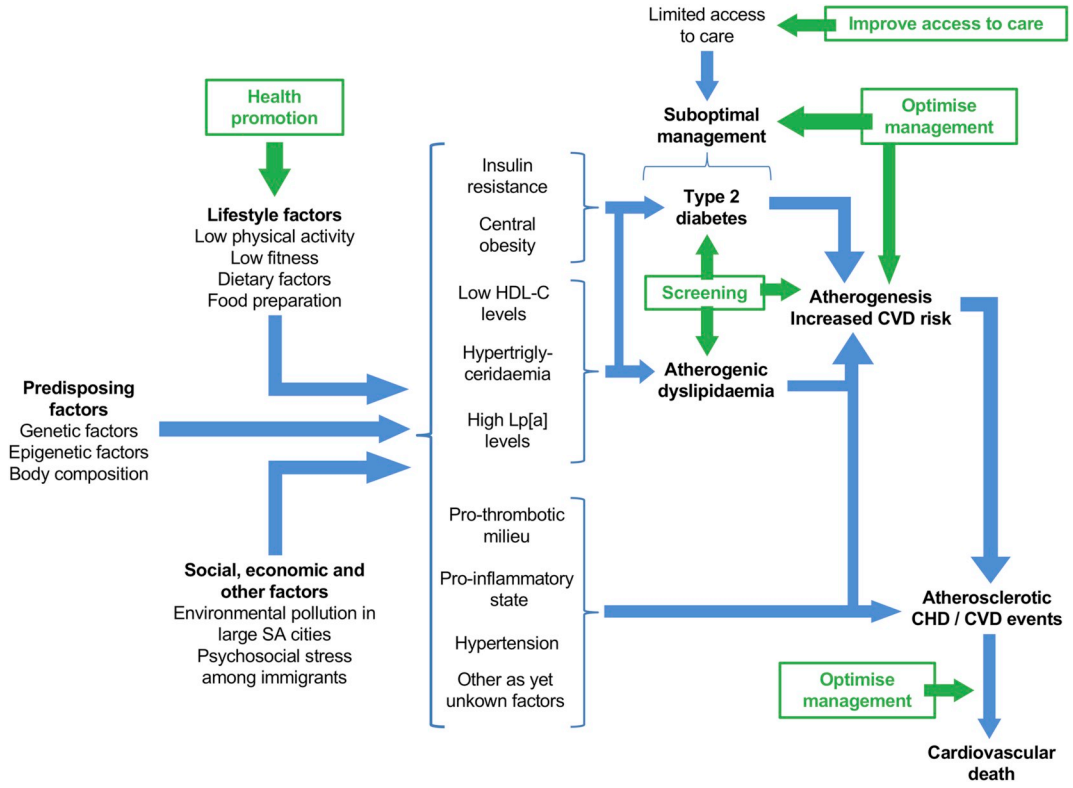

Fig. 3. Factors potentially involved in excess CVD risk in SAs living in Europe, and opportunities for targeted interventions.
CHD, coronary heart disease; CVD, cardiovascular disease; HDL-C, high density lipoprotein cholesterol; Lp [a], lipoprotein [a]; SA, South Asian. In green, opportunities for preventive/therapeutic interventions. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

adaptations may be necessary. Indeed, lifestyle change intervention studies in SAs living in industrialised countries have so far yielded modest results [77].

First, interventions should be holistic and culturally adapted for SAs, making them understandable, acceptable, and relevant to their context and income. For this purpose, cultural mediators and community leaders should be involved, from the design phase to dissemination. Interventions may include, for example, promotion of healthy cooking methods; identification of local sources of affordable, healthy foods; or improved communication of cardiovascular prevention/screening programs available within the local public healthcare system.

Interventions at the individual level may face barriers derived from group values and traditions, and should be combined with community interventions. These may help identify and overcome some of those barriers, thus facilitating paradigm change at the group level [78]; maximise dissemination of preventive initiatives within SA communities, and inform further cultural adaptations of individual-level interventions.

For women, who tend to have less access to the job market [72], household and community sessions as well as interventions within the primary care system may be more effective. Of note, because in many SA households, women take care of the nutrition of the entire family, healthy diet counselling for women may have multiplicative health benefits.

Finally, to maximise the effectiveness of the proposed interventions not only SA individuals, organisations and community leaders should be involved, but also key local stakeholders such as those listed in Table 2.

Acculturation and healthcare utilization: Opportunities to further improve the cardiovascular health of South Asians living in Europe.

Studies conducted in the UK show that second-generation individuals of SA ancestry living in the UK have incorporated some healthy behaviors compared to first-generation immigrants, particularly higher levels of frequent physical activity [79]. This, together with increased provider awareness and improved access to/utilization of healthcare, which may result in the early detection of diabetes, the improved lifelong therapeutic management of diabetes and of other cardiovascular risk factors, and an optimised management of cardiovascular risk in second and subsequent generation immigrants, among other improvements have been proposed as potential mechanisms explaining the lower rates of CVD observed in contemporary SAs, most of which are second/third generation individuals [40]. Indeed, evidence accumulated from studies spanning several decades suggest the excess mortality in SAs with diabetes compared to their white counterparts has been attentuating over time as have CVD morbidity patterns [40]; but further work is needed to validate these changes.

In Southern Europe, where SA immigration is still a recent phenomenon, acculturation to the Mediterranean lifestyle, which includes not only the Mediterranean diet but also frequent physical activity [80], would be expected to result in improved cardiovascular health. Nevertheless, studies on second-generation SAs are currently lacking, and further research is needed to better understand the outcome of progressive Mediterranean acculturation in this ethnic group. Regarding healthcare access, recent epidemiological studies in countries such as Spain or Italy suggest that access of first-generation SA immigrants to some cardiovascular therapies is concerningly lower than among the local population. For example, in a recent population-based study conducted in Catalonia (Spain) [18], despite having similar rates of dyslipidemia and much higher rates of diabetes than Catalans, the frequency of statin use among SAs was much lower. Use of antidiabetic medications has also been observed to be low among SAs living in Spain [39]. Similarly, a recent study carried out in the Lombardia Region (Northern Italy, aprox. 10 million inhabitants) showed that South Asian immigrants with diabetes received fewer drugs for cardiovascular

Table 2
Proposed multi-level approaches for the promotion of regular physical activity among SAs.

Approaches
Communicate
Importance of cardiovascular disease as cause of premature death and morbidity in SAs
Use appealing messages: Improving activity levels can be simple, fun, help socialise, reduce stress, and lower risk of diabetes and heart disease
Engage
Empower SAs as advocates of their own, family and community cardiovascular health
Community leaders, local SA organisations and media
Employers
Healthcare professionals
Cardiovascular scientific societies
Local governments, public health service providers, healthcare managers
Interventions at the work place
Physically active commute: walk, cycle or mixed mode – if not on a daily basis, 1–3 times/week
Minimise periods of sitting
Increase physical activity: go for short walks, walking meetings, walk during phone calls, active lunch breaks, use stairs
Interventions during leisure time
Allocate at least 45min/day at least 5 days/week for brisk walking, dancing, or other cardio
Maximise participation in physically active group activities, local sports and competitions
Interventions in SA communities
Group information sessions
Education interventions encouraging SA boys and girls to take an interest in sports
Interventions targeting women
Structural interventions in key neighbourhoods
Increase availability of safe green spaces and walkable areas
Affordable fitness centres
Motivational tools
Wearable devices to monitor daily physical activity
Information technologies facilitating peer communication and competition
Incentives at the work place
Research
Cultural practices/beliefs regarding sedentary behaviours
Cultural adaptations maximising acceptability of interventions
Evaluate adherence and effectiveness

SA, South Asian.

prevention (e.g. statins, ACE-inhibitors) than Italians; such indicators were more favourable among SAs with longer duration of stay in Italy [38]. These and other studies stress the need for additonal efforts in Southern European countries, aimed at ensuring the optimal therapeutic and risk management of these individuals.

In the US, a country which has also been receiving SA immigrants for decades, studies suggest that SA acculturation to the US lifestyle has yielded improvements in some risk factors [81]. Nevertheless, incorporation of deleterious habits such as high intake of red meat, sugar-rich drinks and processed foods has also occurred [27,82]. In the MASALA study, bicultural SAs (those who adopt some American beliefs/behaviors and retain some SA ones) have the lowest carotid intima-media thickness and lower fasting glucose and 2-h glucose [81]. With regards to healthcare access and utilization, US studies describe very high rates of statin use among SAs [83].

8. Next steps

Despite a large body of published literature, several knowledge gaps still remain in SAs living in Europe (Table 3). These include a better characterization of the potential genetic and epigenetic factors underlying the very high prevalence of diabetes and atherogenic dyslipidemia observed in SAs; as well as of the potential role —if any— of consanguineous marriages, which are highly frequent in some SA communities [84,85]. A better characterization is also needed of the anatomical, cultural, dietary and metabolic factors underpinning their premature CVD, both overall as well as for specific subgroups. Finally, a better understanding of the effects of acculturation, duration of migration, and genetic mix warranted as well.

SA-targeted CVD prevention guidelines should be developed, particularly in countries where this group is large. Similarly, targeted policies are also needed. These should include provision of linguistically and culturally appropriate services, public awareness campaigns, ensure access to care, and allocation of sufficient research funds, among others. Besides local efforts, development of guidelines and policies at the European level will likely improve the dissemination, implementation and effectiveness of preventive interventions.

SA-specific CVD risk estimators should also be developed, accurately informing their risk management. In the UK, functions such as ETHRISK and QRISK-3 allow accounting for ethnicity [13,86]. Moreover, QRISK3 also accounts for within-SA heterogeneity by country and sex, using 1.7 risk multipliers in Pakistanis and Bangladeshi women, and 1.3 factors for Indians and Bangladeshi men [13]. In Norway, NORRISK 2 does not capture ethnicity, but a 1.5 multiplication factor is recommended in individuals of SA origin [87]. Conversely, SA-specific functions are currently not available in other countries, such as Spain or Italy. Local risk estimators in such low-risk European countries would likely underestimate risk in SA immigrants, consequently, local development of SA-specific functions should be prioritised. Alternatively, adaptation and validation of ETHRISK or QRISK-3 to non-UK countries should also be considered. Until those tools are available, current ESC recommendations for CVD risk assessment in SAs [1] should be implemented systematically [88].

9. Conclusions

SAs living in Europe represent a large, growing population. A wealth of European epidemiological studies have shown SA immigrants to be at high risk of T2D, early coronary atherosclerosis, and CVD. Although further studies are warranted, there is currently conclusive evidence of the need for effective prevention interventions targeting this group. These should pay special attention to the promotion of regular physical activity and healthy diets, as well as to the screening and aggressive management of cardiovascular risk factors, particularly T2D. Interventions should involve all key stakeholders and be multi-level, culturally adapted, appealing, and easy to incorporate. Accurate CVD risk assessment and management in SAs should also be prioritised, using relevant risk scores where available or appropriate adjustment factors. Implementation of these recommendations at both the local and European level will likely have large health benefits, contribute to the

Table 3
Knowledge gaps in SAs living in Europe.

Further characterization of
Factors underlying SAs' excess cardiovascular risk
Predisposing polymorphisms
Epigenetic factors
Coronary artery diameter and tortuosity
SA dietary patterns
Other novel risk factors
Heterogeneity
National and cultural heterogeneity
Effect of immigrant duration
Cardiovascular risk in 2nd and 3rd generation SAs
Ethnically-mixed families
Differential effects of diabetes across SA subgroups
Other knowledge gaps
Subclinical atherosclerosis using imaging
Risk of heart failure
Pharmacokinetics of statins
Evaluation
Effectiveness of SA-specific preventive interventions
Benefits of Mediterranean diet subtypes

SA, South Asian.

sustainability of local healthcare systems, and benefit our Society as a whole.

Conflicts of interest

The authors declared they do not have anything to disclose regarding conflict of interest with respect to this manuscript.

Author contributions

All authors participated in the conception of the manuscript, and contributed to the preliminary manuscript outline. MC-A led the drafting, and UB helped prepare the figures. All authors revised the manuscript critically for important intellectual content.

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