HHS Public Access

Author manuscript

Circulation. Author manuscript; available in PMC 2019 May 15.

Published in final edited form as:

Circulation. 2018 May 15; 137(20): 2166–2178. doi:10.1161/CIRCULATIONAHA.117.029652.

Socioeconomic Status and Cardiovascular Outcomes: Challenges and Interventions

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Abstract

Socioeconomic status (SES) has a measurable and significant effect on cardiovascular health. Biologic, behavioral, and psychosocial risk factors prevalent in disadvantaged individuals accentuate the link between SES and cardiovascular disease (CVD). Four measures have been consistently associated with CVD in high-income countries: income level, educational attainment, employment status, and neighborhood socioeconomic factors. Additionally, disparities based on gender have been shown in several studies. Interventions targeting patients with low SES have predominantly focused on modification of traditional CVD risk factors. Promising approaches are emerging that can be implemented on an individual, community, or population basis to reduce disparities in outcomes. Structured physical activity has demonstrated effectiveness in low-SES populations, and geo-mapping may be used to identify targets for large-scale programs. Task shifting, the redistribution of healthcare management from physician to non-physician providers in an effort to improve access to healthcare, may have a role in select areas. Integration of SES into traditional CVD risk prediction models may allow improved management of high-risk individuals, but cultural and regional differences in SES make generalized implementation challenging. Future

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Disclosures

The authors have no financial conflicts of interest to disclose.

research is required to better understand the underlying mechanisms of CVD risk that affect individuals of low SES and to determine effective interventions for high-risk patients. We review the current state of knowledge on the impact of SES on the incidence, treatment, and outcomes of CVD in high-income societies and suggest future research directions aimed at the elimination of these adverse factors as well as the integration of measures of SES into the customization of cardiovascular treatment.

Keywords

Cardiovascular disease; socioeconomic status; social determinants of health; task shifting

Introduction

Cardiovascular diseases (CVD) remain the leading cause of death from chronic disease in the U.S. and worldwide despite remarkable advances made in the last century. CVD accounts for nearly 1 in 3 deaths in the U.S. despite a 25.3% decrease in age-standardized deaths attributed to CVD from 2004 to 2014.[1] Traditional CVD risk factors have been identified, including hypertension, dyslipidemia, diabetes, family history of premature coronary heart disease (CHD), and smoking, however, the contribution of social determinants of health, as best represented by socioeconomic status (SES), to CVD risk is poorly understood. Low SES has been linked to the development of CVD and may confer a cardiovascular risk that is equivalent to traditional risk factors.[2, 3] The increased burden of CVD in people with low SES is due to a constellation of biologic, behavioral, and psychosocial risk factors that are more prevalent in disadvantaged individuals.[4, 5]

Established interventions exist for addressing SES-related determinants of health and health inequities.[6] Several interventions have been evaluated to improve health disparities due to social inequity, but results are inconsistent.[7] Better understanding of SES and risk stratification are critical first steps in identifying and tailoring interventions to improve CVD risk in the population. We review the current state of knowledge on the impact of SES on the incidence, treatment, and outcomes of CVD in high-income societies and suggest future research directions aimed at the elimination of these adverse factors as well as the integration of measures of SES into the customization of cardiovascular treatment.

Overview of Socioeconomic Factors

The factors that comprise an individual's SES vary between location and culture.[8-10] Four markers for SES have demonstrated an association with CVD in high-income countries (HIC): income level, educational attainment, employment status, and environmental factors (see Figure 1).[11-17] Although many factors have been used as surrogates for SES, these particular markers are advantageous due to their ease of collection by questionnaire in addition to the substantial existing literature characterizing their association with clinical CVD outcomes. Additionally, it is unlikely that a single marker of SES is adequate in predicting CVD risk due to the interactions between SES factors, regional variations in SES associations with CVD, and the dynamic changes between SES markers and CVD outcomes throughout an individual's life course.[8, 11, 18]

Low- and middle-income countries (LMIC) carry approximately 80% of the global burden of CVD.[19] However, studies evaluating the association between SES and cardiovascular health in LMIC are limited and often contain conflicting findings.[10, 20] Furthermore, the association of SES and CVD in LMIC cannot be extrapolated from studies in HIC; obesity is an epidemic among the impoverished in HIC but is a disease of the rich in low-income countries due to increased access to a Western diet.[21] Characterization of the impact of SES in LMIC will require additional high-quality prospective studies and is beyond the scope of this review.

Income Level

Income level has been consistently associated with CVD risk.[11, 12] A large study in the United States and Finland found an increased risk of non-fatal MI and sudden cardiac death in the low-income cohorts that persisted after adjusting for smoking and alcohol consumption.[12] The results may be applicable at both an individual and neighborhood level.[22] Gerber *et al.* found that each $10,000 increase in median income of a neighborhood reduced mortality risk in the group by 10%.[22]

A study of more than 15,000 patients admitted for acute myocardial infarction (AMI) or CHD in the Netherlands found that individuals in the lower quintiles of income had significantly higher rates of 28-day and 1-year mortality.[23] Increased mortality was also shown for the lowest income quartile compared to the highest income quartile in a cohort presenting with ST-elevation myocardial infarction (STEMI) (HR 1.17, 95% CI 1.11-1.25).[24] Residents in low-income areas were less likely to receive a left heart catheterization within 24 hours of a STEMI or within 48 hours of a non-ST elevation myocardial infarction compared with patients from high-income areas.[24] The authors of this study posited that the difference may be due to the perception that low-income individuals would be less likely to comply with critical post-percutaneous coronary intervention (PCI) medications (e.g. antiplatelet agents) or that low-income patients were less likely to be offered more expensive procedures (e.g. drug-eluting stents).[24] The mortality difference between income groups in the study was attenuated after adjustment for time to left heart catheterization.[24] Increased mortality rates were also present in patients from low-income areas in Taiwan, a HIC with universal healthcare, who were hospitalized with AMI.[25]

Mortality differences in low-income patients may be partially driven by disparities in standards of care. Low-income patients in the Netherlands were less likely to undergo interventions, including PCI, when presenting with AMI.[23] Cardiac rehabilitation (CR), a proven therapy to reduce mortality and hospital readmissions after AMI,[26, 27] is less likely to be attended or completed by individuals from low-income areas after hospitalization for CHD, PCI, or coronary artery bypass graft (CABG) surgery.[28] Studies have also demonstrated that statin medications were less likely to be initiated after AMI in low-income individuals.[29, 30] Men with low incomes were less likely to receive other guideline-recommended medications, including beta-blockers and angiotensin-converting enzyme inhibitors, but the association was attenuated in women.[30]

The substandard care may be partially explained by decreased access to quality care in the socially disadvantaged.[31-33] Lack of access to quality care has been shown to increase heart failure and post-AMI hospital readmission rates in the United States,[33] and patients with financial barriers to health care had fewer yearly medical checkups, were less likely to use aspirin, and were at higher risk of future CVD events.[32]

Low-income individuals in Taiwan undergoing CABG received lower quality care and experienced higher mortality than the high-income cohort.[31] France, like Taiwan, has a national health system but still faces inequalities in access to primary care and coronary revascularizations in low-income areas.[34] These studies highlight the difficulty in providing equal care to a patient population regardless of income. Inequalities in access to care, interventions, and prescribing practices will need to be addressed before care becomes equivalent between social groups.

Educational Attainment

The inverse relationship between educational attainment and CVD in HIC has been known for decades, and new population-based studies continue to provide insight into the strength of the association and its underlying mechanisms.[13, 35] A large study by Woodward *et al.* analyzed nearly 90,000 individuals in Australia and New Zealand and found that those with a primary education had an increased risk of CVD, cardiovascular mortality, and all-cause mortality compared with individuals with a tertiary education.[35] Higher education was associated with increased alcohol consumption and inversely related to smoking, blood pressure, cholesterol levels, and diabetes.[35]

Several studies have also demonstrated a higher risk of AMI in individuals with lower educational level.[36-38] Lower educational attainment also predicts worse short term (30 day) and long term (≥1 year) outcomes after AMI.[22, 39-41] Of the several socioeconomic factors examined in a cohort of patients from South Korea, only low education (≤6 years of schooling) was associated with increased risk of cardiac events or all-cause mortality.[41] Patients with low SES tend to have an increased number of comorbidities but receive fewer interventions.[40, 42] Despite their increased comorbidities, individuals with lower education level were less likely to be referred to tertiary prevention programs, including CR, than those who had higher education level.[42]

Educational attainment may affect health in several ways. Individuals with less education tend to have an increased number of CVD risk factors.[5] An analysis in the Netherlands by Kershaw *et al.* demonstrated that a majority (56.6%) of CHD risk in individuals with low education was due to behavioral and biological risk factors.[43] The most significant contributors were smoking (27.3%), obesity (10.2%), physical inactivity (6.3%), and hypertension (5.3%).[43] Hu *et al.* determined that approximately half of the increased risk of incident AMI in low education groups was explained by traditional risk factors.[36] Even with these estimates, the mechanisms underlying the remainder of the increased risk associated with low educational attainment remains to be determined.

A potential contributor to CVD risk is the strong correlation between education and health literacy.[44, 45] Individuals with poor health literacy are more likely to be noncompliant with their medications[46] and experience increased all-cause mortality.[47] The association between health literacy and outcomes may be partially mediated by poor reading comprehension, which has an indirect effect on CHD risk.[48] The absolute effect of health literacy and reading comprehension on CVD risk requires further characterization, but may be an area for intervention in individuals with low education attainment. It is also important to note that although studies looking at the impact of SES on outcomes adjust for variables such as traditional risk factors, there is potential for residual confounding that may be contributing to adverse health that is not accounted for in the models.

Employment Status

Employment is a commonly used marker of SES, and unemployment has been associated with increased risk of CVD.[11, 14, 49] Analysis by Mejean *et al.* demonstrated a 20% increase in risk of CHD events in an unemployed, French population without preexisting heart disease (HR 1.20, CI 1.04-1.39) after adjustment for age, gender, diet, and lifestyle.[49] A large proportion (46%) of the CHD risk is explained by dietary and lifestyle mediators, most notably alcohol consumption (17%) and smoking (13%).[49]

A recent study of individuals with high SES relative to the general population also demonstrated an increased risk of cardiovascular events in the unemployed despite extensive adjustment for covariates, including age, gender, biological characteristics, behavioral variables, and socioeconomic factors.[14] The outcomes of the unemployed population in the study were worse than the retired cohort, which suggests that the detrimental effect of unemployment may be driven by the job loss itself.[14] An alternative explanation is that those with poor health may be more likely to become unemployed. Nonetheless, it is important to note that unemployment is associated with increased CVD burden in the socially advantaged as well as those with low SES at baseline.

Dupre *et al.* performed a comprehensive study on the relationship between employment status and risk for AMI in the U.S.[50] Unemployment was associated with a 35% increased risk for AMI (HR 1.35, CI 1.10-1.66) within the first year, after which time the risk disappeared.[50] Cumulative number of job losses was associated with an incremental increase in AMI risk, and cumulative time spent unemployed was also significantly associated with increased risk for AMI.[50] The risks remained significant after adjustment for socioeconomic, behavioral, and clinical variables.[50] The mechanisms underlying poorer outcomes with unemployment are not clear. In this study, time of entry into the workforce, which could suggest educational differences or health difficulties, was not significantly associated with outcomes.[50] A possible explanation is that of cumulative stress, since worse outcomes were seen with additional episodes of job loss and increased time spent unemployed. One limitation of the study was an older cohort (median age 62 years) that may not be representative of the overall workforce.[50]

Environmental Factors

Neighborhood socioeconomic characteristics, in addition to individual SES, have been associated with CVD risk factors, adverse events and mortality.[15-17] A population analysis of the Atherosclerosis Risk in Community study showed that living in disadvantaged areas is linked to higher incidence of CHD after controlling for individual income, education and employment status.[17] The findings were supported by a recent analysis of data from the Jackson Heart Study, which found an association between neighborhood disadvantage and cumulative biological risk, a score derived from biomarkers representing cardiovascular, metabolic, inflammatory, and neuroendocrine health.[51] The environmental impact of health status and outcomes is driven by both physical and social attributes.[16, 52] Physical features of neighborhoods include presence of sidewalks or recreational spaces, access to transportation, and availability and cost of healthy foods, while social attributes include safety, deprivation, social support, and lack of community cohesion.[16] Socioeconomic differences in neighborhood characteristics can impact availability of resources and influence promotion or maintenance of a healthy lifestyle. Favorable neighborhoods are associated with reduced cardiovascular risk factors, as long-term exposure to environments with greater access to physical activity and healthy food was associated with lower incidence of diabetes and lower prevalence of overweight or obesity.[53, 54] Other social characteristics, including neighborhood crime, also contribute to cardiovascular risk. In a multi-ethnic populations, high individual- and neighborhood-level safety were associated with decreasing body mass index over time.[55] In contrast, poorly-rated physical environments based on walking environment, availability of healthy food, safety, aesthetics, and social coherence were associated with elevated depressive symptoms and greater increase in waist circumference in individuals living in those neighborhoods.[56]

Poor dietary options and the increased cost of healthy food may also contribute to the increased CVD risk of disadvantaged neighborhoods. Low income areas have fewer food outlets and supermarkets which results in limited access to fresh fruits and vegetables.[57, 58] The cost of healthy food is also higher in poor areas with limited access, due in part to the lower prevalence of supermarkets which typically offer lower prices and a variety of brand options.[59, 60] Low income areas lacking access to healthy, affordable foods are known as “food deserts” which are associated with diet-related chronic diseases and obesity.[61] There are also racial disparities in food availability as neighborhoods with a high prevalence of African Americans tend to have more fast food restaurants[59], fewer supermarkets[60], and fewer healthy options.[62]

Neighborhood characteristics can change with time and provide additional insight into the relationship between environmental factors and cardiovascular health. Recent results from a longitudinal study with a 12-year follow-up period showed that increasing density of neighborhood healthy food resources was associated with lower coronary artery calcium over time. However, changes in other neighborhood characteristics, including walking and social environment, were not associated with changes in coronary artery calcium.[63] Further longitudinal studies have demonstrated that neighborhoods with favorable physical activity increased individual activities and improved cardiovascular risk factors.[64, 65] However, previous studies also showed that individuals often move into neighborhoods with similar

SES across their life course, which impairs attempts to establish a causal relationship between environment and CVD.[66, 67] Unfortunately, a recent update by the USDA showed relatively small changes in low-income and low-access neighborhoods between 2010 and 2015 data.[68] Disadvantaged communities must be a priority in order to effectively reduce CVD disparities in individuals with low SES.

Psychosocial Factors and CVD Outcomes

Psychosocial factors, including stress and depression, are strongly associated with adverse CVD outcomes, and growing evidence suggests they may disparately affect individuals of low SES.[69, 70] In analysis of the REGARDS study, a prospective observational cohort in the United States, individuals earning <$35,000 annually who reported both stress and depressive symptoms had a 48% higher risk of developing CVD and a 33% increased risk of all-cause mortality after adjustment for socioeconomic, clinical, and behavioral factors.[69] The association was not present in subjects earning ≥$35,000 per year.[69] Likewise, a study of psychological distress (depression, anxiety, and stress) demonstrated that the risk of CHD mortality was increased in those with low (HR 1.31, p=0.001), but not high, SES (p=0.107).[70] The disparity in risk may related to inadequate social or material resources to cope with stressful events and higher rates of adverse health behaviors, including smoking and physical inactivity, that are associated with stress and depression.[71, 72] The contribution of poor health behaviors in psychosocial distress is supported by a study from Ye *et al.* that found the increased risk of MI or death in depressed individuals was attenuated after adjustment for behavioral mechanisms, in particular smoking and physical inactivity.[73] In addition to identification and treatment of the components of psychosocial stress, these findings suggest a role for aggressive targeting of smoking cessation and physical activity in these individuals.

SES and CVD Outcomes based on Sex

Women are overrepresented amongst those living in poverty; thus, are disproportionately affected by the disparities in the distribution of wealth, income and access to resources which ultimately can affect overall health and quality of life. In the Women's Ischemic Syndrome Evaluation (WISE) study, women with ischemic heart disease in the lowest SES (household income <$20,000/year) were more likely to be uninsured or have public insurance, yet had much higher drug costs and higher 5-year re-hospitalization rates when compared with higher-income women.[74] Income had far greater impact than any other SES measure, including race, education, marital status or employment status.[74] In a universal healthcare system (Southern Alberta, Canada), neighborhood SES was associated with the use of cardiac catheterization and 30-day mortality after ACS in women, but this same association was not seen in men.[75]

Interventions to Improve Health Behaviors and Risk Factors

Programs aimed at improving health in the socially disadvantaged must first focus on aggressively targeting traditional risk factors that have strong associations with low SES.[7] Behavioral counseling to reduce CVD risk factors including cholesterol levels, blood

pressure, and diabetes incidence has been proven effective in the general population and is recommended by the U.S. Preventive Services Task Force.[76, 77] Counseling of the family members of a patient with CVD, who are also at higher risk of vascular events, may improve dietary intake and physical activity, but further research into the applicability of these results to low-SES individuals is required. Studies have shown moderate success with smoking cessation programs aimed at patients of low SES.[78] Brown *et al.* utilized an internet-based smoking cessation program to evaluate the success rate between socioeconomic groups and demonstrated a significant improvement in the low-SES cohort that was not realized in the high-SES population.[78]

However, other studies have suggested more limited efficacy in individuals with low SES.[79, 80] Siren *et al.* found that behavioral counseling improved smoking cessation only in a high-education cohort and had no effect in a low-education group.[79] In a study evaluating lifestyle interventions in low-income American Indians and Native Alaskans the low-income groups had less improvement in BMI, unhealthy food consumption, and physical activity when compared with the high-income group.[80] The study did find an indirect relationship between the number of trained staff at each location and the success of risk faster modification.[80] Health-counseling has been shown to improve diet in low-SES individuals, and interventions focused on the lack of convenient and affordable access to the components of a healthy diet may also be necessary to improve dietary habits in low-SES areas.[79]

Regular physical activity is associated with a decreased risk of CVD and its comorbidities.[81, 82] Likewise, physical inactivity is an independent risk factor for poor CVD outcomes.[83] However, despite the known impact of physical activity and inactivity on CVD modulation, fewer than half of U.S. adults met the recommended levels of physical activity in 2011.[84] The burden of inadequate leisure-time physical activity is especially pronounced in individuals of low SES, which may be due to increased occupational responsibilities or reduced access to safe facilities for exercise.[85, 86] Programs aimed at increasing physical activity have demonstrated promising results in individuals with low SES.[79, 87] The “Walk Your Heart to Health” program successfully improved physical activity in a low- to middle-income group consisting primarily of ethnic minorities in Detroit, Michigan.[87] The intervention group met three times weekly at community sites and walked for an increasing amount of time (45-90 minutes). Physical activity of the group was increased at 8 weeks, and improvements were noted in the cohort’s systolic blood pressure, fasting blood glucose, total cholesterol, waist circumference, and BMI at 8 weeks that were maintained at 32 weeks.[87] Physical activity appears to be an important target in low-SES communities due to its widespread benefits and inherently inexpensive nature, however, physical insecurity (violence, crime) or lack of infrastructure (sidewalks, bicycle paths) in the neighborhood social environment may severely impact an individual’s ability to create a sustainable physical activity regimen.[88] Thus, policy intervention to address such factors in low socioeconomic populations must be addressed in conjunction with efforts to change individual behavior.[89]

A substantial barrier to the primary prevention of CVD, especially in low-SES groups, is a lack of access to healthcare providers. Given the increasing demands on physicians, strategies have been developed to better appropriate available resources. One effective

community based strategy using this paradigm is “task shifting,” an idea conceived by the World Health Organization as early as 1980 and defined as redistributing primary care responsibilities from physician to non-physician providers.[90] Although a dearth of evidence exists for the use of task shifting in HIC, the Adeyemo trial in Nigeria, a LMIC, demonstrated a reduction in systolic blood pressure from a pre-intervention mean of 168/92 to a goal of less <140/90 in 66.7% of patients utilizing nurse-driven task shifting compared with 65.4% of patients receiving usual medical care.[91] Task-shifting can be further extended to include health workers without formal healthcare training, known as community health workers (CHW). CHW play a valuable role in cost-effective screening for CVD in low-resource countries and communities.[92, 93] Given the constraints of modern medical practice, task shifting may have utility for CVD screening and risk factor improvement in areas with reduced resources.

Numerous studies have evaluated the role of community interventions on major adverse cardiovascular events and risk factors. Mass media negatively portraying tobacco reduces smoking prevalence by approximately 2%.[94] Tobacco cessation rates can be further impacted by increasing prices of tobacco products and state programs to provide nicotine replacement therapy.[94] Task-shifting the role of smoking cessation management to a community pharmacist increased the “quit rate” from 2.7% to 14.3% in study participants.[94] Similar effects are seen with mass media advocacy for salt restriction and dietary modification.[94] Subsidization of healthy foods is another community-level intervention that has demonstrated benefit in low income individuals. Reducing the cost of healthy foods has been shown to improve diets and reduce the barriers to a healthy diet in food deserts.[95] Similarly, taxation of unhealthy foods decreases their consumption.[95] A combined strategy can be used to improve diets in at-risk communities. Environmental engineering, including construction of new supermarkets to increase access to healthy foods, still lacks adequate data to support its use.[95]

Heart disease exhibits regional clustering in the United States (see Figure 2).[96] Geomapping, the identification of geographic “hot spots” of individuals at high risk for CVD, may be utilized in the future to target communities that would benefit from aggressive community-based interventions.[97] Geomapping has demonstrated promising early results in Sweden for identification of at-risk populations for diabetes and could be adapted to provide increased screening and treatment services for low-SES communities with a high prevalence of CVD risk.[98]

Strategies for identifying and improving health disparities in the United States were addressed in a Think Tank meeting organized by The National Heart, Lung, and Blood Institute.[99] The panel recommendations focus on the conversion of evidence to implementation through an increased breadth of research themes and transdisciplinary training programs to expand research capacities.[99] The panel further emphasized the role of platforms to optimize research and the development of collaborator and stakeholder networks to create benchmark studies.[99] See the Figure 3 for a summary of potential interventions in individuals with low SES.

Targeting lower socioeconomic populations certainly must involve multi-level behavioral interventions at the individual and community level that incorporate a comprehensive understanding of social determinants of health and a concerted effort to engage the community.[89] Specific efforts to reform the socioecological environment for primordial and primary prevention, as outlined by the AHA Guide for Improving Cardiovascular Health at the Community level, include an emphasis to direct resources to support legislation encouraging smoking cessation, promote sodium restriction in processed foods, and support modifications in the environment to encourage physical activity.[89] Through utilization of existing, cohesive networks such as healthcare facilities, schools, religious organizations, worksites, social networks, media networks, and virtual communities, physicians, policy makers, and activists can develop a more effective platform to engage and intervene in communities at a grass-roots level.[89] Unfortunately, data addressing improvement in CVD in lower SES populations through targeted intervention are limited, and further studies should be performed to investigate the potential impact of such interventions.[88] Additionally, while community interventions play an essential role in changing individual behavior, macro-level factors may significantly impede the capacity to change individual behavior and should also be addressed.

Future Trends and Directions

A study in England determined that CHD mortality was decreasing in individuals of all SES, but the rate of decline was steepest in the most affluent group compared to those with lower SES.[100] Lotufo *et al.* noted similar findings in a comparison of high- and low-income groups in Brazil, a high-middle income country.[101] Several countries have also seen flattening of the reductions in CHD mortality in younger individuals of low SES.[102, 103] In the United States and Scotland, the trend may be linked to increasing inequalities in smoking in low socioeconomic groups.[102, 103] The United States has also experienced an increase in diabetes among the socially deprived.[102, 104] These trends are concerning and suggest that while overall cardiovascular care is improving, the advances are preferentially helping the socially advantaged and widening the gap of health inequality.

Properly risk-stratifying patients will be a critical aspect of identifying low-SES patients with an increased risk of CVD that would not be conveyed by traditional risk factors alone. The ASSIGN score and QRISK algorithm in the United Kingdom are alternative risk stratification tools that integrate postal code income with traditional CVD risk factors.[105, 106] The ASSIGN score provided a statistically significant, but marginal, improvement in risk prediction when compared to the Framingham Risk Score (FRS).[105] The QRISK algorithm also improved prediction of CVD events in individuals whose risk was under-predicted by the FRS.[106] While QRISK and ASSIGN are meant to serve as alternative approaches to the FRS, Franks *et al.* incorporated SES markers directly into the existing FRS framework.[107] The integration of educational attainment and income as additional markers to predict risk into the FRS removed the SES bias seen in low-SES individuals.[107] Accurate prediction is important to identify appropriate candidates for aggressive primary prevention, which includes statin therapy in individuals at borderline risk for CVD or additional resources dedicated to counseling in patients with multiple markers for low SES. Models incorporating SES for risk prediction are challenging due to the regional and cultural differences in SES

markers. It remains to be seen if a single risk stratification system will be adequate or if regional variants will be required, particularly with the use of the American College of Cardiology and American Heart Association atherosclerotic CVD risk assessment tool in the U.S. population.

Several organizations have created initiatives to reduce health disparities in the United States and worldwide. In 2011, the World Health Organization (WHO) set a goal to reduce premature deaths from non-communicable diseases, including CVD, by 25% by 2025 (25by25).[108] The WHO action plan targets modifiable CVD risk factors: tobacco use, alcohol intake, sodium intake, physical inactivity, diabetes mellitus/obesity, and hypertension.[109] The World Heart Federation expanded that goal to include a 25% reduction in CVD mortality by the year 2025 through nine strategies, including reduction in tobacco use, detection and treatment of hypertension, improved access to proven CVD medications, implementation of community-based interventions, creation of large studies to characterize lifestyle habits of regional populations, and the development of partnerships between high- and low-resource countries to facilitate transfer of knowledge and funding.[110, 111]

Reducing disparities in health will require a multi-level, collaborative approach. The overarching principles include a focus on identifying individuals and communities at greatest risk and putting more resources towards these groups, improving access to quality health care, increasing cultural competence, and revamping medical education. Government (federal and local), businesses/employers, health care systems, schools, community organizations and individuals/families all have an integral role in elimination of health disparities (Figure 4). Furthermore, since the foundation of SES and health in adulthood are influenced by conditions in childhood, targeted preschool and early childhood interventions have important implications for reducing disparities.[112]

The focus of future studies should be on implementation research evaluating strategies to reduce health disparities. These studies should be designed to identify effective policy changes and program interventions to reduce disparities. Furthermore, the costs and benefits of individual and community-level interventions to identify the most cost-effective strategies and interventions should be studied.[113]

Conclusion

SES has a measurable and significant impact on cardiovascular health. Individuals of low SES carry a substantial burden of CVD and are more likely to experience increased event rates and poorer outcomes. Current models do not adequately account for the risk conveyed by low SES. We now have compelling evidence showing that the independent association between SES and mortality is comparable in strength and consistency to that of the traditional major risk factors.[3] As Tobias concluded, the strength of that evidence “is now impossible to ignore”.[114] The time has come for increased focus on effective and sustainable interventions informed by clinical and population science insights from SES research. Additionally, further research is required to better understand the underlying mechanisms of CVD risk that disproportionately affect individuals of low SES. Once the causes of the

discrepancies in health equity are better understood, targeted interventions can be pursued to better address disparities in populations at risk.

Acknowledgments

Sources of Funding

PS is supported by the Abraham J. & Phyllis Katz Foundation (Atlanta, GA).

AAQ is supported by 1R61HL138657-01, 5P01HL101398-02, 1P20HL113451-01, 1P30DK111024-01, AHA 0000031288, 1RF1AG051633-01, R01 NS064162-01, R01 HL89650-01, HL095479-01, 1U10HL110302-01, 1DP3DK094346-01, 2P01HL086773-06A1.

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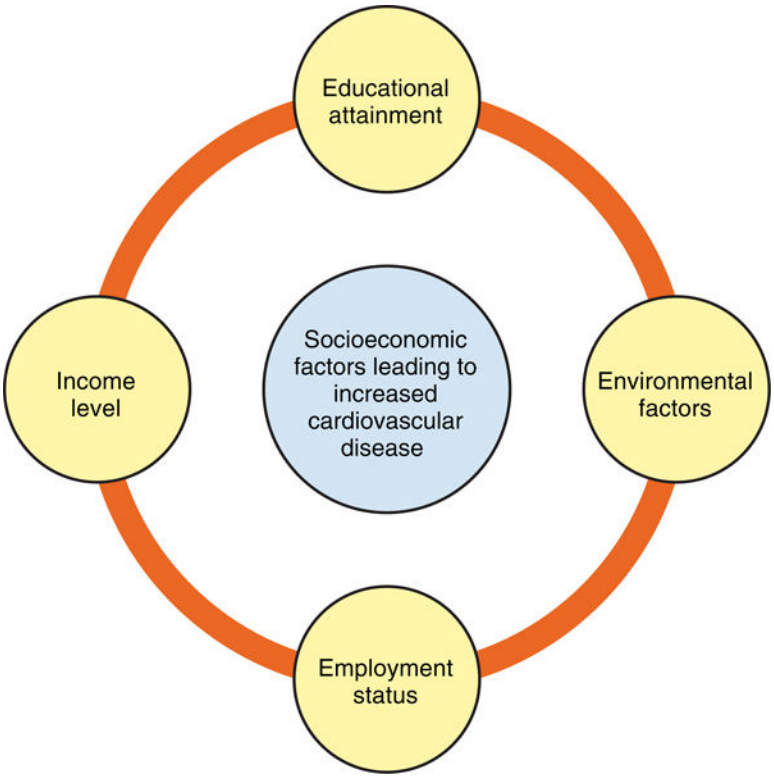

Figure 1.
Markers of socioeconomic status.

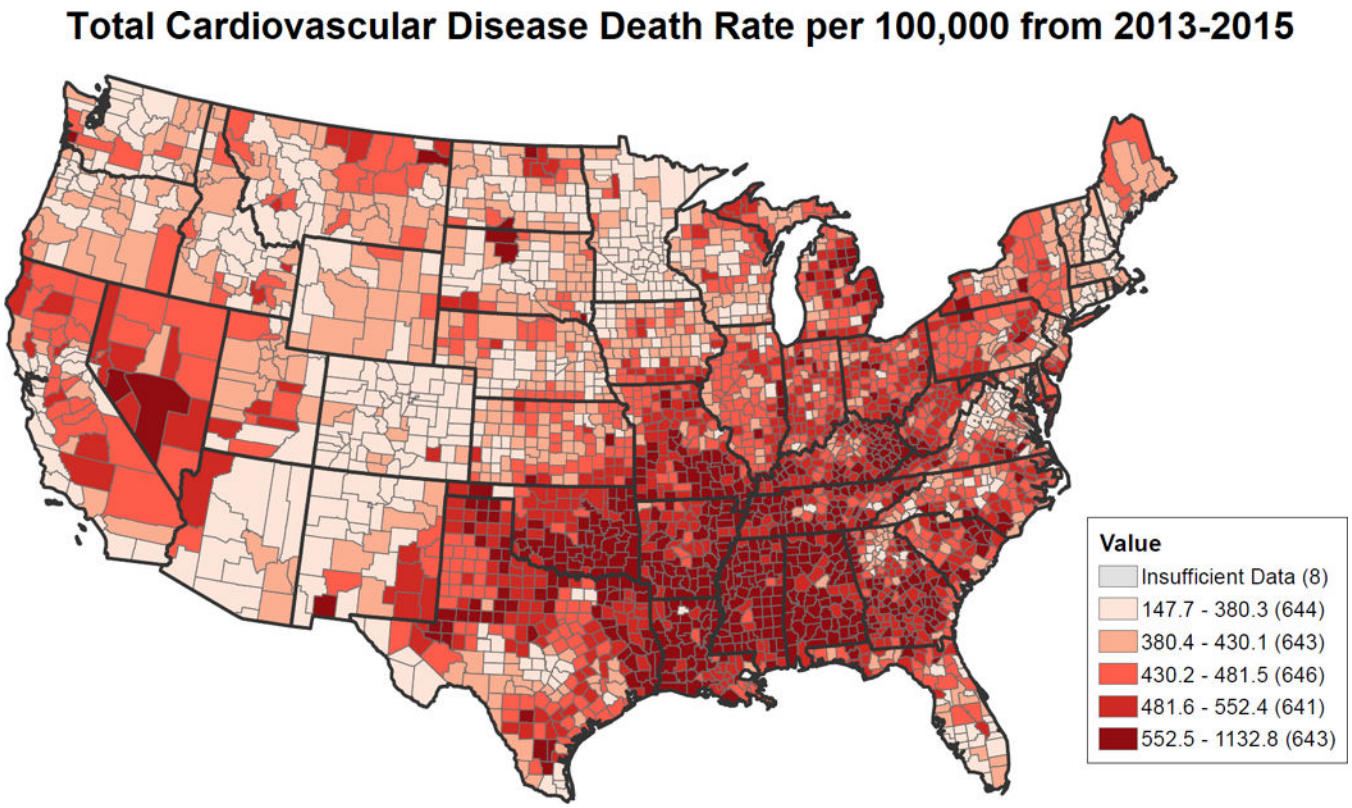

Figure 2.

Cardiovascular disease death rates in individuals aged ≥35, by county between 2013-2015. Rates are spatially smoothed to enhance the stability of rates in counties with small populations. Data sources are the National Vital Statistics System and National Center for Health Statistics. This map was created using the Interactive Atlas of Heart Disease and Stroke, a website developed by the Centers for Disease Control and Prevention, Division for Heart Disease and Stroke Prevention.[96]

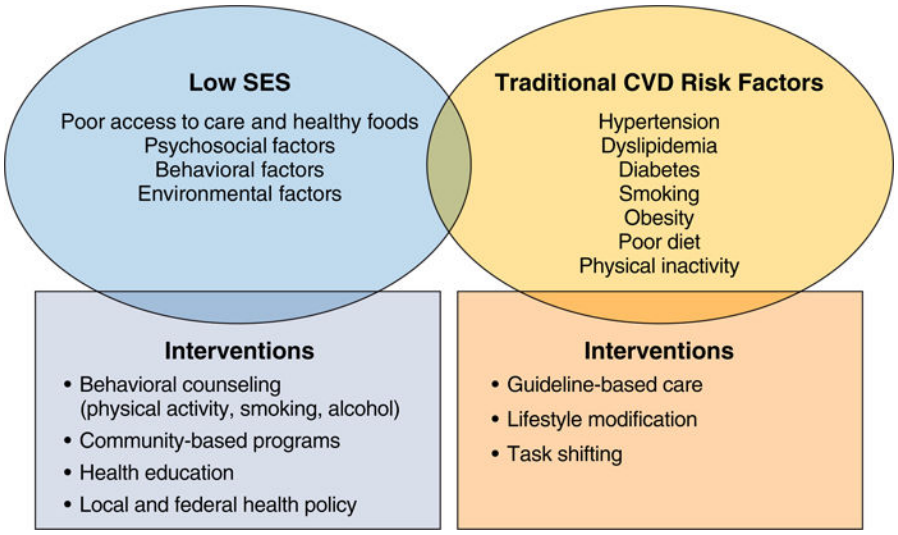

Figure 3.

Association between low socioeconomic status, cardiovascular risk factors, cardiovascular disease, and interventions. CVD, cardiovascular disease; SES, socioeconomic status.

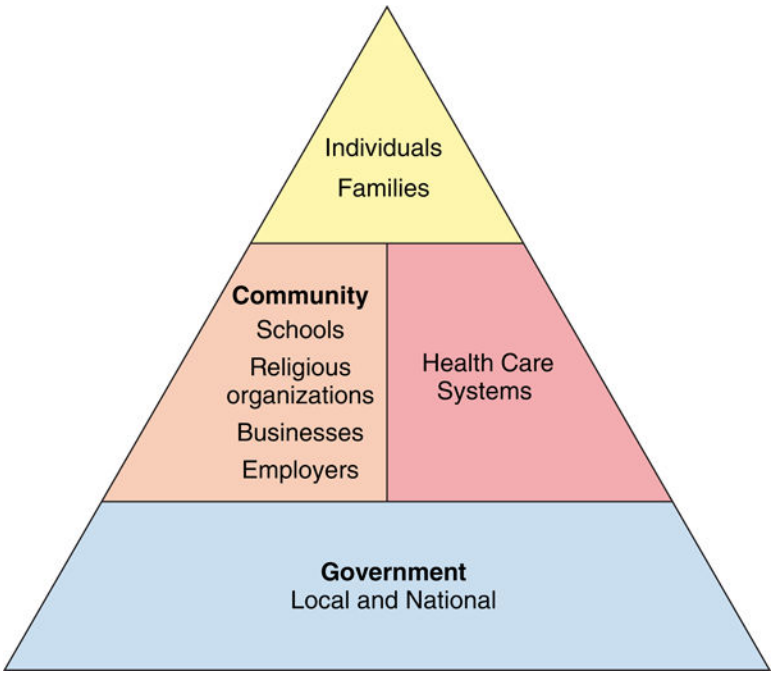

Figure 4.

Interventions at the community, government, healthcare systems and individual level should be targeted equally in efforts to reduce disparities in heath.