Socioeconomic Aspects of Cardiovascular Health

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Abstract

Extensive epidemiological evidence has demonstrated the socioeconomic gradient in cardiovascular health, with the most disadvantaged individuals at greatest risk of developing and dying from cardiovascular disease (CVD). Large-scale studies, beginning in the 1960s, reported significant associations between coronary mortality and occupation grade, income, and education. Individuals with low socioeconomic status (SES) additionally have a poorer prognosis post-myocardial infarction. Explanatory mechanisms explored here include differential access to medical care, differences in risk factor profiles, health literacy, and psychological and environmental factors. The influence of neighborhood SES is examined, beyond individual socioeconomic profile, as well as SES trajectory throughout life, and the relative importance of childhood versus adult SES in the development of CVD. Finally methodological factors are considered, examining the limitations of SES research, measurement issues, and risk prediction. It is proposed that SES should be considered in cardiovascular risk assessment, and that policy changes have the potential to minimize socioeconomic inequalities in cardiovascular health.

Keywords

Socioeconomic status • Cardiovascular disease • Epidemiology • Mortality • Prognosis • Myocardial infarction • Risk prediction

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9.1 Introduction

Decades of research have consistently shown that socioeconomic status (SES) is intimately intertwined with health, be it through behavioral, psychosocial, or pathophysiological pathways, via education and knowledge, financial resources, environmental characteristics or access to health services, healthy food, and sports facilities. Where we live and work; who we socialize with; what we eat, drink, and breathe; and how we spend our free time all impact on our cardiovascular health.

Cardiovascular disease (CVD) is a leading cause of death and disability worldwide; however, it does not strike indiscriminately. The social gradient in health means that those at the lower end of the socioeconomic scale are more likely to develop CVD, contrary to the stereotypical image of the wealthy but stressed executive who dies of a heart attack. Among those who already have the disease, individuals with low SES are more likely to die. Interestingly, the linear relationship between SES and health does not apply only to the extremes of deprivation and wealth, but can be seen within relatively similar western populations (Macintyre 1994). Many factors are at play in this relationship, including individual, community, and environmental factors, and we will here examine socioeconomic factors related to cardiovascular health, the evidence for these associations, and the mechanisms which underlie them.

SES is a combination of the economic resources at one's disposal and social position and typically comprises educational level, type of occupation, income, social class, and wealth. SES is a relative measure and has no meaning in isolation; it is always examined in the context of society, relative to one's neighbors. The construct of SES is based on the assumption that resources are distributed unequally in society.

9.2 SES and Cardiovascular Outcomes

9.2.1 SES and Development of CVD

One of the first large-scale investigations to provide evidence of the social gradient in health was the Whitehall study, a prospective cohort study which recruited 18,000 male employees of the UK civil service in 1967, and discovered a striking association between occupational grade and both all-cause and coronary mortality. Men in the lowest job grade were much more likely to die prematurely than those in the highest grade, with a coronary mortality rate 3.6 times higher (Rose and Marmot 1981). Furthermore, traditional risk factors including high blood pressure, smoking, and elevated cholesterol only explained a third of this association with mortality, inferring a direct relation between occupational grade and coronary health (van Rossum et al. 2000). The subsequent Whitehall II study, which investigated the cardiovascular health of a further 10,000 employees beginning in 1985, reported higher prevalence of risk factors, including smoking and obesity, and lower prevalence of healthy behaviors such as physical activity and healthy diet, in lower-grade

employees (Marmot et al. 1991). The Whitehall cohort, while large, has several limitations, comprising a majority of male white-collar workers in stable employment, and thus not being generalizable to the population as a whole. Among its strengths, the cohort included a wide range of job grades, from messengers to executive managers. In parallel, the Black report released in 1980 published evidence of large differences in mortality and morbidity according to social class (Smith et al. 1990). Far from improving over time, evidence from both the UK and USA showed that the gap between rich and poor grew between the 1970s and 1980s (Smith et al. 1990; Pappas et al. 1993).

While the Whitehall study used occupation as a marker of SES, representing salary, education, and social status, other facets have been equally assessed to represent SES.

The Tromso Heart Study found educational level to be associated with heart healthy behaviors in a cohort of 12,000 Norwegians: participants with the highest education were less likely to smoke and be overweight, were more physically active, and had a healthier diet (Jacobsen and Thelle 1988). It has been argued that education is a more reliable measure of SES when considering the relationship with health outcomes since it is usually fixed in early adulthood and does not tend to change, in contrast to occupation and income. As opposed to recruiting a single measure of SES, many studies have assessed multiple measures in order to gain a fuller picture.

Other longitudinal studies conducted in the USA, such as the Alameda County Study (Beebe-Dimmer et al. 2004), the Evans County Study (Johnson et al. 1986), Georgia Heart Study, the Charleston Heart Study (Nietert et al. 2006), and the US National Longitudinal Mortality Study, all found similar trends between SES and cardiovascular mortality. A recent meta-analysis comprising 70 studies reported an overall increased risk of myocardial infarction (MI) in low SES groups, when assessed on income, education, or occupation (Manrique-Garcia et al. 2011). The lowest income group had a 71 % increased MI risk compared to the highest income groups, while the least educated group had an increased risk of 34 % relative to the most educated.

While the Whitehall study examined only men, the Alameda County Study recruited over 3,000 women and collected socioeconomic data at four different time-points over a 30-year period, including childhood and current SES (Beebe-Dimmer et al. 2004). Low household income (set in 1965 as less than $5,000) was associated with elevated CVD mortality, with a hazard ratio of 1.5 compared to high household income (greater than $10,000), as was low childhood SES. Gender has been shown to interact with SES in the relationship with CVD, for example, in the First National Health and Nutrition Examination Survey, low education was associated with greater risk of coronary heart disease (CHD) in women than in men (Thurston et al. 2005).

9.2.1.1 Job Strain/Control

In recent years, research has investigated additional aspects of employment which may influence cardiovascular risk, beyond the mere fact of being employed, for example, the amount of control in the workplace or effort versus reward. A Swedish

study of 8,000 white-collar workers found that increased job control was associated with reduced CHD score (comprising self-reported high blood pressure, chest pains, and trouble breathing) (Karasek 1990). Increased job strain was also found to be associated with increased blood pressure in an Italian study from the WHO-MONICA project (Cesana et al. 2003). A 50 % excess risk of CHD was reported in employees with high effort and low reward jobs and an increased risk of 43 % in high versus low strain jobs in a meta-analysis including over 80,000 workers (Kivimäki et al. 2006). This line of investigation attempts to explain the stark differences in CV risk seen between different job grades, based on the assumption that lower status jobs usually involve more strain and less control.

9.2.2 SES and Progression of CVD

In addition to increasing the risk of developing CVD, low SES is related to poorer outcome in individuals with established CVD. Research in post-MI patients has shown a clear inverse relationship between socioeconomic status and mortality. Following are several examples presenting evidence from epidemiological studies.

The FINMONICA study recorded all MI events in three Finnish regions over a 10-year period and classified patients according to income (Salomaa et al. 2001). Low-income men had more than twice the rate of pre-hospital coronary death compared to high-income men, and in those surviving MI the 12-month mortality rate was significantly higher in low-income patients. Furthermore, case fatalities showed a graded relationship with both income and education.

In a cohort of 1,500 Israeli MI survivors aged 65 or less followed up for 13 years, comprising 98 % of all incident MIs in the study area during a given year, patients with both low income and low education had a higher risk of mortality compared to their better-off counterparts (Gerber et al. 2008). Low income was more of a risk factor in individuals with less education (Fig. 9.1).

Several other studies reported similar findings, with income inversely related to post-MI mortality (Salomaa et al. 2001; Alter et al. 2006; Rao et al. 2004). Alter et al., in a study of 3,400 Canadian MI patients, reported this relation to be substantially attenuated on multivariable adjustment for age and CV risk factors (Alter et al. 2006), while Rao found that the poorest decile had a much higher short-term mortality rate – within 1 year – than the rest of the population (Rao et al. 2004). This relation is explained since poorer individuals presented later to the hospital and consequently received poorer treatment.

9.2.2.1 Why Are Low SES Patients More Likely to Die After Suffering an MI?

Access to care: There is evidence that lower-income patients are likely to receive poorer medical care. A US study of over 10,000 patients with acute coronary syndromes reported low-income patients as presenting with more severe disease compared to high-income patients (Rao et al. 2003). Furthermore, lower-income patients were less likely to receive evidence-based treatment including cardiac

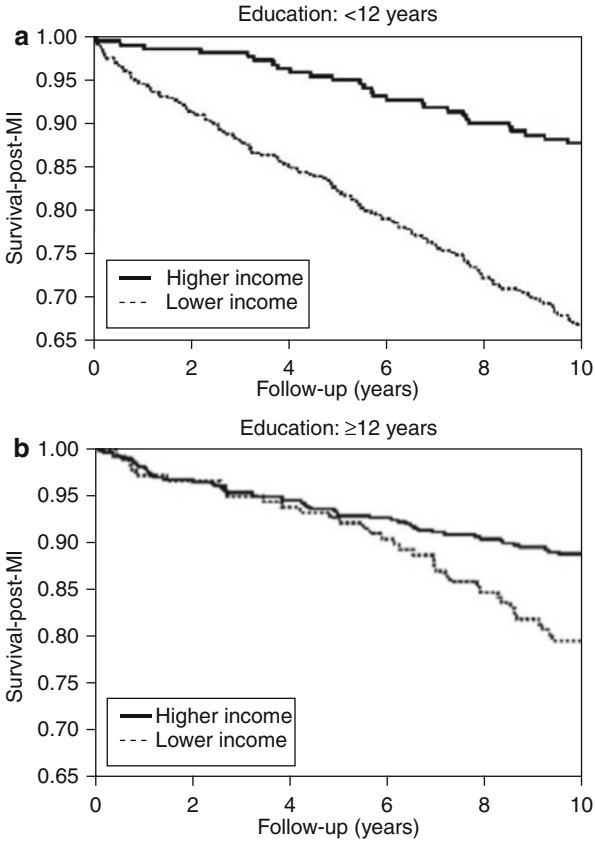

Fig. 9.1 Kaplan–Meier survival curves comparing lower-income patients with higher-income patients by education categories. (**a**) Less educated group [log-rank test, $P<0.001$; (**b**) More educated group [log-rank test, $P=0.003$] (Excerpt from Gerber et al. (2008), SAGE Publications, Inc.; all rights reserved)

catheterization, percutaneous coronary intervention, and prescription of aspirin or beta-blockers, although these differences were attenuated on multivariable adjustment. These trends may go some way to explaining the significantly higher 6-month mortality rate in the low-income group. Additional studies found discrepancies between treatments received by MI patients according to SES. A large-scale cohort study involving over 50,000 Canadian MI patients reported increased use of coronary angiography and reduced waiting times in the highest SES compared to lowest SES neighborhoods, based on census data (Alter et al. 1999). Furthermore, there was a strong inverse relationship between income and mortality 1 year post-MI, despite the universal healthcare provided in Canada. Similar results have been reported in numerous studies, presenting reduced use of invasive cardiac procedures in lower-income MI patients (Philbin et al. 2000; Rathore et al. 2000). Besides provision of treatment, access to medical facilities may differ according to SES. In the FINMONICA study, low-income males with MI were more likely to present with more than 4h delay compared to wealthier patients (Salomaa et al. 2001). Whether this delay is due to poorer access to appropriate care or to reduced help-seeking behavior remains open to debate.

Risk factors: An alternative or parallel explanation for the poorer survival odds of low SES MI patients is a difference in baseline risk factors (Ebrahim et al. 2004), which contribute to both the development and progression of CHD. While CHD mortality has declined over the years as has the prevalence of some primary CV risk factors such as smoking and physical inactivity, socioeconomic inequalities persist (Hotchkiss et al. 2011). Secondary risk factors such as diabetes and hypertension are on the increase. Less educated MI patients were more likely to have a history of diabetes mellitus and congestive heart failure in the Multicenter Investigation of the Limitation of Infarct Size (Tofler et al. 1993). Risk factors differed not only prior to MI but also during follow-up, with less educated patients less likely to stop smoking (never graduated 38 % vs. high school graduates 49 %). Patients who continued to smoke had increased mortality risk. This finding was replicated in an Israeli cohort study, with SES contributing to the likelihood of quitting smoking post-MI (Gerber et al. 2011a). Additionally, low neighborhood SES was associated with lower physical activity after MI (Gerber et al. 2011b), a factor strongly related to prognosis.

9.3 Mechanisms

The Black report identified four types of explanations for social inequalities in health. These are artifacts, or measurement errors in attributing social class, including the fact that lower or working classes are diminishing; social selection which proposes that health status determines socioeconomic status; behavioral, whereby unhealthy behaviors are more prevalent in lower social classes; and materialist, involving "hazards inherent in society," such as working in hazardous jobs or residing in heavily polluted areas (Smith et al. 1990). All these factors contribute to the socioeconomic gradient in cardiovascular health.

Risk factors: Much has been written about risk factors as the link between SES and cardiovascular outcomes. Evidence from the Framingham Heart Study – a long-term investigation which pioneered the concept of cardiac risk factors – has demonstrated that the primary risk factors for CVD are smoking, hypertension, high cholesterol (dyslipidemia), sedentary lifestyle, and diabetes, largely lifestyle-influenced factors alongside genetic predisposition (Mendis 2010). The Kuopio Ischemic Heart Disease Risk Factor Study investigated whether 23 biological, behavioral, psychological, and social risk factors could account for the association between income and CV mortality in men (Lynch et al. 1996). Adjustment for risk factors not only reduced but completely eliminated the association. Multivariable adjustment also attenuated the relation between SES and acute MI. Biological factors had the greatest effect in risk reduction. The question remains, why do low SES populations have a higher prevalence of CV risk factors, such as blood glucose, hypertension, and high cholesterol? There is direct evidence that SES affects behavior styles, coping styles, the endocrine system, the homeostasis system, and access to medical care (Kaplan and Keil 1993). While some evidence exists for psychological, physiological, and biochemical mediators of the relation between SES and disease, much remains open to speculation.

Hypertension, a risk factor for MI, stroke, and heart failure, has been frequently associated with SES (Cirera et al. 1998). This could be due to greater awareness of hypertension, the effects of diet and the importance of regular checkups, and better access to health services among more highly educated people or could be a by-product of a generally more stressful life associated with deprivation. Cumulative stress has an effect on the heart, increasing allostatic load, illustrated by delayed recovery of the cardiovascular system, specifically blood pressure and heart rate variability, after mental stress in low SES groups, in a sub-cohort of the Whitehall II study (Steptoe et al. 2002). This implies that certain characteristics of low SES – prolonged stress, dietary factors – may put a strain on the heart, making it more vulnerable to injury. Evidence has shown that acute stress can have adverse CV effects, for example, impairment of endothelial function or an increase in cytokine levels lasting for several hours (Steptoe et al. 2001). Cumulative stress is therefore likely to have an enduring effect on the CV system. Fibrinogen has also been demonstrated to be higher in lower socioeconomic groups, showing a significant association with four separate socioeconomic measures in the Kuopio Ischemic Heart Disease Risk Factor Study (Wilson et al. 1993).

Psychological factors: Certain psychological factors are associated with poorer outcomes in patients with established CHD and post-MI patients. Patients with depressive symptoms in the aftermath of MI are at significantly increased risk of mortality and re-infarction. Two meta-analyses of post-MI depression reported that patients diagnosed with depression within 3 months of MI had more than double the risk of all-cause and cardiac mortality than those without depression (van Melle et al. 2004; Meijer et al. 2011). Elevated rates of recurrent cardiac events were also detected. Depression is generally more prevalent among low SES backgrounds (Lorant et al. 2003), and low income has been associated with depression in CHD patients. A cohort study of post-MI patients found that those with depressive symptoms were less educated, had lower income, and were more likely to be unemployed than those without depressive symptoms (Myers et al. 2012). Furthermore, depression was associated with increased cardiac-related hospital admissions during 13 years of follow-up. In a British study of 300 patients with acute coronary syndromes, depression was also found to be more prevalent in lower SES individuals (Steptoe et al. 2011).

Health literacy: Various hypotheses have been suggested to determine why education is so strongly associated with health outcomes. The concept of health literacy posits that individuals with lower ability to read and comprehend medical information are likely to have poorer outcomes. This may be due to lack of awareness of the impact of lifestyle behaviors, nonadherence or incorrect adherence to medication, delayed presentation of symptoms, and poorer management of chronic disease due to poorer understanding of the condition. Scales have been devised to test health literacy, involving both reading and numeracy for health information, and studies have reported increased mortality in individuals with inadequate health literacy (Baker et al. 2007; Bostock and Steptoe 2012). A study of community-dwelling adults with heart failure found that patients with low health literacy were older, were less educated, and had more comorbidities than those who scored high (Morrow et al. 2006).

Lifestyle and environment: Behaviors associated with cardiovascular risk seem to be more prevalent in low SES individuals, whether defined by lower educational attainment or lower income, as evidenced in numerous studies. A study of socioeconomic differentials in CV and cancer mortality in Greece found not only a socioeconomic gradient in CV mortality but also that obesity, poor diet, and physical inactivity were more prevalent in the less educated participants (Naska et al. 2012). In fact, while smoking trends are decreasing in industrialized countries, this reduction is more evident in higher SES populations, while less educated sectors continue to smoke at high levels (Filion et al. 2012). Obesity is also strongly related to socioeconomic status (Wang and Beydoun 2007). Many cross-sectional analyses have found a connection between physical activity and both individual (Barnett et al. 2008) and neighborhood deprivation (Yen and Kaplan 1998; Lee et al. 2007). In order to establish a robust association, longitudinal cohort studies are required. Gerber et al., in a study of post-MI patients followed up for 10–13 years, reported neighborhood deprivation to be strongly associated with uptake of physical activity after MI (Gerber et al. 2011b). Some research has attempted to uncover which neighborhood features may influence exercise patterns and explain the discrepancy between high and low SES areas. Explanatory factors include both physical elements (such as lighting, street layout, and access to facilities) and social characteristics, particularly perceptions of others' behavior and perceived safety of the environment. An American study demonstrated that not only did deprived neighborhoods have fewer sports facilities including parks and gyms compared to high-SES neighborhoods, but they were also less likely to provide free sports facilities (Estabrooks et al. 2003). Further environmental factors, such as air pollution or poor living conditions, may also be involved in overall poorer health outcomes.

SES has also been associated with attendance at cardiac rehabilitation, a crucial component of post-MI recovery, but one for which uptake is low. A study of Danish MI survivors reported nonattendance to be associated with low income (Nielsen et al. 2008). A systematic review found nonattenders to be older and to have lower income or greater deprivation among other factors (Cooper et al. 2002).

9.4 Neighborhood SES: Location, Location, Location

Growing evidence suggests that our health may be influenced not only by our own SES but additionally by the socioeconomic characteristics of the neighborhood in which we live. Neighborhood SES may influence health through availability of health services and other resources, infrastructure, prevailing health attitudes and behaviors, social norms, environmental pollution, and stress (Pickett and Pearl 2001).

Epidemiological evidence has shown an increased risk of developing cardiovascular disease in more deprived areas (Diez-Roux et al. 1997, 2001; Sundquist et al. 2004). For example, in Sundquist et al., a random population sample followed up for incident CHD showed an increased risk associated with decreasing neighborhood income and education (Sundquist et al. 2004). By assessing the proportion of residents in each neighborhood with less than 10 years' education and the proportion in

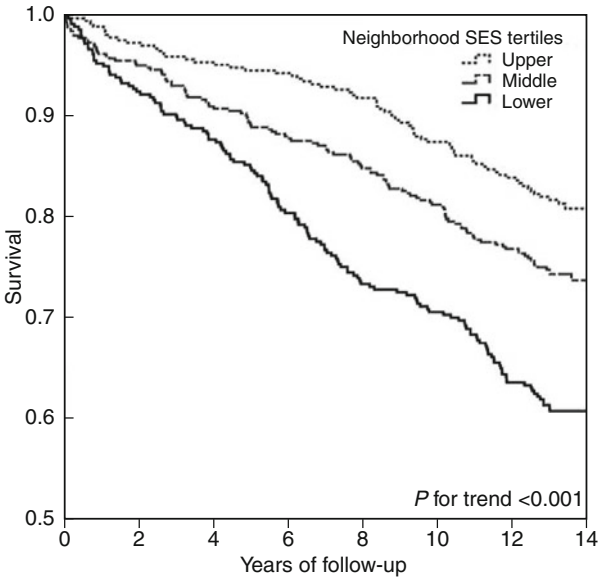

Fig. 9.2 Kaplan–Meier survival curves for neighborhood socioeconomic tertiles (based on 326 deaths occurring in 1,179 incident MI patients) (Reprinted from Gerber et al. (2010), with permission from Wolters Kluwer Health, license no.2874260929086 obtained March 22nd 2012)

the lowest national income quartile, a neighborhood SES score was assigned to each participant, enabling detection of this inverse association, which withstood multivariable adjustment. In addition to increased incidence of CHD, neighborhood deprivation has also been shown to be associated with increased case fatality. In a prospective study of almost four million Swedish men and women, CHD incidence was 1.9 times higher for women and 1.5 times higher for men in the most compared to the least deprived neighborhoods (Winkleby et al. 2007). Case fatality was similarly increased by around 1.6 times. This increased risk occurred regardless of individual SES.

Little data exists on the role of neighborhood SES after heart attack. The Israel Study of First Acute Myocardial Infarction assessed neighborhood SES by geocoding patients' residential addresses based on census data. The authors found neighborhood SES to be strongly related to survival in MI patients, with individuals from the most disadvantaged areas 47 % more likely to die than those in the best neighborhoods, even after controlling for clinical factors and individual SES characteristics (Gerber et al. 2010). There was a clear dose-response pattern between neighborhood SES and post-MI mortality (Fig. 9.2). The relationship with cardiac death was even stronger. Similar results were published from a US study of MI survivors, with a 30 % higher mortality rate in the most deprived neighborhoods compared to the wealthiest and a 47 % higher death rate for areas with the highest proportion of residents with less than high school education (Tonne et al. 2005).

Based on these findings, the Israeli study group went on to investigate the association between neighborhood SES and health behaviors which could potentially mediate the relationship with post-MI outcomes. Indeed, they reported that post-MI patients living in the most deprived areas were less likely to be physically active than their counterparts living in better-off areas (Gerber et al. 2011b) (Fig. 9.3).

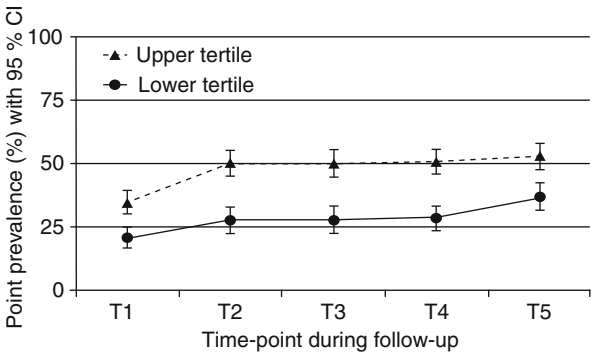

Fig. 9.3 Percentage of post-MI patients regularly engaged in leisure-time physical activity at different time-points by neighborhood SES group. *T1* baseline (pre-MI), *T2* 3–6 months, *T3* 1–2 years, *T4* 5 years, *T5* 10–13 years post-MI (Reprinted from Gerber et al. (2011b), with permission from Elsevier, license no.2874260218863 obtained March 22nd 2012)

Neighborhood SES is also likely to influence access to health services. A study of 50,000 post-MI patients found that not only were those in less deprived areas more likely to undergo angiography within 6 months than their less well-off counterparts, but they also experienced shorter waiting times as well as improved survival (Alter et al. 1999).

9.5 SES Trajectory: Change in SES Across the Life Span

Since SES is so strongly associated with cardiovascular development and progression, it stands to reason that by changing SES – not a trivial matter – cardiovascular risk may be altered. Several studies investigated the impact of social mobility on subsequent risk. The GAZEL French cohort study plotted socioeconomic trajectory by comparing father's occupational grade, own occupation in early adulthood, and midlife occupation. Premature mortality was associated both with persistently low SES/occupational grade (termed "lifelong socioeconomic disadvantage") and with downward mobility (moving from high to low-grade occupation). The strongest associations were for cancer and cardiovascular disease deaths (Melchior et al. 2006). The relationship was partially explained by tobacco and alcohol consumption, BMI, and diet. The authors concluded that while sustained socioeconomic disadvantage predicted premature mortality, occupational trajectory in adulthood played a greater part than socioeconomic circumstances in childhood. A study of Swedish women, also based on occupational class in childhood and adulthood, similarly found adult occupational status to be more strongly associated with CVD mortality than childhood status (Tiikkaja et al. 2009). Women whose occupational class went down (from nonmanual to manual) were twice as likely to die from CV cause compared to those who remained in nonmanual occupations, with a large percentage explained by educational level.

Barker theory lends support to the importance of childhood SES, proposing that early childhood factors influence the development of the heart, going as far back as pregnancy, with reports of low birth weight and small placental size being associated with development of CHD in adulthood (Barker et al. 2010). Childhood BMI measures were also related to the development of heart failure in adulthood. While research in this field is limited, these findings present the possibility of early intervention in childhood and even before birth to reduce levels of CHD in later life.

9.6 Methodological Issues

SES can be measured in a multitude of different ways, from single items to multidimensional indices or aggregate measures. While much earlier research into the relationship between SES and cardiovascular outcomes used single measures such as education or income, later studies noted the importance of multidimensional assessment. SES further operates on various levels including individual, household, and neighborhood levels. In addition to relying on a single SES measure, most health studies do not justify their choice of measure (Braveman et al. 2005). A critical analysis of standard SES measurement approaches proposed the inclusion of multiple SES indicators – including only those which are biologically plausible – the justification of the choice of factors and consideration of unmeasured factors (Braveman et al. 2005).

Education and income: Due to cultural taboos, income is often not directly measured, rather being self-reported as above or below average, thus being largely subjective and susceptible to bias. Education on the other hand is more readily available and people are less reticent about revealing this information, usually coded as years of formal schooling or qualifications achieved. So is it preferable to use one or both of these indices? While education and income are often correlated, it is recommended to include both if possible, since the correlation is not strong enough to risk collinearity, or to justify using one as a proxy for the other (Braveman et al. 2005). Indeed there are numerous examples of successful businesspeople with little in the way of formal education, and vice versa. Furthermore, income differs from wealth, or accumulation of economic resources. A low income may belie a large amount of wealth, thus distorting its effect on health. Further delving into the concept of education, three separate aspects have been recognized: quantity, credentials, and selectivity. However, quantity, or years of schooling, has been shown to have the largest effect on health (Ross and Mirowsky 1999). A workplace study including over 5,000 men aged between 35 and 64 years found both social class and education to be associated with blood pressure and mortality. Occupational social class was a better discriminator of socioeconomic differences in mortality than was education (Davey Smith et al. 1998).

Occupation: In order to determine SES, occupation has traditionally been classified according to skill level and responsibility, for example, manual versus nonmanual or administrative versus managerial, or by job grade as in the Whitehall

study. Many SES indices, including Hollingshead's four-factor index, include lists of all possible occupations ranked into social categories, from architects and doctors in the top rank to cleaners and farm laborers in the bottom category. These classifications are subjective and have been widely criticized, being based either on public perception of their prestige or on the educational requirements required to gain access to them (Liberatos et al. 1988). Investigations of other aspects of work, such as job demand and control, attempt to classify occupation in a more meaningful way (Karasek 1990; Cesana et al. 2003).

Composite index: Hollingshead began examining social status in the 1940s and decided that occupation and years of schooling were the key ingredients in the SES equation (Hollingshead 1975). In 1975 she came up with the "four-factor index" comprising education, occupation, sex, and marital status. While criticisms have been directed at some indices since most have not been validated and may not be generalizable to different populations (Braveman et al. 2005), a comparison of different scales found high agreement between the Hollingshead index and two other SES scales (Cirino et al. 2002).

Census data/aggregate measures: Medical records do not usually include measures of SES; therefore, health studies which wish to consider this aspect must rely on indirect means such as census data. However, some doubt has been cast on the validity of these methods. Low correlations were reported between direct individual data and indirect census data of the same patients (Greenwald et al. 1994), and indirect measures may involve substantial error. Furthermore, associations of health outcomes with aggregate SES measures have been shown to be weaker than individual measures (Geronimus and Bound 1998). Other researchers strongly defend the use of aggregate measures, in order to incorporate macrolevel data, stating that group-level variables may be important in explaining the social gradient in health (Diez-Roux 1998). For example, mean neighborhood income is likely to provide a wealth of information about resources and facilities in the area, factors which affect health regardless of individual SES.

9.6.1 Causal Direction

Due to the nature of the socioeconomic field, little data exists to confirm the causal nature of the relationship between SES and CV outcomes. Since we cannot manipulate SES, we can only conduct observational studies, comparing groups based on their naturally occurring socioeconomic characteristics. Without empirical evidence, we cannot make any definitive claims about causal direction. However, some measures of SES do more than others to overcome this limitation, such as education level, which, since it is usually fixed in late childhood or early adulthood, precedes health outcomes, compared to income or occupation which are far more likely to change over the life course. A recent study, using data from the Whitehall II cohort, attempted to shed light on this conundrum, investigating two conflicting theories: the health-related selection hypothesis, which posits that health predicts social

mobility, and the social causation hypothesis, which suggests that SES influences health. The report found that poorer childhood health was related to lower occupational grade in later life, but that health in adulthood, represented by cardiometabolic factors (e.g., high blood pressure, obesity, glycemia), did not predict chances of promotion to a higher grade (Elovainio et al. 2011). On the contrary, occupational grade did predict subsequent measures including BMI and glucose levels. The authors concluded that childhood health problems predicted lower SES in adulthood and that in adulthood, SES was associated with an increase in CV risk factors including adiposity and glucose metabolism.

9.6.2 Risk Prediction and Importance of Including SES

Since SES has such an impact on the risk of developing CVD, it stands to reason that it should be included, alongside standard risk factors, when calculating risk. Indeed, with regard to primary prevention, several studies reported that the Framingham score – typically used in estimation of CV risk – underestimates risk in individuals with the lowest SES and overestimates in the highest SES groups (Tunstall-Pedoe and Woodward 2006; Ramsay et al. 2011), a fact which could mislead treatment decisions. When SES was incorporated into a risk prediction model for post-MI patients, substantial gains were achieved in long-term mortality prediction (Molshatzki et al. 2011).

9.7 Summary and Perspectives

Epidemiological studies from diverse countries and eras have consistently demonstrated the social gradient in health, illustrating clear differences in cardiovascular risk for low and high socioeconomic groups, both for developing CVD in the general population and for worsening CVD in those with established disease. Pathophysiological investigations go some way to explaining the mechanisms underlying this relationship. SES significantly affects both the risk of developing CVD and mortality risk in established disease and should therefore be considered when assessing risk. It is clear that social inequalities in health need to be addressed and that many factors are at play in this relationship. Unfortunately, socioeconomic status is one CV risk factor that is difficult or impossible to alter; however, it should be considered in the overall CV risk profile. Furthermore, policy that addresses SES disparities in the population could minimize its consequences. While changing individual SES is beyond the scope of health services, several contributing factors can be improved, including access to healthcare and sports facilities, psychoeducation and improvement of health literacy, and improved awareness of other risk factors such as smoking, poor diet, and physical inactivity, with the aim of redressing the balance and improving outcomes for individuals from disadvantaged backgrounds.

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