Published in final edited form as:
Am J Prev Med. 2007 February ; 32(2): 97–106.

Inequities in CHD Incidence and Case Fatality by Neighborhood Deprivation

Marilyn Winkleby, MPH, PhD[1], **Kristina Sundquist, MD, PhD**[2], and **Catherine Cubbin, PhD**[3]

1 *Stanford Prevention Research Center, Stanford University School of Medicine, Palo Alto, California*

2 *Karolinska Institutet, Center for Family and Community Medicine, Stockholm, Sweden*

3 *Center on Social Disparities in Health, University of California, San Francisco, San Francisco, California*

Abstract

Background— Research has not firmly established whether living in a deprived neighborhood predicts the incidence and case fatality of coronary heart disease (CHD), and whether effects vary across sociodemographic groups.

Methods— Prospective follow-up study of all Swedish women and men, aged 35–74 (1.9 million women, 1.8 million men). Women and men, without a history of CHD, were assessed on December 31, 1995 and followed from January 1, 1996 through December 31, 2000 for first fatal or nonfatal CHD event (130,024 cases); data were analyzed in 2006. Neighborhood-level deprivation (index of education, income, employment, welfare assistance) was categorized as low, moderate, and high deprivation.

Results— Age-standardized CHD incidence was 1.9 times higher for women and 1.5 times higher for men in high- versus low-deprivation neighborhoods; 1-year case fatality from CHD was 1.6 times higher for women and 1.7 times higher for men in high versus low deprivation neighborhoods. The higher incidence in more deprived neighborhoods was observed across all individual-level sociodemographic groups (age, marital status, family income, education, immigration status, mobility, and urban/rural status). In multi-level logistic regression models, neighborhood deprivation remained significantly associated with both CHD incidence and case fatality for women and men after adjusting for the seven sociodemographic factors (p values <0.01). Effects were slightly stronger for women than men in an ancillary analysis that tested for gender differences.

Conclusions— The clustering of CHD and subsequent mortality among adults in deprived neighborhoods raises important clinical and public health concerns, and calls for a reframing of health problems to include neighborhood social environments, as they may affect health.

INTRODUCTION

A leading cause of death and disability in all industrialized countries is coronary heart disease (CHD).[1,2] Up to 70% of CHD incidence can be explained by individual-level sociodemographic characteristics (age, gender, socioeconomic status/position), health behaviors (smoking, physical inactivity, poor diet), and risk factors (hypertension,

Correspondence and reprint requests: Marilyn A. Winkleby MPH, PhD, Stanford Prevention Research Center, Stanford University School of Medicine, Hoover Pavilion, Room N 229, 211 Quarry Road, Stanford, California 94305-5705, Phone: (650) 723-7055, Fax: (650) 725-6247; E-mail: winkleby@stanford.edu.

hypercholesterolemia, diabetes).[3] Although some of the unexplained causes of CHD may be due to incomplete or inaccurate measurement of these factors, recent work has focused on the environments and social contexts in which these risk factors may develop or be exacerbated.[4,5]

One important area of research on the social context of CHD has been on the relationship between neighborhood-level deprivation and individual-level CHD. In general, this research has shown significant neighborhood-level effects after "adjustment" for potential confounding factors including individual-level socioeconomic status/position.[4,6–10] This area of research is particularly germane to women as previous work suggests that residence in a deprived neighborhood may affect the cardiovascular health of women to a greater extent than men.[6,7]

Two population-based studies have included both women and men, and examined the associations between neighborhood-level characteristics and CHD incidence.[6,7] Diez-Roux et al. reported hazards ratios for CHD among adults in the most disadvantaged versus the most advantaged neighborhoods of 1.6 and 1.8 for white and black women, respectively, and 1.6 and 1.4 for white and black men, respectively, after adjustment for individual-level income, education, occupation, and established CHD risk factors (615 events).[7] Using a neighborhood medical care need index, Sundquist et al. reported odds ratios among adults in the most versus the least deprived neighborhoods of 1.9 and 1.4 for women and men, respectively, after adjustment for individual-level age and income (14,259 events).[6] Neither of these studies examined neighborhood-level effects on CHD across a broad array of sociodemographic groups, tested for differences by gender, or examined effects on case fatality, an indicator of severity of disease and quality of care. Separate studies have examined the relationship between area-based measures and case fatality/survival following an acute myocardial infarction[11–15] and while all found significant associations, only one presented neighborhood results separately by gender,[12] and none presented case fatality from overall CHD.

This study had four objectives: First, whether there were additive effects of neighborhood-level deprivation on CHD incidence and case fatality for the total population of Swedish women and men, and across individual-level sociodemographic groups (the latter for incidence only). Second, whether neighborhood-level deprivation remained significantly associated with CHD incidence and case fatality using multi-level models to adjust for individual-level sociodemographic characteristics. Third, whether the risk of CHD in high-versus low-deprivation neighborhoods differed by gender. And fourth, which component of this neighborhood deprivation index was most strongly related to CHD incidence.

METHODS

Data sources

The Swedish Statistics Bureau provided individual-level demographic and socioeconomic data for the entire population of women and men, aged 35–74, who resided in Sweden on December 31, 1995, and had lived in Sweden since December 31, 1985 (1.9 million women, 1.8 million men). They were followed from January 1, 1996 through December 31, 2000 for first fatal or nonfatal CHD event (incident cases and 1-year case fatality from CHD). Data were analyzed in 2006.

The home addresses of all Swedish adults have been geocoded to small geographic units that have boundaries defined by homogeneous types of buildings. These neighborhood areas, called small area market statistics, or SAMS, have an average of 1000–2000 people and were used as proxies for neighborhoods, as has been done in previous research.[6] SAMS with fewer than 50 people aged 25–64 were excluded (n =1024 SAMS), as were adults whose addresses were

not able to be geocoded to a neighborhood area (2.6% of the sample). The final sample was 8293 SAMS. Approximately 80% of both women and men lived in the same SAMS neighborhood over the course of the study (to December 31, 2000). There was no loss to follow-up as each individual was tracked with a personal identification number.

The study was approved by the Karolinska Institute Ethics Committee.

Outcome Variables

CHD incidence—To identify incident cases of CHD, individual data were linked to the Swedish Hospital Discharge Register (main and additional diagnoses) and the Cause of Death Register using a unique personal identification number. CHD incidence was defined as the total number of fatal and nonfatal CHD cases from January 1, 1996 through December 31, 2000, divided by the number of women or men on January 1, 1996 for the total population and for each subgroup.[16] The resulting numbers are incidence proportions, defined as the proportion of adults who become cases among those who entered the study time interval[17] (hereby referred to as incidence; see statistical analysis section below).

All fatal and nonfatal hospitalized CHD events, and all fatal out-of-hospital CHD events (1.9% of all events) were eligible for analysis. To ensure as accurate as possible identification of incident cases, adults were excluded who had a previous hospitalization due to CHD up to 10 years before the start of the study. While information was unavailable on hospitalizations prior to this, the large majority of these cases were probably first CHD rather than recurrent cases. All events were classified according to the World Health Organization (WHO)'s International Classification of Diseases, ICD 9 (410–414), and ICD 10 (I20–I25).

Case fatality—Case fatality rates were defined as the number of deaths from CHD following hospital discharge within 1 year of the incident case, divided by the number of women or men with a CHD event from January 1, 1996 through December 31, 2000, and multiplied by 100. This definition is similar to that used by previous studies,[11,13] with the exception that it was based on deaths specifically from CHD.

Independent Variable at the Neighborhood Level

Neighborhood Deprivation Index—A summary measure was used to characterize neighborhood-level deprivation. Deprivation indicators used by past studies were identified to characterize neighborhood environments; a principal components analysis was then used to select deprivation indicators in the 1995 Swedish national database. The following four variables were selected for those aged 25–64: low educational status (<10 years of formal education); low income (income from all sources, including that from interest and dividends, defined as less than 50% of individual median income)[18]; unemployment (not employed, excluding full-time students, those completing compulsory military service, and early retirees); and social welfare recipient (receiving social welfare support during 1995). Each of the four variables loaded on the first principal component with similar loadings (+0.47 to +0.53) and explained 52% of the variation between these variables.

A z score was calculated for each SAMS neighborhood. The z scores, weighted by the coefficients for the eigenvectors, were then summed to create the index.[19] The index was categorized into three groups: below one standard deviation (SD) from the mean (low deprivation), above one SD from the mean (high deprivation), and within one SD of the mean (moderate deprivation). Higher scores reflect more deprived neighborhoods.

Population sizes and neighborhood characteristics in 1995 by level of neighborhood-level deprivation are presented Table 1.

Independent Variables at the Individual Level

Age: 35–74 years, divided in 10-year categories.

Marital status: married/cohabitating, never married, widowed, or divorced.

Family income: based on the annual family income divided by the number of people in the family, that is, individual family income per capita. This variable was provided by Statistics Sweden (the Swedish Government-owned statistics bureau). The income parameter also took into consideration the ages of people in the family and used a weighted system whereby small children were given lower weights than adolescents and adults. The calculation procedure was performed as follows: The sum of all family members' incomes was multiplied by the individual's consumption weight divided by the family members' total consumption weight. The final variable was calculated as empirical quartiles from the distribution.

Educational attainment: completion of compulsory school or less (≤9 years), practical high school or some theoretical high school (10–11 years), or theoretical high school and/or college (≥12 years).

Immigration status: born in Sweden, immigrant from a country mainly referred to as a refugee country, immigrant from Finland, and immigrant from a country mainly referred to as labor immigrant country. Finnish immigrants represented their own category as they have poorer health than other Swedish immigrants.[20]

Mobility: length of time lived in neighborhood, categorized as lived in neighborhood <5 years or ≥5 years, as of December 31, 1995.

Urban/rural status: large cities (Stockholm, Gothenburg, Malmö); middle-sized towns; and small towns/rural areas.

Statistical analysis

Age-standardized incidence proportions were calculated by direct age standardization using 10-year age groups specific to women or men, with the entire Swedish population of women or men in 1996 as the standard population.

Multi-level (hierarchical) logistic regression models with incidence proportions (the proportion of adults who became cases among those who entered the study time interval) were used as the outcome variables. The analyses were performed using MLwiN, version 2.0.[21] First, a neighborhood model was calculated that included only neighborhood-level deprivation to determine the crude odds of neighborhood deprivation. Next, a full model was calculated that included neighborhood-level deprivation, the seven individual-level sociodemographic characteristics added in simultaneously, and cross-level interaction terms between the sociodemographic characteristics and neighborhood-level deprivation. These full models tested whether neighborhood-level deprivation was significantly associated with CHD incidence and case fatality after adjusting for the sociodemographic characteristics, and whether there were differential effects of neighborhood-level deprivation on CHD incidence across sociodemographic characteristics.[22]

Final models were run without interaction terms because there were no meaningful cross-level interactions in any of the full models. This suggests that there were no differential effects of neighborhood-level deprivation on CHD incidence by sociodemographic characteristics, confirming the consistent patterns observed in table 2. The nonsignificant interaction terms were not due to homogeneity of individual SES within any of the three levels of neighborhood

deprivation; individuals from all SES categories (as measured by both education and income) were well represented in each type of neighborhood.

Two ancillary analyses were conducted. First, to test whether CHD incidence was greater for women in high versus low deprivation neighborhoods than that for men, the full model was repeated, combining genders and adding a gender and a gender cross-neighborhood-level deprivation term. Second, to test which component of the neighborhood deprivation index was most strongly related to CHD incidence, the final model was repeated, replacing the neighborhood deprivation index with each separate variable in the index (i.e., low educational status, low income, unemployment, or social welfare recipient).

Multi-level Cox proportional hazards models were not used because the extensive data set was too large to run on available software. However, multi-level logistic regression models are a good approximation of Cox proportional hazards models under certain circumstances such as ours (large sample size, low incidence, risk ratios of moderate size, and relatively short follow-up).[23]

RESULTS

There were 130,024 CHD events among women and men during the 5 years of follow-up (incident cases) (table 2). About two thirds of women and men were married and the large majority were born in Sweden. Most people had been “exposed” to their neighborhoods for 5 years or more—almost 80% lived in the same SAMS neighborhood for 5 or more years before the beginning of follow-up.

With each increasing level of neighborhood deprivation, age-standardized incidence increased (Table 2). For the total population, incidence for women was 1.5% in low deprivation neighborhoods and increased to 2.2% and 2.8%, respectively, in moderate and high deprivation neighborhoods; incidence for men was 3.9%, 4.7% and 5.3%, respectively. A similar pattern of higher incidence in more deprived neighborhoods was observed for both women and men across all individual-level categories of age, marital status, family income, education, immigration status, mobility and urban/rural status.

Case fatality also increased with each increasing level of neighborhood deprivation (data not shown). Age standardized 1-year case fatality rates from CHD for women were 2.6% in low deprivation neighborhoods and increased to 3.6% and 3.9%, respectively, in moderate and high deprivation neighborhoods. For men, rates were 2.7% in low deprivation neighborhoods and increased to 3.6% and 4.4%, respectively, in moderate and high deprivation neighborhoods. Case fatality data are not presented across the individual sociodemographic groups because of an insufficient number of cases in several subgroups. The total number of deaths from CHD following hospitalization within 1 year of discharge was 1114 for women and 2387 for men.

Results of the multi-level logistic regression models are shown for CHD incidence in table 3. Neighborhood-level deprivation remained significantly associated with CHD incidence for both women and men after adjusting for the seven sociodemographic characteristics, odds ratios of 1.28 and 1.21, respectively, for women and men in high versus low deprivation neighborhoods (full model) (Table 3). The odds ratios estimating the effects of individual-level sociodemographic characteristics on CHD showed that those with the highest odds of CHD incidence were older, were widowed or divorced, had lower educations, had immigrated for work from Finland, and/or had lived in their neighborhoods for less than 5 years compared with their respective reference groups.

Neighborhood-level deprivation was also significantly associated with case fatality after adjusting for the seven sociodemographic characteristics; odds ratios of 1.33 and 1.36,

respectively, for women and men in high versus low deprivation neighborhoods (Table 4, full model). The individual groups having the highest odds of case fatality were women and men who were older, not married, who had lower incomes and educations, and who lived in large versus small cities.

The first ancillary analysis showed that CHD incidence for women in high versus low deprivation neighborhoods was slightly greater than that for men (significant interaction term $p \leq .001$). The second ancillary analysis showed that each component of the neighborhood deprivation index was significantly associated with CHD incidence at $p \leq 0$ .001. Unemployment had the strongest effect on incidence (i.e., greatest magnitude), followed by education, social welfare, and low income.

DISCUSSION

In this follow-up study of Swedish women and men, neighborhood-level deprivation was a strong predictor of CHD incidence and 1-year case fatality from CHD. Age-standardized CHD incidence was 1.9 times higher for women and 1.5 times higher for men in high versus low deprivation neighborhoods; 1-year case fatality from CHD was 1.6 times higher for women and 1.7 times higher for men in high versus low deprivation neighborhoods. The relationships were remarkably consistent for CHD incidence across individual-level sociodemographic characteristics and remained significantly associated with CHD incidence and case fatality after adjusting for individual-level sociodemographic characteristics.

The neighborhood effect for CHD incidence was slightly larger for women than for men (odds ratios of 1.28 versus 1.21 from the full models, respectively). To our knowledge, this is the first neighborhood study on CHD incidence that has tested for and found a differential effect by gender. The risk magnitude, however, is similar to several other studies that presented results separately for women without testing for gender differences.[6,7] Given the large sample size and small absolute difference in the odds ratios between women and men, it may be premature to conclude that there are clinically important differences by gender.

Our neighborhood deprivation index included four variables selected on the basis of a principal components analysis: low educational status, low income, unemployment, and social welfare recipient. While each component was significantly associated with CHD incidence, unemployment had the strongest effect, followed by education, social welfare, and low income. Past studies have used similar as well as different variables when constructing neighborhood deprivation indices, including measures of housing value, private transportation, single parenthood, crowding, migration, and proportion of foreign born people.[6,7,12,14,15] Despite differences, studies have shown fairly consistent findings and effects. Further work needs to be completed on how to best construct indices and determine cutpoints for variables in order to examine which variables may be most predictive of outcomes.

While the pathways through which neighborhoods may influence health are unclear, the neighborhood-level inequities in CHD incidence and case fatality may manifest via differences in individual health behaviors and/or risk factors. Previous studies in Sweden and other industrialized countries have found that a variety of neighborhood deprivation indicators are associated with individual-level smoking,[10,24–31] physical inactivity,[24,31,32] obesity,[24,29,31,33,34] diabetes,[24] and high blood pressure,[24,25,35] after controlling for individual-level demographic characteristics. And yet, when previous neighborhood studies have controlled for the primary CHD risk factors, there has been little change in the effects on CHD incidence, leading us to believe that other factors may be important in the association between neighborhood deprivation and CHD outcomes. Normative values, psychological stress (such

as that due to discrimination and/or violence), depression, or chronic infections may be other contributory factors for future studies to explore.[36–42]

Neighborhood-level inequities may also manifest via unequal access to and quality of primary and secondary healthcare services, discrimination in the access or delivery of care, different compliance with medications, and/or other healthcare-related factors, even in countries with universal access to medical care and smaller income-related inequalities in health than in other countries.[11,43] In Sweden, medical care coverage is provided to all permanent residents, and primary healthcare clinics and hospitals are equally distributed and located in central areas in all types of neighborhoods.[43] However, the actual number of health professionals working in primary healthcare clinics can vary considerably by neighborhood type due to difficulties in recruiting and retaining healthcare personnel in high deprivation neighborhoods. This maldistribution of medical personnel across neighborhoods has also been documented in England, another country with universal health care.[44]

Strengths and Limitations

The strengths of this study include its prospective follow-up design that allowed us to calculate incidence rather than prevalence of CHD. The large number of events allowed us to calculate case fatality from CHD unlike other studies that have reported case fatality from all causes because of an insufficient number of CHD events.[11–13,15] Data for the entire population allowed for generalizability, protection against sampling bias, and validity of findings. The validity of the myocardial infarction diagnosis which constituted 46.1% of the CHD events was high—for example in 1995, 95% of myocardial infarction cases were confirmed.[45]

The definition of neighborhood boundaries and completeness of data were added strengths. The SAMS units, used to define neighborhoods, are relatively small and in qualitative studies, such small neighborhoods have been shown to be consistent with how residents themselves define their neighborhoods.[46] The data from the Swedish Population Register and the geocoded addresses were highly complete; 98% or more of the individual-level sociodemographic data and 97% of the geocoded addresses were complete.

There are also limitations. There were no data on health behaviors and/or risk factors that may mediate the relationship between neighborhood deprivation and CHD outcomes. However, in the leading U.S. study on neighborhood deprivation and CHD incidence, when six primary CHD risk factors (smoking, blood pressure, diet, physical inactivity, body mass index, cholesterol) were added to the regression models, the associations between neighborhood deprivation and CHD incidence remained virtually unchanged.[7] There were also no data on primary and secondary preventive measures (e.g., treatment of hypertension, smoking cessation), nor was there data on access to or quality of medical care. Whether such unmeasured factors differed by neighborhood deprivation and contributed to residual confounding requires further study. A further limitation is that adults with a predisposition to CHD may not be randomly allocated to neighborhoods. Neighborhood deprivation effects could also potentially represent important unmeasured individual-level socioeconomic factors that are not captured with family income and educational attainment (e.g., total wealth, quality of education). Finally, although almost 80% of adults lived in the same SAMS neighborhood for 5 or more years before the beginning of follow-up, it is not known where they lived at the time of their CHD event.

Implications

The clustering of CHD and subsequent mortality raises important clinical and public health concerns. Future research on trends in incidence and case fatality in relation to factors that may influence health, economic conditions, and other social determinants of health may give insight

into mechanisms underlying these findings. While more research is needed to determine whether interventions at the neighborhood and policy levels will alleviate disparities at the neighborhood level, these findings suggest the need to reframe health problems and their solutions from a sole focus on individual approaches to include broader societal approaches.[5,47,48] This reframing will require an understanding of how neighborhoods are organized, health care is delivered, and health policies are formulated and implemented. This includes a stronger focus on primary and secondary prevention of CHD in deprived neighborhoods. These broader approaches to the prevention and control of CHD have the opportunity to enhance the health of all adults, in particular those identified by this study who live in high deprivation neighborhoods and experience inequities in CHD incidence and case fatality.

Acknowledgements

The authors thank Max Vikström and Annika Skarle for computer and statistical assistance; Drs. David Ahn, Jan Sundquist and Sven-Erik Johansson for comments on an earlier draft; and Alana Koehler for her technical assistance in preparing the tables.

This work was funded by the National Heart, Lung, and Blood Institute (Grant Number RO1 HL71084) to Dr. Jan Sundquist, Principal Investigator, and Drs. Marilyn Winkleby, Sven-Erik Johansson, and Martin Lindstrom, Co-Investigators, and by the Swedish Research Council (Grant Number K2005-27X-15428-01A) to Dr. Kristina Sundquist, Principal Investigator.

No financial conflict of interest was reported by the authors of this paper.

References

1. Statistiska Centralbyrån (Statistics Sweden). Dödsorsaksregistret. The Cause of Death Register, 2004. Available at: http://www.scb.se/templates/Product6936.asp
2. American Heart Association. Heart Disease and Stroke Statistics—2005 Update. Dallas, TX: American Heart Association; p. 63Report No. 1/05 KC-0078
3. Lynch JW, Kaplan GA, Cohen RD, Tuomilehto J, Salonen JT. Do cardiovascular risk factors explain the relation between socioeconomic status, risk of all-cause mortality, and acute myocardial infarction? Am J Epidemiol 1996;144:934–42. [PubMed: 8916504]
4. Pickett KE, Pearl M. Multilevel analyses of neighborhood socioeconomic context and health outcomes: a critical review. J Epidemiol Commun Health 2001;55:111–22.
5. Kaplan GA. What is the role of the social environment in understanding inequalities in health? Ann N Y Acad Sci 1999;896:116–9. [PubMed: 10681892]
6. Sundquist K, Malmström M, Johansson S-E. Neighbourhood deprivation and incidence of coronary heart disease: a multilevel study of 2.6 million women and men in Sweden. J Epidemiol Community Health 2004;58:71–7. [PubMed: 14684730]
7. Diez Roux AV, Merkin SS, Arnett D, et al. Neighborhood of residence and incidence of coronary heart disease. N Engl J Med 2001;345:99–106. [PubMed: 11450679]
8. LeClere FB, Rogers RG, Peters K. Neighborhood social context and racial differences in women's heart disease mortality. J Health Soc Behav 1998;39:91–107. [PubMed: 9642901]
9. Woodward M. Small area statistics as markers for personal social status in the Scottish heart health study. J Epidemiol Community Health 1996;50:570–6. [PubMed: 8944867]
10. Smith GD, Hart C, Watt G, Hole D, Hawthorne V. Individual social class, area-based deprivation, cardiovascular disease risk factors, and mortality: the Renfrew and Paisley Study. J Epidemiol Commun Health 1998;52:399–405.
11. Alter DA, Naylor CD, Austin P, Tu JV. Effects of socioeconomic status on access to invasive cardiac procedures and on mortality after acute myocardial infarction. N Engl J Med 1999;341:1359–67. [PubMed: 10536129]
12. Engström G, Göransson M, Hansen O, et al. Trends in long-term survival after myocardial infarction: less favourable patterns for patients from deprived areas. J Intern Med 2000;248:425–34. [PubMed: 11123507]

13. Rao SV, Schulman KA, Curtis LH, Gersh BJ, Jollis JG. Socioeconomic status and outcome following acute myocardial infarction in elderly patients. Arch Intern Med 2004;164:1128–33. [PubMed: 15159271]

14. Tonne C, Schwartz J, Mittleman M, Melly S, Suh H, Goldberg R. Long-term survival after acute myocardial infarction is lower in more deprived neighborhoods. Circulation 2005;111:3063–70. [PubMed: 15939820]

15. Tydén P, Hansen O, Engstrom G, Hedblad B, Janzon L. Myocardial infarction in an urban population: worse long term prognosis for patients from less affluent residential areas. J Epidemiol Community Health 2002;56:785–90. [PubMed: 12239206]

16. Breslow, NE.; Day, NE. Analysis of case-control studies. I. Lyon: International Agency for Research on Cancer; 1980. Statistical Methods in Cancer Research.

17. Rothman, KJ. Measures of disease frequency. In: Rothman, KJ.; Greenland, S., editors. Modern Epidemiology. 2. Philadelphia: Lippincott-Raven; 1998. p. 37-8.

18. Statistiska Centralbyrån (Statistics Sweden). Eurostat yearbook 2004. Available at: http://www.scb.se/templates/Standard____36500.asp

19. Gilthorpe MS. The importance of normalisation in the construction of deprivation indices. J Epidemiol Community Health 1995;49 (Suppl 2):S45–S50. [PubMed: 8594134]

20. Sundquist J. Ethnicity, social class and health. A population-based study on the influence of social factors on self-reported illness in 223 Latin American refugees, 333 Finnish and 126 south European labour migrants and 841 Swedish controls. Soc Sci Med 1995;40:777–87. [PubMed: 7747212]

21. Rasbash, J.; Browne, W.; Goldstein, H., et al. A User's Guide to MLwiN, Version 2.1. London, UK: Multilevel Models Project, Institute of Education, University of London;

22. Goldstein, H. Multilevel Statistical Models. 3. London, England: Hodder Arnold Publishers; 2003.

23. Callas PW, Pastides H, Hosmer DW. Empirical comparisons of proportional hazards, poisson, and logistic regression modeling of occupational cohort data. Am J Ind Med 1998;33:33–47. [PubMed: 9408527]

24. Cubbin C, Hadden WC, Winkleby MA. Neighborhood context and cardiovascular disease risk factors: the contribution of material deprivation. Ethnicity Dis 2001;11:687–700.

25. Diez-Roux AV, Nieto FJ, Muntaner C, et al. Neighborhood environments and coronary heart disease: a multilevel analysis. Am J Epidemiol 1997;146:48–63. [PubMed: 9215223]

26. Diez Roux AV, Merkin SS, Hannan P, Jacobs DR, Kiefe CI. Area characteristics, individual-level socioeconomic indicators, and smoking in young adults: the coronary artery disease risk development in young adults study. Am J Epidemiol 2003;157:315–26. [PubMed: 12578802]

27. Tseng M, Yeatts K, Millikan R, Newman B. Area-level characteristics and smoking in women. Am J Public Health 2001;91:1847–50. [PubMed: 11684614]

28. Kleinschmidt I, Hills M, Elliott P. Smoking behaviour can be predicted by neighbourhood deprivation measures. J Epidemiol Community Health 1995;49 (Suppl 2):S72–S7. [PubMed: 8594138]

29. Ecob R, Macintyre S. Small area variations in health related behaviours; do these depend on the behaviour itself, its measurement, or on personal characteristics? Health Place 2000;6:261–74. [PubMed: 11027952]

30. Reijneveld SA. Neighbourhood socioeconomic context and self reported health and smoking: a secondary analysis of data on seven cities. J Epidemiol Commun Health 2002;56:935–42.

31. Sundquist J, Malmstrom M, Johansson SE. Cardiovascular risk factors and the neighbourhood environment: a multilevel analysis. Int J Epidemiol 1999;28:841–5. [PubMed: 10597980]

32. Yen IH, Kaplan GA. Poverty area residence and changes in physical activity level: evidence from the Alameda County Study. Am J Public Health 1998;88:1709–12. [PubMed: 9807543]

33. Ellaway A, Anderson A, Macintyre S. Does area of residence affect body size and shape? Int J Obes Relat Metab Disord 1997;21:304–8. [PubMed: 9130028]

34. van Lenthe FJ, Mackenbach JP. Neighbourhood deprivation and overweight: the GLOBE study. Int J Obes Relat Metab Disord 2002;26:234–40. [PubMed: 11850756]

35. Hart C, Ecob R, Smith GD. People, places and coronary heart disease risk factors: a multilevel analysis of the Scottish Heart Health Study archive. Soc Sci Med 1997;45:893–902. [PubMed: 9255922]

36. Williams DR, Yu Y, Jackson JS, Anderson NB. Racial differences in physical and mental health: socioeconomic status, stress, and discrimination. J Health Psych 1997;2:335–51.

37. Jencks, C.; Mayer, SE. The social consequences of growing up in a poor neighborhood. In: Lynn, LE., Jr; McGeary, MGH., editors. Inner-City Poverty in the United States. Washington, D.C.: (Committee on National Urban Policy, Commission on Behavioral and Social Sciences and Education, National Research Council) National Academy Press; 1990. p. 111-86.

38. Elstad JI. The psycho-social perspective on social inequities in health. Sociol Health Illness 1998;20:598–618.

39. Mattila KJ, Pussinen PJ, Paju S. Dental infections and cardiovascular diseases: a review. J Periodontol 2005;76:2085–8. [PubMed: 16277580]

40. Sundquist J, Li X, Johansson SE, Sundquist K. Depression as a predictor of hospitalization due to coronary heart disease. Am J Prev Med 2005;29:428–33. [PubMed: 16376706]

41. Black PH. The inflammatory consequences of psychologic stress: relationship to insulin resistance, obesity, atherosclerosis and diabetes mellitus, type II. Med Hypotheses 2006;67:879–91. [PubMed: 16781084]

42. Girod JP, Brotman DJ. Does altered glucocorticoid homeostasis increase cardiovascular risk? Cardiovasc Res 2004;64:217–26. [PubMed: 15485680]

43. van Doorslaer E, Wagstaff A, Bleichrodt H, et al. Income-related inequalities in health: some international comparisons. J Health Econ 1997;16:93–112. [PubMed: 10167346]

44. Taylor DH Jr, Leese B. General practitioner turnover and migration in England 1990–1994. Br J Gen Pract 1998;48:1070–2. [PubMed: 9624750]

45. The National Board of Health and Welfare. Validity of the diagnoses from the Swedish In-Care register 1987 and 1995. (In Swedish) Värdering av diagnoskvaliteten för akut hjärtinfarkt i patientregistret 1987 och 1995. Available at: http://www.sos.se/epc/pdf/rapp8795.pdf

46. Bond Huie SA. The concept of neighborhood in health and mortality research. Soc Spectrum 2001;21:341–58.

47. Winkleby MA, Cubbin C. Influence of individual and neighbourhood socioeconomic status on mortality among black, Mexican-American, and white women and men in the United States. J Epidemiol Commun Health 2003;57:444–52.

48. Lawlor DA, Davey Smith G, Patel R, Ebrahim S. Life-course socioeconomic position, area deprivation, and coronary heart disease: findings from the British Women's Heart and Health Study. Am J Public Health 2005;95:91–7. [PubMed: 15623866]

Table 1

Population sizes and neighborhood characteristics in 1995 by neighborhood-level deprivation

	Neighborhood deprivation		
	Low deprivation	**Moderate deprivation**	**High deprivation**
Number of neighborhoods	1,938	4,890	1,465
Number of people			
Women	497,543	1,128,640	294,732
Men	470,534	1,081,129	282,530
Percent of people			
Women	25.9	58.8	15.3
Men	25.7	58.9	15.4
Neighborhood deprivation index (range)	−3.3 to <−1	−1 to 1	>1 to 11.4
Components of neighborhood deprivation index			
<10 years education (%)[a]	18.0	30.2	38.8
Low income (%)[a]	3.1	5.6	10.6
Unemployed (%)[a]	3.5	6.4	10.9
Social welfare recipient (%)[a]	2.4	5.5	15.4

[a] Among those aged 25–64 years

Table 2

Distribution of population, number of CHD events, and age-standardized CHD incidence (%) by neighborhood-level deprivation

	Women (n= 1.9 million)					Men (n= 1.8 million)				
			Age-standardized incidence (%)[a]					Age-standardized incidence (%)[a]		
			Neighborhood deprivation					Neighborhood deprivation		
	Distribution (%)	Number of CHD events	Low	Moderate	High	Distribution (%)	Number of CHD events	Low	Moderate	High
Total population		46,215	1.5	2.2	2.8		83,809	3.9	4.7	5.3
Age (years)[b]										
35–44	27.5	1,449	0.2	0.3	0.4	29.6	3,951	0.5	0.7	1.0
45–54	30.7	6,242	0.8	1.1	1.5	32.6	16,309	2.2	2.8	3.5
55–64	21.4	11,713	2.2	3.0	3.5	20.9	24,732	5.5	6.6	7.4
65–74	20.5	26,811	5.8	6.9	7.9	16.9	38,817	10.9	12.8	13.5
Marital status										
Married/co-habiting	62.0	25,502	1.3	1.9	2.4	63.2	55,238	3.8	4.5	5.1
Never married	13.8	3,414	1.0	1.4	1.6	21.5	11,738	4.0	4.6	5.1
Widowed	8.5	9,653	4.5	5.8	6.4	2.1	4,118	4.6	5.1	5.5
Divorced	15.7	7,646	1.7	2.3	2.9	13.2	12,715	4.3	5.2	6.0
Family income (quartiles)										
High income	22.9	7,595	1.3	1.7	1.9	27.6	20,549	3.5	4.2	4.7
Middle-high income	25.7	11,523	1.6	2.2	2.5	24.4	23,067	4.1	4.7	5.3
Middle-low income	26.4	15,712	1.7	2.7	3.6	23.1	22,398	4.2	4.9	5.7
Low income	25.0	11,385	1.2	2.0	2.6	24.9	17,795	4.3	4.8	5.3
Educational attainment										
Compulsory school or less (≤9 years)	36.3	27,685	2.9	3.6	4.0	37.5	44,847	4.7	5.1	5.7
Practical high school or some theoretical high school (10–11 years)	40.5	14,330	1.4	1.6	2.0	40.3	28,333	3.9	4.5	5.0
Theoretical high school and/or college (≥12 years)	23.2	4,200	0.7	0.9	1.0	22.2	10,629	3.1	3.6	4.0
Immigration status										
Born in Sweden	89.7	40,323	1.4	2.1	2.8	90.7	75,064	3.8	4.6	5.2
Immigrated as a refugee	3.0	1,335	1.7	2.0	2.2	3.3	2,613	4.3	5.0	5.4
Immigrated for work from Finland	4.4	2,778	2.0	3.1	3.4	3.2	3,400	5.0	6.4	7.0
Immigrated for work from another country	2.9	1,779	2.1	3.0	3.3	2.8	2,732	3.8	4.7	4.9
Mobility (time lived in neighborhood)										
<5 years	20.4	7,981	1.2	1.8	2.5	22.0	14,486	3.9	4.9	5.6
≥5 years	79.7	38,234	1.5	2.3	2.9	78.0	69,323	3.9	4.6	5.2
Urban/rural status										
Large cities	32.8	13,697	1.4	2.1	2.8	32.2	24,293	3.7	4.6	5.4
Middle-sized towns	35.9	16,404	1.5	2.1	2.8	35.8	30,093	4.0	4.6	5.3
Small towns/ rural areas	31.2	16,114	1.7	2.3	2.8	32.0	29,243	4.3	4.8	5.1

[a] Incidence proportions = total number of fatal and non-fatal CHD cases from 01/01/96 through 12/31/00, divided by the number of women and men as of 01/01/96 for the total population and for each subgroup.

[b] Incidence rates for each of the 10-year age groups are not age-standardized.

CHD, coronary heart disease

Table 3

Odds ratios (OR) and 95% confidence intervals (CI) for CHD incidence. Results of multi-level logistic regression models

	Women							Men						
	Neighborhood model[a]			Full model[b]				Neighborhood model[a]			Full model[b]			
	OR	95% CI		OR	95% CI		*p*value	OR	95% CI		OR	95% CI		*p*value
Neighborhood-level variable														
Neighborhood deprivation														
Low deprivation	1			1				1			1			
Moderate deprivation	1.47	1.41	1.51	1.13	1.10	1.17	<0.001	1.32	1.30	1.35	1.12	1.09	1.14	<0.001
High deprivation	1.88	1.81	1.95	1.28	1.24	1.33	<0.001	1.54	1.50	1.57	1.21	1.18	1.24	<0.001
Individual-level sociodemographic variables														
Age (years)														
35–44				1							1			
45–54				3.99	3.77	4.24	<0.001				3.78	3.65	3.92	<0.001
55–64				10.32	9.75	10.92	<0.001				9.02	8.70	9.34	<0.001
65–74				22.18	20.99	23.43	<0.001				17.90	17.30	18.53	<0.001
Marital status														
Married/co-habiting				1							1			
Never married				1.01	0.98	1.05	0.722				0.96	0.94	0.98	<0.001
Widowed				1.22	1.19	1.25	<0.001				1.15	1.13	1.18	<0.001
Divorced				1.20	1.17	1.24	<0.001				1.18	1.14	1.22	<0.001
Family income (quartiles)														
High income				1							1			
Middle-high income				1.18	1.15	1.22	<0.001				1.10	1.07	1.12	<0.001
Middle-low income				1.32	1.28	1.36	<0.001				1.13	1.11	1.16	<0.001
Low income				1.32	1.28	1.37	<0.001				1.10	1.08	1.13	<0.001
Education attainment														
Theoretical high school and/or college (≥12 years)				1							1			
Practical high school or some theoretical high school (10–11 years)				1.42	1.38	1.48	<0.001				1.29	1.26	1.32	<0.001
Compulsory school or less (≤9 years)														
Immigration status														
Born in Sweden				1							1			
Immigrated as a refugee				1.19	1.13	1.26	<0.001				1.14	1.10	1.19	<0.001

	Women					Men				
	Neighborhood model[a]		Full model[b]			Neighborhood model[a]		Full model[b]		
	OR	95% CI	OR	95% CI	*p*value	OR	95% CI	OR	95% CI	*p*value
Immigrated for work from Finland			1.48	1.42 1.54	<0.001			1.38	1.33 1.43	<0.001
Immigrated for work from another country			1.07	1.02 1.13	<0.001			1.00	0.96 1.05	0.864
Mobility (time lived in neighborhood)										
<5 years			1					1		
≥5 years			0.89	0.87 0.92	<0.001			0.93	0.92 0.95	<0.001
Urban/rural status										
Large cities			1					1		
Middle-sized towns			0.97	0.95 1.00	0.301			1.02	1.00 1.04	0.052
Small towns/rural areas			1.01	0.98 1.03	0.076			1.03	1.01 1.05	0.002

[a] Neighborhood model: Includes neighborhood-level deprivation.

[b] Full model: Includes neighborhood-level deprivation and the following sociodemographic variables as covariates (age, marital status, family income, educational attainment, immigration status, mobility, and urban/rural status).

CHD, coronary heart disease

Table 4

Odds ratios (OR) and 95% confidence intervals (CI) for one-year case fatality from CHD. Results of multi-level logistic regression models

	Women							Men						
	Neighborhood model[a]			Full model[b]				Neighborhood model[a]			Full model[b]			
	OR	95% CI		OR	95% CI		*p* value	OR	95% CI		OR	95% CI		*p* value
Neighborhood-level variable														
Neighborhood deprivation														
Low deprivation	1			1				1			1			
Moderate deprivation	1.46	1.22	1.74	1.32	1.10	1.58	0.004	1.35	1.24	1.48	1.16	1.06	1.28	0.002
High deprivation	1.56	1.27	1.91	1.33	1.08	1.65	0.009	1.70	1.53	1.88	1.36	1.22	1.52	<0.001
Individual-level sociodemographic variables														
Age														
35–44				1							1			
45–54				1.28	0.62	2.64	0.499				1.58	1.18	2.1	<0.001
55–64				3.11	1.58	6.13	<0.001				3.29	2.49	4.33	0.002
65–74				6.19	3.18	12.04	<0.001				7.53	5.75	9.88	<0.001
Marital status														
Married/co-habiting				1							1			
Never married				1.70	1.35	2.15	<0.001				1.70	1.55	1.87	<0.001
Widowed				1.18	1.02	1.37	0.029				1.46	1.28	1.66	<0.001
Divorced				1.38	1.17	1.65	<0.001				1.61	1.47	1.77	<0.001
Family income (quartiles)														
High income				1							1			
Middle-high income				1.26	1.00	1.60	0.053				1.22	1.10	1.35	<0.001
Middle-low income				1.38	1.10	1.74	<0.006				1.44	1.30	1.60	<0.001
Low income				1.63	1.28	2.07	<0.001				1.57	1.41	1.76	<0.001
Education attainment														
Theoretical high school and/or college (≥12 years)				1							1			
Practical high school or some theoretical high school (10–11 years)				1.36	1.00	1.84	0.052				1.09	0.96	1.24	0.170
Compulsory school or less (≤9 years)				1.54	1.15	2.08	<0.001				1.25	1.11	1.42	<0.001
Immigration status														
Born in Sweden				1							1			
Immigrated as a refugee				0.78	0.52	1.15	0.204				0.95	0.78	1.16	0.623

	Women					Men				
	Neighborhood model[a]		Full model[b]			Neighborhood model[a]		Full model[b]		
	OR	95% CI	OR	95% CI	*p* value	OR	95% CI	OR	95% CI	*p* value
Immigrated for work from Finland			0.75	0.56 1.00	0.056			1.03	0.86 1.22	0.775
Immigrated for work from another country			1.05	0.79 1.41	0.735			1.05	0.89 1.25	0.553
Mobility (time lived in neighborhood)										
< 5 years			1					1		
≥5 years			1.03	0.87 1.22	0.415			0.90	0.82 0.98	0.014
Urban/rural status										
Large cities			1					1		
Middle-sized towns			0.93	0.81 1.09	0.414			0.87	0.80 0.94	<0.001
Small towns/ rural areas			0.81	0.69 0.95	0.011			0.82	0.75 0.90	<0.001

[a] Neighborhood model: Includes neighborhood-level deprivation.

[b] Full model: Includes neighborhood-level deprivation and the following sociodemographic variables as covariates (age, marital status, family income, educational attainment, immigration status, mobility, and urban/rural status).

CHD, coronary heart disease