Cardiovascular risk factors and the neighbourhood environment: a multilevel analysis

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Background  This article examines whether the neighbourhood environment influences intermediate cardiovascular disease (CVD) risk factors, such as obesity (body mass index [BMI]), and lifestyle factors, such as no physical activity and smoking, when adjusted for the individual socioeconomic status (SES).

Methods  The study consists of face-to-face interviews from the Swedish Annual Level of Living Survey (SALLS) matched with the social status of the respondents’ residential areas measured by two composite indices, the Care Need Index (CNI) and the Townsend score. The response rate was about 80%. This study was limited to the residents aged 25–74 years and consists of 9240 interviews from the years 1988–1989, when there were extended items in the SALLS about health and lifestyle. The data were analysed using a hierarchical logistic regression model.

Results  There was a gradient within every SES group so that respondents with a low (or intermediate or high) educational level exhibited an increasing proportion of daily smokers, physically inactive people and obese individuals with increasing neighbourhood deprivation. The multilevel model showed that respondents living in the most deprived neighbourhoods had an increased risk for being a daily smoker, engaging in no physical activity and being obese when adjusted for the individual SES.

Conclusions  We showed that the area level has an important influence on risk factors for CVD which goes beyond the individual educational attainment. An increased level of living standard, more resources for primary health care and health promotion targeting the community level should be beneficial.

Keywords  Neighbourhood deprivation, underprivileged, cardiovascular disease risk factors, Townsend score

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Although there has been a long tradition of research into the relationship between residential area and general health, the role of the neighbourhood environment in the pathogenesis of cardiovascular disease (CVD) is poorly understood. The reason for this could be that epidemiologists have not used multilevel methods, although they have been applied in sociology and educational psychology in more than two decades, for analysing group-level and individual-level. Another reason could be the lack of theoretical models to explain the association between the area level and the individual level in the pathogenesis of CVD.

This article assesses whether the neighbourhood environment in a representative sample of the Swedish population has an independent effect on CVD risk factors.

There is an association between body mass index (BMI), sedentary lifestyle and CVD. For example, mild-to-moderate overweight women have an increased risk of coronary heart disease (CHD).1,2 Furthermore, regular physical activity provides long-standing protection against the manifestations of CHD.3,4 In addition, in community prevention trials targeting multiple CVD risk factors using multiple intervention modalities, regular physical activity was one of the four ‘cornerstone’ approaches to cardiac health.5–7 Another representative study showed that smoking cessation decreases the risk of CVD.8

There is also an association between a sedentary lifestyle and individual socioeconomic status (SES). For example, an inverse association between decline in physical activity and educational level was revealed in the Alameda County Study.9 Another
study in Finland found that the socioeconomic background of adolescents was a strong determinant of daily smoking and physical inactivity. \textsuperscript{10} Pierce \textit{et al.} found a strong inverse relationship between the educational level and daily smoking. \textsuperscript{11} Investigators from the Stanford Five-City Project, \textsuperscript{12} the Minnesota Heart Health Program, \textsuperscript{13} and the Pawtucket Heart Health Program \textsuperscript{14} found a strong relationship between the attained level of education and CVD risk factors.

Only a few studies have examined the influence of neighbourhood environment on intermediate risk factors for CVD. In contrast to the present study, they have been dependent on small samples and to selected geographical areas. For example, the neighbourhood environment in a Glasgow study was significantly associated with BMI after controlling for individual characteristics such as gender, age, social class, smoking behaviour and material deprivation (an index comprising income, housing tenure and car ownership). \textsuperscript{15} Individuals living in the most deprived neighbourhoods were significantly shorter, and had higher BMI. Similarly, it was shown that smoking behaviour could be predicted by neighbourhood deprivation even after the SES of the individual had been taken into account. \textsuperscript{16} A recently published study from Amsterdam based on 5121 face-to-face interviews and area characteristics for 22 areas showed by using multilevel techniques that age- and gender-adjusted prevalences of poor health and smoking are higher in deprived areas. \textsuperscript{17}

The main analysis in the present study focuses on the Care Need Index (CNI) and the Townsend score. The CNI, a composite index similar to the British underprivileged area (UPA) score, was recently introduced in Sweden as an indicator of the social status of the neighbourhood environment. \textsuperscript{18} The CNI for Sweden provides a relative index which indicates whether the neighbourhood environment is likely to have a greater need for or exert pressure on the services of general practitioners and is not a direct measure of the actual workload in primary health care. It is based on a 1996 survey of Swedish general practitioners’ and their ratings of the effect on their workload of the social characteristics of the populations in their respective residential areas. \textsuperscript{19} The CNI provides a measure of the increased relative need of health care in addition to the absolute size and age distribution of the local population. The index includes indicators for material deprivation (the unskilled, the unemployed and residents living in crowded households), socio-demographic factors related to family structures (such as elderly living alone, children under 5 years, and single-parent families), social instability (people who had moved house during the last year) and cultural needs (ethnicity). Townsend, in addition, constructed a material deprivation index based on unemployment, overcrowding, not living in an owner-occupied dwelling and not owning a car. \textsuperscript{19}

In this study, we examined whether a set of primary CVD risk factors, such as BMI, physical activity and smoking, differed among individuals living in different neighbourhoods when adjusted for age and individual SES.

\section{Methods}

The present study consists of data from the Swedish Annual Level of Living Survey (SALLS), matched with the social status of the respondents’ residential areas measured as the CNI and the Townsend score. The SALLS is based on face-to-face interviews that generally took place in the respondents’ homes (Statistics Sweden, 1996). The response rate was about 80\%. The sample is a simple random sample drawn from the register of total population aged 16–84 years, but this study is limited to those aged 25–74 years, and consists of 9240 interviews from the years 1988–1989, when there were extended items about health and lifestyle.

Small area market statistics (SAMS) refers to the smallest area units in a system of geographical co-ordinates for the whole of Sweden. The average population of SAMS areas in Stockholm was about 2000 residents and, in the rest of Sweden, about 1000 residents. After exclusion of 837 SAMS areas with <50 inhabitants, owing to the instability of proportions based on small numbers, 8519 SAMS areas remained.

\subsection*{Dependent variable}

Lifestyle factors included BMI, smoking habits and physical activity. The BMI was calculated as weight/height\(^2\) (kg/m\(^2\)) and comprised three levels: normal weight (BMI <23.8 for females and BMI <25 for males), overweight (23.8 ≤BMI<28.6 for women and 25.0 ≤BMI<30.0 for men) and obesity (BMI ≥28.6 for females and ≥30.0 for males). \textsuperscript{20} There was a question about cigarette smoking and use of pipe tobacco. Three levels were used in the analysis: participants who never smoked, those who were formerly smokers and those who were current smokers. Physical activity was classified as: almost no physical activity at all and physical activity regularly at least once a week.

\subsection*{Independent variables}

Sex and age were analysed in the following groups: 25–34, 35–44, 45–54, 55–64 and 65–74 years.

The social status of the neighbourhood was defined in terms of the CNI and the Townsend score. These variables were categorized into six approximately equal-sized groups; those with missing SAMS data comprised a seventh group.

In brief, the transformed and standardized values (Z-scores) of each of the eight social variables included in the CNI were multiplied by the corresponding weight given by the Swedish general physicians. \textsuperscript{18} The mean value of all scores is 0, which corresponds to the average value for Sweden as a whole. The higher the index, the more deprived the area. The values range between –76 (most affluent areas) and +53 (most deprived areas). The CNI was calculated for all SAMS areas in Sweden. \textsuperscript{18} It was possible to match the residential area of all of but 655 respondents (7.1\%) with the SAMS. The respondents were divided into six approximately equal-sized groups by the CNI, on average, 1300 people in each group.

The Townsend score \textsuperscript{19} is a purely material unweighted deprivation summary index (Z-score), was calculated for the same SAMS areas as for the CNI. Unemployment, car ownership, home ownership and overcrowding were included in the score. The mean for the whole of Sweden is 0.

The socioeconomic status (SES) of the individuals was defined by the attained level of education. The respondents were classified into three groups: (a) primary school (<9 years); (b) completed ≤2 years of high school (10–11 years); (c) completed >2 years of high school or university studies (>11 years).

\subsection*{Statistical method}

The data were analysed by means of a hierarchical logistic regression model proposed by Wong and Mason. \textsuperscript{21} The models
were fitted using the SAS macro GLIMMIX. The method of estimation was a restricted maximum likelihood procedure. The inclusion of a macro error term makes the model mixed with the CNI (Townsend score) as a random effect. Interactions with the CNI were treated as random effects. The individual factors are fixed effects. The fit of the model was judged from an overdispersion parameter which ideally, should be approximately 1. The fitted models met this demand. There were no interactions between CNI and the variables in the model, although we tested all possible interactions.

The reliability of the dependent variable and the majority of the others have been analysed by re-interviews (test-retest method) giving kappa coefficients between 0.7 and 0.9.

Results

The distribution of the independent variables BMI, smoking and physical activity, number of interviews and estimated population by the CNI intervals is demonstrated in Table 1. There is a clear gradient for obesity so that the proportion of people with obesity increases gradually from 7.0% in the most affluent neighbourhoods to 9.9% in the most deprived areas.

In addition, there is a gradient for current smokers with the lowest proportion of smokers in the affluent areas and the highest, 37.4%, in the most deprived neighbourhoods. There was a weaker trend for no physical activity, but 10.0% of the respondents living in the most affluent areas did not engage in physical activity compared with 17.9% in the most deprived neighbourhoods.

Table 2 shows the distribution of daily smoking, no physical activity and obesity by the CNI and attained level of education. Respondents with a low educational level exhibited an increasing proportion of daily smokers with increasing neighbourhood deprivation, from 28.7% in the most affluent neighbourhoods to 38.6% in the most deprived ones. The proportion of smokers among respondents with an intermediate educational level increased with increasing deprivation. The same tendency was found for highly educated smokers. The same increasing proportion was demonstrated for no physical activity in all three educational groups, but the contrasts were largest in the highest educational group. It was possible to see the same increasing proportions for obesity only among those with an intermediate educational level (Table 2).

We did not find any significant interactions in the linear models. With the most affluent neighbourhood as a reference, we found that the CNI was a significant risk factor for smoking

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<td>7.9</td>
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<td>22.2</td>
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when adjusted for the individual SES, age and sex (Table 3). Those living in the most deprived neighbourhoods also had an increased risk for no physical activity when adjusted for the background variables. There was a weaker, but significant, association between deprived neighbourhood environment and obesity. When we used the Townsend score instead of the CNI we found about the same OR for the relationship with smoking and no physical activity. However, the model with Townsend score and obesity did not converge (Table 3).

Discussion

This study examines the influence of neighbourhood environment proxies such as the CNI (Jarman indicators) and Townsend score on CVD risk factors in a large representative national sample of Swedish women and men using a multilevel technique. Consistent with our expectations, we found that the most deprived neighbourhood environments had their own independent increased risk for poor cardiovascular health profiles when adjusted for age, sex and educational status. The most affluent neighbourhood environments had the healthiest cardiovascular health profiles when we adjusted for the individual background variables.

Our findings agreed with those of Diez-Roux et al.,24 who found neighbourhood effects on CVD risk factors which were small but generally consistent across the analysed genders and neighbourhood indicators. They found that living in the most deprived neighbourhoods was related to an increased risk of smoking, increased blood pressure and increased serum cholesterol after adjustments for individual factors. In contrast, most of the differences in poor health and smoking in deprived areas could be explained by the low SES of the population in those areas.17 Some statistically significant area differences remained for obesity. Other studies have suggested that neighbourhood environments have an effect on smoking habits and nutrition.25,26 For example, survey data revealed that young Black women smokers living in public housing were heavier smokers and had weaker motivation to quit. Their health beliefs were less beneficial to smoking cessation and they had less knowledge of where to get help to quit than other young African American women smokers in metropolitan Chicago.26 In addition, another American study found significant variation among communities in the prevalences of smoking, consumption of alcohol and dietary fat, and the use of seat belts and that these differences persisted after adjustment for demographic and health behavioural characteristics of the people in the communities.25 Their findings supported those in the present article concerning the potential importance of contextual effects on individual health behaviour and thus support the theory that changing the community environment may provide effective ways to change individual health behaviour.

Although the mechanism by which the neighbourhood environment may influence individual health behaviours, such as diet, physical activity and smoking, has not been elucidated, affluent neighbourhoods might facilitate access to healthy food, physical leisure activities, cultural activities, safe recreation spaces and smoking-free environments. For example, it has been shown how cultural activities reduce the mortality risk when adjusted for SES.27 However, theatres, music performances, art exhibitions and other cultural activities are often localized centrally in metropolitan areas and require access to a car or good, safe public transportation which is often better in affluent neighbourhoods. There is a growing number of studies suggesting that the neighbourhood environments in which people live may, in and of themselves, have an important influence on disease risks.28–30 It has been shown to be important to use models that include both individual-level and area-level factors in public health research.31,32 Furthermore, epidemiology might be entering a new era of eco-epidemiology; a new paradigm characterized by relations within and between localized structures organized in a hierarchy of levels.33 The present study is also the first one to show, in a large representative sample, that the widely used Jarman score in the UK (CNI Sweden), is a good predictor for area neighbourhood environmental conditions having a significant influence on individual health factors, such as the BMI, smoking and physical activity.

The advantage of the present study is the use of a multilevel model that could separate the effects of the individual SES and a proxy for area SES. We also argue that, using smaller, more homogeneous population aggregations provides a more sensitive indicator of variations in health need and utilization, or mortality. Our study has some limitations. First, the cross-sectional design of the SALLS makes it difficult to draw inferences about causal pathways. Second, it is possible that CNI underestimated neighbourhood effects in our study. The eight variables included in the CNI may not have adequately captured differences across neighbourhoods. A composite index such as the CNI and Townsend score is not a direct measure of the neighbourhood properties potentially related to poor health status.

In conclusion, after adjustments for individual age, sex and SES, we found that people living in deprived neighbourhood environments in Sweden had a higher risk of obesity and a disadvantaged lifestyle with increased smoking and no physical activity. These results call for studies to elucidate the forces behind the influence of small areas on health, which is important for future intervention strategies on CVD.
Acknowledgements

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References