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Neighborhood linking social capital as a predictor of psychiatric medication prescription in the elderly: a Swedish national cohort study

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Abstract (250 words)

Objectives: Little is known about the association between neighborhood linking social capital and psychiatric medication in the elderly. The present study analyzes whether there is an association between linking social capital (a theoretical concept describing the amount of trust between individuals and societal institutions) and prescription of antipsychotics, anxiolytics, hypnotics/sedatives, antidepressants, or anti-dementia drugs. **Design, Setting, Participants and Measurements:** The entire Swedish population aged 65+, a total of 1,292,816 individuals, were followed from 1 July 2005 until first prescription of psychiatric medication, death, emigration, or the end of the study on 31 December 2010. Small geographic units were used to define neighborhoods. The definition of linking social capital was based on mean voting participation in each neighborhood unit, categorized in three groups. Multilevel logistic regression was used to estimate odds ratios (ORs) and between-neighborhood variance in three different models. **Results:** There was an inverse association between the level of linking social capital and prescription of psychiatric medications (except for anti-dementia drugs). The associations decreased, but remained significant, after accounting for age, sex, family income, marital status, country of birth, and education level (except for antidepressants). The OR for prescription of antipsychotics in the crude model was 1.65 (95% CI 1.53-1.78) and decreased, but remained significant (OR = 1.26; 95% CI 1.17-1.35), after adjustment for the individual-level sociodemographic variables. **Conclusions:** Decision-makers should take into account the potentially negative effect of linking social capital on psychiatric disorders when planning sites of primary care centers and psychiatric clinics, as well as other kinds of community support for elderly patients with such disorders.

Key words: Linking social capital; Neighborhood; Psychiatric medication; socioeconomic status

OBJECTIVE

The number of elderly people in industrialized countries is increasing, which constitutes a challenge for somatic and psychiatric health care. The importance of social and contextual factors for people's somatic and psychiatric health is well established and it is therefore essential for clinicians and decision-makers to consider elderly people's health within a social context. An important component of the social context is social capital, which during the past 15–20 years has emerged as a societal component that is associated with democracy, [1,2] economic prosperity[3,4] and different health outcomes in all ages. [5-8] Few previous studies have, however, analyzed in the elderly the association between the amount of vertical trust between individuals and societal institutions, i.e., linking social capital, and prescriptions of psychiatric medications. Linking social capital may be particularly important for elderly people, considering their high need of community support.

Definitions of social capital in the literature are usually obtained from key protagonists such as Putnam, Bourdieu, and/or Coleman, and it has most frequently been operationalized as a collective dimension of society, external from the individual.[9] The concept of linking social capital was introduced in the mid-2000s as a sort of diagonal bridge across power differentials.[10] The theoretical concept of social capital influencing mental health was reviewed carefully in 2005.[11] Social capital belongs to the society or to social organizations, is external from the individual, and is created in social relationships, based on Putnam's definition of social capital: "features of social organization, such as trust, norms, and networks, that can improve the efficiency of society by facilitating coordinated actions."[1] Furthermore, horizontal social capital is between individuals while linking social capital is between individuals and institutions. Linking social capital includes vertical trust, which exists between individuals and societal institutions of any kind.

Japan, well known for its high social capital, has performed several studies on social capital and health. For example, in a recent publication, national survey data were analyzed in a multilevel framework at Shimane University, revealing that both cognitive social capital (trust) and structural social capital (group membership) were associated with psychiatric health.[12] A previous study on elderly persons found that lower social capital, measured by trust, was associated with psychological distress [13]. The same authors also reported that systolic blood pressure, which may be affected by chronic stress, increased with an increasing proportion of individuals who perceived a lack of fairness, after adjustment for individual confounders in a multilevel framework.[14] In another study from 2009, around 4,000 adults were surveyed in Okayama City, Japan for participation in different types of associations. Bridging social capital (between individuals who are not alike) was associated with good health in both men and women, while bonding social capital (between individuals who are alike) had no additional effect on health.[15]

In the present study, we choose to operationalize linking social capital as voting in local government elections because refugees and newly arrived immigrants—arguably among Sweden's most powerless residents—may vote in local government elections after a minimum of one year's residence in Sweden. Additionally, participation in local elections is likely to provide a good measure of linking social capital due to the devolved nature of government in Sweden. Furthermore, local governments bear a great deal of local power because they have the right to apply taxes and are responsible for health care, schools, and city planning. Local politicians from local political parties must deliver key services to their population, i.e. their voters. They must build community trust via repeated interaction with people, and many of them have face-to-face contact with the potential voters in the local community. Finally, voting patterns are very stable in Sweden. The number of people voting

in national or local government elections has not been affected by large swings from election to election in the number of voters mobilized by get-out-the-vote campaigns or other actions of interest groups or political parties. This makes voting in local government elections a relatively stable variable over time. Levels of voting in local government elections could thus be regarded as a good indicator of linking social capital in the neighborhood.

Some studies have found that social capital has a limited effect on psychological distress.[16-19] In contrast, we previously showed that low linking social capital in the neighborhood increases the risk of poor mental and self-rated health.[20,21] Studies from the USA and Sweden have found that low linking social capital, defined as lack of participation in voting, is associated with poor self-rated health.[21,23] A study from Southern Sweden[22] found that poor linking social capital, operationalized as participation in municipal elections, was associated with sense of insecurity in the neighborhood, which may be particularly harmful for elderly people.

The findings from previous studies led to our hypothesis that low linking social capital is associated with psychiatric medication prescription rates in elderly people. In the present study, we will, for the first time, analyze the association between linking social capital and psychiatric medication in the elderly. This study extends the existing literature on social capital and elderly health by estimating prescription rates of psychiatric medications, used as proxies for psychiatric disorders, at the individual level. All elderly men and women were linked through their home addresses to small geographic units covering the whole of Sweden. Small geographic units were used to define neighborhoods because they are consistent with how residents define their neighborhoods.[24] In addition, we used a multilevel framework in which linking social capital was operationalized as voting in local government elections at

the neighborhood level. The specific aim was to analyze the association between linking social capital and psychiatric medication prescription, divided into antipsychotics, anxiolytics, hypnotics/sedatives, antidepressants and anti-dementia drugs, in all Swedish men and women aged 65+ years. We also assessed whether the hypothesized association between linking social capital and psychiatric medication among elderly men and women remained after accounting for potential confounding factors related to individual power in society (age, sex, country of birth, education, marital status, and income).

METHODS

This five-year cohort study included all individuals aged 65+, a total of 543,236 men and 749,580 women. This age group was chosen because 65 is the normal age of retirement in Sweden. The individuals were followed from 1 July 2005 until first prescription of psychiatric medication (further subdivided into antipsychotics, anxiolytics, hypnotics/sedatives, antidepressants, or anti-dementia drugs), death, emigration, or the end of the study on 31 December 2010. This population-based cohort study was based on national register data delivered to us by Swedish authorities. The data included individual-level sociodemographic data collected annually, such as age, marital status, and socioeconomic status. Using the unique personal identification numbers assigned to all residents of Sweden, we linked the Swedish Population Registry (containing sociodemographic data) and the Immigration Registry (containing data on immigration and emigration) to the Cause of Death Register and the National Pharmacy Register. The personal identification numbers were replaced by serial numbers in order to provide anonymity in all registers. In order to examine the effect of the exposure (level of linking social capital in the neighborhood), all individuals were geocoded to their neighborhoods of residence. Small area market statistics (SAMS) were used to define neighborhoods. SAMS are small administrative areas in Sweden with an

average population of around 1000 residents in Sweden. The SAMS boundaries are drawn to include similar types of housing construction in a neighborhood, which implies that SAMS neighborhoods are comparatively homogeneous in terms of socioeconomic structure. Data on the 9119 SAMS covering the whole of Sweden were obtained from Statistics Sweden, the Swedish government-owned statistics bureau. Information on psychiatric medication prescription was obtained using the National Pharmacy Register, which contains data from 1 July 2005 and onwards and was delivered to us by the National Board of Health and Welfare. The National Pharmacy Register includes records of all medications prescribed by health-care providers and dispensed to patients by outpatient and inpatient pharmacies in Sweden.

Predictor variable

Neighborhood-level variable

Neighborhood linking social capital was conceptualized as the number of people in the neighborhood (SAMS) who voted in local government elections divided by the number of people in the neighborhood who were entitled to vote. Neighborhoods were divided into the following three linking social capital groups based on the proportions of residents who voted: (1) low, (2) intermediate, and (3) high. Group 1 comprised the 20% of neighborhoods with the lowest proportions of voters (≤74.0%); group 2 comprised the 60% of neighborhoods with intermediate proportions of voters (74.1–82.0%); and group 3 comprised the 20% of neighborhoods with the highest proportions of voters (>82.0%). Our goal was to have 20% of the neighborhoods in each tail of the distribution, which we considered to represent meaningful groups, in terms of size, for analyses.

Outcome variables

The outcome of interest was dispensation of a prescribed psychiatric medication at any

outpatient or inpatient pharmacy in Sweden during the follow-up period (1 July 2005 through 31 December 2010). Prescription rates of psychiatric medications were used as proxies for psychiatric disorders. This outcome was evaluated separately for each of the following medication groups: antipsychotics, anxiolytics, hypnotics/sedatives, antidepressants, and anti-dementia drugs. In addition, we evaluated at least one or prescription in 'any of the above' medication groups as a further outcome. All pharmacy data were categorized according to the Anatomical Therapeutic Chemical (ATC) Classification System developed by the WHO Collaborating Centre for Drug Statistics Methodology. We obtained information on medications prescribed for conditions of the nervous system (code N), which were further sub-classified as antipsychotics (N05A), anxiolytics (N05B), hypnotics/sedatives (N05C), antidepressants (N06A), and anti-dementia drugs (N06D).

Individual-level variables

Age: Age was categorized as 65–69, 70–74, 75–79, 80–84, 85–89, and 90+ years.

Sex: Separate analyses were performed for women and men.

Education level: Individual level of education was divided into three groups: Compulsory school or less (≤9 years), Practical high school or some theoretical high school (10–11 years), and Theoretical high school and/or college (≥12 years).

Marital status: Married/cohabiting or never married/widowed/divorced.

Country of birth: Categorized as Sweden, Western countries (Western Europe, USA, Canada, Oceania), and Other countries.

Family income: Annual family income was divided by the number of people in the family. The final variable was calculated as empirical quartiles from the distribution.

Statistical methods

Multilevel logistic regression was performed with individuals at the first level and neighborhoods at the second level.[25,26] Logistic regression was considered to be a good approximation of Cox's proportional hazard model because we had a large sample size, a relatively low incidence rate, risk ratios of moderate size, and a relatively short follow-up period.[27] The fixed effects are presented as odds ratios (ORs) with 95% confidence intervals (CIs). The random effects were calculated as the variance between neighborhoods and the explained variance. We performed separate analyses for women and men. Model 1 included the neighborhood-level variable; Model 2 also included age and sex; and Model 3 included the neighborhood-level variable and the individual-level variables.

The logistic model used is given by the formula:

$y_{ij} = \exp(f_{ij} + u_{0j}) / (1 + \exp(f_{ij} + u_{0j})) + e_{0ij}Z_{0ij}$

where f_{ij} denotes the fixed part of the model, u_{0j} denotes the neighborhood random effect, and z_{0ij} denotes the estimated binomial standard variation and equals $\sqrt{[\pi_{ij}(1 - \pi_{ij})]}$. The first-level variance is constrained to unity. These two terms ensure the correct specification of the binomial variance.

Next, we calculated the second-level (i.e. neighborhood-level) intercept variance. The proportion of the second-level variance explained by the different variables was calculated as:

$V_{Explained} = (V_0 - V_1) / V_0 \times 100$

where V_0 is the second-level variance in the initial model and V_1 is the second-level variance in the other models

Possible cross-level interactions were tested. None were found. We did not test for random slopes or heterogeneity between the SAMS neighborhoods since there was little variance left in the final models. Parameters were estimated by second-order penalized quasi-likelihood (PQL). Extra-binomial variation was explored systematically in all models and we found no evidence of under- or over-dispersion. MLwiN software was used to perform the analyses.[28]

Geographic Information Systems (GIS) analyses

Neighborhood linking social capital and psychiatric medication rates are displayed in maps of Malmö, a city in Southern Sweden, as spatial patterns. The maps were constructed in ArcGIS (version 10).

RESULTS

The population distribution and number of psychiatric medication prescriptions (events) by sociodemographic characteristics, as well as age-standardized rates of psychiatric medication prescription by level of linking social capital, are presented in Table 1. Of the 1,292,816 individuals aged 65 and older, 26%, 57%, and 17% lived in neighborhoods characterized by low, intermediate, and high linking social capital, respectively. The prescription rates were higher among women, those who were in the oldest age categories, those with a low income or low education level, those who were not married or cohabiting, and those who lived in neighborhoods with low linking social capital.

Fixed effects

Table 2 presents ORs with 95% CIs for the association between linking social capital and prescription of psychiatric medication in individuals aged 65 years and older. There was a

gradient between linking social capital and prescription of psychiatric medications, with individuals living in neighborhoods with low linking social capital being more likely to be prescribed psychiatric medications compared with individuals living in neighborhoods with high linking social capital (OR = 1.23, 95% CI = 1.21-1.25). Elderly individuals living in neighborhoods with intermediate linking social capital were also more likely to be prescribed psychiatric medications (OR = 1.10, 95% CI = 1.08-1.12). After adjusting for potential confounders (see Table 2 footnote), the OR of being prescribed a psychiatric medication in neighborhoods with low linking social capital decreased to 1.10, but remained significant. There were also associations between most of the individual-level variables and the odds of being prescribed a psychiatric medication. We also performed an additional analysis of those individuals aged less than 65 years and found similar results (supplementary Table 3).

Table 3 shows ORs with 95% CIs for the associations between linking social capital and prescription of antipsychotics, anxiolytics, hypnotics/sedatives, antidepressants and anti-dementia drugs. There was a significant inverse gradient between linking social capital and prescription of most of the subcategories in the crude models, with the exception for anti-dementia drugs. The strongest associations with low linking social capital were for antipsychotics (OR = 1.65; 95% CI = 1.53-1.78) and anxiolytics (OR = 1.30; 95% CI = 1.24-1.37). After accounting for age, sex, family income, marital status, country of birth, and education level (Model 3), the ORs for low linking social capital decreased to 1.26, 1.15, and 1.05 for antipsychotics, anxiolytics, and hypnotics/sedatives, respectively. For antidepressants, the weak association was no longer significant in Model 2, after adjustment for age and sex.

Random effects

Linking social capital

The between-neighborhood variance was over 1.96 times the standard error in the crude model (Model 1), indicating that there were significant differences between neighborhoods (Table 2). After inclusion of age and sex (Model 2) and the individual-level variables (Model 3), the between-neighborhood variance decreased, but remained significant. The explained variance increased after stepwise inclusion of the individual-level variables, reaching 59% in Model 3. This implies that the neighborhood-level and individual-level variables partly explained the variance between neighborhoods.

Linking social capital in Malmö, Southern Sweden

Figure 1 shows the geographic distribution of the population aged 65+, levels of linking social capital, and age-standardized rates of psychiatric medication prescriptions in the urban area of Malmö, the third largest city in Sweden. A separate multilevel analysis was conducted for the association between linking social capital and prescription of psychiatric medications in individuals aged 65 years and older in this urban area. Supplemental Tables 1 and 2 show the results for Malmö from the multilevel regression models for the association between linking social capital and prescription of psychiatric medications. Supplemental Table 2 shows the results for the subcategories antipsychotics, anxiolytics, hypnotics/sedatives, antidepressants, and anti-dementia drugs. In general, the associations between linking social capital and prescription of psychiatric medications were stronger in Malmö than in Sweden as a whole. The strongest association with low linking social capital in Malmö was for antipsychotics in the crude model (OR = 1.95; 95% CI = 1.33-2.88). The confidence intervals were broader than in the nationwide analyses, most likely due to their being fewer events in Malmö than in the entire Swedish population.

CONCLUSIONS

When linking social capital decreased, the odds of being prescribed a psychiatric medication increased in the elderly. These average neighborhood effects on prescription of psychiatric medications (fixed effects) remained significant after inclusion of the individual-level variables, with the exception for those for antidepressants. The between-neighborhood variance indicated significant differences in psychiatric medication between neighborhoods, which were partly explained by the neighborhood-level and individual-level variables (random effects).

A review from 2005 found that there was insufficient evidence to establish a robust association between social capital and mental health.[16] In general, findings of previous studies are inconsistent. For example, Stafford et al.[17] did not find any main effect of social capital on common psychiatric disorders in an analysis of 9,000 residents in 239 neighborhoods in England and Scotland. However, when the authors limited the analysis to less heterogeneous neighborhoods, the associations between social capital and common psychiatric disorders became evident. Another study from England found an association between low social capital and higher incidence of psychoses such as schizophrenia.[29] In contrast, another study from the UK found that neighborhoods with high social capital, measured as perceived community safety, had higher hospital readmission rates for psychosis. The authors explained their findings as being due to less tolerance towards deviant behavior within communities with high social capital.[30,31] A longitudinal study of homeless people in the US found no significant association between social capital and incidence of psychosis.[32]

These interesting studies differ in many respects from our study. Most of them were based on cross-sectional surveys and relied on mailed questionnaires for the construction of the social capital variable and/or for the assessment of the outcome variables. Others were based on relatively small sample sizes or certain subgroups of the population, or used various indicators in the measurement of social capital. In addition, many studies lacked objective information on the neighborhood context. In general, multilevel studies suggest small differences in the variation in psychological distress across neighborhoods.[18,19] However, no previous large-scale multilevel study has examined the potential effect of low linking social capital on prescription of psychiatric medications in elderly people, after accounting for a comprehensive set of individual-level sociodemographic factors. This is a novel contribution of the present study.

The stronger associations between social capital and psychiatric medication found in Malmö, the third largest city in Sweden, may be due to the higher levels of urbanization compared to Sweden as a whole. Previous research from Sweden has found significant associations between urbanization and psychosis and depression [33].

The causal processes by which the neighborhood context may affect mental health have still not been established. It is possible that poor social networks, alienation, and high crime rates in certain neighborhoods contribute to the development of psychiatric disorders in vulnerable individuals [34-38]. High social capital, characterized by high levels of social cohesion and interpersonal trust may, on the other hand, protect against the adverse effects of neighborhood stressors in the development of psychotic disorders [34,39]. However, it is also possible that individuals with psychiatric disorders tend to migrate to socially deprived neighborhoods, thus increasing the risk of psychiatric disorders in such neighborhoods by

"reverse causation." This may be particularly salient for individuals with chronic psychiatric illnesses, such as psychiatric patients with schizophrenia or other psychoses.

We found significant associations between linking social capital and doctors' prescriptions of most psychiatric medications with the exception for antidepressants and anti-dementia drugs. Although our data does not allow us to draw any causal inferences, one possible explanation behind these findings may be that depression is less stigmatizing than many other psychiatric disorders and that the higher levels of social cohesion and social networks in neighborhoods with high social capital may encourage depressed elderly persons to seek health care. In contrast, elderly persons living in neighborhoods with low social capital may be less inclined to seek help for their depressive or neurological symptoms. Further research is needed to elucidate the potential pathways behind the increased contextual risk of psychiatric disorders in certain neighborhoods.

Neighborhood differences in health may be due to neighborhood differences in accessibility to health-related resources, i.e., underserved neighborhoods may have poorer access to such resources. However, our research group performed a nationwide study and found that underserved neighborhoods had better access to all types of resources, including pharmacies/drug stores, public hospitals, health care centers, and dentists, which suggests that neighborhood differences in health in the Swedish population are not explained by a lack of health-promoting neighborhood resources. Other factors seem to play a larger role [40].

Strengths and limitations

This study has a number of strengths. First, it provides a good estimate of the collective burden of treated psychiatric disorders in both specialist and primary health care in a large

national cohort as it includes all prescriptions in Sweden since 1 July 2005 (the date that the National Pharmacy Register started). Our study was based on 1,292,816 elderly people living in 9,119 homogenous neighborhoods with around 1,000 people per neighborhood. The geographic units (SAMS) are therefore small in terms of population size. This is an advantage according to a recent review of social capital and psychiatric disorders.[41] Some research suggests that the immediate neighborhood contributes most to etiological pathways among individuals suffering from psychiatric disorders.[29] The availability of almost 100% complete national outpatient and inpatient pharmacy data allowed us to incorporate a broad spectrum of psychiatric illness, including the large majority of cases that do not require hospitalization. This enabled a more comprehensive assessment of the association between linking social capital and psychiatric medication. Linkage of the pharmacy data to population registers enabled us to include a broad set of individual sociodemographic characteristics, which allowed us to adjust for potential confounders. We also evaluated several different classes of psychiatric medications, among which antipsychotic medications had the strongest association with linking social capital. The differential odds we observed among these medication groups need replication in future studies. Furthermore, by using a multilevel model we could separate the neighborhood effect on prescription of psychiatric medications from the individual effect, taking into consideration both fixed and random effects in the analyses. The prospective design of our study is stronger than a cross-sectional or retrospective design when evaluating the effect of the exposure, i.e. the level of neighborhood linking social capital. Finally, although voting rates may not be the single best measure of trust in the population it has several advantages over the use of questionnaires (which were not possible to use in a nationwide study such as ours). For example, questionnaires will most often assess the exposure variable and the outcome variable simultaneously. Such an approach will lead to a same-source bias because psychiatric disorders are most likely

associated with a negative perception of the neighborhood. However, our outcome variables and exposure variable were collected from two different sources, which eliminates self-source bias.

This study also has some important limitations. We could not adjust the models for the length of time the individuals had lived in their neighborhoods. Furthermore, some residual confounding most likely exists in the measurement of socioeconomic conditions. For example, years of education is not equal to quality of education.[42] Finally, the multidimensional nature of social capital creates several possibilities for its measurement. A consensus has not yet been established as to which measurement is the most accurate. However, we argue that measuring social capital in multiple different ways can broaden its multidimensional conceptualization, which could serve in the future as a rationale for interventions.

In summary, these findings from a large national study suggest that low linking social capital may have important independent effects on the prescription of psychiatric medications among elderly men and women, which is important information for clinicians working in such neighborhoods. Decision-makers should take into account the potentially negative effect of linking social capital on psychiatric disorders regarding sites of primary health care centers and psychiatric clinics, as well as other kinds of community support for elderly patients with such disorders.

Conflicts of Interest: No Disclosures to Report

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References

1. Putnam R. *Making democracy work*. Princeton: Princeton University Press; 1993.

2. Putnam R. *Bowling alone: The collapse and revival of American community*. New York: Simon and Schuster; 2000.

3. Holzmann R, Jorgensen S. *Social protection as social risk management. Social protection discussion paper 9904.* Washington DC: Social Protection Team, Human Development Network, World Bank;1999.

4. Woolcock M, Narayan D. Social capital: Implications for development theory, research and policy. *World Bank Res Obs.* 2000;15:225-249.

5. Green G, Grimsley M, Suokas A, Prescott M, Jowitt T, R L. *Social capital, health and economy in South Yorkshire Coalfield Communities.* Sheffield: Center for Regional Economic and Social Research;2000.

6. Hyyppä MT, Mäki J. Why do Swedish-speaking Finns have longer active life? An area for social capital research. *Health Promot Int.* Mar 2001;16:55-64.

7. Kawachi I, Kennedy B, Lochner K. Long live community: Social capital as public health 1997;8:56-59.

8. Sundquist J, Johansson SE, Yang M, Sundquist K. Low linking social capital as a predictor of coronary heart disease in Sweden: a cohort study of 2.8 million people. *Soc Sci Med.* Feb 2006;62:954-963.

9. Kawachi I, Berkman L. *Social epidemiology* New York: Oxford University Press; 2000.

10. Szreter S, Woolcock M. Health by association? Social capital, social theory, and the political economy of public health. *Int J Epidemiol.* Aug 2004;33:650-667.

11. Almedom AM. Social capital and mental health: an interdisciplinary review of primary evidence. *Social science & medicine.* Sep 2005;61:943-964.

12. Hamano T, Fujisawa Y, Ishida Y, Subramanian SV, Kawachi I, Shiwaku K. Social capital and mental health in Japan: a multilevel analysis. *PLoS One.* 2010;5:e13214.

13. Hamano T, Yamasaki M, Fujisawa Y, Ito K, Nabika T, Shiwaku K. Social capital and psychological distress of elderly in Japanese rural communities. *Stress and Health.* 2011;27:163-169.

14. Hamano T, Fujisawa Y, Yamasaki M, Ito K, Nabika T, Shiwaku K. Contributions of social context to blood pressure: findings from a multilevel analysis of social capital and systolic blood pressure. *Am J Hypertens.* Jun 2011;24:643-646.

15. Iwase T, Suzuki E, Fujiwara T, Takao S, Doi H, Kawachi I. Do bonding and bridging social capital have differential effects on self-rated health? A community based study in Japan. *J Epidemiol Community Health.* Jun 2012;66:557-562.

16. De Silva MJ, McKenzie K, Harpham T, Huttly SR. Social capital and mental illness: a systematic review. *Journal of epidemiology and community health.* Aug 2005;59:619-627.

17. Stafford M, De Silva M, Stansfeld S, Marmot M. Neighbourhood social capital and common mental disorder: testing the link in a general population sample. *Health & place.* Sep 2008;14:394-405.

18. Weich S, Twigg L, Lewis G, Jones K. Geographical variation in rates of common mental disorders in Britain: prospective cohort study. *Br J Psychiatry.* Jul 2005;187:29-34.

19. Propper C, Jones K, Bolster A, Burgess S, Johnston R, Sarker R. Local neighbourhood and mental health: evidence from the UK. *Social science & medicine.* Nov 2005;61:2065-2083.

20. Lofors J, Sundquist K. Low-linking social capital as a predictor of mental disorders: a cohort study of 4.5 million Swedes. *Soc Sci Med.* Jan 2007;64:21-34.

21. Sundquist K, Yang M. Linking social capital and self-rated health: a multilevel analysis of 11,175 men and women in Sweden. *Health Place.* Jun 2007;13:324-334.

22. Lindstrom M, Merlo J, Ostergren PO. Social capital and sense of insecurity in the neighbourhood: a population-based multilevel analysis in Malmo, Sweden. *Social science & medicine.* Mar 2003;56:1111-1120.

23. Blakely TA, Kennedy BP, Kawachi I. Socioeconomic inequality in voting participation and self-rated health. *American journal of public health.* Jan 2001;91:99-104.

24. Bond Huie S. The concept of neighborhood in health and mortality research. . *Sociological Spectrum.* 2001;21:341-358.

25. Larsen K, Petersen JH, Budtz-Jørgensen E, Endahl L. Interpreting parameters in the logistic regression model with random effects. *Biometrics.* Sep 2000;56:909-914.

26. Snijders T, Bosker R. *Multilevel analysis: An introduction to basic and advanced multilevel modeling*. London: Sage Publications; 1999.

27. Callas PW, Pastides H, Hosmer DW. Empirical comparisons of proportional hazards, poisson, and logistic regression modeling of occupational cohort data. *Am J Ind Med.* Jan 1998;33:33-47.

28. Rasbash J, Browne W, H G, et al. *A User's Guide to MLwiN (2nd edition).* London: Institute of Education, University of London; 2000.

29. Boydell J, McKenzie K, van Os J, Murray R. The social causes of schizophrenia: An investigation into the influence of social cohesion and social hostility. Report of a pilot study. *Schizophrenia Res.* 2002;53:264.

30. McKenzie K, Whitley R, Weich S. Social capital and mental health. *Br J Psychiatry.* Oct 2002;181:280-283.

31. McKenzie K. Neighborhood safety and mental health outcomes. 2000. Available at: http://www.worldbank.org/poverty/scapital/sctalk/talk28.htm. Accessed January 28. 2013.

32. Rosenheck R, Morrissey J, Lam J, et al. Service delivery and community: social capital, service systems integration, and outcomes among homeless persons with severe mental illness. *Health Serv Res.* Aug 2001;36:691-710.

33. Sundquist K, Frank G, Sundquist J. Urbanisation and incidence of psychosis and depression: follow-up study of 4.4 million women and men in Sweden. *Br J Psychiatry.* Apr 2004;184:293-298.

34. Allardyce J, Boydell J. Review: the wider social environment and schizophrenia. *Schizophr Bull.* Oct 2006;32:592-598.

35. Lofors J, Sundquist K. Low-linking social capital as a predictor of mental disorders: a cohort study of 4.5 million Swedes. *Social science & medicine.* Jan 2007;64:21-34.

36. Ross CE. Neighborhood disadvantage and adult depression. *J Health Social Behavior.* 2000;42:177-187.

37. Evans GW. The built environment and mental health. *J Urban Health.* Dec 2003;80:536-555.

38. Boydell J. Risk factors for schizophrenia. *Expert Rev Neurother.* Nov 2001;1:183-191.

39. Howes OD, McDonald C, Cannon M, Arseneault L, Boydell J, Murray RM. Pathways to schizophrenia: the impact of environmental factors. *Int J Neuropsychopharmacol.* Mar 2004;7 Suppl 1:S7-S13.
40. Kawakami N, Winkleby M, Skog L, Szulkin R, Sundquist K. Differences in neighborhood accessibility to health-related resources: a nationwide comparison between deprived and affluent neighborhoods in Sweden. *Health & place.* Jan 2011;17:132-139.
41. Whitley R, McKenzie K. Social capital and psychiatry: review of the literature. *Harv Rev Psychiatry.* 2005 Mar-Apr 2005;13:71-84.
42. Kaufman JS, Cooper RS, McGee DL. Socioeconomic status and health in blacks and whites: the problem of residual confounding and the resiliency of race. *Epidemiology.* Nov 1997;8:621-628.

Figure legends

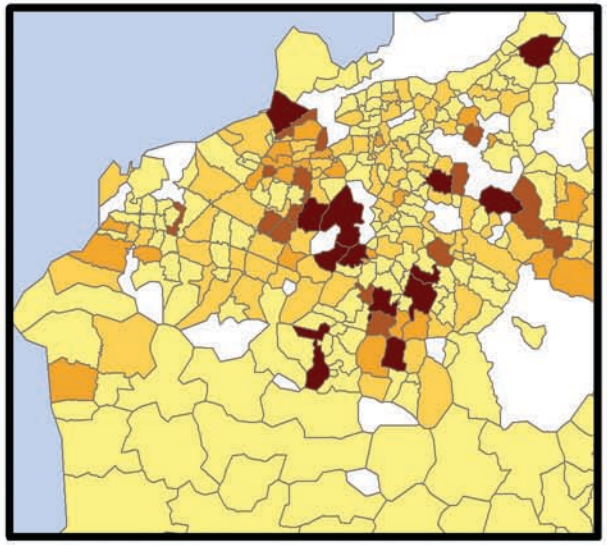
Figure 1. Neighborhood linking social capital and psychiatric medication in the urban area of Malmö, Sweden.

Supplemental Digital Content

Supplemental Digital Content 1. doc

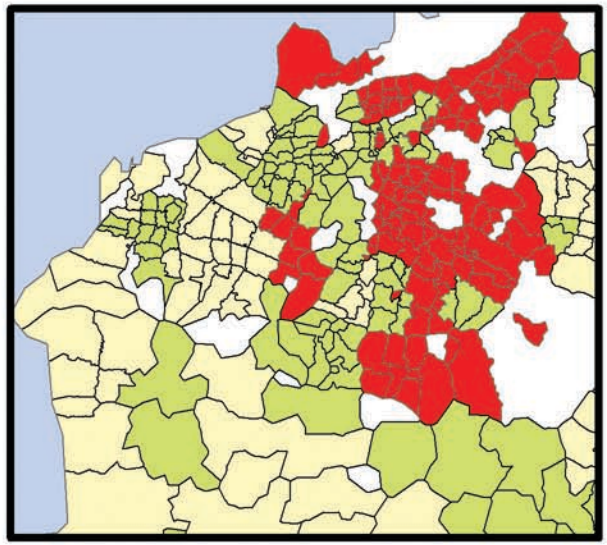
Supplemental Digital Content 2. doc

Supplemental Digital Content 3. doc



The population aged 65+ years

- ≤ 100
- > 100 and ≤ 200
- > 200 and ≤ 300
- > 300 and ≤ 400
- > 400
- **Missing data / Industrial area**



Linking social capital

- Low
- Intermediate
- High
- **Missing data / Industrial area**

Psychiatric medication prescription rate*

- ≤ 10.0 per 100
- > 10.0 and ≤ 20.0
- > 20.0
- **Missing data / Industrial area**

Table 1. Population distribution, number of psychiatric medication prescriptions (events), and age-standardized cumulative rates (per 100) by level of linking social capital. Ages 65 and over.

	Population	Distribution (%)	All events	Linking social capital		
				Low	Moderate	High
Total population (%)	1292816			333443 (26%)	741204 (57%)	218169 (17%)
Psychotropic medication			214427	17.7	16.6	15.0
Antipsychotics (ATC N05A)			9450	0.9	0.7	0.5
Anxiolytics (ATC N05B)			24986	2.2	1.9	1.7
Hypnotics/sedatives (ATC N05C)			54679	4.4	4.2	4.0
Antidepressants (ATC N06A)			28111	2.2	2.2	2.1
Anti-dementia drugs (ATC N06D)			6503	0.5	0.5	0.5
Gender						
Men	543236	42.0	71810	14.5	13.6	12.2
Women	749580	58.0	142617	19.7	18.6	17.3
Age (years)						
65-69	352640	27.3	47143	15.0	13.2	12.0
70-74	323443	25.0	47771	16.0	14.6	13.5
75-79	281403	21.8	47954	17.7	17.0	15.9
80-84	206976	16.0	40542	20.2	19.6	18.6
85-89	95078	7.4	22230	23.6	23.4	22.9
≥ 90	33276	2.6	8787	26.9	26.3	25.9
Family income (quartiles)						
Low income	323718	25.0	68027	20.9	19.6	19.0
Middle–low income	322851	25.0	55596	17.7	16.9	16.2
Middle–high income	323138	25.0	48959	16.2	15.6	14.7
High income	323109	25.0	41845	14.9	14.7	13.2
Marital status						
Married/cohabiting	685550	53.0	98396	15.8	15.2	13.9
Never married, Widowed, or divorced	607266	47.0	116031	19.4	18.1	16.8
Immigrant status						
Sweden	1168141	90.4	194509	17.7	16.5	15.0
Western Countries	92698	7.2	14885	18.1	16.9	15.0
Other countries	31977	2.5	5033	16.9	15.8	14.5
Educational attainment						
Compulsory school or less (≤ 9 years)	960005	74.3	169830	17.9	16.7	15.5
Practical high school or some theoretical high school (10–11 years)	167847	13.0	24117	7.9	7.3	7.6
Theoretical high school and/or college (≥ 12 years)	164964	12.8	20480	6.8	6.5	6.6

Table 2. Odds ratios (ORs) and 95% confidence intervals (CIs) for psychiatric medication: Results of multi-level logistic regression. Ages 65 and over.

	Model 1			Model 2			Model 3			
	OR	95% CI		OR	95% CI		OR	95% CI		P-value
Linking social capital										
High	1			1			1			
Moderate	1.11	1.09	1.13	1.07	1.05	1.08	1.03	1.02	1.05	<0.001
Low	1.23	1.21	1.25	1.15	1.13	1.18	1.10	1.08	1.12	<0.001
Sex										
Male				1			1			
Female				1.46	1.45	1.47	1.39	1.38	1.40	<0.001
Age				1.03	1.03	1.03	1.02	1.02	1.03	<0.001
Family income										
High							1			
Middle-high							1.09	1.07	1.10	<0.001
Middle-low							1.14	1.12	1.16	<0.001
Low							1.25	1.22	1.27	<0.001
Marital status										
Married/cohabiting							1			
Never married/widowed/divorced							1.05	1.03	1.06	<0.001
Country of birth										
Sweden							1			
Western countries							0.99	0.97	1.01	0.317
Other countries							0.92	0.89	0.95	<0.001
Education level										
Compulsory school or less (≤ 9 years)							1.06	1.04	1.08	<0.001
Practical high school or some theoretical high school (10–11 years)							1.04	1.02	1.06	<0.001
Theoretical high school and/or college (≥ 12 years)							1			
Between-neighborhood variance (S.E.)	*0.029 (0.001)*			*0.016 (0.001)*			*0.014 (0.001)*			
Explained variance (%)	*15*			*53*			*59*			

Model 1: Crude model

Model 2: Adjusted for age and sex

Model 3: Adjusted for age, sex, family income, marital status, country of birth, and education level

Table 3. Odds ratios (OR) and 95% confidence intervals (CIs) for subtypes of psychotropic medication; Results of multi-level logistic regression. Ages 65 and over.

	Model 1			Model 2			Model 3			
	OR	95% CI		OR	95% CI		OR	95% CI		P-value
Antipsychotics (ATC N05A)										
High linking social capital	1			1			1			
Moderate linking social capital	1.36	1.27	1.46	1.29	1.20	1.38	1.13	1.05	1.21	<0.001
Low linking social capital	1.65	1.53	1.78	1.54	1.43	1.65	1.26	1.17	1.35	<0.001
Anxiolytics (ATC N05B)										
High linking social capital	1			1			1			
Moderate linking social capital	1.13	1.08	1.18	1.08	1.04	1.13	1.03	0.99	1.07	0.194
Low linking social capital	1.30	1.24	1.37	1.22	1.17	1.28	1.15	1.10	1.20	<0.001
Hypnotics/sedatives (ATC N05C)										
High linking social capital	1			1			1			
Moderate linking social capital	1.04	1.01	1.07	1.00	0.97	1.03	1.00	0.98	1.03	0.842
Low linking social capital	1.10	1.07	1.14	1.04	1.01	1.07	1.05	1.02	1.08	0.002
Antidepressants (ATC N06A)										
High linking social capital	1			1			1			
Moderate linking social capital	1.05	1.01	1.09	1.01	0.97	1.04	0.99	0.96	1.03	0.617
Low linking social capital	1.05	1.01	1.10	0.99	0.95	1.03	0.98	0.94	1.02	0.368
Anti-dementia drugs (ATC N06D)										
High linking social capital	1			1			1			
Moderate linking social capital	1.01	0.93	1.09	0.96	0.89	1.03	0.99	0.92	1.07	0.764
Low linking social capital	0.93	0.86	1.02	0.88	0.81	0.96	0.94	0.86	1.02	0.162

Model 1. Crude model.

Model 2. Adjusted for age and gender.

Model 3. Adjusted for age, gender, family income, marital status, immigrant status, and education attainment.

Supplementary Table 1. Odds ratios (OR) and 95% confidence intervals (CI) for psychotropic medication in Malmö; Results of multi-level logistic regression models. Ages 65 and over.

	Model 1			Model 2			Model 3			
	OR	95% CI		OR	95% CI		OR	95% CI		P-value
Linking social capital										
High	1			1			1			
Moderate	1.33	1.21	1.46	1.21	1.11	1.31	1.16	1.07	1.26	<0.001
Low	1.44	1.31	1.58	1.33	1.22	1.45	1.26	1.16	1.38	<0.001
Gender										
Men				1			1			
Women				1.46	1.38	1.54	1.38	1.30	1.46	<0.001
Age				1.03	1.03	1.03	1.02	1.02	1.03	<0.001
Family income										
High income							1			
Middle-high income							1.14	1.05	1.24	0.002
Middle-low income							1.13	1.02	1.24	0.016
Low income							1.19	1.07	1.33	0.001
Marital status										
Married/co-habiting							1			
Never Married,widowed, divorced							1.10	1.02	1.19	0.016
Immigrants										
Sweden							1			
Western countries							0.92	0.84	1.01	0.089
Others							0.86	0.76	0.96	0.009
Education attainment										
Compulsory school or less (≤ 9 years)							1.09	0.98	1.20	0.110
Practical high school or some theoretical high school (10–11 years)							1.08	0.96	1.21	0.194
Theoretical high school and/or college (≥ 12 years)							1			
Variance (S.E.)	*0.020 (0.006)*			*0.008 (0.004)*			*0.007 (0.004)*			
Explained variance (%)	*46*			*78*			*81*			

Model 1: Crude model

Model 2: Adjusted for age and sex

Model 3: Adjusted for age, sex, family income, marital status, country of birth, and education level

Supplementary Table 2. Odds ratios (OR) and 95% confidence intervals (CI) for subtypes of psychotropic medication in Malmö; Results of multi-level logistic regression models. Ages 65 and over.

	Model 1			Model 2			Model 3			
	OR	95% CI		OR	95% CI		OR	95% CI		P-value
Antipsychotics (ATC N05A)										
High linking social capital	1			1			1			
Moderate linking social capital	1.58	1.07	2.35	1.41	0.95	2.09	1.20	0.81	1.78	0.368
Low linking social capital	1.95	1.33	2.88	1.79	1.22	2.64	1.39	0.93	2.08	0.110
Anxiolytics (ATC N05B)										
High linking social capital	1			1			1			
Moderate linking social capital	1.57	1.29	1.93	1.42	1.16	1.73	1.40	1.14	1.72	0.001
Low linking social capital	1.53	1.25	1.88	1.42	1.16	1.74	1.42	1.15	1.76	0.001
Hypnotics/sedatives (ATC N05C)										
High linking social capital	1			1			1			
Moderate linking social capital	1.11	0.96	1.30	1.04	0.89	1.20	1.01	0.87	1.17	0.920
Low linking social capital	1.17	1.01	1.36	1.11	0.95	1.28	1.10	0.94	1.28	0.230
Antidepressants (ATC N06A)										
High linking social capital	1			1			1			
Moderate linking social capital	1.51	1.21	1.87	1.34	1.09	1.66	1.35	1.09	1.67	0.005
Low linking social capital	1.28	1.02	1.59	1.16	0.93	1.44	1.20	0.96	1.50	0.110
Anti-dementia drugs (ATC N06D)										
High linking social capital	1			1			1			
Moderate linking social capital	0.80	0.53	1.22	0.70	0.46	1.07	0.73	0.48	1.12	0.162
Low linking social capital	0.79	0.52	1.21	0.72	0.47	1.10	0.79	0.51	1.24	0.317

Model 1. Crude model.

Model 2. Adjusted for age and gender.

Model 3. Adjusted for age, gender, family income, marital status, immigrant status, and education attainment.

Supplementary Table 3. Odds ratios (OR) and 95% confidence intervals (CI) for psychotropic medication.; Results of multi-level logistic regression models. Ages 20-64 years (N=4,649,414)

	Model 1			Model 2			Model 3			
	OR	95% CI		OR	95% CI		OR	95% CI		P-value
Linking social capital										
High	1			1			1			
Moderate	1.11	1.10	1.13	1.12	1.11	1.14	1.03	1.02	1.04	<0.001
Low	1.31	1.30	1.33	1.34	1.32	1.36	1.13	1.12	1.14	<0.001
Gender										
Men				1			1			
Women				1.05	1.05	1.06	1.06	1.05	1.07	<0.001
Age				1.01	1.00	1.01	1.01	1.00	1.01	<0.001
Family income										
High income							1			
Middle-high income							1.05	1.04	1.06	<0.001
Middle-low income							1.13	1.12	1.14	<0.001
Low income							1.44	1.43	1.45	<0.001
Marital status										
Married/co-habiting							1			
Never Married,widowed, divorced							1.10	1.09	1.10	<0.001
Immigrants										
Sweden							1			
Western countries							1.10	1.09	1.11	<0.001
Others							1.03	1.02	1.04	<0.001
Education attainment										
Compulsory school or less (≤ 9 years)							1.39	1.38	1.40	<0.001
Practical high school or some theoretical high school (10–11 years)							1.31	1.30	1.32	<0.001
Theoretical high school and/or college (≥ 12 years)							1			
Variance (S.E.)	*0.020 (0.001)*			*0.020 (0.001)*			*0.013 (0.000)*			
Explained variance (%)	*33*			*33*			*57*			

Model 1: Crude model

Model 2: Adjusted for age and sex
Model 3: Adjusted for age, sex, family income, marital status, country of birth, and education level