eAppendix 1. Supplemental introduction

Immigration status is associated with mental health.[1-4] While some immigrants have better health than native-born groups,[5] refugees are uniquely vulnerable due to the often involuntary and sudden nature of their displacement, and due to adverse experiences in their home countries.[6-8] This may reduce earnings and employment rates,[7, 9] as well as ultimately impede the ability of refugees to lead a healthy and productive life, given their higher rates of morbidity and mortality.[10] Previous studies examining factors associated with mental health among refugees focused primarily on individual risk factors, e.g., gender and exposure to violence.[11] Few studies have investigated the importance of neighborhood factors,[11] which theory suggests are key determinants of immigrant health.[12]

Studies have repeatedly found associations between neighborhood socioeconomic deprivation and mental health in the general population.[1, 13-18] Possible mechanisms include stress, e.g., due to low income, unemployment, discrimination, and lack of social support and trust.[19, 20] Yet much of this prior work suffers from potential confounding due to self-selection bias, in that individuals with poor mental health may be more likely to reside in or move to deprived neighborhoods (eFigure 1). Critics have called for the use of stronger study designs to understand neighborhood effects on mental health.[21] The U.S. Moving to Opportunity (MTO) study is one of the only experimental studies in this literature, randomly assigning low-income individuals to vouchers for low-poverty neighborhoods.[22] MTO found that low-poverty neighborhoods reduced depression and psychological distress in adults and improved mental health among adolescent girls, but worsened mental health among adolescent boys.[23-25] Other quasi-experimental studies

of U.S. public housing programs have found that neighborhood deprivation worsened mental health.[26, 27] A natural experiment in the United Kingdom found improved mental health in residents of neighborhoods that received socioeconomic regeneration.[28] No studies to our knowledge have used an experimental or quasi-experimental design to examine neighborhood effects on immigrant mental health.

Here, we leveraged a natural experiment in Sweden in the form of a refugee dispersal policy, where incoming refugees were assigned to neighborhoods across Sweden in a nearly random (quasi-random) fashion during 1987-1991. We took advantage of this dispersal policy to estimate the effects of neighborhood deprivation on mental health among refugees. We compared these estimates with the association of neighborhood deprivation among non-refugee immigrants who self-selected their neighborhood of residence during the same period. In doing so, we provide evidence on the health effects of neighborhood deprivation among immigrants, while also informing methodological discussions on the role of confounding in the neighborhood-health literature.

eAppendix 1. Supplemental methods

Data

The dataset was constructed using Swedish population and clinical registers, which include 11.8 million residents, living and deceased, representing 99% of the native-born and immigrant population. Validation studies have found Sweden's clinical registers to have broad coverage and high quality.[29-32] Prior work has validated the use of clinical and prescription drug registers to classify mental health outcomes.[33, 34] Individual-level

and neighborhood-level characteristics were available in the population and inpatient registers for the full study period (1987-2015), the outpatient and primary health care registers for 2002-2015, and the prescription drug registers for 2005-2015. Those data were made available through a data use agreement which prevents us from sharing individual-level data.

From 1980-1989, Sweden received nearly 100,000 refugees.[35] We included refugees and non-refugee immigrants age 18 or older who arrived in Sweden during 1987-1991, when the refugee dispersal policy was in effect (details below). Refugees are individuals unable to return to their home countries because of persecution or fear of persecution due to race, religion, nationality, or membership in a particular social or political group.[36] Non-refugee immigrants are foreign-born persons who are not refugees. Swedish registers include information on the reason for migration, which we used to group foreign-born individuals into two groups: refugees subject to the dispersal policy and non-refugee immigrants not subject to the policy. The final sample size was 48,506 refugees and 97,254 non-refugee immigrants.

Refugee dispersal policy

In 1985, the Swedish Immigration Board was tasked with assigning refugees to neighborhoods across the country. This was in response to strains on the housing market in large cities, where most refugees congregated, and efforts to integrate refugees into labor markets. The dispersal policy ran from 1985-1994.[37] It was strictly enforced from 1987-1991, during which 90% of all incoming refugees were placed in an initial municipality chosen by the Board.[38] In this study, we focused on immigrants who

arrived during 1987-1991. The policy did not apply to refugees arriving for family reunification or those with the financial means to support themselves. Although we were unable to identify the latter in our sample, we excluded refugees who were reunited with family (N=3,362). By 1989, 277 out of 284 municipalities in Sweden participated in the dispersal program.[38]

Prior to approval of residential permit and relocation to a municipality, refugees spent 3 to 12 months in centers across Sweden assigned by the Immigration Board.[39] Placement officers, who had no direct contact with refugees, assigned individuals to available housing. Any potential selection bias would be based on demographic characteristics available to the officers: language, schooling, and family size.[38] Refugees received residential placement and welfare support, as well as Swedish language and job training courses for up to 18 months. Also, although refugees could indicate a municipality of preference, finding an apartment in large urban areas was challenging due to the competitive housing market during 1987-1991.[38] This meant that housing assignments were based strictly on availability, and that refugee placement, conditional on assigned municipality and information available to officers, was essentially random, as supported by prior studies.[38, 40, 41] The geographical distribution directed by the placement policy was therefore unconfounded by unobserved individual characteristics.[38]

Refugees could later move without affecting welfare receipt. Here, we estimated the effect of *initial* quasi-random neighborhood placement for refugees (i.e., neighborhood at arrival), and self-selected neighborhood at arrival for non-refugee immigrants. For refugees, this is analogous to a randomized “encouragement” design, similar to the

MTO experiment. Previous studies have shown nationwide dispersal of refugees during our study period (eFigure 2), with no evidence of ethnic grouping and similar refugee characteristics by neighborhood deprivation level.[38, 40]

Variables

Outcome

The primary outcome was date of diagnosis with depression or anxiety (eFigure 3). This was extracted from clinical register data using International Classification of Disease (ICD) codes for clinical encounters and Anatomic Therapeutic Chemical (ATC) codes for relevant medication prescriptions. Because of overlapping symptoms and difficulties in distinguishing between these two conditions using ICD and ATC codes, we considered someone to have a mental health diagnosis based on the first diagnosis in the registry of either depression or anxiety. Inpatient register data were available for the years 1987-2015, outpatient data for 2002-2015, and medication data for 2005-2015. Thus, incident depression and anxiety was not clearly captured. To exclude preexisting cases, individuals identified in the inpatient register as diagnosed with depression/anxiety within two years of arrival in Sweden were excluded, a technique commonly used in the prior literature.[42, 43]

Neighborhood deprivation

As in prior studies in Sweden,[41, 44-46] we defined neighborhood as Small Area Market Statistics (SAMS) nested within municipalities. In Sweden, the population in each SAMS is about 1,000 residents (about 2,000 in Stockholm).[41] We excluded SAMS with less

than 50 residents due to confidentiality concerns and unreliable estimates (final N=6,536 neighborhoods).

A composite index of neighborhood socioeconomic deprivation was created using measures available in Swedish registers.[41, 47] We used principal component analysis to combine the following neighborhood-level variables (measured among adults 25-64 years old): 1) percent with <10 years of schooling), 2) percent with <50% of individual median income), 3) unemployment rate, and 4) percent receiving social welfare. *Z*-scores were calculated for each SAMS, weighted by the coefficient for the eigenvectors. To allow for non-linear relationships between neighborhood deprivation and mental health, this index was split into tertiles.

In addition to estimating the relationship with neighborhood deprivation at arrival, we constructed a variable representing neighborhood deprivation after participants had resided in Sweden for 10 years. We hypothesized that estimates for refugees using this exposure would resemble those of non-refugee immigrants, since this exposure would incorporate some degree of self-selection. Geographical distribution of refugees resembles that of non-refugee immigrants after a decade in Sweden.[38]

Covariates

Covariates included the following characteristics measured in the year of arrival: 5-year age categories (e.g., 25-29, 30-34), gender, years of education (≤9 years, 10-12 years, >12 years), marital status (married/cohabitating versus not), region of initial placement (large cities in southern Sweden, other areas in southern Sweden, northern Sweden), family size, and region of origin (Iran, Latin America, Eastern Europe, Middle East/North

Africa, Asia, Africa, other).

Statistical analyses

Cox models were performed to estimate the association of neighborhood deprivation (1) on arrival and (2) 10 years later with diagnosis of depression/anxiety. We stratified by refugees versus non-refugee immigrants. Models were adjusted for the individual characteristics listed above, and indicator variables for year of arrival to account for secular trends. Sensitivity analyses controlling for neighborhood percent immigrants on arrival and 10 years after arrival were also performed, as this is a possible confounder or mediator between neighborhood deprivation and mental health.

All models also included fixed effects (i.e., indicator variables) for initially assigned municipality. Thus, our estimates show neighborhood effects from immigrants assigned to higher or lower deprivation neighborhoods within the same municipality. Models also incorporated shared frailty at the municipality level to account for correlated observations within families, neighborhoods, and municipalities. Ethics approval for this study was provided by the Regional Ethical Committee at Lund University (Dnr 2012/795).

eAppendix 3. Supplemental results

Demographic characteristics

Our sample included 48,056 refugees and 97,254 non-refugee immigrants (eTable 1). Most non-refugee immigrants came from non-refugee-sending countries (54%). There were more non-refugee immigrants in large cities (63%) compared with refugees (42%),

as expected given the dispersal policy. Overall, refugees experienced higher cumulative incidence of depression/anxiety (39%) than non-refugee immigrants (20%).

Ten years after arrival, 31,749 refugees and 51,593 non-refugee immigrants in our sample remained in Sweden. During these 10 years, 54.7% of refugees and 45.2% of non-refugee immigrants changed neighborhoods. About 3.6% of refugees and 7.9% of non-refugee immigrants moved from a high-deprivation neighborhood to a lower deprivation neighborhood (eTable 2).

Neighborhood deprivation and depression/anxiety

We analyzed the association of neighborhood deprivation on arrival with subsequent depression/anxiety (Figure 1). Among non-refugee immigrants, moderate-deprivation neighborhoods on arrival were associated with greater depression/anxiety (HR 1.04, 95%CI 1.00, 1.09). These estimates were close to the null, and thus susceptible to being explained by small amounts of bias.

We next analyzed the association of neighborhood deprivation 10 years after arrival—when roughly half of the refugees had resettled into a neighborhood that was no longer quasi-randomly assigned—with subsequent depression/anxiety (Figure 1). The estimate for non-refugee immigrants was different from that of refugees.

We observed marked gender differences in the neighborhood-mental health association for refugees and non-refugee immigrants (eFigure 4). Among non-refugee immigrants, the association between high neighborhood deprivation on arrival and worse mental health was greater for men (HR 1.09, 95% CI 1.01, 1.17) than women (HR 1.02, 95% CI

0.97, 1.07), and this difference grew over time. Ten years after arrival, the hazard ratio was 1.28 (95% CI 1.18, 1.38) for men compared with 1.06 (95% CI 1.01, 1.12) for women in high-deprivation neighborhoods. Among refugees, the association between high neighborhood deprivation on arrival was similar for men (HR 0.97, 95% CI 0.91, 1.03) and women (HR 0.95, 95% CI 0.89, 1.01), but 10 years after arrival women had worse mental health (HR 1.07, 95% CI 0.99, 1.16) than men (HR 0.98, 95% CI 0.91, 1.06).

Point estimates in sensitivity analyses controlling for neighborhood percent immigrants did not differ substantially from our primary findings (eTable 3).

eAppendix 4. Supplemental discussion

This is among the first studies to use a natural experiment to examine the effect of neighborhood deprivation on mental health, and the first to use this approach to study mental health among immigrants. There are two major explanations for the contrasting findings between refugees and non-refugee immigrants: (1) the discrepancy may reflect differential effects by immigration status, or (2) the quasi-experimental neighborhood assignment may reduce confounding due to selection effects.

First, it may be that these two groups have different experiences upon arrival to Sweden; i.e., different mediating pathways linking neighborhood deprivation with mental health. While cumulative incidence of anxiety/depression was higher in refugees, similar to findings in prior studies,[2, 48] greater neighborhood deprivation on arrival was associated with less anxiety/depression in refugees. Low-deprivation neighborhoods may be less welcoming to refugees, and refugees may face increased discrimination in

these circumstances. This echoes the findings of the MTO study, which found greater mental health problems among boys in low-poverty neighborhoods.[24, 25, 49, 50] Alternately, low-deprivation neighborhoods may provide fewer opportunities for integration due to differences in social class between refugees and their surrounding communities; this may be especially true for women, explaining the gender differences in our findings among refugees. Non-refugee immigrants living in low-deprivation neighborhoods likely self-selected into these neighborhoods because of greater financial stability, and therefore did not face the same challenges as refugees involuntarily placed in these neighborhoods. Meanwhile, residing in a high-deprivation neighborhood among non-refugee immigrants may reflect fewer economic opportunities and greater exposure to violence, since refugees may be viewed more sympathetically relative to economic migrants.[2, 51] This may be particularly true for men, who face higher expectations as breadwinners, which may contribute to their worsened mental health relative to non-refugee immigrant women. A previous study found that high- and moderate-deprivation neighborhoods provided higher access to health-related resources compared to low-deprivation neighborhoods, suggesting that the differences we observe are not due to differences in healthcare access.[52] Alternately, it could be that for refugees, who fled dire circumstances in their home countries, neighborhood factors are less important than the experiences of past trauma and discrimination. A US-based study found more PTSD in refugees compared with voluntary migrants in the pre-migration period, whereas post-migration PTSD was not different for either group.[4] It may be that the additional language training and welfare support provided to refugees who agreed to the dispersal policy provided critical support for this population.[53]

Second, the difference between refugees and non-refugee immigrants may be explained by the difference between an observational analytic approach and a quasi-experimental approach derived from the refugee dispersal policy. Many studies have shown a strong association between neighborhood socioeconomic deprivation and mental health,[13, 15, 20] including twin studies[54, 55] and prior work in Sweden.[44, 46] Yet, these estimates may be confounded by unobserved factors,[56] including individual socioeconomic and health characteristics (eFigure 1). One study found that the association between neighborhood income and anxiety was reduced when adjusting for potential confounders such as immigration status, income, social networks, and gender.[1]

As an example of the mechanism through which this confounding may operate, historically most non-refugee immigrants concentrate in ethnic enclaves found in large urban centers in Sweden.[38, 53, 57] Ethnic enclaves provide a network for residents, but may also hinder acquisition of skills (i.e., learning a new language), prevent dissemination of information regarding new employment and welfare opportunities, and further housing market segregation.[38, 53] For low-income immigrants, living in an ethnic enclave with high deprivation has a negative impact on economic outcomes[38] and may increase rates of depression.[17] While social cohesion has been shown to have a protective effect on mental health, it has not had the same effect for immigrants and minorities who face systematic discrimination.[58-60] Experiencing discrimination may reduce the protective effect of social cohesion provided by ethnic enclaves for non-

refugee immigrants living in high-deprivation neighborhoods. With time, refugees' geographic distribution becomes more similar to that of non-refugee immigrants,[53] which may explain the change in relationship between neighborhood deprivation and mental health observed for refugees when examining neighborhood location 10 years after arrival.

Relatedly, the difference between the refugee and non-refugee samples may also be due to compositional effects. Half of the refugee sample came from Iran, the Middle East, and North Africa, compared to a quarter of non-refugee immigrants. Most other non-refugee immigrants came from Northern Europe.[39] Our study is not sufficiently powered for subgroup analyses by country of origin.

There are several limitations to our study. First, we did not have data on which refugees agreed to neighborhood assignment. However, prior work has shown that adherence to the dispersal policy during 1987-1991 was 90%. Of the remaining 10%, we were able to exclude roughly 7% who moved in with family, leaving only 3% misclassified or "non-adherent," which likely resulted in minimal bias. Second, only inpatient registers were available prior to 2002. We therefore may have missed individuals who had episodes of depression or anxiety before 2002 that were not documented in an inpatient encounter. Third, our study may also not generalize to other settings, e.g., due to the strong social safety net in Sweden. Nevertheless, we see differences by level of neighborhood deprivation, and findings may be more extreme in settings with weaker safety nets like the U.S. Also, we may have underestimated the actual prevalence of

depression/anxiety, due to the use of register data. For example, clinical screenings of depression/anxiety may not capture cultural variations of such conditions.[61] This may bias our results if immigrants and refugees in different neighborhoods differ in their utilization of mental health services.[62]

By comparing a natural policy experiment that resulted in quasi-randomly neighborhoods among refugees with self-selected neighborhoods of residence among non-refugee immigrants, we unmasked important differences in the association of neighborhood deprivation on mental health in immigrant populations. These results may suggest different mediating pathways linking neighborhood deprivation and mental health by immigration status, and they also call into question whether neighborhood deprivation estimates based on observational data from previous studies are fraught with self-selection bias.

eAppendix 5. Supplemental references

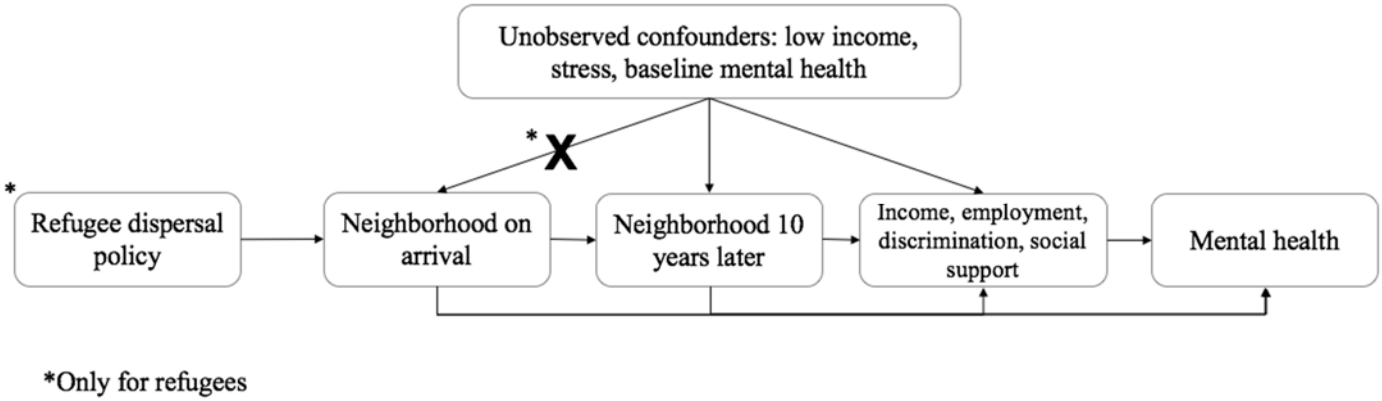
1. Lofors J, Ramirez-Leon V, Sundquist K. Neighbourhood income and anxiety: a study based on random samples of the Swedish population. *Eur J Public Health* 2006; **16**: 633-9.
2. Mousa S. Boosting Refugee Outcomes: Evidence from Policy, Academia, and Social Innovation. In: Lab SIP, editor.; 2018.
3. Steel JL, Dunlavy AC, Harding CE, Theorell T. The Psychological Consequences of Pre-Emigration Trauma and Post-Migration Stress in Refugees and Immigrants from Africa. *J Immigr Minor Health* 2017; **19**: 523-32.
4. Rasmussen A, Crager M, Baser RE, Chu T, Gany F. Onset of posttraumatic stress disorder and major depression among refugees and voluntary migrants to the United States. *J Trauma Stress* 2012; **25**: 705-12.
5. Markides KS, Rote S. Immigrant health paradox. In: Scott RA, Kosslyn SM, editors. *Emerging trends in the social and behavioral sciences*; 2015.
6. Inhorn MC, Serour GI. Islam, medicine, and Arab-Muslim refugee health in America after 9/11. *The Lancet* 2011; **378**: 935-43.

7. Connor P. Explaining the Refugee Gap: Economic Outcomes of Refugees versus Other Immigrants. *Journal of Refugee Studies* 2010; **23**: 377-97.
8. Steel Z, Chey T, Silove D, Marnane C, Bryant RA, van Ommeren M. Association of torture and other potentially traumatic events with mental health outcomes among populations exposed to mass conflict and displacement: a systematic review and meta-analysis. *JAMA* 2009; **302**: 537-49.
9. Hainmueller J, Hangartner D, Lawrence D. When lives are put on hold: Lengthy asylum processes decrease employment among refugees. *Sci Adv* 2016; **2**: e1600432.
10. Bauer TK, Giesecke M, Janisch LM. The Impact of Forced Migration on Mortality: Evidence From German Pension Insurance Records. *Demography* 2019; **56**: 25-47.
11. Fazel M, Reed RV, Panter-Brick C, Stein A. Mental health of displaced and refugee children resettled in high-income countries: risk and protective factors. *The Lancet* 2012; **379**: 266-82.
12. Edberg M, Cleary S, Vyas A. A Trajectory Model for Understanding and Assessing Health Disparities in Immigrant/Refugee Communities. *Journal of Immigrant and Minority Health* 2011; **13**: 576-84.
13. Pickett KE, Wilkinson RG. Income inequality and health: a causal review. *Soc Sci Med* 2015; **128**: 316-26.
14. Fone D, White J, Farewell D, et al. Effect of neighbourhood deprivation and social cohesion on mental health inequality: a multilevel population-based longitudinal study. *Psychol Med* 2014; **44**: 2449-60.
15. Graif C, Arcaya MC, Diez Roux AV. Moving to opportunity and mental health: Exploring the spatial context of neighborhood effects. *Soc Sci Med* 2016; **162**: 50-8.
16. Dowdall N, Ward CL, Lund C. The association between neighbourhood-level deprivation and depression: evidence from the south african national income dynamics study. *BMC Psychiatry* 2017; **17**.
17. Ho HC, Lau KK, Yu R, et al. Spatial Variability of Geriatric Depression Risk in a High-Density City: A Data-Driven Socio-Environmental Vulnerability Mapping Approach. *Int J Environ Res Public Health* 2017; **14**.
18. Truong KD, Ma S. A systematic review of relations between neighborhoods and mental health. *J Ment Health Policy Econ* 2006; **9**: 137-54.
19. Wickham S, Taylor P, Shevlin M, Bentall RP. The impact of social deprivation on paranoia, hallucinations, mania and depression: the role of discrimination social support, stress and trust. *PLoS One* 2014; **9**: e105140.
20. Klijs B, Kibele EU, Ellwardt L, et al. Neighborhood income and major depressive disorder in a large Dutch population: results from the LifeLines Cohort study. *BMC Public Health* 2016; **16**: 773.
21. Mair C, Diez Roux AV, Galea S. Are neighbourhood characteristics associated with depressive symptoms? A review of evidence. *J Epidemiol Community Health* 2008; **62**: 940-6, 8 p following 6.
22. Kling JR, Liebman JB, Katz LF. Experimental Analysis of Neighborhood Effects. *Econometrica* 2007; **75**: 83-119.

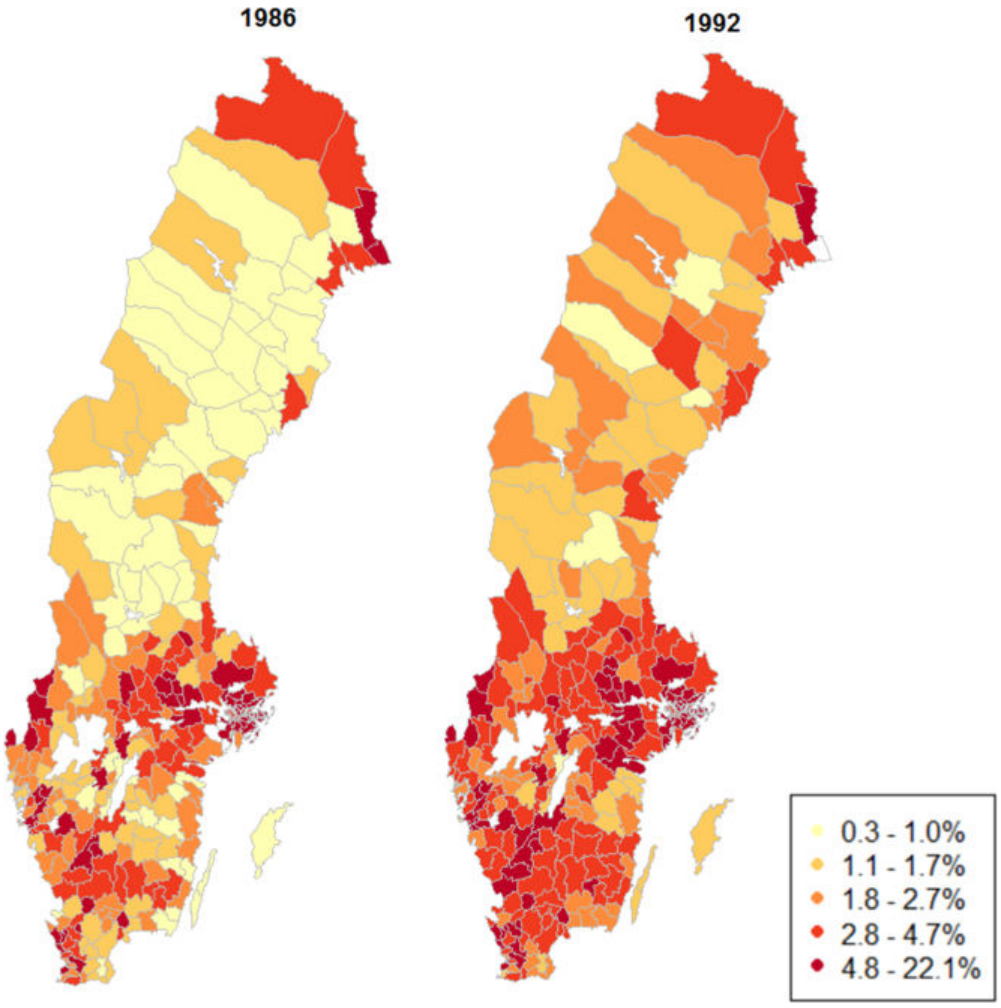
23. Kessler RC, Duncan GJ, Gennetian LA, et al. Associations of housing mobility interventions for children in high-poverty neighborhoods with subsequent mental disorders during adolescence. *JAMA* 2014; **311**: 937-48.
24. Sanbonmatsu L, Marvakov J, Potter PA, et al. The long-term effects of moving to opportunity on adult health and economic self-sufficiency. *Cityscape: A Journal of Policy Development and Research* 2012; **14**: 109-36.
25. Nguyen QC, Rehkopf DH, Schmidt NM, Osypuk TL. Heterogeneous Effects of Housing Vouchers on the Mental Health of US Adolescents. *Am J Public Health* 2016; **106**: 755-62.
26. Fenelon A, Mayne P, Simon AE, et al. Housing Assistance Programs and Adult Health in the United States. *Am J Public Health* 2017; **107**: 571-8.
27. Casciano R, Massey DS. Neighborhood disorder and anxiety symptoms: new evidence from a quasi-experimental study. *Health Place* 2012; **18**: 180-90.
28. White J, Greene G, Farewell D, et al. Improving Mental Health Through the Regeneration of Deprived Neighborhoods: A Natural Experiment. *Am J Epidemiol* 2017; **186**: 473-80.
29. Ludvigsson JF, Andersson E, Ekbom A, et al. External review and validation of the Swedish national inpatient register. *BMC Public Health* 2011; **11**: 450.
30. Ragnarson Tennvall G, Apelqvist J, Eneroth M. The inpatient care of patients with diabetes mellitus and foot ulcers. A validation study of the correspondence between medical records and the Swedish Inpatient Registry with the consequences for cost estimations. *Journal of Internal Medicine* 2000; **248**: 397--405.
31. Rawshani A, Landin-Olsson M, Svensson A-M, et al. The incidence of diabetes among 0–34 year olds in Sweden: new data and better methods. *Diabetologia* 2014; **57**: 1375-81.
32. Carlsson AC, Wändell P, Ösby U, Zarrinkoub R, Wettermark B, Ljunggren G. High prevalence of diagnosis of diabetes, depression, anxiety, hypertension, asthma and COPD in the total population of Stockholm, Sweden – a challenge for public health. *BMC Public Health* 2013; **13**: 670.
33. Solberg LI, Engebretson KI, Sperl-Hillen JM, Hroscikoski MC, O'Connor PJ. Are claims data accurate enough to identify patients for performance measures or quality improvement? The case of diabetes, heart disease, and depression. *Am J Med Qual* 2006; **21**: 238-45.
34. Fiest KM, Jette N, Quan H, et al. Systematic review and assessment of validated case definitions for depression in administrative data. *BMC Psychiatry* 2014; **14**: 289.
35. *Statistics*. Swedish Migration Board [cited October 01, 2018]; Available from: https://www.migrationsverket.se/English/About-the-Migration-Agency/Statistics.html
36. *What is a refugee?* [cited October 18, 2018]; Available from: http://www.unhcr.org/
37. Edin P-A, Fredriksson P, Åslund O. Settlement policies and the economic success of immigrants. *Journal of Population Economics* 2004; **17**: 133-55.
38. Edin P-A, Fredriksson P, Åslund O. Ethnic Enclaves and the Economic Success of Immigrants: Evidence from a Natural Experiment. *The Quarterly Journal of Economics* 2003; **118**: 329–57.
39. Rooth D. *Refugee immigrants in Sweden*: Lund University; 1999.
40. Åslund O, Edin P-A, Fredriksson P, Grönqvist H. Peers, Neighborhoods, and Immigrant Student Achievement: Evidence from a Placement Policy. *American Economic Journal: Applied Economics* 2011; **3**: 67–95.

41. White JS, Hamad R, Li X, et al. Long-term effects of neighbourhood deprivation on diabetes risk: quasi-experimental evidence from a refugee dispersal policy in Sweden. *The Lancet Diabetes & Endocrinology* 2016; **4**: 517-24.
42. Hamad R, Modrek S, Kubo J, Goldstein BA, Cullen MR. Using "big data" to capture overall health status: properties and predictive value of a claims-based health risk score. *PLoS One* 2015; **10**: e0126054.
43. Scherrer JF, Virgo KS, Zeringue A, et al. Depression increases risk of incident myocardial infarction among Veterans Administration patients with rheumatoid arthritis. *Gen Hosp Psychiatry* 2009; **31**: 353-9.
44. Crump C, Sundquist K, Sundquist J, Winkleby MA. Neighborhood deprivation and psychiatric medication prescription: a Swedish national multilevel study. *Ann Epidemiol* 2011; **21**: 231-7.
45. 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* 2007; **64**: 21-34.
46. Sundquist K, Ahlen H. Neighbourhood income and mental health: A multilevel follow-up study of psychiatric hospital admissions among 4.5 million women and men. *Health & Place* 2006; **12**: 594-602.
47. Mezuk B, Chaikiat A, Li X, Sundquist J, Kendler KS, Sundquist K. Depression, neighborhood deprivation and risk of type 2 diabetes. *Health Place* 2013; **23**: 63-9.
48. Fazel M, Wheeler J, Danesh J. Prevalence of serious mental disorder in 7000 refugees resettled in western countries: a systematic review. *Lancet* 2005; **365**: 1309-14.
49. Leventhal T, Dupere V. Moving to Opportunity: does long-term exposure to 'low-poverty' neighborhoods make a difference for adolescents? *Soc Sci Med* 2011; **73**: 737-43.
50. Osypuk TL, Tchetgen EJT, Acevedo-Garcia D, et al. Differential Mental Health Effects of Neighborhood Relocation Among Youth in Vulnerable Families. *Archives of General Psychiatry* 2012; **69**: 1284.
51. Crawley H, Skleparis D. Refugees, migrants, neither, both: categorical fetishism and the politics of bounding in Europe's 'migration crisis'. *Journal of Ethnic and Migration Studies* 2017; **44**: 48-64.
52. 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* 2011; **17**: 132-9.
53. Åslund O, Fredriksson P. Peer Effects in Welfare Dependence: Quasi-Experimental Evidence. *The Journal of Human Resources* 2009; **44**: 798-825.
54. Cohen-Cline H, Beresford SAA, Barrington WE, Matsueda RL, Wakefield J, Duncan GE. Associations between neighbourhood characteristics and depression: a twin study. *J Epidemiol Community Health* 2018; **72**: 202-7.
55. Strachan E, Duncan G, Horn E, Turkheimer E. Neighborhood deprivation and depression in adult twins: genetics and genexenvironment interaction. *Psychol Med* 2017; **47**: 627-38.
56. Oakes JM. The (mis)estimation of neighborhood effects: causal inference for a practicable social epidemiology. *Soc Sci Med* 2004; **58**: 1929-52.
57. Hedström J. Residential Mobility and Ethnic Segregation in Stockholm. 2015.

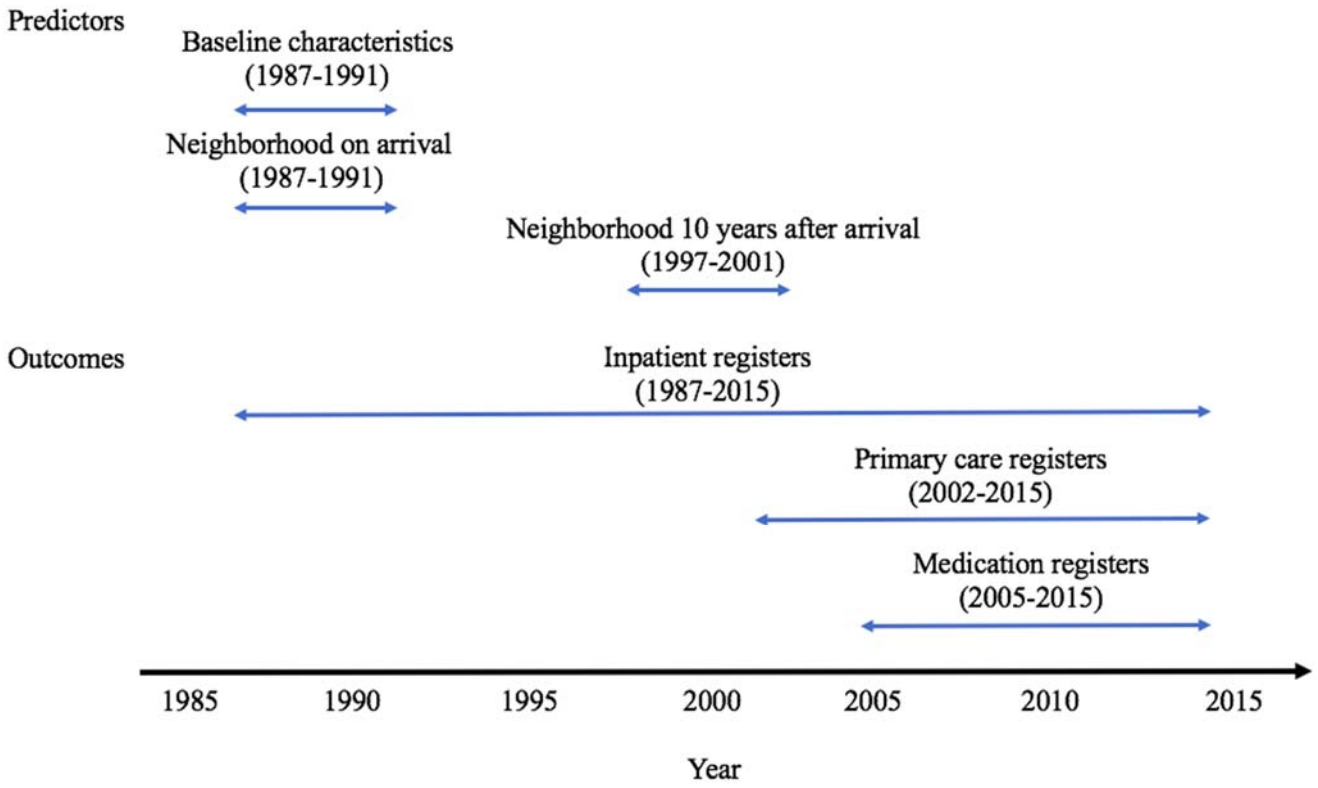
58. Gary TL, Stark SA, LaVeist TA. Neighborhood characteristics and mental health among African Americans and whites living in a racially integrated urban community. *Health Place* 2007; **13**: 569-75.
59. Jarrin I, Garcia-Fulgueiras A, Ibanez-Rojo V, et al. Absence of protective ethnic density effect on Ecuadorian migrants' mental health in a recent migration setting: a multilevel analysis. *Soc Psychiatry Psychiatr Epidemiol* 2013; **48**: 95-103.
60. Lee MA. Neighborhood residential segregation and mental health: a multilevel analysis on Hispanic Americans in Chicago. *Soc Sci Med* 2009; **68**: 1975-84.
61. Bauldry S, Szaflarski M. Immigrant-based Disparities in Mental Health Care Utilization. *Socius* 2017; **3**.
62. Erdal K, Singh N, Tardif A. Attitudes about depression and its treatment among mental health professionals, lay persons and immigrants and refugees in Norway. *J Affect Disord* 2011; **133**: 481-8.



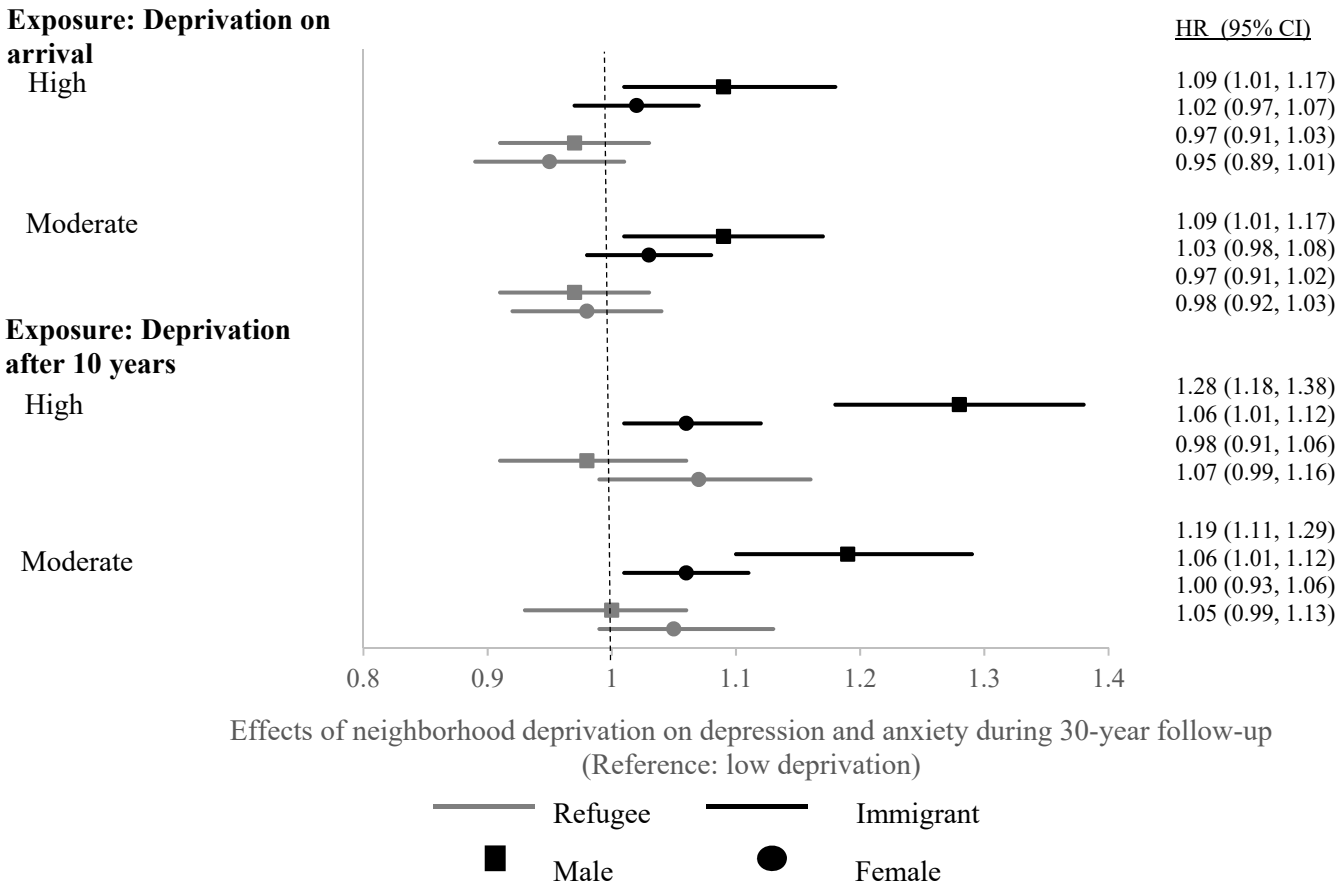
eFigure 1. Conceptual diagram linking neighborhood deprivation and mental health among refugees and non-refugee immigrants



eFigure 2. Percent immigrants by municipality in the year before and after the dispersal policy was strictly implemented
Note: Data from Statistics Sweden. Municipalities were classified into quintiles at baseline in order to create categories. Reproduced with permission from White et al., *Lancet D&E* 2016.



eFigure 3. Timeline of availability of study variables



eFigure 4. Association of neighborhood deprivation with poor mental health by gender during 30-year follow-up

Refugees on arrival: men n=30,177 and women n=17,879; after 10 years: men n=19,729 and women n=12,020

Non-refugee immigrants on arrival: men n=46,615 and women n=50,639; after 10 years: men n=20,922 and women n=30,671

Note: Analyses involved Cox proportional hazards models, adjusting for characteristics listed in eTable 1, year of arrival to account for secular trends, and fixed effects for initial municipality. Models incorporated shared frailty at the municipality level to account for correlated observations within families and municipalities.

eTable 1. Sample characteristics of refugees and non-refugee immigrants arriving to Sweden during 1987-1991, by level of neighborhood deprivation upon arrival

	Level of neighborhood deprivation (%)					
	Refugees (n=48,056)			Non-refugee immigrants (n=97,254)		
	Low deprivation n=15,999	Moderate deprivation n=16,048	High deprivation n=16,009	Low deprivation n=32,417	Moderate deprivation n=32,420	High deprivation n=32,417
Age (years)						
18-24	25.1	24.0	23.9	30.6	32.4	33.4
25-29	25.7	26.9	26.2	24.6	24.4	22.5
30-34	19.6	21.4	20.5	16.0	14.5	13.3
35-39	13.6	13.1	12.8	9.3	8.8	8.0
40-44	7.0	6.4	6.6	6.1	5.7	5.3
45-49	3.6	3.3	3.6	3.5	3.8	3.7
50-54	2.1	2.0	2.3	2.6	2.4	2.9
55+	3.4	2.8	4.1	7.4	8.0	10.9
Male	62.6	63.2	62.6	47.6	49.0	47.2
Educational attainment						
≤ 9 years	24.4	26.8	27.4	14.8	20.2	23.9
10–12 years	20.9	22.5	21.2	13.1	16.6	16.5
> 12 years	52.0	48.3	47.8	42.7	36.2	33.2
Unknown	2.8	2.3	3.6	29.4	26.9	26.5
Married/cohabiting	60.9	61.7	61.3	48.2	50.0	57.6
Family size						
No children	21.2	18.4	19.7	48.4	46.9	43.6
One child	12.9	11.6	12.5	15.0	15.3	15.0
Two children	27.3	28.0	27.6	22.4	21.4	21.4
Three children	18.4	19.9	18.7	9.6	10.1	11.6
Four or more children	20.2	22.2	21.5	4.6	6.4	8.4
Region of residence						
Large cities	50.2	31.3	45.1	72.6	55.0	62.0
Southern Sweden	30.6	46.9	41.8	18.1	31.6	27.3
Northern Sweden	19.2	21.7	13.1	9.3	13.4	10.7
Year of arrival						
1987	15.8	14.2	16.9	16.6	13.4	15.7
1988	19.9	18.4	18.2	18.8	17.5	17.6
1989	25.5	27.4	26.1	22.8	25.8	24.0
1990	18.5	21.5	16.7	23.9	25.5	24.4
1991	20.3	18.5	22.1	17.8	17.8	18.3
Country/region of origin						
Iran	25.5	27.5	26.9	4.3	6.5	9.4
Latin America	13.1	12.7	10.7	4.1	5.0	4.8
Eastern Europe	13.5	12.3	12.7	12.2	14.0	17.2
Middle East / North Africa	23.1	26.2	30.2	7.0	8.9	15.3
Asia	6.0	5.6	5.8	7.8	7.0	6.8

Sub-Saharan Africa	15.0	13.1	11.4	2.1	2.6	3.2
Other	3.6	2.7	2.3	62.4	56.1	43.3
Diagnosis with anxiety/depression	38.3	39.1	38.9	17.6	19.9	22.6

Note: Data set was created using Swedish registers. Depression and anxiety diagnoses were based on inpatient, outpatient, and primary care registers (ICD-10 codes F30-F48 and F93) and medication registers (Anatomical Therapeutic Chemical code N06A). The neighborhood deprivation index was created by applying principal components analysis to the following variables in residents 25-64 years old: 1) percent low education (<10 years of formal schooling), 2) percent low income (<50% of individual median income from all sources), 3) unemployment rate (excluding full-time students, military, and retirees), and 4) percent receiving social welfare.

eTable 2. Moving from neighborhood of arrival, by immigration status

	Refugees (N=31,749)		Non-refugee immigrants (N=51,593)	
	Total	%	Total	%
Not moved	14,392	45.3	28,261	54.8
Moved	17,357	54.7	23,332	45.2
Moved from high to lower deprivation neighborhood	1,134	3.6	4,098	7.9

Note: Data set was created using Swedish registers. This table includes those who remained in Sweden 10 years after arrival.

eTable 3. Association of neighborhood deprivation with poor mental health by gender during 30-year follow-up, adjusting for neighborhood-level percent immigrants

	Refugees	Non-refugee immigrants
	HR (95% CI)	HR (95% CI)
Exposure: Deprivation on arrival (ref: Low)		
High	0.96 (0.91, 1.02)	1.10 (1.04, 1.16)
Moderate	0.98 (0.94, 1.02)	1.06 (1.02, 1.10)
Percent immigrants	1.00 (1.00, 1.00)	1.00 (0.99, 1.00)
Exposure: Deprivation after 10 years (ref: Low)		
High	1.02 (0.94, 1.12)	1.14 (1.07, 1.21)
Moderate	1.03 (0.97, 1.08)	1.11 (1.06, 1.15)
Percent immigrants	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)

Note: Analyses involved Cox proportional hazards models, adjusting for characteristics listed in eTable 1, year of arrival to account for secular trends, fixed effects for initial municipality, as well as the percent of immigrants in each neighborhood. Models incorporated shared frailty at the municipality level to account for correlated observations within families and municipalities.