Supplemental Information

METHODS

Standardized Mean Differences

Standardized mean differences (SMD) between characteristics of refugee women at resettlement and tertile of neighborhood socioeconomic disadvantage in the assigned neighborhood was calculated to provide balancing tests for the assumption of quasirandom neighborhood assignment. SMD is the difference in the mean or proportion of each covariate between exposure groups standardized by a standardization factor, resulting in uniform scaling for all covariates.[68] Balance tests based on SMDs have the advantage of being independent of sample size. SMDs close to 0 indicate good balance, with a recommended threshold of 0.1 for signs of imbalance.[69,70] We calculated SMDs both for characteristics observed by the placement officers (age, marital status, number of children, and country of origin) as well as educational level, which was unknown to placement officers.

Linear Probability Models

We used linear probability models (OLS models with a binary dependent variable) rather than logistic models because of difficulties in model convergence when a large number of covariates (ie, municipality-level fixed effects) were included in secondary analyses. Linear regressions with dichotomous outcomes have been shown to produce reliable results, especially when samples are large, like ours, and have the advantage of providing effect estimates with an intuitive interpretation.[71,72]

Secondary Analysis

We examined the association in the subsample of refugee women ($N = 6381$) with an extended exposure to the quasirandomly assigned neighborhood from resettlement to the time of birth. When limiting the analytical sample to women who still lived in the assigned neighborhood at the time of birth, we lose the advantage of the quasiexperiment because whether refugees stay or move can be expected to be influenced by individual characteristics. However, the analysis gives insight into how the association between neighborhood disadvantage and birth outcomes changes with longer follow-up in a sample with constant exposure levels.

We conducted an additional sensitivity analysis excluding refugees from former Yugoslavia ($N = 12\,889$). Yugoslavs were, in most cases, granted provisional asylum for up to 2 years, during which they were accommodated in special refugee centers across the country; thereafter, they were covered by a policy permitting placement in more rural parts of the country.[73] These special regulations may have had different policy effects.

Finally, we examined the association between neighborhood disadvantage and birth outcomes in the population of refugee women who were younger than 18 years at the time of resettlement. From the initial 14 674 female refugees arriving as children or adolescents, an analytical sample of 10 959 was reached after excluding children and adolescents unaccompanied by at least 1 parent ($n = 2675$), those who immigrated more than 1 year after their parent(s), as they may not have been included under the dispersal policy ($n = 420$), births less than 9 months after resettlement ($n = 49$), nonsingleton births ($n = 404$), and births with missing outcome data ($n = 167$). In analyses of birth outcomes in this sample, we had to consider that the information placement officers had available to find housing referred to the parent(s) of the girls at the time. Therefore, we adjust for the primary parent's age, marital status, and number of children at the time of resettlement in the linear probability models.

RESULTS

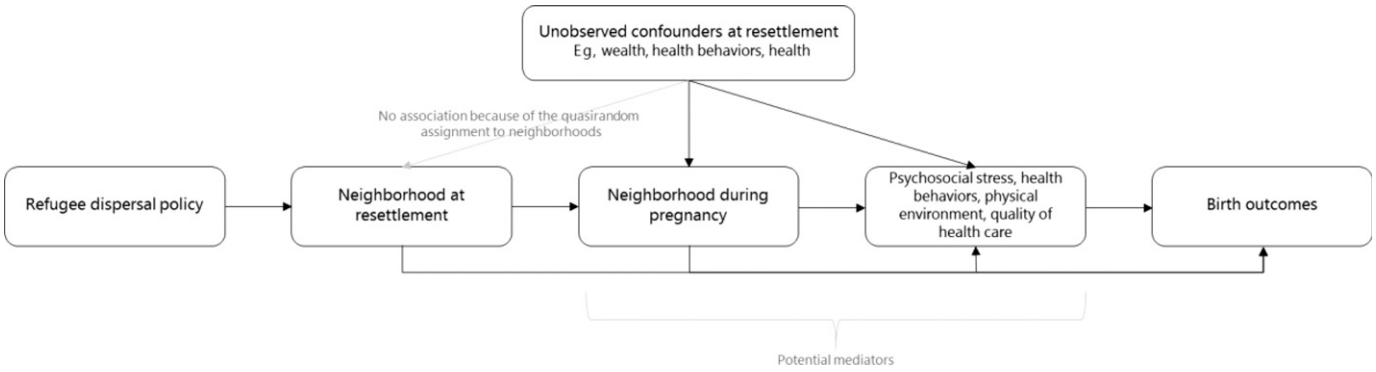
Secondary Analysis

Greater neighborhood disadvantage was associated, with an increased risk of adverse birth outcomes in analyses that restricted the sample to refugee women who lived in the same neighborhood at the time of resettlement and birth (Supplemental Table 7). For the full 20-year follow-up period, each SD increase in neighborhood disadvantage at resettlement was associated with a 0.64 pp increase (95% CI: 0.18 to 1.09) in LBW, and a 0.63 pp increase (95% CI: 0.14 to 1.12) in PTB. Thus, effect estimates were similar, though larger in magnitude than in the main analysis, but importantly, also more likely to be contaminated by confounding because of residential selection. For SGA, the association was only significant with a 5-year follow-up period (1.10 pp, 95% CI: 0.05 to 2.15). Across all 3 outcomes, effect estimates decreased with longer follow-up periods, similar to the main results.

After excluding refugees from former Yugoslavia, estimates were similar but less precise (Supplemental Table 8) compared with the main results. For the full 20-year follow-up period, each SD increase in neighborhood disadvantage at resettlement was associated with a 0.33 pp increase (95% CI: 0.02 to 0.64) in LBW, a 0.34 pp increase (95% CI: −0.01 to 0.68) in PTB, and a 0.72 pp increase (95% CI: 0.16 to 1.27) in SGA.

Greater neighborhood socioeconomic disadvantage was associated with a higher risk of SGA (0.81 pp, 95% CI: 0.16 to 1.45) among refugee women who were younger than 18 years at the time of resettlement; however, confidence

intervals included the null for associations with LBW and PTB (Supplemental Table 9). Half of the birth outcomes in this sample happened between 17 and 32 years after resettlement, and there was a weak correlation of 0.20 between the neighborhood disadvantage index at the time of resettlement and the time of birth. The long period between exposure and outcome, combined with the smaller sample size, may mean that these analyses were underpowered.



SUPPLEMENTAL FIGURE 3
Conceptual diagram linking neighborhood disadvantage and birth outcomes among women arriving as refugees in Denmark during 1986 to 1998.

SUPPLEMENTAL TABLE 4 Socioeconomic Variables Included in the Neighborhood Disadvantage Index

Variables	Description
Income	Median equivalized disposable family income
Education	Percent of inhabitants aged 25 to 69 years with low educational attainment (<10 years of formal schooling)
Unemployment	Percent of inhabitants aged 18 to 59 years in the labor force who had been unemployed for more than 6 months
Welfare assistance	Percent of families receiving welfare benefits because of unemployment, sickness, or parental leave[a]

Data sources: National administrative registers maintained by the Danish Census Bureau and the Danish Medical Birth Register.
[a]Information on sickness benefits and parental leave benefits were reported jointly in the administrative registers. Therefore, both were included in this analysis, even though parental leave is less of a marker of neighborhood disadvantage relative to other welfare benefits.

SUPPLEMENTAL TABLE 5 Standardized Mean Differences for Characteristics of Women Arriving as Refugees in Denmark During 1986 to 1998 by Tertile of Neighborhood Socioeconomic Disadvantage at Resettlement, $N = 15\,118$

	Percentage by Neighborhood Disadvantage			Standardized Differences		
Characteristics at Resettlement	**Low**	**Moderate**	**High**	**Low Versus Moderate**	**Low Versus High**	**Moderate Versus High**
Education						
Basic	33.1	35.8	35.5	0.06	0.05	0.01
Upper secondary or vocational	37.9	38.7	38.7	0.01	0.02	0.00
Higher	15.5	14.6	14.6	0.03	0.03	0.00
Unknown	13.5	10.9	11.2	0.08	0.07	0.01
Age in years, mean (SD)	25.1 (4.6)	25.4 (4.7)	25.0 (4.5)	0.06	0.02	0.08
Not married	30.2	28.5	29.8	0.04	0.01	0.03
Number of children						
0	47.2	48.3	49.4	0.02	0.04	0.02
1	21.1	21.9	20.5	0.02	0.02	0.03
2	14.8	15.1	14.1	0.01	0.02	0.03
3	8.6	6.3	8.0	0.09	0.02	0.06
≥4	8.2	8.3	8.1	0.00	0.01	0.01
Country of origin						
Afghanistan	2.0	2.2	1.8	0.01	0.02	0.03
Former Yugoslavia	12.1	17.4	15.2	0.15	0.09	0.06
Iran	7.4	6.3	3.9	0.04	0.15	0.11
Iraq	11.4	10.3	12.4	0.04	0.03	0.07
Lebanon (Palestinians)	24.0	20.3	17.9	0.09	0.15	0.06
Somalia	30.2	28.6	36.0	0.04	0.12	0.16
Sri Lanka	7.5	8.7	4.2	0.04	0.14	0.19
Vietnam	5.4	6.2	8.7	0.04	0.13	0.09

Study sample: Women arriving as refugees in Denmark during 1986 to 1998 who gave birth to liveborn singletons with a gestational age of 20 to 44 wk at least 9 mo after resettlement. Data sources: National administrative registers maintained by the Danish Census Bureau and the Danish Medical Birth Register.

SUPPLEMENTAL TABLE 6 Association Between Neighborhood Socioeconomic Disadvantage Level and Adverse Birth Outcomes After Adjusting for Population Density and Conational Density

	Low Birth Weight		Preterm Birth		Small-for-Gestational-Age	
	Coef.	(95% CI)	Coef.	(95% CI)	Coef.	(95% CI)
Including Population Density as Covariate						
5-y follow-up, $N = 7947$						
Neighborhood disadvantage	0.62**	(0.20 to 1.04)	0.64**	(0.20 to 1.07)	0.71	(−0.07 to 1.48)
Population density[a]	−0.19	(−1.01 to 0.63)	0.06	(−0.90 to 1.01)	0.81	(−0.72 to 2.35)
10-y follow-up, $N = 12\,508$						
Neighborhood disadvantage	0.41*	(0.09 to 0.73)	0.39*	(0.04 to 0.74)	0.69*	(0.11 to 1.26)
Population density[a]	−0.09	(−0.74 to 0.55)	0.14	(−0.65 to 0.93)	0.34	(−0.79 to 1.47)
20-y follow-up, $N = 15\,118$						
Neighborhood disadvantage	0.38*	(0.08 to 0.68)	0.33	(−0.01 to 0.66)	0.75*v	(0.22 to 1.27)
Population density[a]	0.05	(−0.55 to 0.65)	0.25	(−0.49 to 0.99)	0.04	(−0.96 to 1.04)
Including Conational Density as Covariate						
5-y follow-up $N = 7947$						
Neighborhood disadvantage	0.62**	(0.18 to 1.05)	0.79**	(0.32 to 1.26)	0.91*	(0.08 to 1.74)
Conational density[b]	−0.02	(−0.27 to 0.24)	−0.21	(−0.45 to 0.03)	−0.19	(−0.67 to 0.29)
10-y follow-up, $N = 12\,508$						
Neighborhood disadvantage	0.43*	(0.10 to 0.76)	0.53**	(0.16 to 0.90)	0.82**	(0.20 to 1.44)
Conational density[b]	−0.04	(−0.23 to 0.14)	−0.18	(−0.38 to 0.02)	−0.16	(−0.52 to 0.21)
20-y follow-up, $N = 15\,118$						
Neighborhood disadvantage	0.41*v	(0.10 to 0.72)	0.42*	(0.07 to 0.77)	0.80**	(0.24 to 1.36)
Conational density[b]	−0.04	(−0.21 to 0.13)	−0.11	(−0.29 to 0.08)	−0.07	(−0.39 to 0.24)

Estimates from linear probability models adjusted for characteristics of the mother at the time of resettlement (age, marital status, number of children, country of origin) and year of resettlement, with robust standard errors. Coefficients representing percentage point difference in risk per 1 SD of the disadvantage index, with 95% CIs in parentheses. * $P < .05$, ** $P < .01$.

[a] 10 000 residents per square kilometer of land in the neighborhood.

[b] Proportion of residents from the same country of origin in the neighborhood at the time of resettlement.

SUPPLEMENTAL TABLE 7 Association Between Neighborhood Socioeconomic Disadvantage Level and Adverse Birth Outcomes in Subsample Who Lived in the Same Neighborhood at Resettlement and Birth

	Low Birth Weight		Preterm Birth		Small-for-Gestational-Age	
Neighborhood Disadvantage	Coef.	95% CI	Coef.	95% CI	Coef.	95% CI
5-y follow-up ($N = 4407$)	0.91**	(0.36 to 1.46)	0.77**	(0.20 to 1.34)	1.10*	(0.05 to 2.15)
10-y follow-up ($N = 5834$)	0.61**	(0.15 to 1.06)	0.57*	(0.08 to 1.07)	0.68	(−0.19 to 1.55)
20-y follow-up ($N = 6381$)	0.64**	(0.18 to 1.09)	0.63*	(0.14 to 1.12)	0.72	(−0.12 to 1.56)

Estimates from linear probability models adjusted for characteristics of the mother at the time of resettlement (age, marital status, number of children, country of origin) and year of resettlement, with robust standard errors. Coefficients representing percentage point difference in risk per 1 SD of the disadvantage index, with 95% CIs in parentheses. * $P < .05$, ** $P < .01$.

SUPPLEMENTAL TABLE 8 Association Between Neighborhood Socioeconomic Disadvantage Level and Adverse Birth Outcomes After Excluding Refugees From Former Yugoslavia

	Low Birth Weight		Preterm Birth		Small-for-Gestational-Age	
Neighborhood Disadvantage	**Coef.**	**(95% CI)**	**Coef.**	**(95% CI)**	**Coef.**	**(95% CI)**
5-y follow-up ($N = 6770$)	0.51*	(0.08 to 0.94)	0.55*	(0.11 to 0.99)	0.68	(−0.14 to 1.50)
10-y follow-up ($N = 10\,662$)	0.32	(−0.01 to 0.65)	0.36	(−0.00 to 0.72)	0.68*	(0.07 to 1.28)
20-y follow-up ($N = 12\,889$)	0.33*	(0.02 to 0.64)	0.34	(−0.01 to 0.68)	0.72*	(0.16 to 1.27)

Estimates from linear probability models adjusted for characteristics of the mother at the time of resettlement (age, marital status, number of children, country of origin) and year of resettlement, with robust standard errors. Coefficients representing percentage point difference in risk per 1 SD of the disadvantage index, with 95% CIs in parentheses.
* $P < .05$.

SUPPLEMENTAL TABLE 9 Association Between Neighborhood Socioeconomic Disadvantage Level and Adverse Birth Outcomes Among Refugee Women Who Were Younger Than 18 Years at the Time of Resettlement, $N = 10\,959$

	Low Birth Weight		Preterm Birth		Small-for-Gestational-Age	
Neighborhood Disadvantage	**Coef.**	**(95% CI)**	**Coef.**	**(95% CI)**	**Coef.**	**(95% CI)**
Index, continuous	0.30	(−0.04 to 0.64)	−0.09	(−0.49 to 0.31)	0.81*	(0.16 to 1.45)
Index, in tertiles						
Low	Ref.		Ref.		Ref.	
Moderate	0.34	(−0.60 to 1.28)	0.08	(−0.97 to 1.13)	1.13	(−0.43 to 2.68)
High	0.16	(−0.73 to 1.06)	−0.13	(−1.14 to 0.88)	1.74*	(0.23 to 3.26)

Estimates from linear probability models adjusted for characteristics of the primary parent of the mother at the time of resettlement (age, marital status, number of children, country of origin) and year of resettlement, with robust standard errors. Coefficients representing percentage point difference in risk per 1 SD of the disadvantage index, with 95% CIs in parentheses.
* $P < .05$.