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Neighborhood Deprivation and Adherence to Initial Diabetic Retinopathy Screening

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Abstract

Residence within a disadvantaged US neighborhood was significantly associated with adherence to initial diabetic retinopathy screening. Composite measures of community-level socioeconomic status have the potential to be utilized to inform patient-specific care and policy interventions.

Precis

Residence within the 30% most disadvantaged neighborhoods in the United States is independently associated with significantly decreased adherence to referral for diabetic retinopathy evaluation compared with the remainder of the population in this single-institution study.

Annual diabetic retinopathy screening is an essential and cost-effective strategy to prevent vision loss.[1] However, over 1/3 of patients with diabetes in the US do not receive annual dilated eye examinations.[2] While individual-level socioeconomic factors such as insurance status and education level have been associated with adherence to diabetic retinopathy examinations, the impact of neighborhood-level deprivation has not previously been studied.[2] Therefore, we aimed to determine if a composite measure of neighborhood deprivation was associated with adherence to first-time ophthalmology referral for diabetic retinopathy evaluation.

This retrospective, single-institution analysis was conducted in compliance with the tenets of the Declaration of Helsinki and with approval from the institutional review board of Yale University. The Yale-New Haven Health System electronic medical record was queried for patients 18-years or older with diabetes who received a first-time referral for diabetic retinopathy evaluation in the primary care setting from 2013–2017.

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This study utilized the Area Deprivation Index (ADI), a metric of neighborhood-level deprivation derived from 17 sociodemographic US Census metrics.[3] To obtain national-level ADI percentiles, patient addresses were geocoded to obtain 12-digit Federal Information Processing System codes, the geographical unit by which ADI values are assigned. The cohort was divided into quintiles based on ADI national percentiles: Quintile 1 comprised of patients with national ADI percentiles from 1–20% (least disadvantaged), Quintile 2 comprised 21–40% and so on. The dependent variable of this study, adherence to referral for diabetic retinopathy evaluation, was determined by evidence of a dilated fundus examination received within 12 months of first-time referral or an indicator in a patient's chart that the exam was or was not received.

In preliminary data analysis, the two most disadvantaged quintiles (Quintiles 4 and 5) demonstrated the lowest likelihood of adherence. Therefore, in secondary analysis, individuals residing in the 40% most disadvantaged neighborhoods, stratified by decile, were compared to the remaining cohort residing in the least disadvantaged 60% of neighborhoods to identify a potential ADI cutoff above which disadvantaged status was significantly associated with screening non-adherence.

All statistical analyses were conducted in R 3.6.0 (R foundation for Statistical Computing). A 2-sided p-value <0.05 was considered statistically significant.

Of 1,397 patients included, 727 (52.0%) received a dilated eye exam as referred, 797 (57.1%) were female, 580 (41.5%) were Black or African American and 642 (46.0%) were insured with Medicaid (Table S1, available at www.aaojournal.org). More disadvantaged quintiles consisted of greater proportions of Black or African American and uninsured patients (Figure S1, available at www.aaojournal.org).

Table 1 shows primary unadjusted bivariate and multivariate analyses. Adjustment for individual factors with $P<0.2$ on univariate analysis (age, insurance and race) significantly attenuated the association between ADI and adherence when comparing the most disadvantaged and least disadvantaged quintile (OR, 1.39; 95% CI, 0.82–2.37, P=0.216) although significance remained when comparing the most disadvantaged quintile to Quintile 3 (OR, 1.80; 95% CI, 1.25–2.61, P=0.0016) and Quintile 2 (OR, 1.55; 95% CI, 1.05–2.31, P=0.028).

In secondary analysis, when comparing the four most disadvantaged ADI deciles individually to the least disadvantaged 60% of neighborhoods, residence within each of the three most disadvantaged deciles was associated with an increased risk of non-adherence to diabetic retinopathy screening (Table S2, available at www.aaojournal.org). When these three deciles were combined into a single group, residence within the 30% most disadvantaged neighborhoods significantly increased risk of non-adherence compared with the remaining cohort (OR, 0.56; 95% CI, 0.42–0.72, P=0.0033).

This study demonstrates that residence in more disadvantaged neighborhoods, as measured by ADI, is independently associated with non-adherence to first-time ophthalmology referrals for diabetic retinopathy screening after controlling for known individual-level predictors of adherence to annual dilated eye examinations. Furthermore, a threshold effect was observed whereby adverse effects of ADI on screening adherence arose once a threshold level of neighborhood disadvantage was reached, which has been previously reported in the association between ADI and rehospitalization rates.[4] While research has shown the impact of neighborhood deprivation status on health outcomes,[4] previous studies have not associated a US-population derived metric with diabetic retinopathy screening adherence.

The association between ADI and diabetic eye screening adherence is likely multifactorial in nature. First, more disadvantaged neighborhoods may lack proximity to ophthalmology clinics and have limited means of transportation, as has previously been described in the context of mammography adherence.[5] Second, perceived neighborhood quality in disadvantaged communities may be a barrier to diabetic eye screening adherence. Social disorganization and crime prevalence have been previously associated with cancer screening adherence.[6] Third, more disadvantaged neighborhoods, which have demonstrated lower diabetes health literacy and prevalence of diabetes self-care practices,[7] may lack normative values that reinforce diabetic screening behaviors.

The potential of ADI in clinical care is broad. ADI is publicly available and requires only an address as input. Integration of ADI within electronic medical systems could direct provision of additional discussion about screening importance or resources. For example, travel vouchers, assistance in arranging transportation, telephone prompts or automated alerts in medical charts for screening reminders could be implemented in primary care settings for patients identified as being at high-risk of nonadherence. In a population-based approach, ADI could be used to target communities below cutoff ADI percentiles with interventions such as education initiatives or mobile clinics.

There are several limitations to this study. First, the use of a composite index precludes the analysis of specific socioeconomic components and their association with screening adherence. Second, this study cohort is comprised of patients within a single health system which could have specific institutional practices about diabetic retinopathy screening referrals. Third, this study does not include other individual factors typically associated with socioeconomic status or control for characteristics of the eye care referral source such as travel time to the eye clinic; features that should be evaluated in future studies.

In summary, ADI as a measure of neighborhood disadvantage demonstrates a strong association with non-adherence to ophthalmology referral for diabetic retinopathy after accounting for individual characteristics. If the relationship between ADI and adherence is demonstrated in broader populations in future work, predictive models of nonadherence can be developed with the goal of improving post-referral adherence rates.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1.

Univariate and multivariate regression analysis of Area of Deprivation Index quintiles and the association with adherence to first-time referral for diabetic retinopathy screening

	Univariate analysis Odds ratio (95% CI)	p-value	Multivariate analysis Odds ratio (95% CI)	p-value
ADI National Quintile				
Quintile 1	1.00		1.00	
Quintile 2	1.54 (1.07–2.22)	**0.019**	1.43 (0.98–2.08)	0.064
Quintile 3	1.91 (1.34–2.74)	**>0.001**	1.80 (1.25–2.61)	**0.0016**
Quintile 4	1.98 (1.36–2.89)	**>0.001**	1.55 (1.05–2.31)	**0.028**
Quintile 5	2.00 (1.23–3.31)	**0.0059**	1.39 (0.82–2.37)	0.216
Age	1.02 (1.01–1.02)	**>0.001**		**0.0037**
Gender				
Female	1.00			
Male	1.03 (0.84–1.28)	0.77		
Race				
Non-Hispanic White	1.00		1.00	
Asian or Pacific Islander	1.50 (0.68–3.84)	0.32	1.62 (0.70–4.12)	0.28
Black or African American	0.57 (0.42–0.78)	**>0.001**	0.61 (0.44–0.85)	**0.0039**
Hispanic or Latino	0.49 (0.36–0.68)	**>0.001**	0.52 (0.37–0.73)	**>0.001**
Other	0.60 (0.34–1.07)	0.08		0.36
Insurance Status				
Commercial	1.00		1.00	
Medicaid	0.59 (0.33–1.02)	**0.0022**	0.52 (0.34–0.80)	**0.0035**
Medicare	0.87 (0.49–1.54)	0.24	0.64 (0.40–1.03)	0.067
Medicare Managed Care	1.08 (0.58–1.97)	0.65	0.78 (0.45–1.33)	0.36
Self-pay	0.36 (0.18–0.69)	**>0.001**	0.34 (0.19–0.60)	**>0.001**
Other	0.32 (0.01–3.57)	0.58	0.53 (0.06–4.68)	0.54

ADI = Area Deprivation Index; CI = Confidence interval