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Social deprivation index and ischemic events after percutaneous coronary intervention in patients with diabetes mellitus

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Abstract

The aim of this study was to assess neighborhood-based differences in outcomes of diabetics versus non-diabetics undergoing percutaneous coronary interventions. Disparities in healthcare access impact long-term outcomes in safety net populations. Diabetes mellitus (DM) is associated with worse clinical outcomes in patients with coronary artery disease (CAD) and may disproportionately impact patients with CAD from underserved populations. We created a geocoded retrospective cohort of patients who underwent percutaneous coronary intervention (PCI) at an urban safety net hospital in this single-center cohort analysis. We evaluated long-term ischemic events in diabetics versus nondiabetics through review of electronic medical records. Social deprivation index (SDI) was calculated based on US-census tract level and stratified according to quintiles. Among 1002 patients, 46% ($n = 463$) were diabetic and among those 48% ($n = 222$) were in the highest quintile of SDI. Baseline and angiographic characteristics were similar among diabetic and nondiabetic subjects. Among diabetic patients, those in the highest SDI quintile had significantly higher risk of cardiovascular death and myocardial infarction as compared to those in the remaining quintiles (log rank: $p = 0.029$) (adjusted hazard's ratio: 1.72 [95% CI: 1.01–2.92], $p = 0.04$). There was no association of the SDI with outcomes in nondiabetic patients (log rank: $p = 0.39$). In an underserved population, patients with diabetes and high SDI demonstrate higher rates of adverse ischemic events and cardiovascular death during long-term follow up after PCI. Further research examining the impact of disparities in healthcare access on outcomes after PCI in patients with diabetes is warranted.

KEYWORDS

coronary artery disease, diabetes mellitus, percutaneous coronary intervention

1 | INTRODUCTION

Disparities in healthcare access and cardiovascular care can impact long-term outcomes in safety net populations.[1] The American College of Cardiology and the Henry J. Kaiser Family Foundation have extensively reviewed this topic,[2] which has served as a catalyst for federal and state responses to these disparities, including the Marion county healthcare system Eskenazi Health serving the population of central Indiana.[3] The reasons behind disparities and the incidence and prevalence of cardiovascular disease remain a heavily discussed topic. There is increasing evidence that social determinants of health, including neighborhood and environment, can contribute to disparities and cardiovascular outcomes, particularly in African Americans.[4] Additionally, early evidence suggests that neighborhood socioeconomic status may serve as a predictive model for heart failure admissions[5,6] and in readmissions for patients following percutaneous coronary intervention (PCI).[7] Uncertainties remain in determining the extent to which neighborhood healthcare disparities are causally linked to increased morbidity and mortality in patients with coronary artery disease (CAD).

Diabetes mellitus (DM) is associated with worse clinical outcomes in patients with CAD, particularly in patients requiring PCI. Because DM may disproportionately impact patients with CAD from underserved populations, we decided to examine long-term event rates after PCI in an urban safety net hospital system stratified according to social deprivation index (SDI) status and DM.

2 | METHODS

2.1 | Study population

In this single-center retrospective cohort analysis, we identified patients who underwent successful PCI at Eskenazi Health, an urban safety net hospital, and evaluated survival and ischemic events through review of electronic medical records and coronary angiograms. Successful PCI was defined as PCI of at least 1 significant lesion without death or need for coronary artery bypass grafting (CABG) during the index PCI. Patients were then stratified according to the presence or absence of diabetes based on baseline history. All patient baseline characteristics, number of diseased vessels, and vessels that were intervened upon are reported for patients with and without diabetes. The study was approved by the Indiana University Institutional Review Board.

2.1.1 | Geocoding and assigning socioeconomic status

The SDI summarizes social and demographic measures from the US Census American Community Survey.[8] The SDI was derived from the modified Townsend deprivation index which is a score calculated through factor analysis using four census variables (household without car, overcrowded households, households not owner occupied, persons unemployed).[9] For this analysis, we used the SDI at the census tract level.

To assign each patient an SDI, patient addresses were geocoded using the US Census geocoder. Scores range from −20 to 20, with a higher score indicating greater deprivation.

2.2 | Clinical outcomes

The primary endpoint was defined as a composite of cardiovascular death (CVD) and myocardial infarction (MI). Secondary endpoints included all-cause death, CVD, and MI (criteria according to Academic Research Consortium definitions[10]). Endpoints were analyzed with time from the index PCI date to the date of the initial event, and cases were censored at last follow up.

To examine the potential of neighborhood deprivation as a modifier for social determinants of health in CAD outcomes, we stratified diabetic versus nondiabetic patients by quintiles of the SDI scores among patients in the cohort (least deprived Quintile 1 to most deprived Quintile 5). Patients in Quintiles 1–4 were defined as lower social deprivation and patients in Quintile 5 were defined as high social deprivation, characterizing the highest amount of neighborhood deprivation at the census tract level. Patients that we were unable to match to an SDI were not included in the clinical outcome analysis.

2.3 | Statistical methods

Continuous variables are reported as mean ± standard deviation (SD) and categorical variables are reported as counts and percentages. Differences between patient baseline characteristics were tested by Student's t tests for continuous variables and χ^2 tests for categorical variables.

Differences in the time to event analysis were compared between patients in the highest SDI quintile and those in lower quintiles among patients with and without diabetes using the log rank test. Cox regression models were created to estimate the hazard ratio of having the relative outcome for patients with highest social deprivation versus the remaining quintile of SDI stratified according to the presence of diabetes. Multivariate analysis with forward conditional adjustment was performed with inclusion of variables with statistically significant associations ($p < 0.05$) with the outcome variables in the model.

3 | RESULTS

A total of 463 patients with diabetes and 538 patients without diabetes who underwent PCI between 2012 and 2017 were identified. Approximately 86% of patients received a DES (second generation) and 14% of patients received a bare metal stent. Patients with diabetes were older, more likely to have hypertension (86% vs. 71%, $p < 0.001$), had higher body mass index, more likely to have dyslipidemia (50% vs. 39%, $p < 0.001$), less likely to smoke (63% vs. 71%, $p = 0.006$), more likely to have history of CABG (14% vs. 8%, $p = 0.004$), and more likely to have end stage renal disease (Table 1). The extent of CAD (single vessel vs. multivessel) was comparable between the two groups as were the target

TABLE 1 Baseline demographics and clinical variables

Variable	Diabetes (N = 463)	No diabetes (N = 538)	p value	Diabetes: high social deprivation (N = 222)	Diabetes: low social deprivation (N = 208)	p value
Age, years	59.2 ± 9.8	57.2 ± 11	0.002	58.3 ± 10	60.1 ± 9.5	0.06
Male	268 (58%)	369 (69%)	<0.001	131 (59%)	118 (57%)	0.63
Race			0.36			0.12
Asian	7 (2%)	8 (2%)		2 (1%)	4 (2%)	
Black	177 (38%)	185 (34%)		99 (45%)	69 (33%)	
White	236 (51%)	296 (55%)		101 (46%)	114 (55%)	
More than one race	4 (1%)	2 (0.4%)		1 (0.5%)	3 (1.4%)	
Not reported	39 (8%)	45 (8%)		19 (9%)	18 (9%)	
Hypertension	399 (86%)	381 (71%)	<0.001	200 (90%)	171 (82%)	0.018
History of tobacco use	291 (63%)	382 (71%)	0.006	143 (64%)	134 (64%)	1.0
Body mass index, kg/m^2	33.1 ± 7.9	30.0 ± 7.4	<0.001	33 ± 7.6	33.5 ± 8.4	0.59
Prior MI	77 (17%)	82 (15%)	0.55	31 (14%)	38 (18%)	0.22
Prior CVA	49 (11%)	50 (9%)	0.496	28 (13%)	18 (9%)	0.18
Prior CABG	65 (14%)	45 (8%)	0.004	37 (17%)	24 (12%)	0.13
ESRD	14 (3%)	3 (1%)	0.003	6 (3%)	7 (3%)	0.69
Dyslipidemia	232 (50%)	210 (39%)	<0.001	113 (51%)	101 (49%)	0.63
Peripheral vascular disease	41 (9%)	33 (6%)	0.1	11 (5%)	24 (12%)	0.013
Extent of coronary artery disease			<0.001			0.43
One diseased vessel	146 (32%)	213 (40%)		72 (32%)	66 (32%)	
Two diseased vessels	156 (34%)	207 (38%)		72 (32%)	73 (35%)	
Three diseased vessels	148 (32%)	107 (20%)		75 (34%)	61 (29%)	
Four diseased vessels	12 (3%)	10 (2%)		3 (1%)	7 (3%)	
STEMI	63 (14%)	122 (23%)	<0.001	27 (12%)	32 (15%)	0.33
NSTEMI	234 (50%)	262 (49%)	0.57	118 (53%)	98 (47%)	0.21
Aspirin on discharge	453 (98%)	519 (96%)	0.2	215 (97%)	206 (99%)	0.11
P2Y12 inhibitor on discharge			0.06			0.04
Clopidogrel	224 (48%)	298 (55%)		106 (48%)	101 (49%)	
Prasugrel	145 (31%)	137 (26%)		61 (28%)	74 (36%)	
Ticagrelor	95 (21%)	103 (19%)		55 (25%)	33 (16%)	
Statin on discharge	447 (97%)	521 (97%)	0.79	214 (96%)	201 (97%)	0.89
Beta-blocker on discharge	463 (100%)	538 (100%)	0.08	212 (95%)	194 (93%)	0.32
ACE inhibitor/ARB on discharge	380 (82%)	409 (76%)	0.019	186 (84%)	164 (79%)	0.19
PCI target vessel						
Left main	6 (1%)	13 (2%)	0.051	3 (1%)	2 (1%)	0.35
Left anterior descending artery	205 (44%)	224 (42%)	0.038	96 (43%)	100 (48%)	0.65

(Continues)

TABLE 1 (Continued)

Variable	Diabetes (N = 463)	No diabetes (N = 538)	p value	Diabetes: high social deprivation (N = 222)	Diabetes: low social deprivation (N = 208)	p value
Right coronary artery	156 (33%)	192 (36%)	0.228	75 (34%)	66 (32%)	0.08
Left circumflex artery	143 (31%)	156 (29%)	0.28	73 (33%)	58 (28%)	0.013
SDI (mean)	2.9 ± 4.3	2.3 ± 4	0.047			
Highest SDI quintile	222 (52%)	247 (52%)	0.96			
Remaining SDI quintiles	208 (48%)	231 (48%)	0.96			

Abbreviations: ACE, angiotensin converter enzyme inhibitor; ARB, angiotensin II receptor blockers; CABG, coronary artery bypass grafting; CVA, cerebral vascular accident; ESRD, end stage renal disease; MI, myocardial infarction; PCI, percutaneous coronary intervention; SDI, social deprivation index.
[a]Matching 910 out of 1001 individuals to a social deprivation index.
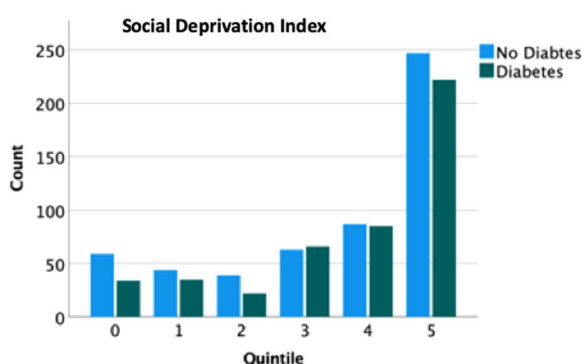

FIGURE 1 Social deprivation index by quintiles and diabetes status. Quintile 0 indicates individuals which were not matched to a social deprivation index. Patients in Quintiles 1–4 were defined as lower social deprivation index and patients in Quintile 5 were defined as high social deprivation index [Color figure can be viewed at wileyonlinelibrary.com]

vessels. Both groups had comparable guideline-directed medication regimens on discharge. Neighborhood associated SDI scores for each group are identified (Table 1, Figure 1). Almost half of the study population was found to have SDI scores in the highest quintile (Table 1, Figure 1). Diabetic patients within the highest quintile were comparable to the low quintile group, including indications for PCI, but were more likely to have hypertension (90% vs. 82%, $p = 0.018$; Table 1). No significant race-based differences in the distribution of SDI were observed (Table 1).

Patients with DM had significantly higher risk of recurrent CV events as compared to nondiabetics (Table 2, Figure S1.)

During subsequent median 5-year follow up, high social deprivation with diabetes as defined by highest quintile SDI was associated with an increased risk of all-cause death (hazard's ratio [HR]: 1.82; 95% CI: 1.04–3.19; $p = 0.036$), and combined CVD and MI (HR: 1.77; 95% CI: 1.05–2.99; $p = 0.03$) (Figure 2). After adjusting for age, gender, smoking history, hypertension, hyperlipidemia, prior MI, prior CABG, number of diseased vessels, and medications on discharge, high SDI with diabetes was independently associated with all-cause mortality, as well as CV death and MI (Table 3). No significant

association with clinical outcomes was observed between highest quintile SDI and lower quintiles of SDI among nondiabetic patients (Table 4, Figure S2). All-cause death after PCI was not increased in black patients compared to nonblack patients (HR: 1.08; 95% CI: 0.7–1.7; $p = 0.72$). Event-free survival from all cause death and CVD was not significantly different in black diabetic patients compared to nonblack diabetic patients (log-rank: $p = 0.15$ and $p = 0.65$).

4 | DISCUSSION

The findings of our study illustrate the impact of social deprivation as defined by US census tract index data on event-free survival after PCI. Higher SDI was associated with higher risk of all-cause death (15.8% vs. 9.1%), as well as specifically CV death and recurrent MI among patients with a diagnosis of DM (17.6% vs. 11.6%). Among patients without diabetes, no significant association could be demonstrated between high SDI and outcomes after PCI. Overall risk of recurrent ischemic events was significantly higher among patients with diabetes than nondiabetic patients.

Our findings are in line with prior analyses, which indicate that diabetes persists as an independent long-term risk factor after PCI in the modern era despite the use of newer generation drug eluting stents (DES).[11–14] We used a neighborhood-based index to examine the relative risk of clinical outcomes in CAD. After adjustment for confounding variables, diabetic patients exhibited a higher risk of adverse events, specifically among the top quintile of the SDI, with increased risk observed in patients located in neighborhoods that were most deprived. These findings emphasize the importance of identifying social determinants of health in patients undergoing PCI, as well as the particularly high risk for poor health outcomes among patients with DM.

There are several hypotheses that may account for the neighborhood-based differences in CAD outcomes. In a scientific statement from the American Heart Association, inactivity and less healthy diets are thought to be more prevalent in patients with lower socioeconomic status.[15,16] Patients living in lower socioeconomic

Events	Diabetics b (N = 463)	Nondiabetics (N = 538)	HR (95% CI)	p value	Adjusted HR (95% CI)	Adjusted p value
All-cause death	60 (13%)	37 (6.9%)	1.9 (1.29-2.9)	0.002	1.8 (1.2-2.9)	0.004
MI	56 (12.1%)	43 (8%)	1.58 (1.06-2.4)	0.024	1.56 (1.05-2.3)	0.029
Stent thrombosis	11 (2.4%)	4 (0.7%)	3.26 (1.04-10.2)	0.043	3.36 (1.07-10.6)	0.039
CV death	17 (3.7%)	11 (2%)	1.8 (0.85-3.9)	0.12	1.6 (0.71-3.5)	0.27

Note: Adjusted for age, gender, smoking history, body mass index, peripheral vascular disease, hypertension, hyperlipidemia, prior MI, prior CABG, prior PCI, medications on discharge.

Abbreviations: CABG, coronary artery bypass grafting; CV, cardiovascular; PCI: percutaneous coronary intervention; HR, hazard's ratio; MI, myocardial infarction.
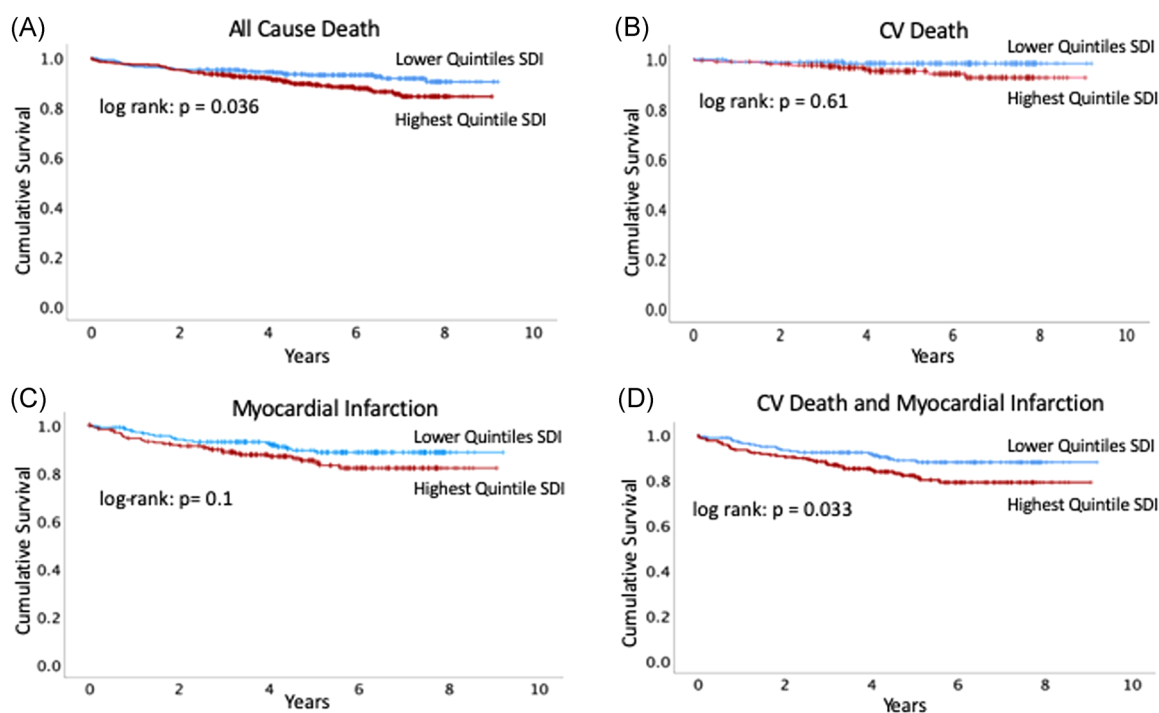
FIGURE 2 Kaplan–Meier survival curves according to social deprivation index in patients with diabetes mellitus. (A) All-cause death. (B) Cardiovascular death (CVD). (C) Myocardial infarction (MI). (D) CVD and MI [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 3 Clinical outcomes stratified by social deprivation index in patients with diabetes

Events (median 5-year)	High social deprivation	Low social deprivation	HR (95% CI)	p value	Adjusted HR (95% CI)	Adjusted p value
All-cause death	35/222 (15.8%)	19/208 (9.1%)	1.82 (1.04–3.2)	0.036	2.27 (1.27–4.1)	0.006
CV death	12/222 (5.4%)	4/208 (1.9%)	2.95 (0.95–9.2)	0.61	4.2 (1.3–13.9)	0.019
MI	32/222 (14.4%)	20/208 (9.6%)	1.6 (0.91–2.8)	0.1	1.46 (0.83–2.6)	0.19
MACE (CVD and MI)	39/222 (17.6%)	22/208 (11.6%)	1.77 (1.05–3)	0.033	1.72 (1.01–2.9)	0.044

Note: Adjusted for age, gender, smoking history, hypertension, hyperlipidemia, prior MI, prior CABG, number of diseased vessels, medications on discharge.

Abbreviations: CABG, coronary artery bypass grafting; CV, cardiovascular; HR, hazard's ratio; MACE, major adverse cardiac events; MI, myocardial infarction.

TABLE 4 Clinical outcomes stratified by social deprivation index in patients without diabetes

Events (median 5-year)	High social deprivation	Low social deprivation	HR (95% CI)	p value	Adjusted HR (95% CI)	Adjusted p value
All-cause death	18/247 (7.3%)	13/233 (5.6%)	1.38 (0.67–2.8)	0.38	1.43 (0.69–3)	0.34
CV death	5/247 (2%)	4/233 (1.7%)	1.22 (0.33–4.5)	0.77	1.7 (0.44–6.5)	0.44
MI	17/247 (6.9%)	24/233 (10.3%)	0.68 (0.37–1.27)	0.23	0.63 (0.33–1.19)	0.15
MACE (CVD and MI)	33/247 (13.4%)	33/233 (14.2%)	0.78 (0.45–1.4)	0.4	0.72 (0.4–0.6)	0.25

Note: Adjusted for age, gender, smoking history, hypertension, hyperlipidemia, prior MI, prior CABG, number of diseased vessels, medications on discharge.

Abbreviations: CABG, coronary artery bypass grafting; CV, cardiovascular; HR, hazard's ratio; MACE, major adverse cardiac events; MI, myocardial infarction.

neighborhoods may have a more sedentary lifestyle due to barriers in transportation,[15] however, some suggest that this may not necessarily be the case.[17] The relationship between diet and lower socioeconomic status is complex and poorly understood but may also be in part related to the accessibility of healthy food sources.[18,19] There also likely are differences in health insurance which may influence primary or specialty care follow-up or adherence to prescribed medications. It is also noteworthy that we only observed differences in cardiovascular outcomes between high and low SDI among the diabetic population, which may suggest that the level of diabetic control could account for some of these differences.

Disparities in healthcare access can influence long-term care for diabetes and nondiabetes-related outcomes, yet how this may influence outcomes specifically after PCI is less studied.[20] In an observational single-center cohort study of 13,770 patients, long-term mortality and recurrent MI after PCI increased progressively with higher levels of social deprivation over the span of 6 years follow up.[21] Among possible links between socioeconomic variables and outcomes that have been studied, employment, income, education, and neighborhood, have been found to be associated with cardiovascular outcomes in several studies.[22–24] This raises the need to better understand differences in health equity and the mechanisms associated with excess cardiovascular disease risk in at-risk populations. There are also differences in cardiovascular health by race, and in the Heart Disease and Stroke Statistics 2015 Update, African American men were found to have the highest mortality rate from MI or CAD.[25] Black diabetic patients in our cohort did not have worse outcomes which suggests that the differences in outcomes in our study are more driven by socioeconomic factors than racial differences. This reinforces the importance of focusing efforts in studying racial disparities when assessing cardiovascular outcomes in minority groups and the need for publishing "real-world" outcomes to supplement registry data.[26,27]

We chose to focus on diabetics in this cohort because of the poor cardiovascular outcomes seen in this high-risk group. Atherosclerosis in diabetes is accelerated leading to more cardiovascular events[28] and it was our hypothesis that worse outcomes in diabetes may disproportionately impact patients with CAD from underserved populations, which we demonstrated by the use of SDI to identify subjects at higher risk of CVD and MI.

There are several limitations to this study. We lacked access to social determinants of health at the individual level, such as level of education, health insurance, income level, and patients were pooled at the US census tract level. Variables that are not accounted for in the SDI but may also affect CAD outcomes were not assessed. Such factors may include postdischarge orders like referral to cardiac rehabilitation, tobacco cessation counseling, or measures of quality of diabetes control. As a single-center study, we may have lacked the power to assess differences across all levels of social deprivation or to assess smaller differences in outcomes among patients without diabetes.

5 | CONCLUSION

In conclusion, in this study examining long-term outcomes among patients treated at an urban safety net hospital, high social deprivation among patients with diabetes was associated with a significant increased risk of death, and major adverse cardiac events. The increased risk seen in patients with diabetes is likely at least partially exacerbated by socioeconomic determinants. Further studies are needed to examine the effects of social deprivation and healthcare access on long-term outcomes after coronary revascularization to better understand these differences.

CONFLICT OF INTERESTS
Dr. Kreutz has served as a scientific consultant for Haemonetics. Dr. Kovacs is on the Adjudication Committee for Clintrex; is on the Clinical Events Committee for Cook Med Institute; is a clinical events adjudication and consultant for Eli Lilly and is a consultant for ERT and Prilenia. The remaining authors have no relationships relevant to the contents of this paper to disclose.

DATA AVAILABILITY STATEMENT

The data that supports the findings of this study are available in the supplementary material of this article.

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REFERENCES

1. Riley WJ. Health disparities: gaps in access, quality and affordability of medical care. *Trans Am Clin Climatol Assoc*. 2012;123:167-172.
2. Graham G. Disparities in cardiovascular disease risk in the United States. *Curr Cardiol Rev*. 2015;11:238-245.
3. Vest JR, Harris LE, Haut DP, Halverson PK, Menachemi N. Indianapolis provider's use of wraparound services associated with reduced hospitalizations and emergency department visits. *Health Aff (Millwood)*. 2018;37:1555-1561.
4. Institute of Medicine (US) Committee on Understanding and Eliminating Racial and Ethnic Disparities in Health Care. Assessing potential sources of racial and ethnic disparities in care: patient- and system-level factors. In: Smedley BD, Stith AY, Nelson AR, eds. *Unequal treatment: confronting racial and ethnic disparities in healthcare*. The National Academic Press; 2003.
5. Akwo EA, Kabagambe EK, Harrell FE, et al. Neighborhood deprivation predicts heart failure risk in a low-income population of Blacks and Whites in the southeastern united states. *Circ Cardiovasc Qual Outcomes*. 2018;11:e004052.
6. Patel SA, Krasnow M, Long K, Shirey T, Dickert N, Morris AA. Excess 30-day heart failure readmissions and mortality in Black patients increases with neighborhood deprivation. *Circ Heart Fail*. 2020;13: e007947.
7. Hannan EL, Wu Y, Cozzens K, et al. The association of socioeconomic factors with percutaneous coronary intervention outcomes. *Can J Cardiol*. 2022;38:13-22.
8. Butler DC, Petterson S, Phillips RL, Bazemore AW. Measures of social deprivation that predict health care access and need within a rational area of primary care service delivery. *Health Serv Res*. 2013;48:539-559.
9. Townsend P, Phillimore P, Beattie A. Health and Deprivation Published by Croom Helm 212pp pound19.95 0-7099-4351-2 [Formula: see text]. *Nurs Stand*. 1988;2:34.
10. Cutlip DE, Windecker S, Mehran R, et al. Clinical end points in coronary stent trials: a case for standardized definitions. *Circulation*. 2007;115:2344-2351.
11. Serruys PW, Morice MC, Kappetein AP, et al. Trial of everolimus-eluting stents or bypass surgery for coronary disease. *N Engl J Med*. 2015;372:1204-1212.
12. Farkouh ME, Domanski M, Sleeper LA, et al. Percutaneous coronary intervention versus coronary-artery bypass grafting for severe coronary artery disease. *N Engl J Med*. 2009;360:961-972.
13. Park SJ, Ahn JM, Kim YH, et al. Strategies for multivessel revascularization in patients with diabetes. *N Engl J Med*. 2012;367: 2375-2384.
14. Mathew V, Gersh BJ, Williams BA, et al. Outcomes in patients with diabetes mellitus undergoing percutaneous coronary intervention in the current era: a report from the Prevention of REStenosis with Tranilast and its Outcomes (PRESTO) trial. *Circulation*. 2004;109: 476-480.
15. Havranek EP, Mujahid MS, Barr DA, et al. Social determinants of risk and outcomes for cardiovascular disease: a scientific statement from the american heart association. *Circulation*. 2015;132:873-898.
16. Mullie P, Clarys P, Hulens M, Vansant G. Dietary patterns and socioeconomic position. *Eur J Clin Nutr*. 2010;64:231-238.
17. Stalsberg R, Pedersen AV. Are differences in physical activity across socioeconomic groups associated with choice of physical activity variables to report? *Int J Environ Res Public Health*. 2018;15:922.
18. Morland K, Wing S, Diez, Roux A. The contextual effect of the local food environment on residents' diets: the atherosclerosis risk in communities study. *Am J Public Health*. 2002;92:1761-1767.
19. Assis MM, Leite MA, Carmo AS, et al. Food environment, social deprivation and obesity among students from Brazilian public schools. *Public Health Nutr*. 2019;22:1920-1927.
20. Aggarwal R, Chiu N, Loccoh EC, Kazi DS, Yeh RW, Wadhera RK. Rural-urban disparities: diabetes, hypertension, heart disease, and stroke mortality among black and white adults, 1999–2018. *J Am Coll Cardiol*. 2021;2021(77):1480-1481.
21. Jones DA, Howard JP, Rathod KS, et al. The impact of socioeconomic status on all-cause mortality after percutaneous coronary intervention: an observational cohort study of 13,770 patients. *EuroIntervention*. 2015;10:e1-e8.
22. Schultz WM, Kelli HM, Lisko JC, et al. Socioeconomic status and cardiovascular outcomes: challenges and interventions. *Circulation*. 2018;137:2166-2178.
23. Lynch JW, Kaplan GA, Cohen RD, Tuomilehto J, Salonen JT. Do cardiovascular risk factors explain the relation between socioeconomic status, risk of all-cause mortality, cardiovascular mortality, and acute myocardial infarction? *Am J Epidemiol*. 1996;144:934-942.
24. Gebreab SY, Diez Roux AV, Brenner AB, et al. The impact of life-course socioeconomic position on cardiovascular disease events in African Americans: the Jackson Heart Study. *J Am Heart Assoc*. 2015;4:3. e001553.
25. Mozaffarian D, Benjamin EJ, Go AS, et al. Heart disease and stroke statistics--2015 update: a report from the American Heart Association. *Circulation*. 2015;131:e29-322.
26. Golomb M, Redfors B, Crowley A, et al. Prognostic Impact of race in patients undergoing PCI: analysis from 10 randomized coronary stent trials. *JACC Cardiovasc Interv*. 2020;13:1586-1595.
27. Nanna MG, Peterson ED. Racial differences in long-term cardiovascular outcomes: the need to move from description to action. *JACC Cardiovasc Interv*. 2020;13:1596-1598.
28. Kaur R, Kaur M, Singh J. Endothelial dysfunction and platelet hyperactivity in type 2 diabetes mellitus: molecular insights and therapeutic strategies. *Cardiovasc Diabetol*. 2018;17:121.