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Social Needs Network for Evaluation and Translation

The Contribution of Social Risk Factors to Racial Differences in Type 2 Diabetes and Hypertension

December 2022

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Contents

Acknowledgments
We would like to acknowledge the programmers and analysts from across Kaiser Permanente (including KP Georgia, KP Colorado, and the KP Insight Team) who extracted electronic health record data for our analyses. We are also grateful for colleagues at KP Mid-Atlantic States who provided valuable insights into community health programs and ongoing activities to address social risks at Kaiser Permanente. Finally, we would like to thank Drs. Stacie Daugherty, Doug Roblin, and Morgan Clennin for their helpful feedback on our scientific abstracts.

This project was funded by the Kaiser Permanente (KP) Social Needs Network for Evaluation and Translation (SONNET). SONNET is a learning network that is committed to supporting KP leaders, clinicians, and staff as they design and evaluate effective interventions to address the social needs of our members. The Network includes researchers and evaluators from the eight KP regions, KP's Bernard J Tyson School of Medicine, KP's Office of Community Health, and from the KP and Robert Wood Johnson Foundation-supported Social Interventions Research and Evaluation Network (SIREN). SONNET is supported by KP's Office of Community Health.

Suggested citation
Vupputuri S, Kim S, Cromwel L, Gander J. The Contribution of Social Risk Factors to Racial Differences in Type 2 Diabetes and Hypertension. Kaiser Permanente Social Needs Network for Evaluation and Translation. December 2022.

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Executive summary

Why we did our project

There is a substantial, longstanding **racial gap in the prevalence of type 2 diabetes (T2D) and hypertension** between Black and white populations in the United States. Several studies point to socioeconomic factors as the major reason for these gaps, but little evidence exists on the specific contribution of social risks to racial differences. Using data from the Kaiser Permanente (KP) National Social Health Survey (SHS) fielded in 2020, we were able to **quantify the contribution of social risks to racial gaps in T2D and hypertension outcomes**.

What we did

We linked National SHS data to electronic health record (EHR) data from 7 Kaiser Permanente regions to understand how social risks affect racial differences in T2D and hypertension outcomes. Specifically, we:

- Examined characteristics of our project sample by race
- Assessed the association between social risk factors and T2D and hypertension outcomes by race
- Assessed the explained and unexplained variation in those outcomes by race and calculated the percent contribution of social risk variables

What we learned

- **Financial strain, food insecurity, and housing instability** were the most common social risks reported and were **markedly higher for Black members** compared to white members.
- Black members had more hypertension and T2D compared to white members (the gaps being 11% and 9%, respectively).
- The combined variable of financial strain, food insecurity, or housing instability **contributed to 11% of the overall racial differences** in T2D and in hypertension.

Sample size

10,226 members completed the KP National SHS in 2020

4,595 of those members have T2D or hypertension

Racial differences

Prevalence of T2D

22% of Black members

11% of white members

Prevalence of Hypertension

52% of Black members

43% of white members

Link to social needs

11% of racial differences can be attributed to the 3 most common social needs we observed:

- Financial strain
- Food insecurity
- Housing instability

How we can use this work to advance social health practice at KP and beyond

Our findings describe stark racial differences in social risks between Black and white members of Kaiser Permanente and can be used to **guide quality and disease management programs that address racial/ethnic disparities**. This report points to financial strain, food insecurity, and housing instability as **specific social risks that programs can prioritize** to help achieve racial health equity. Further, our findings emphasize the importance of **social outreach programs** focusing on the needs of Black members and members from other traditionally underserved communities.

Introduction

Guidance for health systems to address disparities in chronic disease care

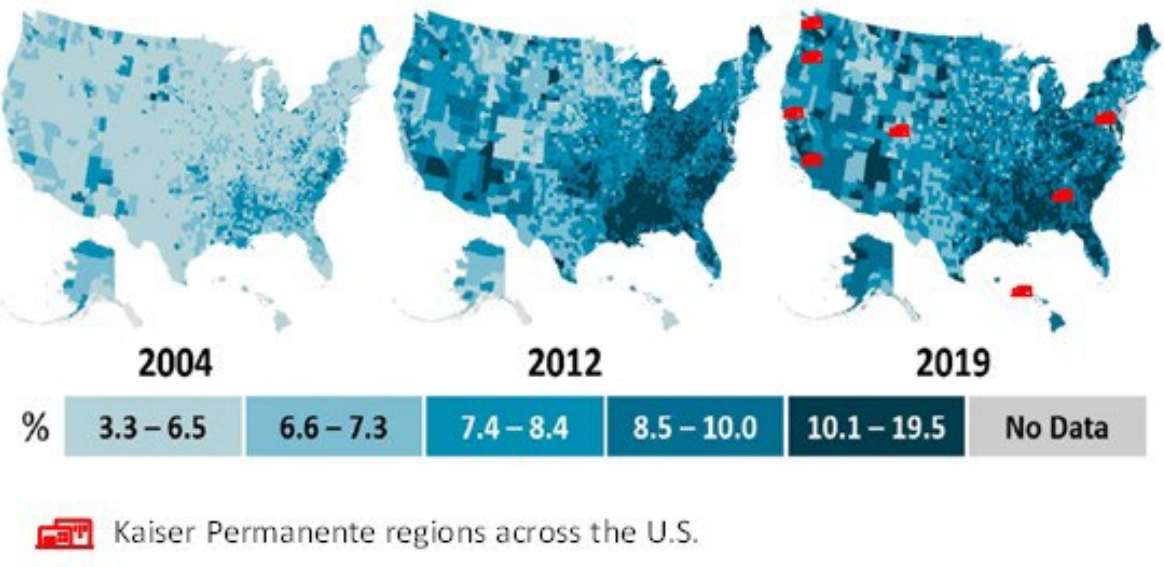
Racial and ethnic disparities in health outcomes are well documented in the United States. For example, rates of chronic diseases, such as type 2 diabetes (T2D) and hypertension, are significantly higher among people from racial or ethnic populations and in socially deprived areas of the country. We know that populations who face social disadvantages have fewer opportunities to thrive — socially, economically, and especially with respect to their health[1].

Health systems like Kaiser Permanente are uniquely positioned to address gaps in racial, ethnic, and social inequities in health care. But most health systems lack specific evidence-based targets to focus resources on. This report shares results of a quality improvement project that aimed to disentangle the effects of social risk gaps from racial gaps in the prevalence of T2D and hypertension. Our results provide concrete social risk targets that health systems can prioritize in order to reduce racial differences in chronic disease outcomes.

Prevalence of type 2 diabetes

In 2019, about 28.7 million people (8.7%) were diagnosed with T2D in the U.S. The prevalence was highest among American Indian/Alaskan Native (15%), non-Hispanic Black (12%), and Hispanic (12%) populations — with the lowest prevalence among white populations (7.4%)[2]. The median county-level prevalence of T2D increased from 6% to 8% between 2004 and 2019 (Figure 1)[3,4]. Among adults with less than a high school education, 13% had T2D compared to only 9% among those who completed high school and 7% among those with more than high school education.

Figure 1. County-level prevalence of adult Type 2 Diabetes in the United States, 2004-2019

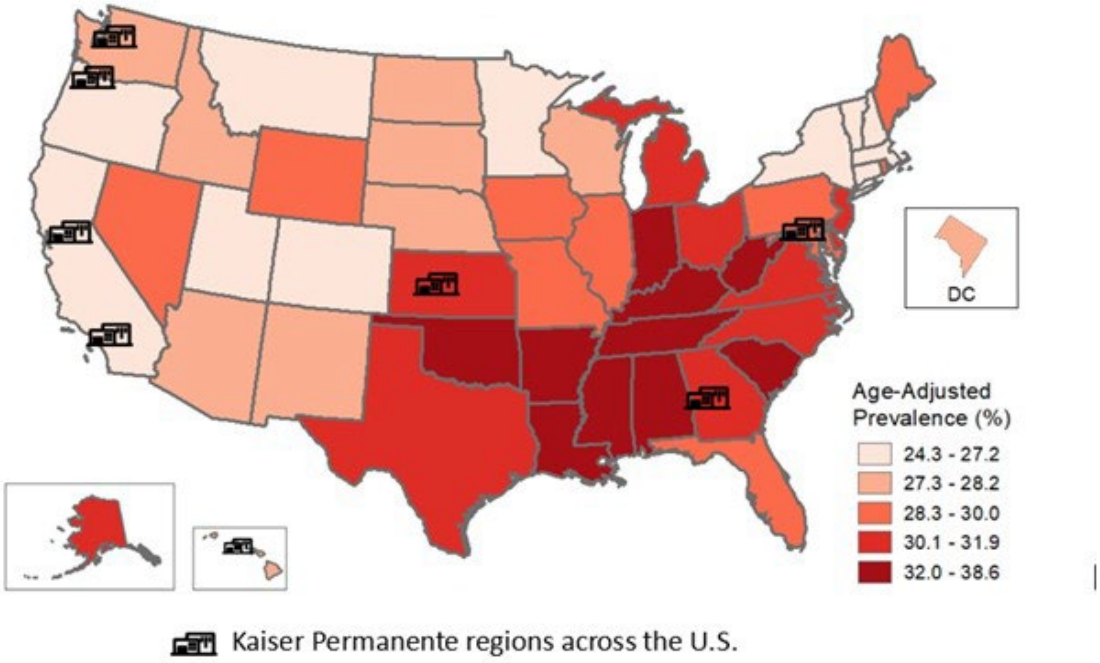


Prevalence of hypertension

Almost half of adults in the United States (about 37 million people) have uncontrolled hypertension according to the definition from the American College of Cardiology[5,6]. Differences in the prevalence of hypertension exist across race and ethnicity, with Black populations having the highest estimates at 56%, followed by white (48%), Asian (46%), and Hispanic (39%) populations[6].

Among people taking prescribed medications, blood pressure control is highest among white patients (32%), followed by Black (25%), Asian (19%), and Hispanic (25%) patients[7]. State-level geographic variation shows that hypertension is most common in the south and southeastern United States (Figure 2). As with T2D, social factors including socioeconomic status, education, income, and occupation have been associated with hypertension[8,9].

Figure 2. State-level prevalence of adult hypertension in the United States, 2018-2020



Methods

Methods overview

- We conducted a cross-sectional analysis to quantify the contribution of social risks to racial gaps in the prevalence of T2D and hypertension.
- We linked data from data from the Kaiser Permanente National Social Health Survey (SHS)[9] to electronic health record (EHR) data among survey respondents who had T2D or hypertension.
- We used self-reported race data to stratify results and weighted all statistical analyses to account for the survey design.
- Finally, we assessed the odds of having T2D or hypertension by race and separated the racial differences in outcomes into explained and unexplained variation to calculate the percent contribution of social risks to those differences.

Data sources

Data from the KP National SHS
Kaiser Permanente's National SHS included a diverse, representative sample of members from all 8 regions. **More than 10,000 members completed the survey** online, on paper, or by phone from January to September 2020.

The SHS sample included members in equal proportions from each region, along with a selection of members at high risk for social adversity. The sample was proportionate to gender and age distribution within each region and high-risk strata, and the survey used a weighted design in order to yield generalizable results. (A detailed description survey methods for the KP National Social Health Survey is available in their final report)[10]. We performed all analyses using a weighted sample, while also accounting for missingness/non-response of EHR measures.

EHR data
Each of Kaiser Permanente's 8 regions maintain comprehensive EHRs that tie together patient information from all aspects of patient care, including primary and specialist care, lab services, pharmacy, and membership data. For this project, we extracted **patient-level EHR data from 4,595 members** in 7 Kaiser Permanente regions whose data indicated they have T2D or hypertension. The data we collected included: demographics, comorbidities, insurance, enrollment, health care encounters, filled medications, completed lab values, and hospitalization visits.

Social risk variables

Our analyses included social risk variables from the KP National SHS: financial strain, food insecurity, social isolation, transportation, and housing instability (defined in Table 1).

In addition to looking at each variable individually, we also created a combined variable of financial strain, food insecurity, or housing instability. This combined variable helps account for overlap in definitions and collinearity between variables in our models.

Table 1. Social risk variables from the KP National SHS

Social risk	Definition
Financial strain	Ability to pay for food, housing, medical care and heating; money leftover at the end of month (e.g., more than enough, some money left, not enough, etc.)
Food insecurity	Worried about food running out; food bought did not last and no money for more; hard to get healthy food
Housing instability	Ability to pay mortgage/ rent on time; number of places lived in past year; steady place to sleep or experience living in shelter; current living situation
Social isolation	Talk on phone with family/ friends; use social media with family/friends; see family/ friends; attend church/ religious services; attend club/ organization meetings; get needed social and emotional support
Transportation	Lack of transportation kept from medical appointments/getting medications; lack of transportation kept from meetings, work, getting things needed for daily living

Outcomes

Our outcome of interest were the prevalence T2D and hypertension.

- T2D was defined as a diagnosis of diabetes; OR two medication fills for antidiabetic medications within the past 365 days.
- Hypertension was defined as a diagnosis of hypertension; OR the use of antihypertensive medications; OR a systolic blood pressure over 140 mmHg or a diastolic blood pressure over 80 mmHg.

Covariates

Our covariates from the KP National SHS data included:

- Race (Black*, white)
- Sex (male, female, or other)
- Insurance type (commercial, Medicare, Medicaid, or other)
- KP region (Northern California, Southern California, Northwest, Colorado, Mid-Atlantic States, and Georgia)†

For the 60 participants with missing sex data (0.59%), we imputed values from the EHR. Due to estimation issues, we excluded the 49 participants who reported "other" sex (0.48%). We also excluded 22 participants with missing survey data on race (0.22%).

Our covariates from EHR data included:

- Age (in years)
- Body mass index (in kg/m^2)
- Tobacco use (yes [current]; no [never, quit, passive])
- Blood pressure (mmHg)
- Comorbidities (cardiovascular disease, chronic kidney disease, hypertension, peripheral vascular disease, and hyperlipidemia)
- Prescription fills for diabetes, hypertension, and lipid-lowering medications

Statistical analyses

We weighted all analyses using survey weights to account for the complex survey design and non-response. Our descriptive analyses explored weighted and unweighted results across project variables.

We used logistic regression models to assess the odds of having an outcome of interest, with race as a covariate.

We selected covariates for the logistic regression models based on: 1) a priori knowledge of the relationship between the exposures and outcomes; 2) to minimize collinearity within models; and 3) statistical considerations to optimize model parsimony.

We then used the Oaxaca-Blinder (OB) method to calculate the contribution of the covariates described above to the racial differences in outcomes. The OB method makes it possible to divide differences in outcomes into "explained" and "unexplained" variation:

- **Explained variation:** differences due to observable characteristics/covariates
- **Unexplained variation:** the difference in the effects of those characteristics across groups (i.e., the portion attributed to predictors of our outcomes that cannot be accounted for by observable characteristics)

Through the OB method, we used coefficients from logistic regression models stratified by race as well as average covariate values within each race to separate a racial disparity into:

- **A covariate effect** (the effect of differences in the average value of all covariates between Black and white populations)
- **A coefficient effect** (the effect of differing impact of the covariates on outcomes between Black and the white populations)

We then estimated the relative contribution of each of the covariates to: 1) the covariate effect, 2) the coefficient effect, and 3) the total racial disparity.

This report shares results on the explained variation (i.e., covariate effects) in racial differences in T2D and hypertension — providing findings that health systems can act upon to reduce racial differences in health outcomes.

More detailed information about our statistical analyses is available in Appendix A.

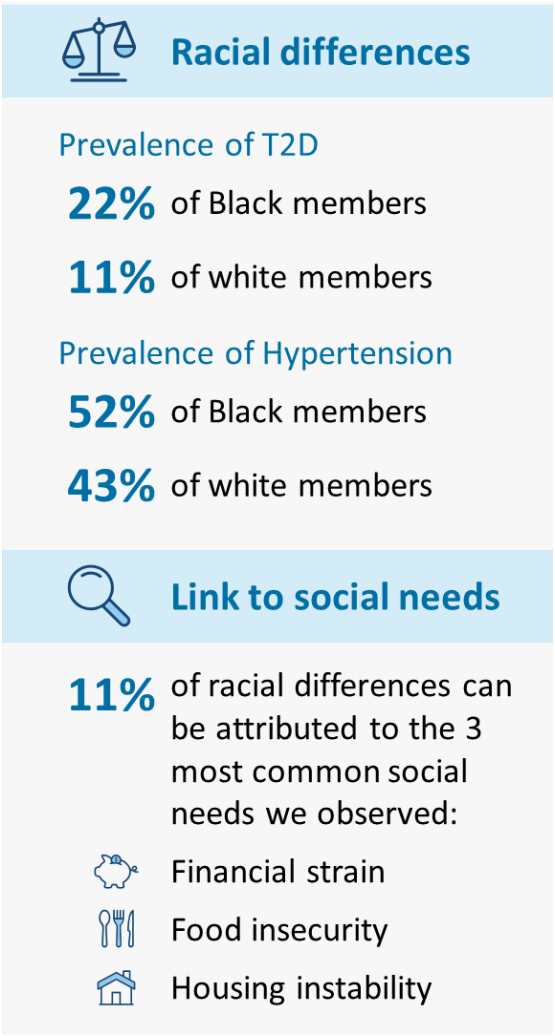
**Survey variable = "Black/African American"*

†KP Washington excluded from analytic sample due to missing data

Results

Key findings

- Black members in our sample had a **higher prevalence of T2D and hypertension** than white members.
- Black members were also more likely to have **more social risks** and a greater burden of comorbidities.
- The combined variable of financial strain, food insecurity or housing instability accounted for **11% of the overall racial difference** in both T2D and hypertension.



Characteristics of members in our sample

Our analyses included **4,595 members** who responded to the National SHS and who had non-missing data for the covariates of interest: 1,223 Black members and 3,372 white members. A selection of race stratified descriptive characteristics are given in Table 2. (See Appendix B for the full table).

Table 2. Descriptive characteristics of study participants

	Black members	White members
Total	1223	3372
% with T2D	21.9%	11.1%
% with hypertension	51.7%	48.3%
Demographics		
Average age	50.05	55.20
% female	63.00%	55.25%
Average BMI	31.80	28.95
% with Social risks		
Food insecurity	41.63%	19.32%
Financial strain	54.81%	33.84%
Transportation	10.91%	3.00%
Housing instability	26.05%	10.62%
Social isolation	38.50%	27.51%

Racial differences in member characteristics and comorbidities

Compared to white members in our sample, Black members were significantly younger, lived in more deprived neighborhoods, and were more likely to report social risks.

Both Black and white members were most commonly insured with commercial insurance. But because white members skewed older, they had a higher proportion insured with Medicare.

Looking at comorbidities, Black members were more likely than white members to take antidiabetic and antihypertensive medications and to have chronic kidney disease. They also had a significantly higher mean body mass index than white members.

Other outcomes of interest: Black members were less likely than white members to have peripheral vascular disease. The prevalence of cardiovascular disease was similar in both groups.

Racial differences in association of social risk with T2D

Race-stratified results related to T2D and other select characteristics are given in Table 3. (See Appendix C for the full table.)

Table 3. Odds of T2D associated with social risks and covariates, by race

	Black members (n=1223)	White members (n=3372)
Combined measure of food, financial, and housing	2.08 (1.03, 4.2)	1.78 (1.17, 2.71)
Social isolation	0.53 (0.26, 1.07)	0.94 (0.6, 1.47)
Transportation	1.24 (0.56, 2.74)	1.07 (0.32, 3.65)
Age	1.39 (1.09, 1.78)	1.37 (1.13, 1.67)
Sex	1.2 (0.66, 2.19)	0.85 (0.57, 1.26)
BMI	1.1 (1.05, 1.14)	1.08 (1.05, 1.11)
Medicaid	1.21 (0.33, 4.44)	1.93 (0.89, 4.17)
Medicare	0.95 (0.57, 1.59)	0.95 (0.38, 2.38)

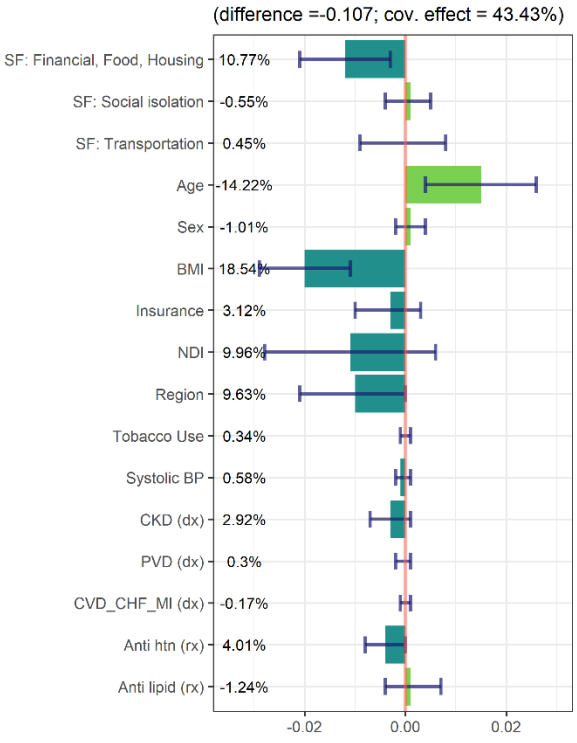
The odds of having T2D increase significantly when members experience financial strain, housing instability, or food insecurity:

- Black members with one of these risks are **2.1 times more likely to have T2D.**
- White members with one of these risks are **1.8 times more liked to have T2D.**

Contribution of social risks to racial differences in T2D

Figure 3 shows results of the Oaxaca-Blinder method for assessing the difference in the probability of T2D between Black and white members.

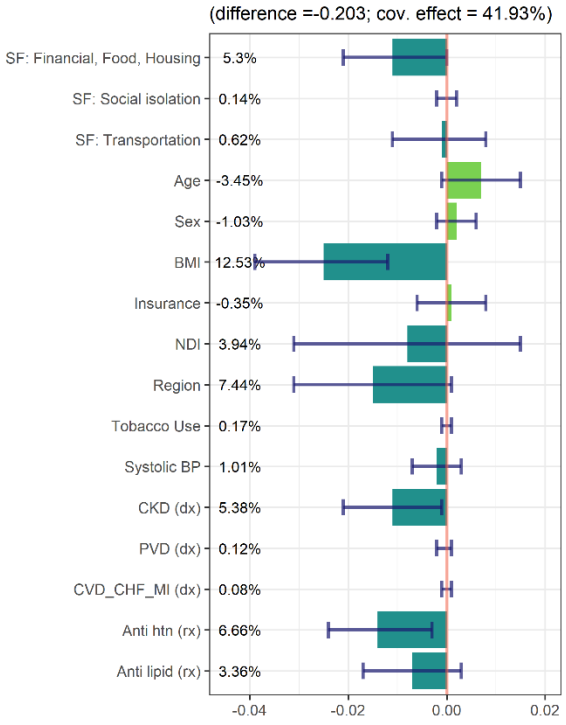
Figure 3. Oaxaca-Blinder estimates for the racial difference in type 2 diabetes (overall)



- The overall difference T2D in between Black and white members was **11%**.
- Our models were able to **explain 43% of this difference** — i.e., the explained racial difference.
- Having financial strain, food insecurity or housing instability contributed to **11% of the explained racial difference in T2D**.

Other factors that contributed to the racial gap in T2D included BMI (contributing 19%) and use of antihypertensive medications (contributing 4%). In a sensitivity analysis (shown in Figure 4), we restricted our sample to members age 45 and older and found similar contributions to racial difference in T2D.

Figure 4. Oaxaca-Blinder estimates for the racial difference in type 2 diabetes (age >45)



Racial differences in association of social risk with hypertension

Race-stratified results related to hypertension and other select characteristics are given in Table 4. (See Appendix D for the full table). The odds of having hypertension increase significantly when members experience financial strain, housing instability, or food insecurity:

- Black members with one of these risks are **1.5 times more likely to have hypertension.**
- White members with one of these risks are **1.7 times more liked to have hypertension.**

Table 4: Odds of hypertension associated with social risks and covariates, by race

	Black members (n=1223)	White members (n=3372)
Combined measure of food, financial, and housing	1.48 (1.04, 2.12)	1.74 (0.87, 3.51)
Social isolation	0.78 (0.54, 1.12)	1.87 (0.87, 4)
Transportation	0.8 (0.33, 1.94)	2.09 (0.6, 7.23)
Age	1.56 (1.34, 1.83)	2.59 (1.92, 3.51)
Sex	0.92 (0.67, 1.27)	1.93 (0.95, 3.91)
BMI	1.07 (1.04, 1.09)	1.04 (0.99, 1.09)
Medicaid	0.82 (0.35, 1.9)	1.31 (0.39, 4.4)
Medicare	1 (0.64, 1.55)	0.76 (0.24, 2.4)

Looking at comorbidities, chronic kidney disease, peripheral vascular disease, and cardiovascular disease were associated with a greater chance of having hypertension — and the association was stronger among Black members.

Contribution of social risks to racial differences in hypertension

Figure 5 (next page) shows results of the Oaxaca-Blinder method for assessing the difference in the probability of hypertension between Black and white members.

- The overall difference hypertension in between Black members and white members was **9%**.
- Our models were able to **explain 38% of this difference** — i.e., the explained racial difference.
- Having financial strain, food insecurity or housing instability contributed to **11% of the explained racial difference in hypertension**.

Other factors that contributed to the racial gap in hypertension included BMI (contributing to 22%) and use of antidiabetic medications (contributing 15%).

In a sensitivity analysis (shown in Figure 6), we restricted our sample to members age 45 and older and found similar contributions to racial difference in hypertension.

Figure 5. Oaxaca-Blinder estimates for the racial difference in hypertension (overall)

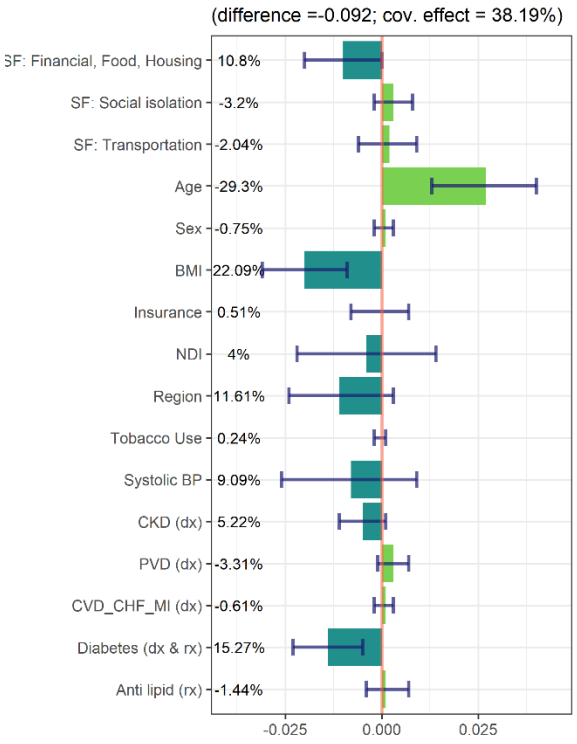
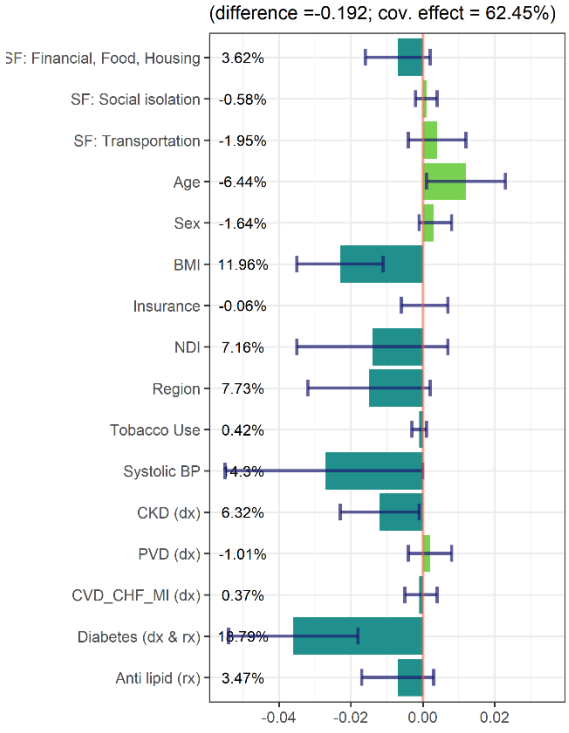


Figure 6. Oaxaca-Blinder estimates for the racial difference in hypertension (age >45)



Conclusions and future directions

Discussion and conclusions

Racial differences in chronic conditions create an undue burden on racial and ethnic populations and can contribute to long-term health consequences. Health systems require innovative solutions to address disparities and to provide equitable care across diverse populations.

Addressing patients' social risks is one promising way to reduce racial differences in chronic conditions, combat systemic racism and racial disparities, and promote an equitable health system.

We found that financial strain, food insecurity, and housing instability contributed significantly to the racial gaps in T2D and hypertension. These findings suggest that **interventions that promote social health equity among members should be a priority for Black patients with T2D and hypertension**.

We used the Oaxaca-Blinder (OB) method to assess explained and unexplained racial differences in study outcomes. A growing number of epidemiology and health services studies are using this novel and timely method because it helps identify which determinants account for the greatest proportion of the

total racial disparity in outcomes. That helps point health systems toward social health factors that can have the biggest impact on reducing racial differences and alleviating racial disparities.

In particular, **our results point to three specific social health factors** that can help health systems move the needle on racial differences in chronic conditions: financial strain, food insecurity, and housing instability.

Our results also provide important evidence to inform new interventions and to prioritize efficacy trials that assess factors known to exacerbate health inequities. In addition, our findings will support clinical disease management programs at Kaiser Permanente by providing guidance on which clinical factors (i.e., BMI) have the biggest impact on reducing racial differences.

We have plans to share findings from this project at the 20223 Health Care Systems Research Network Conference (see Appendix E) and have submitted an abstract to present at the American Diabetes Association 83rd Scientific Sessions (see Appendix F).

Limitations

The main limitation in this study is that many variables that were not available could have improved our estimates (such as environmental, behavioral, psychosocial, lifestyle, and lived experience variables).

For example, other significant contributors to racial gaps in both T2D and hypertension may be diet, exercise, and history of discrimination.

The inclusion of these variables could potentially alter the contribution of financial strain, food insecurity, and housing instability in our analyses. In addition, we restricted our analysis to only Black and white members of Kaiser Permanente.

Future recommendations

- The findings presented in this report describe **racial differences** in social risks between Black and white members of Kaiser Permanente.
- This report should be used to **inform Kaiser Permanente quality and disease management programs** that seek to address racial and ethnic disparities and deliver equitable health care.
- Specifically, enhancing programs that **address financial strain, food insecurity, and housing instability among members** as well as the communities Kaiser Permanente serves should be an important priority.
- **Dedicated resources should be allocated to social outreach programs** focusing on the needs of Black members and members from other traditionally underserved communities.

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Appendices

Appendix A

Additional information on statistical analyses

All analyses were weighted using trimmed survey weights to account for the complex survey design and non-response. Distributions of variables were explored graphically used line and bar charts. Descriptive analyses explore weighted and unweighted frequencies (and percentages) as well as means (and standard deviations) of project variables.

Logistic regression models assessed the odd of having the outcome and were conducted overall with race as a covariate and stratified by race. P-values for the association between categorical variables with race and continuous variables with race were calculated using Rao Scott Chi-squared[11,12] and weighted ANOVA[13,14,15], respectively. The logistic regression models were constructed with covariates selected for inclusion based on: 1) a priori knowledge of the relationship between the exposures and outcomes; 2) to minimize collinearity within models; and 3) statistical considerations to optimize model parsimony.

We then used the Oaxaca-Blinder decomposition method for logistic models to calculate the contribution of the covariates described above to the disparity in our outcomes. The OB method allowed us to assess the difference between Black and white members to be partitioned (or decomposed) into differences that were observable characteristics/covariates (explained variation), and the difference in the effects of those characteristics across groups (unexplained variation -- the portion attributed to unobserved predictors of our outcomes that cannot be accounted for by these difference in average level of our model covariates).

The Oaxaca-Blinder methodology used coefficients from logistic regression models stratified by race as well as average covariate values within each race to decompose the racial disparity into a **covariate** effect (the effect of differences in the average value of all covariates between the Black and white groups on vaccination), and the coefficient effect (the effect of differing impact of the covariates on vaccination between the Black group and the white group). We then estimated the relative contribution of each of the covariates to: (1) the covariate effect; (2) the coefficient effect; and (3) the total racial disparity. We present results from the covariate effects which comprise the explained variation and support findings that can be acted upon by the health system in order to reduce racial differences in health outcomes.

We conducted sensitivity analyses among those participants aged 45 years and older because of the strong association between age and our outcomes and because the Black group had an age distribution that skewed towards younger age.

Data extraction and quality control were performed using SAS software (version 9.4; SAS Institute, Cary, NC). Descriptive statistics and logistic regression models were computed using R software (R version 3.1.1, Core Team 2013, Vienna, Austria). The Oaxaca-Blinder decomposition for logistic models was computed using the Oaxaca command with the logit option in Stata (Release 14, StataCorp LP 2015, College Station, TX)[16].

Appendix B

Table 2 - Descriptive Characteristics of Social Needs Survey Participants

	Unweighted frequency or mean		Weighted % or SD		Weighted difference	
	BAA	White	BAA	White	White-BAA difference	P of difference
Total members	1223	3372				
Hypertension						
Yes	690	1594	51.72%	42.62%	-0.091	0.0023
No	533	1778	48.28%	57.38%	0.091	
Diabetes						
Yes	291	479	21.90%	11.17%	-0.107	<.0001
No	932	2893	78.10%	88.83%	0.107	
Baseline patient demographics						
Age	50.05	55.20	17.44	17.27	5.760	<.0001
Female	793	1953	63.08%	55.32%	-0.078	0.0107
Male	430	1419	36.92%	44.68%	0.078	0.0107
BMI	31.80	28.95	7.45	6.65	2.870	<.0001
Region						
KP Colorado	33	692	1.60%	9.99%	0.084	<.0001
kP Georgia	604	460	15.17%	2.48%	-0.127	<.0001
KP Mid-Atlantic States	381	391	24.18%	5.64%	-0.185	<.0001
KP Northern California	77	584	24.29%	38.98%	0.147	<.0001
KP Northwest	29	835	2.35%	11.85%	0.095	<.0001
KP Southern California	99	410	32.41%	31.06%	-0.014	<.0001
Insurance						
Commercial	882	1840	70.42%	60.54%	-0.099	<.0001
Medicaid	81	168	8.63%	3.23%	-0.054	<.0001
Medicare	200	1014	16.43%	26.64%	0.102	<.0001
Other	60	350	4.53%	9.59%	0.051	<.0001
Neiborhood deprivation index (NDI)						
Q1	105	1134	13.02%	35.37%	0.224	<.0001
Q2	217	994	22.33%	32.80%	0.105	<.0001
Q3	371	783	24.44%	21.60%	-0.028	<.0001
Q4	530	461	40.22%	10.23%	-0.300	<.0001
Tobacco Use						
Yes	115	251	7.44%	5.27%	-0.022	0.0801
No	1108	3121	92.56%	94.73%	0.022	0.0801
Social factor						
Food insecurity	535	716	41.69%	19.29%	-0.224	<.0001
Financial strain	688	1213	54.80%	33.83%	-0.210	<.0001
Transportation	113	130	10.89%	3%	-0.079	<.0001
Housing	313	398	26.14%	10.62%	-0.155	<.0001
Social isolation	475	979	38.44%	27.48%	-0.110	<.0001
Combined measure of food, financial, and housing	782	1364	62.02%	38.72%	-0.233	<.0001
Clinical factors						
Diiastolic blood pressure	72.36	71.47	8.74	8.10	-0.300	0.5766
Systolic blood pressure	125.73	123.40	11.45	11.44	-0.670	0.3326
Anti-diabetes medications	191	326	13.84%	7.04%	-0.068	<.0001
Anti-hypertensive medications	346	793	27.80%	20.39%	-0.074	0.0029
Lipid lowering medications	304	972	23.50%	24.82%	0.013	0.6065
Peripheral vascular disease	137	562	11.90%	15.83%	0.039	0.0656
Chronic kidney disease	108	288	10.80%	7.49%	-0.033	0.0530
Cardiovascular disease	114	360	8.69%	9.48%	0.008	0.6307

Appendix C

Table 3. Odds of Type 2 Diabetes Associated with Social Needs and Covariates, by Race			
Characteristic	**White (N=3,372)**	**Black/African-American (N= 1,223)**	**Reference**
Combined measure of food, financial, and housing	1.77 (1.16, 2.69)	2.06 (1.02, 4.15)	
Social isolation	0.94 (0.6, 1.48)	0.53 (0.26, 1.07)	
Transportation	1.08 (0.32, 3.65)	1.24 (0.57, 2.73)	
Age	1.37 (1.13, 1.67)	1.39 (1.09, 1.78)	
Sex	0.85 (0.58, 1.26)	1.2 (0.66, 2.19)	Male
Body mass index	1.08 (1.05, 1.11)	1.1 (1.05, 1.14)	
Medicaid insurance	1.92 (0.89, 4.16)	1.21 (0.33, 4.42)	Commercial
Medicare insurance	0.95 (0.57, 1.59)	0.94 (0.37, 2.36)	
Other insurance	1.04 (0.57, 1.91)	1.39 (0.23, 8.32)	
Q2 NDI	1.32 (0.81, 2.14)	0.97 (0.35, 2.67)	Q1 NDI
Q3 NDI	1.16 (0.7, 1.95)	2.31 (0.96, 5.56)	
Q4 NDI	1.64 (0.84, 3.17)	1.43 (0.57, 3.61)	
KP Colorado	0.85 (0.52, 1.39)	1.8 (0.41, 7.85)	KP Southern California
kP Georgia	1.5 (0.81, 2.77)	0.75 (0.36, 1.56)	
KP Mid-Atlantic States	0.95 (0.55, 1.65)	0.52 (0.24, 1.13)	
KP Northern California	0.71 (0.43, 1.18)	0.52 (0.19, 1.41)	
KP Northwest	0.87 (0.55, 1.39)	2.61 (0.26, 26.28)	
Tobacco Use	1.22 (0.72, 2.07)	1.41 (0.47, 4.25)	No tobacco
Systolic blood pressure	1.01 (0.99, 1.03)	1.01 (0.98, 1.04)	
Chronic kidney disease	2.94 (1.77, 4.89)	2.12 (0.75, 5.96)	
Peripheral vascular disease	0.91 (0.56, 1.47)	0.58 (0.23, 1.43)	
Cardiovascular disease	1.3 (0.74, 2.26)	2.05 (0.89, 4.72)	
Anti-hypertensive medications	1.95 (1.28, 2.97)	2.56 (1.3, 5.02)	
Lipid lowering medications	3.42 (2.19, 5.34)	11.93 (6.46, 22.02)	
*NDI=neighborhood deprivation index			

Appendix D

Table 4. Odds of Hypertension Associated with Social Needs and Covariates, by Race			
Characteristics	**White (N=3,372)**	**Black (N= 1,223)**	**Reference**
Combined measure of food, financial, and housing	1.48 (1.04, 2.11)	1.73 (0.86, 3.47)	
Social isolation	0.78 (0.55, 1.12)	1.85 (0.87, 3.93)	
Transportation	0.81 (0.33, 1.94)	2.07 (0.6, 7.12)	
Age	1.56 (1.34, 1.82)	2.58 (1.92, 3.48)	
Sex	0.92 (0.67, 1.27)	1.93 (0.96, 3.88)	Male
Body mass index	1.07 (1.04, 1.09)	1.04 (0.99, 1.09)	
Medicaid insurance	0.82 (0.35, 1.91)	1.33 (0.4, 4.43)	Commercial
Medicare insurance	1 (0.65, 1.55)	0.77 (0.25, 2.41)	
Other insurance	0.75 (0.44, 1.29)	0.98 (0.3, 3.24)	
Q2 NDI	1.57 (1.08, 2.27)	1.51 (0.37, 6.16)	Q1 NDI
Q3 NDI	1.15 (0.76, 1.74)	1.76 (0.48, 6.42)	
Q4 NDI	1.28 (0.73, 2.25)	2.55 (0.69, 9.38)	
KP Colorado	1.15 (0.74, 1.79)	1.84 (0.53, 6.36)	KP Southern California
kP Georgia	1.47 (0.9, 2.4)	0.9 (0.42, 1.91)	
KP Mid-Atlantic States	1.41 (0.76, 2.6)	0.83 (0.36, 1.9)	
KP Northern California	0.83 (0.55, 1.24)	1.26 (0.41, 3.86)	
KP Northwest	1.37 (0.88, 2.14)	0.57 (0.15, 2.17)	
Tobacco Use	1.11 (0.61, 2.02)	0.47 (0.15, 1.43)	No tobacco
Systolic blood pressure	1.12 (1.1, 1.15)	1.18 (1.13, 1.24)	
Chronic kidney disease	3.77 (1.97, 7.2)	6 (1.53, 23.54)	
Peripheral vascular disease	2.06 (1.26, 3.38)	10.6 (2.44, 46.03)	
Cardiovascular disease	1.92 (1.07, 3.46)	25.28 (2.03, 315.1)	
Anti-hypertensive medications	3.35 (1.99, 5.63)	4.61 (1.82, 11.66)	
Lipid lowering medications	2.63 (1.78, 3.9)	2.52 (0.59, 10.78)	

Appendix E

Abstract to be presented at the Health Care Systems Research Network Conference in Denver, CO, Feb 22-23, 2023

The Contribution of Social Needs Factors to Racial Differences in Hypertension

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Studies have attributed gaps in hypertension (HTN) between Black/African-American (BAA) and White adults to socioeconomic factors. We quantified the contribution of social needs to racial gaps in HTN in 6 Kaiser Permanente regions.

Social Needs Survey data were linked to electronic health records. Exposures included financial strain, food insecurity, and housing instability; the outcome was either HTN diagnosis, HTN medication use or blood pressures above 140/90 mmHg; strata were self-reported race. Covariates included demographics, insurance, and health measures. Weighted Oaxaca-Blinder models calculated contributions of variables to the racial difference in HTN.

Analyses included 1223 BAA and 3372 White participants. BAA participants had a higher proportion of HTN (52% vs 43% in Whites) and were more likely to be younger, female, have more social needs and a greater comorbidity burden. Of the 9% gap in HTN between BAA and White participants the covariates in our Oaxaca-Blinder model explained 38% of the difference. Of this explained difference, financial strain, food insecurity or housing instability significantly contributed to the racial gap by 11%.

Racial gaps in HTN create an undue burden on BAA populations. We found that if levels of social needs in BAA participants were equalized to their White counterparts the racial gap in HTN could be reduced. However, the impact is relatively small and other social factors such as discrimination will be important to explore.

Appendix F

Abstract submitted to the American Diabetes Association 83rd Scientific Sessions, June 23-26, 2023, San Diego, CA

The Contribution of Social Needs Factors to Racial Differences in Type 2 Diabetes Prevalence

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Studies have attributed gaps in type 2 diabetes (T2D) between Black/African-American (BAA) and White adults to socioeconomic factors. We quantified the contribution of social risk factors to racial gaps in T2D in 6 Kaiser Permanente health systems across the U.S. We utilized data collected from the National KP Social Needs Survey conducted in 2020 among 10,226 health system members. We linked survey data to electronic health record data. Exposures included financial strain, food insecurity, and housing instability in the past year. The outcome, prevalent T2D, was defined as either a diagnosis of T2D or medication fills for anti-diabetic medications. Self-reported BAA and White race were used to stratify data. Other covariates included demographics, insurance type, clinical measures, and comorbidities. Cross-sectional logistic regression models assessed the odds of T2D by race and the Oaxaca-Blinder decomposition method calculated the percent contribution of all variables to the racial difference in T2D. All statistical analysis were weighted to account for the complex survey design. Our final analysis included 1,223 BAA and 3,372 White survey participants. BAA participants were more likely to be younger, female, report having more social risk factors, and a greater burden of comorbidities. The prevalence of T2D was 22% in BAA patients and 11% in White patients. The covariates in the Oaxaca-Blinder analysis explained 43% of the 11% overall difference in T2D prevalence between BAA and White patients. Of this explained difference, the combined variable of financial strain, food insecurity, or housing instability significantly contributed to the racial gap in T2D by 11%. Our results demonstrated, that if social risk factors of BAA patients were equal to White patients the racial difference in T2D would be reduced by 11% in our mostly insured population. However, the impact is relatively small and other social factors (e.g. discrimination) will be important to explore using this methodology.

Appendix G

Author Contributions

Project idea conception: SV; proposal: SV, JG; project study design: SV; data extraction: LC, JG; analysis plan: SV, SK; statistical analysis: SK, SV; presentation of findings: SV; final report draft: SV; critical review of final report: SK, SV; final report revisions: SV.