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# Association of Unmet Social Needs with Chronic Illness: A Cross-Sectional Study

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## Abstract

Screening for social needs during routine medical visits is increasingly common. To date, there are limited data on which social needs are most predictive of health outcomes. The aim of this study is to build a predictive model from integrated social needs screening and health data to identify individual or clusters of social needs that are predictive of chronic illnesses. Using the electronic medical record data from a Federally Qualified Health Center collected from January 2016 to December 2020, demographic, diagnosis, and social needs screening data were used to look at adjusted and unadjusted associations of individual unmet social needs with chronic illnesses ( $n=2497$ ). The least absolute shrinkage and selection operator (LASSO) model was used to identify which social need(s) were associated with overall burden of chronic illness, and individual diagnoses of hypertension, obesity, diabetes, and psychiatric illness. The LASSO model identified age, race, language, gender, insurance, transportation, and food insecurity as significant predictors of any chronic illness. Using these variables in a multivariable model, transportation (adjusted odds ratio [aOR] 1.66) was the only social need that remained significantly associated with chronic illness diagnosis. Transportation need was also significantly associated with diabetes (aOR 1.44) and psychiatric illness (aOR 1.98). Food insecurity was associated with obesity (aOR 10.21). Using LASSO models to identify significant social needs, transportation was identified as a predictor in 3 of the 5 models. Further research is warranted to evaluate if addressing patients' transportation needs has the potential to mitigate chronic disease sequelae for vulnerable adults to advance health equity.

**Keywords:** community health centers, social determinants of health, LASSO

## Introduction

**D**ESPITE THE MEDICAL ADVANCEMENTS MADE in the last century, health outcomes for individuals continue to vary dramatically based on social context.<sup>1,2</sup> Social determinants of health (SDOH) are defined as the circumstances in

which people are born, grow up, live, and work, which materially affect the health of communities.<sup>3</sup> These social determinants function at a community or societal level to confer advantage or disadvantage.<sup>4,5</sup> Individually, the downstream consequences of deleterious SDOH include unmet social needs, such as housing instability, food insecurity,

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unemployment, and difficulty affording utilities, medication, and internet costs, which can adversely affect health at the individual and population levels.

National and state initiatives have increased interest and implementation for screening for unmet social needs during routine medical visits. As outlined in the National Academy of Medicine report *Integrating Health and Social Care*, awareness of a patient's unmet social needs is a critical first step toward addressing them.<sup>6</sup> In this context, the goal of social needs screening is to both document unmet social needs and link patients with resources to address unmet social needs. With growing social needs data collection efforts, researchers may be able leverage this collected information to identify which social needs may be most relevant to improving health outcomes.

To date, however, there are limited data on which unmet social needs are most predictive of health outcomes. Furthermore, there is little agreement across stakeholders on which social needs are crucial to improving population health and reducing the burden of chronic illnesses.<sup>7,8</sup> The growing data on unmet social needs in patient populations can be leveraged to identify which social needs are most highly associated with common diagnoses. Identifying social needs that are correlated with chronic illness can be useful to both maximize screening utility for time-constrained providers and to identify potential interventions for specific targets that are most likely to improve long-term health outcomes.

The aim of this study is to build a model from linked social needs screening and health data from an electronic medical record (EMR) to identify individual or clusters of social needs that are predictive of chronic illness. If providers can identify key social needs that are most associated with specific diagnoses or overall chronic illness severity, clinicians can prioritize actionable screening instruments and optimize targeted social service delivery for patient populations that are most likely to improve long-term health for their patients.

## Methods

### *Study sample and population*

Retrospective EMR data were extracted from January 2016 to December 2020 from a single Federally Qualified Health Center (FQHC). In partnership with a local food bank-developed program in 2016, the FQHC providers began to screen patients for food insecurity using the 2-item Hunger Vital Sign.<sup>9</sup> In September of 2017, the FQHC expanded its social needs screening tool to 9 questions covering housing insecurity and quality, food insecurity, financial hardship, literacy, immigration concerns, and transportation concerns. In 2018, after pilot testing<sup>10</sup> and in response to new requirements from the state Medicaid program, 3 additional questions were added to the screening tool to include utilities concerns, interpersonal violence, and social isolation.

Screening was initially done *ad hoc* by providers, but due to Medicaid 1115 waiver implementation requirements starting March 2018, screening was required for all Medicaid-enrolled patients.<sup>11</sup> Patients and caregivers of pe-

diatric patients were screened while waiting for regular visits (annual or routine follow-up care). Screening tools were read aloud to patients and caregivers to ensure low literacy was not a limitation to participation. Responses were entered into the EMR at time of screening. The screening tool was available in English and Spanish. Only patients  $\geq 18$  years old who completed either the 9- or 12-item social needs screener were included. Fewer than 1% of all patients declined screening.<sup>10</sup>

### *Measures*

The authors extracted demographic information—age, preferred language (English, Spanish, other), gender, self-reported race, self-reported ethnicity, and insurance type (Medicaid, Medicare, private, uninsured), for all patients who had been screened for social needs at least once during the study period. Social needs were collapsed into 9 domains (housing concerns, financial hardship, food insecurity, literacy concerns, immigration concerns, transportation need, utilities, physical abuse, and social isolation) with dichotomous outcomes (has need/does not have need).

Responses to individual social needs questions were combined to create a categorical social needs variable. Because social needs questions were added over time, if a patient had been screened more than once during the study period, the most recent screening data were reported. Supplementary Data contain the final screening instrument used in this study.

The study identified 2 outcomes of interest. First, the authors used a global measure of chronic illness severity, the Charlson Comorbidity Index (CCI). Based on the established literature, specific International Classification of Diseases (ICD)-10 codes for 19 diagnoses were used to calculate the CCI for each patient.<sup>12</sup> The CCI is a validated measure of comorbid disease status, where the sum of the CCI score is an indicator of global disease burden and mortality.<sup>13</sup> CCI scores were categorized into 0 (no illness severity), 1 (mild illness severity), and 2 or more (moderate-severe illness severity) to approximate total comorbidity burden for the patients in this study. The second outcome of interest was individual diagnoses of the most common chronic illnesses in the patient population.

The study team extracted specific ICD-10 codes for 12 categories of common chronic illnesses: cancer (excluding skin cancers), anemia, diabetes, hyperlipidemia, substance use disorder, hypertension, psychiatric illness (including depression, anxiety, post-traumatic stress disorder), cardiovascular disease (including stroke, myocardial infarction, and congestive heart failure), obesity, chronic obstructive pulmonary disease, asthma, and chronic kidney disease. To assign an illness diagnosis to a patient, the ICD-10 diagnoses had to be associated with a clinic visit (in person or telehealth), telephone call, prescription, hospitalization, or emergency room visit during the study period. By having an associated clinical encounter during the study period for each ICD-10 code, the diagnoses were considered active for each patient.

The total number of clinic visits and no shows were extracted for each patient during the study period. No shows

were scheduled visits where the patient was neither checked in nor canceled. Visits to behavioral health and social work providers were included by using provider-type visit codes.

### Statistical analyses

Demographic and clinical characteristics were described using means [standard deviations], medians, and proportions as appropriate. Univariate logistic regression was conducted to evaluate the association between each social need and the categorical CCI score. Multivariable ordinal logistic models were created to evaluate the association between each social need while adjusting for age, race, ethnicity, gender, language, and insurance type.

In general, social needs are highly collinear. For example, financial strain in 1 domain has downstream effects in affording other things, such as food or utilities. Because of this, using all social needs data as covariates in predictive model building can lead to overfitting, resulting in conclusions that describe random errors rather than true relationships between variables.<sup>14,15</sup>

To account for collinearity concerns in identifying predictive social needs, the study team used the least absolute shrinkage and selection operator (LASSO). The LASSO model is optimized for prediction and prevents overfitting in data sets with multiple and collinear covariates.<sup>16</sup> The goal of the LASSO logistic regression analysis was to identify key social needs that were most predictive of diagnosis of chronic illness. The LASSO model included 9 social needs variables. Utilities concerns, physical abuse, and social isolation were excluded due to higher rates of missingness, as they were the last domains added to the screening instrument. The model also included age, race, gender, language, and insurance type. The LASSO outcome was dichotomized disease severity created by collapsing the CCI score into no comorbidities/1 or more comorbidities.

Internal cross-validation of the LASSO model was performed by randomly splitting the sample into 2 equal groups, a training set and a test set. This model iteratively shrinks some coefficients to 0 and results in keeping only the strongest predictors in the model.<sup>17</sup> The final LASSO model used cross-validation, minimum Bayes Information Criteria,<sup>18</sup> and adaptive models, all of which identified the same predictors. The testing set R-squared was comparable with the training set. Using the LASSO-identified predictors, an ordinal logistic regression model was created for categorical disease severity.

Exploratory analysis using LASSO and then multivariable logistic regression models using the most prevalent diagnoses in the study population as outcomes (hypertension, diabetes, psychiatric illness, and obesity) were also performed. Statistical analyses were completed using Stata, version 17.0. This study was approved by the Tufts Medical Center Institutional Review Board.

### Results

This cross-sectional study included 2497 patients who completed the social needs screener (Table 1). The average age was 46, patients were 68% female, 66% white, and 85% Hispanic or Latino. Sixty-nine percent of patients reported Spanish as their preferred language, 74% were Medicaid enrolled, and 55% had a CCI of 0. The most prevalent

TABLE 1. PATIENT DEMOGRAPHICS

	<i>N</i> = 2497 (%)
Age, mean ( $\pm$ SD)	46 ( $\pm$ 15)
18–29	426 (17)
30–39	501 (20)
40–49	514 (21)
50–59	531 (21)
$\geq$ 60	525 (21)
Preferred language (%)	
Spanish	1736 (69)
English	496 (20)
Other	26 (1)
Missing	239 (10)
Female	1701 (68)
Race (%)	
White	1655 (66)
Black/African American	647 (26)
Asian	31 (1)
Missing	161 (6)
Ethnicity (%)	
Not Hispanic or Latino	297 (12)
Hispanic or Latino	2118 (85)
Missing	82 (3)
Insurance (%)	
Medicaid	1853 (74)
Medicare	358 (14)
Private	112 (4)
Uninsured	174 (7)
Chronic disease (%)	
Cancer	95 (4)
Anemia	413 (17)
Diabetes	506 (20)
Hyperlipidemia	777 (31)
Substance use disorder	317 (13)
Psychiatric illness	1266 (51)
Hypertension	852 (34)
Cardiovascular disease	158 (6)
Obesity	1104 (44)
COPD	118 (5)
Asthma	322 (13)
Chronic kidney disease	161 (6)
CCI (%)	
None (0)	1367 (55)
Mild risk (1)	701 (28)
Moderate to severe risk ( $\geq$ 2)	429 (17)
Provider visits	
Mean ( $\pm$ SD)	28.0 ( $\pm$ 21.2)
Median (IQR)	23 (13–38)
Behavioral health visits	
Mean ( $\pm$ SD)	5.2 ( $\pm$ 7.0)
Median (IQR)	2 (1–6)
Social work visits	
Mean ( $\pm$ SD)	2.4 ( $\pm$ 3.1)
Median (IQR)	1 (1–2)
No shows	
Mean ( $\pm$ SD)	5.8 ( $\pm$ 6.0)
Median (IQR)	4 (1–52)

CCI, Charlson Comorbidity Index; COPD, chronic obstructive pulmonary disease; IQR, interquartile range; SD, standard deviation.

TABLE 2. PREVALENCE OF UNMET SOCIAL NEEDS

	<i>n</i> (%)
Housing concerns	549 (23)
Material/financial hardship	1331 (55)
Food insecurity	1648 (66)
Literacy concerns	761 (32)
Immigration concerns	221 (9)
Transportation	425 (18)
Utilities	252 (12)
Physical abuse	57 (3)
Social isolation	825 (43)
Mean unmet social needs ( $\pm$ SD)	3.3 ( $\pm$ 2.5)
0	493 (20)
1	315 (13)
$\geq 2$	1689 (67)

SD, standard deviation.

chronic illnesses in the study population were psychiatric illness, which included depression, anxiety, and post-traumatic stress disorder (51%), obesity (44%), and hypertension (34%). The prevalence of social needs is described in Table 2, with 80% of patients reporting at least 1 social need. Food insecurity (57%) and financial hardship (55%)

were the most frequently reported social needs. Table 3 shows the univariate and multivariable associations between each social need and chronic illness severity.

In univariate analyses, financial hardship (odds ratio [OR] 0.73), food insecurity (OR 0.83), and immigration concerns (OR 0.72) were significantly associated with a reduction in odds of chronic illness severity, while transportation (1.74) and literacy concerns (1.63) were associated with increased odds of chronic illness severity. The decreased odds for financial hardship, food insecurity, and immigration concerns were no longer significant in the multivariable models after adjusting for age, race, gender, language, and insurance type. In the multivariable models, housing (adjusted odds ratio [aOR] 1.23), literacy concerns (aOR 1.40), and transportation (aOR 1.86) were all associated with increased odds of chronic illness severity.

The LASSO model identified age, race, language, gender, insurance, transportation, and food insecurity as significant predictors of any chronic illness. Using these variables in a multivariable model, transportation (aOR 1.86, OR 1.66) was the only social need that remained significantly associated with chronic illness diagnosis (Table 3). Age (aOR 1.05) and Medicare insurance (aOR 2.44) were associated with higher odds of any chronic illness. Female gender was associated with lower odds (aOR 0.62). The area under the

TABLE 3. UNADJUSTED AND ADJUSTED ODDS RATIOS OF SOCIAL NEED AND CHRONIC ILLNESS SEVERITY

	<i>No chronic illness,<sup>a</sup> n (%)</i>	<i>Mild chronic illness,<sup>a</sup> n (%)</i>	<i>Moderate-severe chronic illness,<sup>a</sup> n (%)</i>	<i>OR (CI)</i>	<i>aOR<sup>b</sup> (CI)</i>
<b>Housing concerns</b>					
No	1059 (56)	502 (27)	324 (17)	Ref.	Ref.
Yes	283 (52)	171 (31)	95 (17)	1.15 (0.96–1.38)	1.23 (1.00–1.51)
<b>Material/financial hardship</b>					
No	569 (52)	303 (27)	229 (21)	Ref.	Ref.
Yes	773 (58)	370 (28)	188 (14)	0.73* (0.63–0.86)	1.00 (0.83–1.20)
<b>Food insecurity</b>					
No	564 (53)	286 (27)	218 (20)	Ref.	Ref.
Yes	786 (56)	409 (29)	209 (15)	0.83* (0.71–0.96)	0.92 (0.77–1.10)
<b>Literacy concerns</b>					
No	960 (58)	455 (28)	231 (14)	Ref.	Ref.
Yes	364 (48)	214 (28)	183 (24)	1.63* (1.38–1.92)	1.40* (1.16–1.70)
<b>Immigration concerns</b>					
No	1180 (54)	615 (28)	379 (17)	Ref.	Ref.
Yes	138 (62)	52 (24)	31 (14)	0.72* (0.55–0.96)	1.03 (0.75–1.41)
<b>Transportation need</b>					
No	1128 (57)	538 (27)	304 (15)	Ref.	Ref.
Yes	190 (45)	125 (29)	110 (26)	1.74* (1.43–2.12)	1.86* (1.49–2.32)
<b>Utilities</b>					
No	1010 (56)	480 (26)	324 (18)	Ref.	Ref.
Yes	133 (53)	89 (35)	30 (12)	0.99 (0.77–1.27)	1.05 (0.79–1.39)
<b>Physical abuse</b>					
No	1111 (55)	545 (27)	346 (17)	Ref.	Ref.
Yes	27 (47)	23 (40)	7 (12)	1.16 (0.72–1.88)	1.18 (0.69–2.04)
<b>Social isolation</b>					
No	615 (57)	280 (26)	186 (17)	Ref.	Ref.
Yes	475 (58)	227 (27)	123 (15)	0.94 (0.79–1.12)	0.96 (0.78–1.18)

<sup>a</sup>No chronic illness=0; mild chronic illness=1; moderate-severe chronic illness  $\geq 2$ .

<sup>b</sup>Adjusted for age, race, gender, language, and insurance.

\* $P < 0.05$ .

aOR, adjusted odds ratio; CI, confidence interval; OR, odds ratio.

curve for the new logistic regression model including the identified significant variables was 0.78, with the Hosmer–Lemeshow test *P*-value being 0.01.

Secondary analysis with LASSO-identified variables for the most prevalent individual diagnoses in the study population as the outcome (diabetes, hypertension, psychiatric illness, and obesity) is shown in Table 4. Transportation was the only significant social need in the adjusted models for diabetes and psychiatric illness. Food insecurity was significantly associated with obesity and there were no social needs that remained significant with hypertension.

**Discussion**

This study uses linked social needs screening and EMR data to identify which social needs are significantly associated with chronic illness. Overall, transportation was the only social need associated with increased odds of chronic illness severity, diabetes, and psychiatric illness. In secondary analysis, food insecurity was significantly associated with increased odds of obesity.

The study’s model highlights transportation as a critical need associated with increased risk of diagnosis with 1 or more chronic illnesses. A study by Xu et al evaluated the stability of social needs over time among FQHC participants in a prospective cohort study.<sup>19</sup> Their findings demonstrated that transportation was a persistent social need, changing

little over time compared with all other social needs. Transportation may be considered a more foundational need in relation to other more immediate needs, such as food or affording utility bills. To arrive at medical appointments, get to work, go to the grocery store, or pick up prescriptions, one must have reliable transportation.

While many social service organizations provide emergency food, or can help with utility bills, there is little in the way of social service offerings to provide transportation, especially to address transportation needs unrelated to health care. Access to reliable transportation has been shown to reduce households’ poverty exposure, and increases opportunities for employment.<sup>20,21</sup> This effect is magnified in rural areas, or areas with little public transportation infrastructure.<sup>22</sup> Food and housing interventions have shown associations in improving health outcomes,<sup>23–30</sup> yet the few transportation interventions have not shown similar improvements.<sup>31,32</sup>

Many studies have limited the intervention to transportation to medical appointments, neglecting the need for transportation to access groceries, employment, and other essential activities that have an impact on health outcomes. Social service interventions may benefit from a more holistic view of transportation barriers and its relationship with poverty and health.

The study sample included patients with extremely high visit rates. The median number of visits in the study is 23 over the 3-year study period, which is nearly 1 visit every 2 months. Prior studies have demonstrated high no-show rates

TABLE 4. ADJUSTED ODDS OF CHRONIC ILLNESS DIAGNOSIS FROM MULTIVARIABLE LOGISTIC MODEL WITH LEAST ABSOLUTE SHRINKAGE AND SELECTION OPERATOR PREDICTORS

	<i>Any chronic illness diagnosis</i>	<i>Hypertension</i>	<i>Diabetes</i>	<i>Psychiatric illness</i>	<i>Obesity</i>
Age, mean (±SD)	1.05 (1.04–1.06)*	1.11 (1.10–1.12)*	1.07 (1.06–1.08)*	1.01 (1.00–1.01)*	1.00 (1.00–1.01)*
Language					
Spanish	Ref.	Ref.	Ref.	Ref.	Ref.
English	2.18 (1.70–2.80)*	0.84 (0.62–1.13)	0.61 (0.43–0.85)*	2.79 (2.19–3.56)*	0.95 (0.76–1.18)
Other	0.37 (0.10–1.32)	1.30 (0.34–4.88)	0.13 (0.01–1.19)	0.58 (0.17–1.94)	0.33 (0.10–1.10)
Gender					
Male	Ref.	Ref.	Ref.	Ref.	Ref.
Female	0.62 (0.50–0.77)*	0.62 (0.49–0.79)*	0.54 (0.42–0.69)*	1.51 (1.23–1.85)*	1.60 (1.31–1.95)*
Race					
White	Ref.	Ref.	Ref.	Ref.	Ref.
Black or African American	1.28 (1.02–1.60)*	1.40 (1.08–1.81)*	1.07 (0.82–1.39)	0.86 (0.70–1.05)	1.24 (1.02–1.52)*
Other	0.88 (0.34–2.28)	1.56 (0.54–4.47)	2.88 (0.97–8.55)	0.19 (0.07–0.49)*	0.57 (0.23–1.41)
Insurance					
Medicaid	Ref.	Ref.	Ref.	Ref.	Ref.
Medicare	2.44 (1.71–3.47)*	1.18 (0.83–1.67)	1.03 (0.94–1.81)	2.27 (1.66–3.11)*	0.88 (0.66–1.18)
Private	0.91 (0.57–1.47)	0.78 (0.43–1.42)	0.53 (0.24–1.16)	0.77 (0.49–1.21)	0.90 (0.58–1.40)
Uninsured	0.96 (0.64–1.45)	0.68 (0.41–1.08)	0.67 (0.39–1.11)	0.86 (0.59–1.26)	0.72 (0.49–1.05)
Unmet social needs					
Food insecurity					
No	Ref.	Ref.	Ref.	Ref.	Ref.
Yes	0.83 (0.67–1.03)	0.97 (0.76–1.23)	1.14 (0.89–1.47)	1.10 (0.91–1.34)	1.21 (1.01–1.46)*
Transportation need					
No	Ref.	Ref.	Ref.	Ref.	Ref.
Yes	1.66 (1.28–2.15)*	1.22 (0.91–1.63)	1.44 (1.07–1.47)*	1.98 (1.54–2.55)*	1.11 (0.88–1.41)
Literacy concerns					
No	Ref.	Ref.	Ref.	Ref.	Ref.
Yes	1.12 (0.97–1.51)	0.87 (0.68–1.11)	0.87 (0.67–1.12)	1.26 (1.03–1.55)*	0.89 (0.73–1.09)

\**P* < 0.05.

and lower preventative care utilization among patients with unmet social needs, which have been hypothesized to contribute to worse health outcomes among a high social need population.<sup>33</sup> Lack of reliable transportation may also be an underpinning of no-show rates that has been demonstrated in other studies. These findings build on prior work identifying clusters of social needs across patient subgroups<sup>34,35</sup> and associations of individual social needs with chronic illnesses<sup>36</sup> or disease process outcomes.<sup>33</sup>

This study demonstrates high prevalence of concurrent social needs, with participants identifying an average of 3 unmet social needs. This further supports the concept of social needs clustering, where individuals rarely face unmet social needs in isolation, and therefore, single-referral solutions for each need are unlikely to make long-term improvements.<sup>33,37–39</sup>

This study does have limitations of note. First, it was conducted at a single FQHC that serves a predominantly Latinx population. Findings may not be generalizable to other populations. The study included 12 common chronic illnesses for the secondary analysis; not all possible chronic illnesses were captured and the analysis did not discriminate on disease severity. Exploration of individual illnesses or process outcomes may identify additional social needs in a similarly constructed model. The high frequency of clinic visits among the study sample suggests that patients may have a disproportionately high burden of chronic illness requiring more frequent visits and therefore may not represent standard health center patients.

The authors were not able to distinguish if the high visit rate was due to the poorly controlled chronic illness or due to the routine care for multiple chronic conditions. As a cross-sectional study, the study is not able to assess causality between transportation and the outcomes of interest. Results are limited to significant associations between social needs and chronic illnesses, and it is possible that reverse causality could explain the findings, that is, high disease burden could make transportation more difficult. The transportation measure specifically asks about transportation to health care appointments. It is possible that this may not accurately estimate all transportation-related needs.

Finally, 8 months of study data were collecting during the global coronavirus pandemic (April–December 2020), where patient check-in and screening processes were disrupted because all medical visits were conducted via telehealth. These pandemic circumstances likely decreased the overall data collection during the impacted months.

## Conclusion

As health care systems implement social needs screening and referral programs, it is critically important to use these data to better provide equitable health care to patients with unmet social needs. Understanding which social needs may be the most discriminant for health care outcomes, including morbidity and mortality, is of critical importance for time-constrained clinicians. Long, multi-item screening tools may not be the most efficient way to identify clinically relevant social needs in a diverse patient population, but instead, 1 or few select social needs can be prioritized.

Using novel statistical methods to identify which social needs are associated with chronic illness diagnoses, the

authors found that the transportation need was significant and may benefit from further study and increased attention in integrating social service delivery practices for at-risk populations to advance health equity.

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## Authors' Contributions

Concept and design: Dr. Byhoff and Prof. Tripodis. Acquisition, analysis, or interpretation of data: Prof. Xiao, Dr. Byhoff, Mr. Guardado, and Prof. Tripodis. Drafting of the article: Dr. Byhoff. Critical revision of the article for important intellectual content: Mr. Guardado, Dr. Nokes, Prof. Xiao, Prof. Tripodis, and Dr. Garg. Statistical analysis: Dr. Byhoff, Mr. Guardado, and Prof. Tripodis.

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## Supplementary Material

Supplementary Data

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