Community–Clinical Linkages: The Effects of the Healthy Here Wellness Referral Center on Chronic Disease Indicators Among Underserved Populations in New Mexico

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The majority of U.S. adults are living with at least one chronic condition, and people of color bear a disproportionate burden of chronic disease. Prior research identifies community–clinical linkages (CCLs) as a strategy for improving health. CCLs traditionally use health care providers to connect patients to community-based self-management programs. The purpose of this study was to examine the effectiveness of a centralized CCL system on health indicators and health disparities. Administrative health data were merged with referral system data to conduct a quasi-experimental comparative time series study with a comparison group of nonreferred patients. Interrupted time-series comparisons within referred patients were also conducted. Of the 2,920 patients meeting inclusion criteria, 972 (33.3%) received a referral during the study period (January 2019—September 2021). Hemoglobin A1c levels, used to diagnose diabetes, declined significantly among referred patients, as did disparities among Hispanic/Latinx participants compared with non-Hispanic White participants. No changes were observed in body mass index (BMI). Blood pressure increased among both referred and nonreferred patients. CCLs with a centralized referral system can effectively reduce markers of diabetes and may contribute to the maintenance of BMI. The observed increase in blood

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pressure may have been affected by the COVID-19 pandemic and warrants further study. Practitioners can work with community partners to implement a centralized CCL model, either on its own or to enhance existing clinician or community health worker-based models.

Keywords: Chronic Disease; Behavior Change; Community Intervention; Health Disparities; Health Equity; Health Promotion; Hispanic; Latinx; Outcome Evaluation; REACH—Racial and Ethnic Approaches to Community Health

BACKGROUND

In 2019, type 2 diabetes, heart disease, and hypertension accounted for nearly 900,000 deaths nationwide (Murphy et al., 2021), and more than half of United States adults are living with at least one chronic condition (Boersma et al., 2020). These conditions also put people at higher risk for severe illness and complications from COVID-19 infection (Centers for Disease Control and Prevention [CDC], 2020). Hispanic/Latinx individuals and Native Americans experience higher rates of obesity, hypertension, and type 2 diabetes than White, non-Hispanics (Dominguez et al., 2015; Indian Health Services, 2019). Social determinants of health, including access to care and the built environment, contribute substantially to disparities (Gomez et al., 2021; Office of Disease Prevention and Health Promotion, 2020). Finding effective ways to address social determinants of health, specifically among people of color, is critical to improving health and achieving health equity.

The Socio-Ecological Model (SEM) posits that individual behavior is affected by multiple spheres of influence including the individual, interpersonal, organizational, and community levels (Golden et al., 2015; Sallis et al., 2015). Addressing health behaviors affecting chronic disease, like physical activity and nutrition, can be done at the individual level (e.g., nutrition education), interpersonal level (e.g., provider influence), organizational level (e.g., health clinics), and community level (e.g., access to chronic disease self-management classes).

Community–clinical linkages (CCLs) are grounded in the SEM. There is evidence that CCLs maximize health care provider time and resources; increase patient access to community-based programs; and improve health outcomes (CDC, 2016; Sequist & Taveras, 2014). CCLs traditionally consist of three components, a health care provider, a patient, and a community resource (Buckley et al., 2013). Studies have examined the effects of CCLs on chronic disease health behaviors (Balcazar et al., 2010) and outcomes (de Heer et al., 2015; Ingram et al., 2017) using Community Health Workers (CHWs)/promotoras with positive results. However, it is time intensive for health care providers to identify and remain current with community-based chronic disease prevention and self-management programs, and their eligibility, availability, locations, and accessibility.

A centralized CCL system uses a referral center, specializing in receiving and managing referrals, as a hub to connect referred patients to community resources. The impact of this novel approach on measures of chronic disease, or on health disparities among Hispanic/Latinx and Native American populations, is unknown.

PURPOSE

The purpose of this study is to examine the effectiveness of a centralized CCL system on health indicators and health disparities. A centralized CCL system addresses chronic disease prevention at multiple levels of the SEM, and addresses social determinants of health by providing increased access to health care and opportunities for healthy eating and physical activity. The authors hypothesized that patients referred to the centralized CCL system would see decreases in measures of diabetes, obesity, and hypertension. Results will provide practitioners with evidence to support the use of centralized CCLs to improve health outcomes and health disparities.

METHODS

Design

We used a quasi-experimental comparative time series design with a comparison group of nonreferred patients and interrupted time series comparisons within referred patients. To leverage baseline health records data prior to intervention, we merged administrative data from clinical partners from January 1, 2018, to September 30, 2021, with referral data from the Wellness Referral Center (WRC) for the period of January 1, 2019, to September 30, 2021.

Eligibility Criteria

Individuals were eligible for this study if they (a) were at least 18 years old, (b) resided in a focus zip code, (c) were seen at a participating health clinic, and (4) had at least one elevated value for body mass index (BMI), systolic or diastolic blood pressure, or glycated hemoglobin (HbA1c).

Intervention

Healthy Here is a Racial and Ethnic Approaches to Community Health (REACH) initiative (O'Toole et al., 2022) to address chronic disease among low-income Hispanic/Latinx and Native American populations in Bernalillo County, New Mexico (NM). Healthy Here initiated one component, a centralized CCL system, in 2016. A description of the development and implementation of the system is available (Cruz et al., 2022). Briefly, the system includes a network of primary care clinics that refer patients to a central hub called the WRC. WRC staff contact referred patients and connect them with community-based organizations that provide nutrition education, physical activity opportunities, and chronic disease self-management programs. The referring clinics serve under-resourced, predominantly Hispanic/Latinx and Native American populations.

Consistent with guiding principles for CCLs (CDC, 2016) and public health interventions (Leask et al., 2019), a participatory approach was used throughout the process. Active partnerships with clinics, health care providers, and community organizations were used to increase referrals and program offerings over time. CCLs were strengthened through regular partner meetings, feedback, and evaluation. The intervention aligned with the SEM by incorporating individual-level education, health care provider and WRC support, organizational changes at the clinic level, and increased access to programming and opportunities for healthy eating and active living at the community level.

Procedures

Presbyterian Healthcare Services (PHS) provided clinical data from an Epic Clarity database (Epic, 2021), including vital signs, body measurements, diagnoses, medications, laboratory test results, and patient demographics. Similar data were not available from the clinics that serve large Native American populations in the focus zip codes, and therefore could not be used for analysis, although their patients and providers participated in the referral system. The WRC provided referral data from a Salesforce© database (Salesforce, 2021) including date referred, program referrals, and program registration, attendance, and completion. A PHS data analyst obtained, extracted, cleaned, and transformed the clinical data and merged it with WRC referral data through a generated unique identifier using SAS software. The final data set included data for (1) PHS patients referred to the WRC who participated in community-based programs, (2) PHS patients referred to the WRC who *did not* participate in community-based programs, and (3) PHS patients who were not referred but met eligibility criteria. This de-identified data set was transferred through a secure file transfer protocol to the University of New Mexico (UNM) Prevention Research Center evaluation team for analysis.

Data were screened for missing and extreme values for the health outcomes of interest: BMI, systolic and diastolic blood pressure, and HbA1c. Prior to the calculation of BMI, height and weight measures were screened for extreme values, and height values were screened for accuracy following a validated algorithm (Muthalagu et al., 2014). Missing height values were imputed using age-adjusted linear interpolation. To minimize the use of values reflecting acute exacerbation, blood pressure values were retained if measured in primary or specialty care settings, excluding, for example, values obtained in emergency care.

Measures

Patients were classified as having an elevated value for a study outcome if BMI was $\geq$25, systolic blood pressure was $\geq$140, diastolic blood pressure was $\geq$90, or HbA1c was $\geq$5.7 at any point in the study period. To allow for the possibility of time-dependent shocks, the study period was divided into 15 yearly quarters. Consistent with a study focus on health disparities for Hispanic/Latinx and Native American populations, race/ethnicity was categorized as non-Hispanic White, Hispanic/Latinx, Native American, and "Other." Details of patients that comprised the "Other" category are in Table 1. Sex was coded into the two available categories, female and male, and age was calculated using date of birth. For each outcome of interest, the 7,269 drugs in the data set were coded as 1 if indicated for the outcome or 0 if not indicated. Each drug was coded as 1 if identified as a common adverse event for an outcome, or 0 if not a common adverse event for that outcome. An independent reviewer conducted quality control, reviewing a random sample of 10% of the pharmaceutical data. A complete description of the pharmaceutical data methodology is in the supplemental materials.

Data Analysis

Descriptive statistics were used to characterize the referred and nonreferred patients. We used Pearson's chi-square tests to compare frequency distributions between groups and independent samples *t*-tests to compare means between groups. Using an intent-to-treat approach, patients were considered referred if they received a referral to the WRC during the study period, regardless of referral utilization, and patients were considered "pre-referral" at all time points prior to the first WRC referral. Per the study protocol, paired samples *t*-tests were used to compare mean levels of study outcomes within

referred patients between the last available measurement prior to referral and the first available measurement at least 180 days after referral.

In addition, we used weighted, mixed effects linear regression models to compare time trajectories of study outcomes between referred and nonreferred patients. These models included fixed effects for demographics and medications, full interaction terms between an indicator of referral in a prior quarter and quarterly time indicators, and patient- and patient-day-level (if there were multiple measures on the same day) random effects for all outcomes. The use of mixed effects due to nested levels of observation is consistent with the SEM. In addition, an indicator variable was included for specialty care versus primary care setting for blood pressure outcomes. Consistent with recommendations from the literature (Linden & Adams, 2011; Pirracchio et al., 2011; Zhang et al., 2020), we calculated time-dependent inverse probability weights based on non-parsimonious logistic regression models for referral propensity within each study quarter for inclusion into these mixed effects models. Consistent with recommendations from the health survey literature (Mang et al., 2021) for the use of weights in multilevel models, all time-dependent inverse probability weights were scaled based on effective cluster sample size prior to model incorporation. We conducted Wald tests to assess the joint significance of interaction terms, and binomial probability tests to test null hypotheses of no directionality in sign for interaction terms. Tests were conducted across all interaction terms and across the six interaction terms corresponding to study quarters within the period of the COVID-19 pandemic. This analysis allowed for study of effects associated with the pandemic period as programming was forced to pivot and external contexts changed substantially (O'Toole et al., 2022). Stata 17.0 was used for statistical analyses and $\alpha = .05$ was the threshold for statistical significance. The UNM Human Research Protections Office approved the study.

TABLE 1
Demographic and Clinical Characteristics of Study Participants, 2018–2021, by End-Of-Analysis Referral Status ($N = 2920$)

	n (%)	
Characteristic	*Not referred to WRC*	*Referred to WRC*
n	1948	972
Age, *M* (*SD*)	55.42 (18.82)	55.18 (16.27)
Race/ethnicity		
Non-Hispanic White	586 (30.1)	174 (17.9)
Hispanic/Latinx	1159 (59.5)	716 (73.7)
Native American	30 (1.5)	22 (2.3)
Other[a]	175 (9.0)	63 (6.5)
Gender		
Female	1124 (57.7)	691 (71.1)
Male	824 (42.3)	281 (28.9)
Count of key elevated values		
One	734 (37.7)	159 (16.4)
Two	542 (27.8)	260 (26.8)
Three	430 (22.1)	283 (29.1)
Four	242 (12.4)	270 (27.8)
Prescribed meds treating[b]		
Blood pressure	1074 (55.1)	715 (73.6)
Obesity	322 (16.5)	433 (44.6)
Diabetes	419 (21.5)	491 (50.5)
Prescribed meds with side effects on[b]		
Blood pressure	1643 (84.4)	929 (95.6)
Obesity	1184 (60.8)	771 (79.3)
Diabetes	1352 (69.4)	866 (89.1)

Note. WRC = Wellness Referral Center.
[a] Includes 7 multi-racial, 67 African American or Black, 30 Asian, 3 Native Hawaiian or other Pacific Islander, 43 designated "Other" in the database, and 88 designated as "Unknown."
[b] Medication categories are not mutually exclusive. Within-column percentages may add to more than 100%.

RESULTS

A total of 2,920 patients met study inclusion criteria, with 972 (33.3%) receiving a referral to the WRC during the study period. Among referred patients, 391 (40.2%) referrals were made in 2019, 345 (35.5%) in 2020, and 236 (24.3%) in the first three quarters of 2021. Half ($n = 494$; 50.8%) were made in the six study quarters that occurred during the COVID-19 pandemic.

Table 1 displays demographic characteristics and clinical data for study participants. Patients referred to the WRC were statistically significantly ($p < .001$) more likely to be Hispanic/Latinx (73.7% vs. 59.5%), female (71.1% vs. 57.7%), show multiple elevated values for study outcomes (83.6% vs. 62.3%), and be prescribed medications impacting study outcomes compared to nonreferred patients. The average age for patients in both groups was 55 years, $t(2918) = 0.34$, $p = .74$. A majority of the study sample was female, Hispanic/Latinx, and prescribed medication to treat blood pressure at some point during the study period.

TABLE 2
Average Treatment Effects Among the Treated. Pre/Post Study Outcomes, Overall and by Race/Ethnicity, Within Referred Patients, 2019–2021 (N = 972)

Study outcome	*Total sample*	*Non-Hispanic White*	*Hispanic/Latinx*
A1C			
n	423	76	319
Pre, *M* (*SD*)	7.30 (2.03)	6.82 (1.50)	7.43 (2.13)
Post, *M* (*SD*)	7.17 (2.05)	7.02 (2.07)	7.16 (1.98)
Pre vs. Post, *t*	–1.69	1.35	–2.95**
Body mass index			
n	637	118	469
Pre, *M* (*SD*)	34.18 (8.27)	34.14 (8.75)	34.29 (8.16)
Post, *M* (*SD*)	34.20 (8.49)	34.33 (9.60)	34.30 (8.22)
Pre vs. Post, *t*	0.22	0.70	0.09
Systolic blood pressure			
N	656	117	486
Pre, *M* (*SD*)	126.74 (15.90)	125.31 (16.84)	126.94 (15.67)
Post, *M* (*SD*)	129.97 (16.53)	130.02 (17.53)	129.72 (16.31)
Pre vs. Post, *t*	4.81***	2.54*	3.75***
Diastolic blood pressure			
n	656	117	486
Pre, *M* (*SD*)	75.08 (10.31)	74.98 (10.55)	74.95 (10.16)
Post, *M* (*SD*)	76.21 (11.20)	77.01 (11.87)	75.74 (10.84)
Pre vs. Post, *t*	2.32*	1.57	1.47

Note. Pre-referral measure is at the last available time point prior to initial referral; Post-referral measure is at the first available time point after 180 days after initial referral.
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 2 displays average treatment impacts among referred patients with observed values for study outcomes prior to referral and at least 180 days after referral. Blood pressure values showed statistically significant increases of, on average, approximately three points for systolic blood pressure and about one point for diastolic blood pressure for the overall sample. Systolic blood pressure increased, on average, statistically significantly for both non-Hispanic White (approximately 5 points) and for Hispanic/Latinx patients (approximately 3 points). In contrast, the average BMI of 34 remained unchanged for both non-Hispanic White and Hispanic/Latinx patients, and for the overall sample. HbA1c was observed to decrease significantly within the Hispanic/Latinx sample.

The difference-in-differences between the average increase of .2 points in HbA1c in the non-Hispanic White sample and the average decrease of .3 points in the Hispanic/Latinx sample was also statistically significant, $t(393) = 2.34$, $p = .02$; Figure 1.

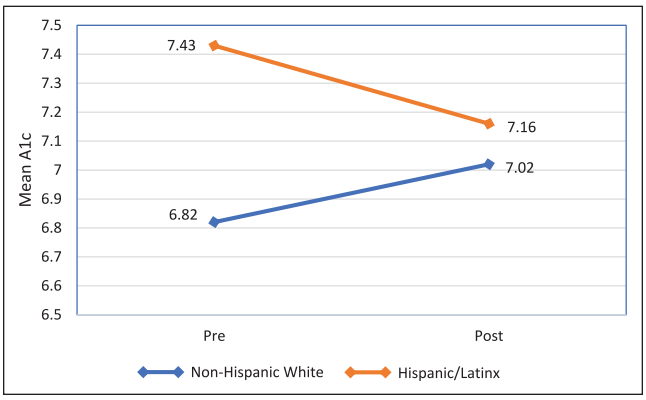

FIGURE 1 Pre/Post Trends in Mean A1c by Race/Ethnicity Within Patients Referred to the Wellness Referral Center, 2019–2021

To account for nonequal and shifting probabilities of referral over time, we calculated time-dependent propensity-based inverse probability weights prior to

fitting regression models. Logistic regression models for probability of referral were statistically significant for all quarters in which referral was possible, with $p < .005$ for the overall model in a majority of quarters (7 of 11). In contrast to the values in Table 1, inverse probability weighted values for characteristics generally did not show statistically significant differences between referred and nonreferred patients. After weighting, only number of diagnoses remained a statistically significant individual predictor of quarterly referral, with attenuated significance, $\chi^2(4) = 9.53$, $p = .05$ versus $\chi^2(4) = 137.32$, $p < .001$ for an unweighted model. Across the 16,135 calculated weights, the mean weight was 2.00 ($SD = 3.18$), and large weights were relatively rare with a maximum weight of 144.78; only three weights exceeded 100.

Across the 10 study quarters in which having a referral in a previous quarter was possible, Figure 2 displays the regression model–based magnitude of the relative impact of referral for the overall sample and the non-Hispanic White and Hispanic/Latinx subsamples, adjusting for impacts of referral propensity, contemporaneous presence of outcome-impacting medication, and demographics. Results were mixed, but there was some evidence of beneficial impact within the Hispanic/Latinx subsample. Although, in the overall sample, we observed consistent increases in HbA1c (positive coefficients in 9 of 10 study quarters including all COVID-19 study quarters), among the Hispanic/Latinx subsample, a statistically significant decrease in HbA1c was observed (negative coefficients in 9 of 10 study quarters including all COVID-19 study quarters). For BMI, we did not observe a consistent direction of impact in any model over the entire study period; however, omnibus relative impacts of referral were statistically significant within the six study quarters occurring during the COVID-19 pandemic for the overall sample, $\chi^2(6) = 13.16$, $p = .04$, and the Hispanic/Latinx subsample, $\chi^2(6) = 12.72$, $p = .05$. Models for systolic blood pressure demonstrated neither consistent directionality nor significant omnibus relative impacts of referral. In contrast, although statistically significant impacts of referral were not observed in any model for diastolic blood pressure, statistically significant consistency in direction of impact was observed in all models. Regression coefficients for the relative impact of referral were positive in both the overall sample and the non-Hispanic White subsample for all COVID-19 study quarters ($p = .03$), and 9 of 10 study quarters ($p = .02$) in the non-Hispanic White subsample. The Hispanic/Latinx subsample showed statistically significantly consistent decreases, having negative regression coefficients for the relative impact of referral on diastolic blood pressure in 9 of 10 study quarters ($p = .02$) and all COVID-19 study quarters ($p = .03$).

DISCUSSION

This study demonstrates that a centralized CCL model can improve HbA1c, particularly among Hispanic/Latinx participants, and contribute to maintenance of BMI. The Healthy Here wellness referral system used health care providers from primary care clinics to refer patients with hypertension, overweight, obesity, diabetes, or prediabetes for community-based chronic disease management and prevention programs. The intervention included individual-level nutrition and physical activity programming, interpersonal activities with social support, organizational changes to promote participation, and community-level access to increase opportunities for improved nutrition and active living. This is consistent with prior interventions using the SEM to promote physical activity (Pratt et al., 2015) and healthy eating (Bowen et al., 2015).

Consistent with our hypothesis and the limited literature (Ingram et al., 2017), HbA1c showed a statistically significant reduction among Hispanic/Latinx participants. As Hispanic/Latinx individuals experience higher rates of diabetes compared with non-Hispanic White individuals, the ability to reduce HbA1c can have a substantial impact. In fact, in this study, the decrease in HbA1c among the Hispanic/Latinx participants, combined with a nonsignificant increase in HbA1c among non-Hispanic White participants, resulted in a reduction in health disparity for this indicator. Specifically, Hispanic/Latinx participants had an HbA1c 8.9% higher than non-Hispanic Whites pre-referral. This disparity narrowed to 2.0% postintervention. More research is needed to see if that reduction can be maintained and replicated.

Previous research shows that lifestyle intervention programs have limited success in affecting BMI (Burgess et al., 2017). Although individuals in our study did not experience a reduction in BMI during the study period, maintaining BMI was interpreted as a success for two reasons. First, BMI tends to increase with age, and second, recent research on the COVID-19 pandemic found statistically significant increases in BMI following shelter-in-place orders, likely due to decreased physical activity and increased food consumption (Bhutani et al., 2021; Lin et al., 2021; Seal et al., 2022). One study only observed this among women (Mulugeta et al., 2021). Evaluating the effects of the WRC in the future, after pandemic-related precautions are eased, may provide further insights.

Results for blood pressure were not consistent with prior research on referrals to community-based chronic disease self-management programs (Balcazar et al., 2010; de Heer et al., 2015). Both referred and nonreferred patients experienced an increase in systolic and

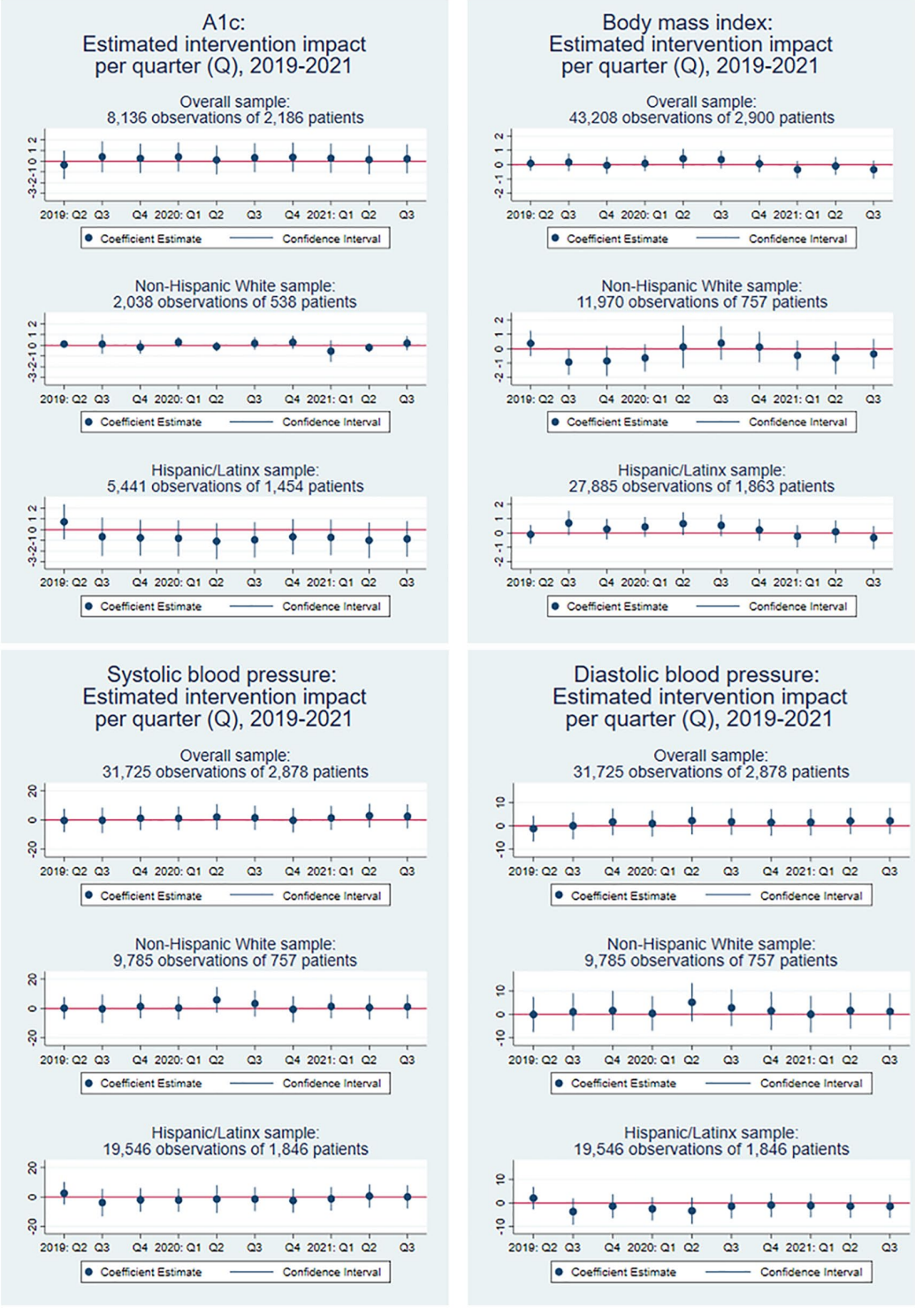

FIGURE 2 Regression Model–Based Estimates of the Impact of Referral in a Previous Quarter Across Study Outcomes and by Race/Ethnicity: Quarter 2 of 2019 Through Quarter 3 of 2021

diastolic blood pressure over time. This is consistent with research on the effects of the COVID-19 pandemic (Laffin et al., 2022; Shah et al., 2022) which occurred concurrently with the intervention. Blood pressure is a sensitive measure. Individuals may have experienced an increase in blood pressure due to pandemic-related stressors, postponed health care visits, or delays in filling prescriptions (Gonzalez et al., 2020). One promising outcome was the statistically significant direction of comparative decreases in diastolic blood pressure associated with referral among the Hispanic/Latinx intervention participants. Further research is needed to understand this effect.

Finally, the referred sample in our study was significantly different from the nonreferred sample. Individuals referred to the WRC were more often female, which may reflect a bias among health care providers regarding whom they offer referrals to, or a greater willingness among women to accept referrals for community-based programs (Pavey et al., 2012). Referred patients were also sicker than nonreferred patients. This was anticipated, as health care providers would more likely see a need for referral among patients with multiple elevated indicators, and patients may more readily accept a referral to address multiple health issues.

Limitations

Use of secondary data precluded the ability to collect medical data on a specific schedule. Therefore, measures were considered postintervention if they were collected at least 180 days (approximately 6 months) following referral under the assumption that this would allow sufficient time for participants to be enrolled in and to begin to see effects of programming. Because the types and availability of programming differed, this allowed for variation in dose. In addition, because individuals visited clinics with differing frequencies, a more complex study design was needed to account for variation in available data by patient over time.

Data were not available from the clinics that serve large Native American populations in the focus zip codes. Therefore, there was insufficient information to determine any effects of the intervention among Native Americans. A long-standing history of data misuse by researchers, a tendency to conduct research focused on deficits, and issues of data sovereignty make access to Native American health data complex and challenging. A long-term Healthy Here partner and clinic serving Native Americans provided referral data (Cruz et al., 2022). Clinic leadership, PHS, and the Healthy Here evaluation team are working to identify ways to include health data from clinics serving Native Americans in the future.

Strengths

This study successfully implemented a centralized CCL system serving two under-resourced majority Hispanic/Latinx communities. The study was grounded in the SEM, focused on social determinants of health, and was led by a collaboration rooted in community and health equity. The study used a large, de-identified data set, with an appropriate comparison population. The study also employed a complex design and analysis to account for changes over time, and used a rigorous process to classify and control for the effects of medications on outcomes of interest.

Implications for Public Health Research, Policy, and Practice

This study demonstrates that using an innovative centralized CCL model in under-resourced, majority Hispanic/Latinx communities can result in a significant decrease in HbA1c, particularly among Hispanic/Latinx participants. Results for BMI and blood pressure were more equivocal, and warrant further study. Increased use of a centralized CCL model to address chronic disease and health disparities necessitates the collaboration of multiple partners, including those experienced in receiving, managing, and tracking referrals. Communities with existing clinician or CHW CCL models may consider enhancing their systems with a centralized hub to expand reach and capitalize on the expertise of referral center staff. Implementing organizational policies to encourage routine referral of patients to centralized CCLs and developing data sharing agreements among organizations are important steps toward realizing reductions in chronic disease and related disparities.

Note

The authors would prefer to use Hispanic/Latinx instead of Latino if permitted, to be consistent with the manuscript.

Compliance With Ethical Standards

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The University of New Mexico Human Research Protections Office approved the study (approval number 20-090).

Tweet

Referral to the Healthy Here Wellness Referral Center is associated with a reduction in hemoglobin A1c, a blood test for diabetes. The reduction among Hispanic/Latinx participants was strong, resulting in a reduction in disparities.

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Supplemental Material

Supplemental material for this article is available online at https://journals.sagepub.com/home/hpp.

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