Evaluation of an Integrated Intervention to Address Clinical Care and Social Needs Among Patients with Type 2 Diabetes



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BACKGROUND: The Providence Diabetes Collective Impact Initiative (DCII) was designed to address the clinical challenges of type 2 diabetes and the social determinants of health (SDoH) challenges that exacerbate disease impact.

OBJECTIVE: We assessed the impact of the DCII, a multifaceted intervention approach to diabetes treatment that employed both clinical and SDoH strategies, on access to medical and social services.

DESIGN: The evaluation employed a cohort design and used an adjusted difference-in-difference model to compare treatment and control groups.

PARTICIPANTS: Our study population consisted of 1220 people (740 treatment, 480 control), aged 18–65 years old with a pre-existing type 2 diabetes diagnosis who visited one of the seven Providence clinics (three treatment and four control) in the tri-county area of Portland, Oregon, between August 2019 and November 2020.

INTERVENTIONS: The DCII threaded together clinical approaches such as outreach, standardized protocols, and diabetes self-management education and SDoH strategies including social needs screening, referral to a community resource desk, and social needs support (e.g., transportation) to create a comprehensive, multi-sector intervention.

MAIN MEASURES: Outcome measures included SDoH screens, diabetes education participation, HbA1c, blood pressure, and virtual and in-person primary care utilization, as well as inpatient and emergency department hospitalization.

KEY RESULTS: Compared to patients at the control clinics, patients at DCII clinics saw an increase in diabetes education (15.5%, p<0.001), were modestly more likely to receive SDoH screening (4.4%, p<0.087), and had an increase in the average number of virtual primary care visits

Prior Presentations We confirm that this work is original and has not been published elsewhere or been presented at any prior conferences, nor is it under consideration for publication elsewhere.

Received October 10, 2022 Accepted October 31, 2022 Published online March 2, 2023 of 0.35 per member, per year (p<0.001). No differences in HbA1c, blood pressure, or hospitalization were observed. **CONCLUSIONS:** DCII participation was associated with improvements in diabetes education use, SDoH screening, and some measures of care utilization.

KEY WORDS: Diabetes mellitus; Health disparities; Social determinants of health.

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INTRODUCTION

Type 2 diabetes is one of the most widespread and fastest growing chronic conditions in the United States (U.S.), with an estimated 34.1 million Americans living with type 2 diabetes in 2018.^{1–3} The ubiquity of diabetes has immense health and economic consequences. Individuals with diabetes report poor health-related quality of life at seven times the rate of those without chronic conditions,⁴ describe the experience of living with diabetes as one requiring significant lifestyle change and sacrifice,⁵ and spend nearly three times more on healthcare than the U.S. population average.^{6,7} Moreover, while diabetes is prevalent and costly, the burden of disease is not evenly distributed evenly across the U.S. population.

Factors associated with diabetes prevalence and outcomes are multidimensional, and there is increasing recognition that diabetes is not only biologically determined but is also deeply influenced by broader social factors.^{8,9} Also known as social determinants of health (SDoH), these factors shape access to resources, choices, and opportunities available to individuals and communities to manage their health. Existing literature on the association between SDoH and increased diabetes incidence, poorer self-management, and worse outcomes is extensive and includes the roles of housing and the larger built environment, food accessibility and security, and healthcare affordability and quality.^{10–14}

Socioeconomic (SES) status is particularly salient when understanding SDoH needs. People who face socioeconomic disadvantage are more likely to experience social needs.¹⁰ A recent study of Medicaid recipients found high rates of social need: more than 87% of the sample reporting at least one SDoH need and more than half of respondents reporting three or more social needs.¹⁵ Low SES and SDoH need not only impact diabetes outcomes,^{11,12,14,16,17} but also create barriers to effective diabetes care management. Low SES and high SDoH needs are associated with reduced access to diabetes education, lack of a regular provider, decreased adherence to preventative screenings, and higher levels of hospitalization.^{14–16,18,19}

Diabetes and socioeconomic disadvantages can be cyclical and self-reinforcing. Poverty creates stress, which can produce biological responses associated with diabetes, and diabetes in turn can create financial burdens further intensifying poverty; poverty can also create barriers to accessing the resources most necessary to manage diabetes like adequate housing, quality healthcare, and healthy food.²⁰ Thus, the same communities that face the largest disparities in diabetes prevalence and outcomes are often the same communities that face the greatest SDoH-related inequities.

Given the connection between SES, social need, and outcomes, the need for clinicians to consider SDoH when treating patients with diabetes is increasingly recognized. The American Diabetes Association has issued a call for research that investigates how SDoHs "influence behaviors and how the relationships between these variables might be modified for the prevention and management of diabetes."²¹ Preliminary evidence supports the role of addressing social needs on improving diabetes outcomes. Interventions addressing housing,^{10,22} food access,²³ and leveraging a community-based work force²⁴ have led to positive impacts on diabetes including lower HbA1c levels. Even so, research on social interventions and diabetes care is relatively scarce, particularly in clinical settings.^{14,25}

Altogether, current research highlights that SDoH impact diabetes prevalence and outcomes, social needs interventions can improve diabetes outcomes, and programs designed to address the multiple dimensions of diabetes are scarce but can be effective. This study combines these elements to better understand how programs that blend social and clinical interventions can reduce disparities in diabetes care and outcomes.

We assessed the impact of the Providence Diabetes Collective Impact Initiative (DCII), a diabetes treatment intervention that employed both clinical and SDoH strategies, on access to medical and social services. The DCII prioritized patients with type 2 diabetes and social needs, using Medicaid status as a proxy for potential SDoH need, at three pilot clinics located in high-needs areas in Portland, Oregon. The three participating clinics were all family medicine clinics operated by Providence and served lowincome and vulnerable community members.

METHODS

The DCII combined strategies to create a comprehensive, multi-sector intervention designed to simultaneously address the clinical challenges of diabetes and the SDoH challenges that exacerbate its impact on low-income and underserved populations (see Fig. 1). They designed the DCII intervention to incorporate (1) programmatic efforts area clinics already had in place that leaders hoped to expand, (2) approaches that aligned with system strategies and metrics, and 3) activities that leveraged funding from other sources to test new components.

Clinical Interventions

Identifying Care Gaps and Conducting Clinical Outreach. Using an existing diabetes registry in the electronic medical record (EMR) system, intervention sites proactively scanned patients living with diabetes who had clinical care gaps, including patients overdue for one or more of the following: an HbA1c test, a blood pressure measurement, a cholesterol test, a foot exam, or an eye exam. When a care gap was identified, a medical assistant proactively reached out to that patient via telephone to schedule the patient. Additionally, the DCII implemented a clinical *in-reach* program designed to make providers aware of diabetes care gaps for any patients on their daily schedule. Each morning, the EMR generated an automated in-reach report for each scheduled patient which listed of all diabetes care gaps that could be closed during the upcoming visit.

Standardized Care Pathways. Order sets in the EMR-guided primary care providers along the Providence Standardized Pathways for Diabetic Care. Pathways included prompts referring patients to a range of existing resources within the system, such as pharmacists, social workers, or behavioral health specialists, as well as new programs and interventions featured in the DCII, such as referral to address identified social needs.

Diabetes Self-management Education and Tools. The DCII proactively connected patients living with diabetes with an outstanding diabetic education referral to a diabetes self-management education program. The program offered inperson and virtual, multilingual counseling and education for patients and their families; support groups designed to improve diabetes self-management outcomes; and access to virtual and hands-on culinary nutrition education, including supplemental food/recipe bags.

Social Determinants of Health Interventions

SDoH Screening. Using a set of validated questions embedded into existing clinical workflows, primary care teams systematically screened patients for SDoH needs, including food, housing, utilities, and transportation.^{26–29} Patients who screened positive were directed to the



Figure 1 The Providence Diabetes Collective Impact Initiative (DCII). Abbreviations: PMG, Providence Medical Group; SDoH, social determinants of health

Community Resource Desk (CRD), an on-site resource center staffed by a community social service agency.

Community Resource Desks. Staffed by full-time multilingual and multicultural resource specialists employed by community partners on site at Providence facilities, the CRD supported people with navigating community services such as nutrition assistance, housing and employment support, and dental care. Patients could self-identify, be referred after screening positive for an SDoH need, or otherwise referred by any healthcare provider or clinic staff member. Using motivational interviewing and trauma-informed care, the CRD resource specialists employed person-centered approaches to identify and prioritize resource needs and develop customized action plans aligned to the individual's circumstances.

Diabetic Transportation Program. Based on past partnerships, and demonstrated success operating a dialysis transportation program, the DCII partnered with a community partner which offers accessible transportation for vulnerable populations to streamline transportation services for patients living with diabetes. Through the partnership, patients, and clinical staff could reach a real-time dedicated mobility specialist to navigate transportation solutions, including travel to medical appointments, pharmacy visits, grocery stores, and food box deliveries.

Study Design and Population

The evaluation employed a cohort design with patients assigned to treatment or control groups based on the initial clinic they visited. The DCII was implemented at three Providence clinics in the Portland tri-county area. Four clinic sites in the Portland tri-county areas were selected as control sites to represent usual care groups. These sites were selected because they had not implemented elements of the DCII intervention at baseline and served similar patient demographics as the treatment clinics.

Our study population consisted of 1220 people (740 treatment, 480 control) of which 813 were enrolled in Medicaid (513 treatment, 300 control), all adults aged 18–65 years old with a pre-existing type 2 diabetes diagnosis who visited one of the seven Providence clinics (three treatment and four control) in the Portland tri-county area between August 2019 and November 2020. Patients who had a visit at one of the treatment clinics were considered part of the treatment group. Similar patients who had a visit at a control clinic were considered part of the control group. This study was reviewed and approved by the Providence Institutional Review Board (#2019000135).

Data Source

EMR data were used both to identify eligible participants and assess key health and healthcare measures at baseline (12 months prior to their qualifying visit) and follow-up (12 months following the qualifying visit). We constructed data summaries on all study participants at baseline retrospectively capturing their last 12 months of healthcare utilization, then again for their 12 months post-baseline.

Measures

The primary predictor variable was clinic assignment according to the initial visit. Intermediate outcomes measures included SDoH screens (prevalence of individual SDoH questions was too low for analysis), referrals to the CRD, referrals to a diabetic educator, and receiving diabetic education. Impact measures included HbA1c levels, blood pressure, primary care utilization (divided into virtual and in-person care), and hospitalization (divided into inpatient and emergency department care). EMR data also stores information on patient age, race, ethnicity, sex, and language; all of which were used as covariates for modeling.

ED PMPY utilization (mean [SD])

Had ED event (% [SD])

Statistical Analysis

We described the demographic, clinical, and utilization outcomes for the population at baseline. The demographic variables age, race, ethnicity, sex, and language were all captured at the time of the qualifying visit. The clinical outcomes were a simple average of metrics in the 12 months preceding the qualifying visit and the utilization outcomes were calculated as per member per year (PMPY) for the same 12-month period. We used an adjusted difference-in-difference (DiD) model to compare our treatment and control groups. Our DiD models used generalized estimating equations (GEE) for robust standard errors accounting for patients being in the data more than once. The models also used an interaction term between clinic group and time (baseline or follow-up) to understand how these health outcomes changed over time in the treatment group relative to the control group. The models also adjusted for age, race, sex, and language. Ethnicity was excluded as a confounding variable because of the

collinearity with race. The entire analysis was repeated with a subgroup of patients who were Medicaid insured in EMR data. All analysis was conducted in R 4.1.1.

RESULTS

Most of the sample was over the age 45 (mean: 51.56), female, spoke English as their primary language, and identified as White (Table 1). Demographics were mostly similar across treatment and control clinics. More patients at treatment clinics spoke Spanish as their primary language (10.8% vs. 7.3%), with a higher proportion of patients identifying as Black (12.9% vs. 8.0%), and less identifying their race as "other" (17.9% vs. 24.5%) relative to those at the control clinics. In the Medicaid subgroup, trends in primary language and race were similar.

0.68 [1.35]

35.0% [47.8%]

35.7% [48.0%]

0.81 [2.43]

	Overall		Medicaid only		
	Control (<i>n</i> =480) % (95% C.I.)	Treatment (<i>n</i> =740) % (95% C.I.)	Control (<i>n</i> =300) % (95% C.I.)	Treatment (n=513) % (95% C.I.)	
Age group					
45 and under	24 2% (20 6-28 2)	25 4% (22 4-28 7)	27 7% (22 9-33 0)	28 1% (24 4-32 1)	
46-55	33.3% (29.3–37.7)	34.9% (31.5–38.4)	31.7% (26.7–37.2)	34.5% (30.5–38.7)	
56-60	22.9% (19.4–26.9)	21.1% (18 3–24 2)	22.7% (18 3–27 8)	19.9% (16.7–23.6)	
Over 60	19.6% (16.3-23.4)	18.7% (16.0–21.6)	18.0% (14.1–22.8)	17.5% (14 5–21 1)	
Mean [SD]	516 [9 41]	51 1 [9 84]	50.7 [10.0]	50 40[10 1]	
Sex	51.0 [5.11]	51.1 [5.64]	50.7 [10.0]	50.10[10.1]	
Female	54.0% (49.5-58.4)	56.8% (53.2-60.3)	58 3% (52 7-63 8)	60.0% (55.7-64.2)	
I anguage	54.070 (49.5-50.4)	50.8% (55.2 00.5)	56.570 (52.7-65.6)	00.070 (35.7-04.2)	
English	873% (840.900)	81.0% (78.0.83.6)	86.3% (82.0.90.0)	70.1% (75.4.82.4)	
Spanish	7.3% (34.0-90.0)	10.9% (8.9, 12.2)	7.7% (5.2, 11.2)	12.1% (0.5, 15.2)	
Other	5.10% (3.3-10.0)	8.2% (6.5 10.5)	6.0% (3.8.0.2)	8.8% (6.6, 11.6)	
Page	5.4% (5.7-7.8)	8.2% (0.5–10.5)	0.0% (3.8-9.3)	8.8% (0.0–11.0)	
White	5670 (522 610)	55 80% (52 2 50 4)	55 70% (50 0 61 2)	50.70% (16.1.55.0)	
Plash	12.0% (10.2, 16.2)	33.8% ($32.2-39.4$) 8.0% ($6.2, 10.2$)	15.0% (11.4.10.5)	50.7% (40.4–55.0) 0.6% (7.2, 12.4)	
Diack	12.9% (10.2–10.2)	8.0% (0.2-10.2)	13.0% (11.4-19.3)	9.0% (7.5–12.4)	
Asian	8.3% (0.4-11.4)	9.9%(7.9-12.2)	0.7% (4.5-10.1)	8.8% (0.0-11.0)	
Uner	1/.9% (14. -21.0)	24.5%(21.5-27.7)	19.0% (13.0-23.8)	28.7% (24.9–32.7)	
	4.0% (2.3-0.1)	1.9% (1.1–3.2)	3.1% (2.1-0.3)	2.5% (1.3-4.1)	
Ethnicity Net Heneric	82.50 (78.8.95.6)	70.10 (7(0.01.0)	82.20 (77.6.86.2)	7(20) (72 2 70 7)	
Not Hispanic	82.5% (78.8-85.6)	/9.1% (/6.0-81.8)	82.3% (77.6-86.3)	76.2% ($72.3-79.7$)	
Hispanic	14.6% (11.7-18.0)	18.9% (16.3–21.9)	15.3% (11.7-20.0)	21.6% (18.3–25.4)	
	2.9% (1.7-4.9)	2.0% (1.2–3.3)	2.3% (1.1–4.8)	2.1% (1.2–3.8	
INTERMEDIATE MEASURES	1.50 (0.7.2.0)	2(10) (22.0.20.4)			
SDOH screen	1.5% (0.7-3.0)	26.1% (23.0–29.4)	2.0% (0.9–4.4)	26.5% (22.8–30.5)	
Referred to the CRD	2.5% (1.4–4.4)	7.6% (5.9–9.7)	3.0% (1.6–5.7)	9.6% (7.3–12.4)	
Diabetic educator referrals	20.2% (16.9–24.0)	15.1% (12.7–18.0)	20.3% (16.2–25.3)	15.2% (12.4–18.6)	
Worked with a diabetes educator	22.9% (19.4–26.9)	15.5% (13.1–18.3)	24.0% (19.5–29.2)	16.2% (13.2–19.6)	
OUTCOME MEASURES					
Diastolic blood pressure (mean [SD])	77.9 [7.69]	77.3 [8.4]	77.5 [7.63]	77.2 [8.48]	
Systolic blood pressure (mean [SD])	128.8 [11.85]	127.7 [13.3]	128.1 [11.64]	127.9 [13.94]	
HbA1c (Mean [SD])	7.76 [1.64]	8.10 [2.0]	7.71 [1.72]	8.21 [2.05]	
Primary care provider					
Had in-person event (% [SD])	90.8% [29.0%]	94.1% [23.5%]	92.3% [26.7%]	94.2% [23.4%]	
In-person PMPY utilization (mean [SD])	4.30 [4.97]	4.5 [4.8]	4.75 [5.76]	4.87 [5.31]	
Had virtual event (% [SD])	10.6% [30.8%]	15.5% [36.2%]	10.8% [31.1%]	16.9% [37.5%]	
Virtual PMPY utilization (mean [SD])	0.11 [0.41]	0.224 [0.70]	0.12 [0.42]	0.26 [0.78]	
Hospitalization					
Had inpatient event (% [SD])	16.0% [36.7%]	15.6% [36.3%]	21.7% [41.3%]	18.3% [38.7%]	
Inpatient PMPY utilization (mean [SD])	0.24 [0.83]	0.25 [0.85]	0.34 [1.01]	0.31 [0.93]	
		00 0 C F 4 5 5 C 7	25.00 545.001		

29.2% [45.5%]

0.65 [2.19]

Table 1 Sample demographics and baseline outcome measures

SDoH social determinants of health, CRD community resource desk, PMPY per member per year *All data are % (95% C.I.) unless otherwise specified

26.4% [44.1%]

0.48 [1.14]

Table 1 also presents baseline outcome measures. At baseline, patients at treatment clinics had a higher proportion of SDoH screenings (26.1%) and referrals to the CRD (7.6%) in the last 12 months than patients at control clinics (SDoH Screen: 1.5%, CRD Referral: 2.5%) with similar trends observed in the Medicaid subgroup. Conversely, patients at the control clinics had more referrals to a diabetes educator (20.2%) and had worked more with a diabetes educator (22.9%) in the 12 months prior to the DCII relative to patients at the treatment sites (diabetes educator referral: 15.1%, diabetes education: 15.5%). HbA1c levels were marginally higher among patients at treatment sites (8.1%) than those at control sites (7.8%).

More than 90% of patients across all sites had an in-person primary care visit in the 12 months prior to the DCII, and more than 10% had a virtual primary care visit (Table 1). More than 15% of the overall sample had an inpatient event at baseline, with higher rates in the Medicaid subgroup (treatment: 18.3%, control: 21.7%). More than a quarter of all patients had an emergency department visit at baseline (treatment: 29.2%, control: 26.4%) with similarly higher rates in Medicaid patients (treatment: 35.7%, control: 34.9%).

Table 2 shows the effect on intermediate healthcare measures. Patients at DCII clinics saw a greater increase in diabetes education (15.5%, p<0.001) than those at control clinics with a similar increase in the Medicaid subgroup (18.8%, p<0.001). Among the overall sample, patients at treatment clinics were modestly more likely to receive SDoH screening (4.36%, p<0.087) than those at control clinics. There were no differences in mean HbA1c levels for either the overall sample or the Medicaid subgroup (Table 3).

Table 4 shows the effect on healthcare utilization. Patients at DCII clinics had an increase in the average number of virtual primary care visits of 0.35 PMPY (p<0.001) compared to control clinics with a similar increase in the Medicaid subgroup (0.32 PMPY, p<0.026). We also observed a marginally significant decrease of 5.3% (p<0.064) for in-person primary care visits among the overall treatment population. No significant differences in the likelihood of an inpatient or emergency department event were observed. Similarly, no differences in the amount of primary care, inpatient, and emergency department utilization PMPY were observed.

 Table 3 Difference in difference regression on health measures

	Overall		Medicaid only	
	Est*	<i>p</i> -value	Est*	<i>p</i> -value
Diastolic blood pressure Systolic blood pressure HbA1C	-0.003 0.650 -0.029	0.9951 0.4430 0.8211	-0.168 -0.721 -0.043	0.7924 0.4799 0.7967

*Adjusted for age (continuous), race, sex, and language

DISCUSSION

Well-documented gaps in diabetes prevalence and outcomes by SDoH need underscores the imperative to identify evidencebased strategies to reduce disparities. Increasingly, research points to interventions that are multifaceted and leverage community resources as promising practices for decreasing disparities in diabetes health and healthcare.^{30,31} The DCII employed multiple clinical approaches in conjunction with strategies aimed at assessing and addressing social needs. Evaluation of the DCII showed significant improvement in connection to diabetes education among the overall treatment population. This connection to care is critical as strong evidence connects diabetes selfmanagement education to improvements in glycemic control and quality of life.^{32,33} Importantly, this result held in analysis restricted to the Medicaid population. Previous research has found that diabetes education is often unavailable or inaccessible to low-income patients.¹⁸ This finding suggests that a combination of clinical outreach and social needs support can be effective in engaging Medicaid patients in diabetes care.

We observed mixed results related to primary care utilization. While we saw a significant increase in the number of virtual primary care visits among patients living with diabetes overall and among those with Medicaid at treatment clinics, we also observed a marginally significant decrease in inperson primary care visits. Regular utilization of wellcoordinated primary care is essential to diabetes management and has been shown to reduce emergency department use, hospitalization, morbidity, and mortality among patients with diabetes.^{34–36} Although we did not see significant changes in

Table 4 Difference-in-difference regression on health utilization

Medicaid only

Overall

			,	
	Est*	<i>p</i> -value	Est*	<i>p</i> -value
Primary care provider				
Had in-person event	-5.31%	0.0643	-4.33%	0.1979
In-person PMPY	-0.126	0.6335	-0.057	0.8795
utilization				
Had virtual event	4.75%	0.1619	-1.16%	0.7805
Virtual PMPY utilization	0.354	0.0007	0.317	0.0257
Hospitalization				
Had inpatient event	0.61%	0.8111	2.77%	0.4231
Inpatient PMPY	-0.005	0.9291	0.024	0.7519
utilization				
Had ED event	-4.13%	0.1677	-4.31%	0.2730
ED PMPY utilization	-0.106	0.1481	-0.097	0.3488

 Table 2 Difference-in-difference regression on intermediate health care measures

	Overall		Medicaid only	
	Est*	<i>p</i> -value	Est*	<i>p</i> -value
SDoH screen Referred to the CRD Diabetic educator referrals Worked with a diabetes educator	4.36% 1.31% 4.53% 15.52%	0.0873 0.4729 0.1341 <0.0001	0.60% 1.43% 5.77% 18.75%	0.8523 0.5714 0.1300 <0.0001

SDoH social determinants of health, CRD community resource desk *Adjusted for age (continuous), race, sex, and language

*Adjusted for age (continuous), race, sex, and language

hospitalization among the DCII treatment population, increased primary care use in the 12-month follow-up period may contribute to future decreases in hospitalization. And because the bulk of the intervention period took place during COVID-19, this result points to the success of the DCII in pivoting clinical outreach to its diabetic patients to virtual primary care. The disruption of healthcare delivery by COVID-19 has caused widespread concern for patients with chronic diseases like diabetes, including fear of worsening outcomes due to deferred care as well as increased disparities in utilization among patients with high levels of SDoH need resulting from inadequate technology or internet connectivity.^{37,38}

Evaluation of the DCII also showed marginally significant increases in SDoH screening among the overall population at treatment sites. Prior research has identified successful SDoH screening integration into healthcare settings as a key tool to address population health more holistically and provide more equitable healthcare.³⁹ However, these efforts can be challenging. In our case, efforts to scale SDoH screening across treatment sites was slowed by EMR system capacity of to build out desired tools. Even so, previous evidence suggests as the burden of social need increases for patients with diabetes, so too does patient interest in engaging with a social needs navigator,¹⁵ which further highlights the perceived value of SDoH-focused interventions. Although evaluation of the DCII did not reveal a significant increase in referrals to the CRD, the timing of the intervention during COVID-19 may have complicated the implementation of this strategy. For instance, staff burnout and turnover were especially high during this period which presented challenges for both implementation and evaluation. Future research should explore effective means for connecting patients with SDoH needs to services and support.

Although we did not observe significant improvements in health outcomes, we do observe a trend of decreasing HbA1c levels among the treatment group both overall and among the Medicaid-only population. Process measures often improve much more quickly than outcomes measures illustrating the complexity and inherent challenges in improving health outcomes, particularly SDoH needs that disproportionately impact health.⁴⁰ Future research evaluating the integration of SDoH strategies should incorporate longer time horizons to fully understand the health benefits of these approaches.⁴¹

This study has several limitations. The close connection of the clinics within the same health system was a limiting factor in that some control sites began adopting elements of the DCII during the study period, thus reducing our ability to capture the full impact of the DCII. And, while follow-up data were collected over a 12-month period, this may have been insufficient to capture the full intervention effects. Moreover, we were unable to adjust for the effect that COVID-19 had on outcomes, utilization, and screening data. Finally, various issues arise in the use of EHR data and should be taken into consideration when understanding our findings. For instance, DCII patients who received care outside of a Providence setting would not have it recorded in the EHR or included in our analyses.

CONCLUSION

Our findings suggest the DCII model, which combined clinical interventions with strategies to address SDoH needs, was associated with connecting individuals with type 2 diabetes to diabetes education, slight increases on SDoH screening, and mixed effects on care utilization. Given the close connection between SDoH need and diabetes outcomes, more holistically treating diabetes requires health systems to not only recognize but also work towards identifying effective strategies aimed at addressing patients' social needs alongside clinical care.

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Data availability The datasets generated during and/or analyzed during the current study contain individual-level identifiers and protected health information and are not publicly available due to human subjects protection requirements.

Declarations:

Conflict of Interest: The authors declare that they do not have a conflict of interest.

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