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Health Care Providers' Knowledge, Attitudes, and Practices and the Association With Referrals to the National Diabetes Prevention Program Lifestyle Change Program

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Abstract

Purpose: To examine how health care providers' knowledge, attitudes, and practices affect their referrals to the National Diabetes Prevention Program.

Design: Cross-sectional, self-report data from DocStyles—a web-based survey

Setting: USA

Sample: Practicing family practitioners, nurse practitioners, pharmacists, and internists, *n* = 1,503.

Measures: Questions regarding health care providers' knowledge, attitudes, and practices and their referrals to the National Diabetes Prevention Program.

Analysis: Bivariate and multivariate analyses were used to calculate predictive margins and the average marginal effect.

Results: Overall, 15.2% of health care providers (*n* = 1,503) reported making a referral to the National Diabetes Prevention Program. Health care providers were more likely to make referrals if they were familiar with the program (average marginal effect = 36.0%, 95% CI: 29.1%, 42.8%), reported knowledge of its availability (average marginal effect=49.1%, 95% CI: 40.2%, 57.9%), believed it was important to make referrals to the program (average marginal effect = 20.7%, 95% CI: 14.4%, 27.0%), and used electronic health records to manage patients with prediabetes (average marginal effect = 9.1%, 95% CI: 5.4%, 12.7%). Health care providers' demographic characteristics had little to no association with making referrals.

Conclusion: Making referrals to the National Diabetes Prevention Program was associated with health care providers' knowledge of the program and its reported availability, their attitudes, and their use of the electronic health record system to manage patients with prediabetes.

Keywords

chronic disease prevention, type 2 diabetes, pre-diabetes, health communication, health system referrals, interventions, health policy, lifestyle change program

Purpose

There are 88 million adults in the United States who have prediabetes, a condition characterized by blood glucose levels that are high but not high enough to be diagnosed as diabetes.[1] If left untreated, prediabetes can lead to type 2 diabetes, a devastating chronic disease that affects millions of people in the United States.[1] Diabetes is the seventh leading cause of death in the United States, and contributes to over $320 billion dollars in direct health care expenses and reduced productivity costs.[1,2]

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Several landmark studies, including the Diabetes Prevention Program (DPP) trial, have demonstrated that a structured lifestyle change program is an effective way to prevent or delay progression to type 2 diabetes for those at risk.[3-7] Subsequently, Congress authorized the Centers for Disease Control and Prevention (CDC) to establish the National Diabetes Prevention Program (National DPP), a partnership between public and private organizations to deliver its lifestyle change program (LCP) nationwide.[8,9]

A vital piece of the National DPP is health care providers' referrals of their at-risk patients to the LCP.[3] Providers who promote the National Diabetes Prevention Program and make referrals to it can be enormously influential because they are often a trusted source for their patients and potentially influence their health behaviors.[10-13] The American Diabetes Association, along with other professional organizations, has recommended that providers refer their at-risk patients to a lifestyle change program, such as the one offered through the National DPP.[7,14-16] Evidence has shown that patients who receive a referral from their provider for a lifestyle change program are more likely to participate in such a program. However, only 15% of individuals with prediabetes have been informed that they have the condition.[1] Additionally, less than 5% of patients with prediabetes or at risk for type 2 diabetes are reported to have received a referral to a lifestyle change program.[13,17] Also, many providers have confirmed that they had not made referrals to a lifestyle change program,[18-22] a result that may be linked to the large number of providers reporting that they are not familiar with the program.[19,22] It is also unclear if providers are aware of the availability of the lifestyle change program.[22] Studies show that providers' attitudes toward managing prediabetes are positive,[18,21,23-25] but it is unclear if that same attitude extends to making referrals to the National DPP LCP. Therefore, the researchers sought to better understand providers' knowledge, attitudes, and practices that may be associated with their decision to refer to the National DPP LCP.

Methods

Design

The researchers used data from the web-based survey DocStyles,[1] administered between June and August 2018. DocStyles was commissioned by Porter Novelli Public Services,[26] a public relations firm, and conducted by SERMO[27] to solicit responses from providers regarding various health conditions. Participants from SERMO's Global Medical Panel of health care providers were sent a link to the survey and were paid an honorarium of $40-$90 for completing it.

Sample

SERMO set quotas to reach a certain number of family practitioners and internists (1,000), obstetrician/gynecologists (OB/GYNs) (250), pediatricians (250), oncologists (250), nurse practitioners (250), and pharmacists (250). To meet this quota, 3,465 providers were invited to participate in the survey. Only providers who practice in the United States; who actively see patients; who work in an individual, group, or hospital practice; and who have been practicing for at least three years were selected to participate in the survey. There were 2,256 providers who met those criteria and completed the entire survey, representing a 65.1% response rate. The remaining 34.9% either did not complete the entire survey (43), were excluded based on the screener questions (99), were excluded due to filled quotas (78), or did not respond to the invitation or tried to respond after the survey closed (989). Of the 2,256 respondents, diabetes-specific questions were only given to family practitioners and internists, nurse practitioners, and pharmacists, so the final sample for the current study consisted of 1,503 providers. No individual identifying information was included in the survey dataset and therefore this analysis was deemed exempt from [details omitted for double-anonymized peer review] Institutional Review Board approval process.

Measures

Demographic variables, including age, gender, race, ethnicity, region of practice, and provider type were collected in the survey and included in the current study. The researchers recoded the race and ethnicity variables to represent five categories: non-Hispanic white, non-Hispanic black or African American, non-Hispanic Asian, Hispanic, and non-Hispanic other (includes Native Hawaiian or other Pacific Islander, American Indian or Alaska Native, two or more races, and "other" race). The researchers recoded the continuous age variable into five categories: 25–34, 35–44, 45–54, 55–64, and 65+ years.

Providers' familiarity with the program was assessed through the question, "*How familiar are you with the National Diabetes Prevention Program lifestyle change program (National DPP LCP), a yearlong structured program, offered in person or online, aimed at preventing or delaying the onset of type 2 diabetes for individuals with prediabetes?*". Answer choices were *very familiar, somewhat familiar,* or *not familiar.* Their reported knowledge of the program availability was assessed through the question, "*Is the National DPP LCP available in your community or health system?*" with answer choices being *yes, no,* or *don't know/not sure.* Skip patterns were used so that only providers who previously indicated that they were either *very familiar* or *somewhat familiar* with the National DPP LCP could respond to the second question. The main variable of interest was provider referral practices, which was addressed through the question, "*Have you referred your patients with prediabetes to the in-person or online National DPP LCP to prevent or delay type 2 diabetes?*". The response categories for this variable were *yes, no,* and *don't know/not sure*. Due to there being a small number of providers (N = 187)

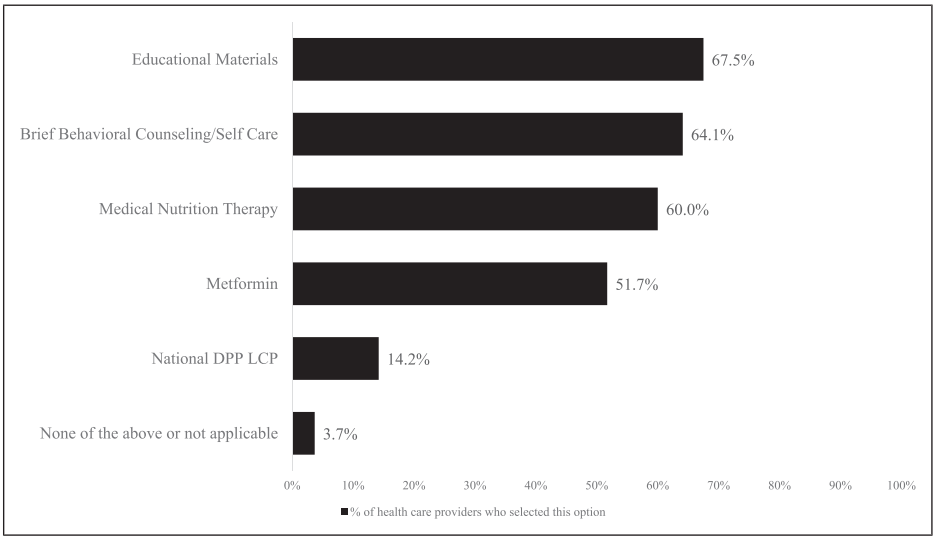

Figure 1. Health care provider-recommended *prediabetes* treatment/management choices, DocStyles 2018. Description: Results from the question, "*Which of the following are you most likely to recommend to your patients to prevent type 2 diabetes? (Select all that apply)*".[2]

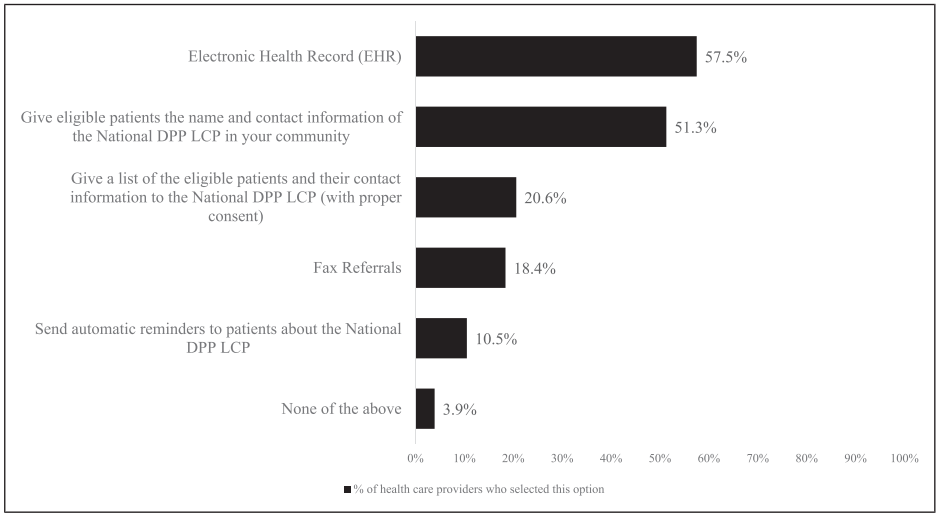

Figure 2. Health care providers method of referral to the National DPP LCP, DocStyles 2018. Description: Results from the question, "*How do you refer your eligible patients with prediabetes to an in-person or online National DPP LCP? (Select all that apply)*".[3,4]

who selected the *don't know/not sure* option, they were included with those who answered *no.* Providers' attitudes toward the National DPP LCP were examined through the question, "*How important is referring patients with prediabetes to the National DPP LCP, specifically?*". Answers were provided on a five-point Likert scale, from *very important* to *not important.* Providers were asked about whether they used an integrated electronic health record (EHR) in their practice or pharmacy. For those who did, they were then asked, *"Do you use the capabilities of your integrated EHR system to identify and manage your patients with prediabetes?"* Answer choices were *yes, my EHR does not have this capability, don't know/not sure,* and *no.* Since the number of providers who selected *my EHR does not have this capability* and *don't know/not sure* were too small to change the results of the analysis, they were included with those who said *no.* Two additional questions were asked (Figures 1 and Figure 2) to further understand providers' treatment preferences for their patients with prediabetes and referral practices.

Analysis

Cross tabulations were used to conduct bivariate analyses to determine the association between providers' referrals to the National DPP LCP and providers' demographics, knowledge, attitudes, and practices; Wald test was used to obtain *P*-values.

Multiple logistic regression was used to generate predictive margins and 95% confidence intervals (CI) to estimate the

Table 1. Health Care Provider Demographic Characteristics, Knowledge, Attitudes, and Practices: DocStyles 2018 Survey Respondents.

Demographic Characteristics	Total, N = 1,503 N (%)
Age	
>64	95 (6.3)
55-64	350 (23.3)
45-54	427 (28.4)
35-44	470 (31.3)
25-34	161 (10.7)
Gender	
Male	821 (54.6)
Female	682 (45.4)
Race/Ethnicity	
Non-Hispanic White	1,029 (68.5)
Non-Hispanic Other[a]	82 (5.5)
Non-Hispanic Asian	286 (19.0)
Hispanic	61 (4.1)
Non-Hispanic Black or African American	45 (3.0)
Provider type	
Nurse practitioner	252 (16.8)
Family practitioner	483 (32.1)
Pharmacist	250 (16.6)
Internist	518 (34.5)
Region of practice	
Midwest region	350 (23.3)
South region	513 (34.1)
West region	290 (19.3)
Northeast region	350 (23.3)
Made referrals to the National DPP LCP	
Yes	228 (15.2)
No/don't know	1,275 (84.8)
Familiarity with National DPP LCP	
Not familiar	763 (50.8)
Somewhat familiar	540 (35.9)
Very familiar	200 (13.3)
Importance of referring to the National DPP LCP specifically	
Not important	322 (21.4)
Slightly important	297 (19.8)
Moderately important	389 (25.9)
Important	321 (21.4)
Very important	174 (11.6)
Uses EHR to identify and manage patients with prediabetes[b]	*N* = 1,239
No	703 (56.7)
Yes	536 (43.3)
National DPP LCP available in their community or health system[c]	N = 740
Don't know/Not sure	351 (47.4)
No	183 (24.7)
Yes	206 (27.8)

EHR, Electronic Health Record.
National DPP LCP, National Diabetes Prevention Program Lifestyle Change Program.
[a]Other includes Native Hawaiian or other Pacific Islander, American Indian or Alaska Native, two or more races, and other.
[b]Only asked of providers who indicated that they use an integrated electronic health record (EHR) at their pharmacy or practice (n = 1,239).
[c]Only asked of providers who answered that they were *very familiar* or *somewhat familiar* with National DPP LCP (*n* = 740).

probability of making referrals based on provider characteristics, knowledge, attitudes, and EHR use.[28,29] The first adjusted model included only providers who responded to the question regarding using the EHR to manage their patients with prediabetes (N = 1,239 of 1,503). The second adjusted model further narrowed the sample because the addition of the

Table 2. Factors Associated With Referrals to the National DPP LCP Among Health Care Providers Who Use Integrated EHRs in their Practice/Pharmacy.[a,b]

		Bivariate (Unadjusted) Results					Multivariate (Adjusted) Results[c]			
		Made Referrals, N = 202		Difference from Referent Category	95% CI		Predictive Margin	Average Marginal Effect[d]	95% CI	
Variables	Total N = 1,239		%	%	%	*P* Value	%	%	%	*P* Value
Age										
>64	64	7	10.9	Ref	—	—	13.2	Ref	—	—
55–64	269	44	16.4	5.4	−3.4, 14.2	.283	18.5	5.3	−3.3, 13.9	.256
45–54	352	47	13.4	2.4	−6.0, 10.8	.598	13.6	0.4	−7.8, 8.7	.915
35–44	411	86	20.9	10	1.4, 18.6	.067	18.1	4.9	−3.3, 13.2	.243
25–34	143	18	12.6	1.6	−7.7, 11.0	.737	14.8	1.6	−7.5, 10.9	.723
Gender										
Male	660	109	16.5	Ref	—	—	16.5	Ref	—	—
Female	579	93	16.1	−0.4	−4.5, 3.6	.829	16.0	−0.5	−4.2, 3.1	.781
Race/Ethnicity										
Non-Hispanic White	826	109	13.2	Ref	—	—	15.6	Ref	—	—
Non-Hispanic Other[e]	72	15	20.8	7.6	−2.0, 17.2	.075	14.3	−1.3	−8.0, 5.4	.705
Non-Hispanic Asian	249	52	20.9	7.7	2.1, 13.2	**.003**	16.1	0.5	−3.7, 4.7	.823
Hispanic	52	14	26.9	13.7	1.4, 26.0	**.007**	22.2	6.6	−1.7, 14.9	.123
Non-Hispanic Black or African American	40	12	30.0	16.8	2.4, 31.1	**.004**	22.6	7.0	−3.0, 16.8	.172
Provider type										
Nurse practitioner	234	30	12.8	Ref	—	—	18.6	Ref	—	—
Family practitioner	414	62	14.9	2.1	−3.3, 7.6	.451	16.1	−2.5	−8.4, 3.4	.411
Pharmacist	134	25	18.6	5.8	−2.0, 13.7	.133	21.0	2.3	−5.2, 9.8	.554
Internist	457	85	18.6	5.8	.2, 11.3	**.055**	14.6	−4.0	−9.8, 1.9	.189
Region of practice										
Midwest region	297	37	12.5	Ref	—	—	13.4	Ref	—	—
South region	422	66	15.6	3.1	−1.9, 8.2	.231	16.1	2.7	−1.9, 7.3	.256
West region	235	44	18.7	6.2	.0, 12.5	**.047**	17.9	4.5	−.6, 9.6	.084
Northeast region	285	55	19.3	6.8	.9, 12.7	**.025**	17.7	4.2	−.6, 9.1	.088
Familiarity with National DPP LCP										
Not familiar	616	9	1.5	Ref	—	—	2.0	Ref	—	—
Somewhat familiar	441	97	22.0	20.5	16.5, 24.5	**<.001**	19.5	17.5	13.9, 21.1	**<.001**
Very familiar	182	96	52.7	51.2	43.9, 58.6	**<.001**	38.0	36.0	29.1, 42.8	**<.001**
Importance of referring to the National DPP LCP specifically										
Not important	260	3	1.1	Ref	—	—	3.1	Ref	—	—
Slightly important	239	23	9.6	8.5	4.5, 12.4	**<.001**	12.4	9.3	4.0, 14.6	**.001**
Moderately important	319	46	14.4	13.3	9.1, 17.3	**<.001**	13.9	10.8	6.1, 15.4	**<.001**
Important	272	73	26.8	25.7	20.2, 31.1	**<.001**	20.8	17.7	12.6, 22.7	**<.001**

(continued)

Table 2. (continued)

		Bivariate (Unadjusted) Results					Multivariate (Adjusted) Results[c]			
Variables	Total N = 1,239	Made Referrals, N = 202	%	Difference from Referent Category %	95% CI %	*P* Value	Predictive Margin %	Average Marginal Effect[d] %	95% CI %	*P* Value
Very important	149	57	38.2	37.1	29.1, 45.0	**<.001**	23.8	20.7	14.4, 27.0	**<.001**
Uses EHR to identify and manage patients with prediabetes										
No	703	56	8.0	Ref	—	—	11.2	Ref	—	—
Yes	536	146	27.2	19.2	15.0, 23.5	**<.001**	20.3	9.1	5.4, 12.7	**<.001**

EHR, Electronic Health Record.
National DPP LCP, National Diabetes Prevention Program Lifestyle Change Program.
[a]Note: There may be rounding errors present in the table and bold indicates statistical significance
[b]This model only includes providers who responded to the question regarding using an EHR in their practice or pharmacy (n=1239)
[c]Adjusted for age, gender, race/ethnicity, provider type, region of practice, familiarity with National DPP LCP, importance of referring to National DPP LCP specifically, and use of EHR to manage patients with prediabetes.
[d]The predicted change in the percentage of referrals to the National DPP LCP associated with a 1-unit change in the independent variable (eg, change between males and females or from 0 to 1).
[e]Other includes Native Hawaiian or other Pacific Islander, American Indian or Alaska Native, two or more races, and "other" race

Table 3. Factors Associated with Referrals to the National DPP LCP Among Providers Who Use Integrated EHRs and are Familiar with the National DPP LCP.[a,b]

		Bivariate (Unadjusted) Results					Multivariate (Adjusted)[c] Results			
		Made Referrals, N = 193		Difference from Referent Category	95% CI		Predictive Margin	Average Marginal Effect[d]	95% CI	
Variables	Total N = 623		%	%	%	*P* Value	%	%	%	*P* Value
Age										
>64	33	7	21.2	Ref	—	—	28.7	Ref	—	—
55-64	126	44	34.9	13.7	−2.5, 29.9	.138	33.6	4.9	−10.0, 19.9	.514
45-54	185	45	24.3	3.1	−12.1, 18.4	.699	28.7	.03	−14.4, 14.4	.996
35-44	216	82	37.9	16.7	1.4, 32.1	.067	33.5	4.8	−9.5, 19.2	.509
25-34	63	15	23.8	2.6	−14.8, 20.0	.774	25	−3.6	−19.4, 12.1	.648
Gender										
Male	348	105	30.2	Ref	—	—	30.9	Ref	—	—
Female	275	88	32.0	1.8	−5.4, 9.1	.624	31.0	0.1	−6.0, 6.2	.979
Race/Ethnicity										
Non-Hispanic White	373	103	27.6	Ref	—	—	30.2	Ref	—	—
Non-Hispanic Other[e]	43	14	32.6	5.0	−9.7, 19.6	.495	25.3	−4.9	−15.5, 5.8	.373
Non-Hispanic Asian	154	50	32.5	4.8	−3.8, 13.5	.265	31.9	1.7	−5.3, 8.8	.635
Hispanic	31	14	45.1	17.5	−.5, 35.6	**.042**	36.0	5.8	−7.1, 18.7	.377
Non-Hispanic Black or African American	22	12	54.5	26.9	5.6, 48.2	**.010**	38.5	8.3	−8.2, 24.8	.324
Provider type										
Nurse practitioner	92	29	31.5	Ref	—	—	33.8	Ref	—	—
Family practitioner	196	58	29.6	−1.9	−13.3, 9.5	.739	29.7	−4.1	−13.9, 5.7	.417
Pharmacist	75	24	32.0	0.5	−13.7, 14.6	.947	38.8	5.0	−7.3, 17.3	.424
Internist	260	82	31.5	0.0	−11.0, 11.0	.998	29.0	−4.8	−14.6, 5.0	.342
Region of practice										
Midwest region	138	36	26.1	Ref	—	—	28.2	Ref	—	—
South region	203	62	30.5	4.4	−5.2, 14.1	.373	30.0	1.8	−5.9, 9.5	.652
West region	127	43	33.9	7.8	−3.2, 18.7	.168	32.7	4.5	−4.0, 13.0	.304
Northeast region	155	52	33.5	7.4	−2.9, 17.8	.165	33.0	4.8	−3.3, 13.0	.248
Familiarity with National DPP LCP										
Somewhat familiar with National DPP LCP	441	97	22.0	Ref	—	—	28.5	Ref	—	—
Very familiar with National DPP LCP	182	96	52.7	30.7	22.5, 38.9	**<.001**	36.0	7.5	.4, 14.6	.038
Importance of referring to the National DPP LCP specifically										
Not important	58	3	5.2	Ref	—	—	10.4	Ref	—	—
Slightly important	104	22	21.2	16.0	6.2, 25.6	**.013**	27.2	16.8	4.9, 28.7	.005
Moderately important	180	43	23.9	18.7	10.2, 27.1	**.005**	28.4	18.0	6.9, 28.9	.001
Important	177	70	39.5	34.3	25.1, 43.5	**<.001**	35.4	25.0	13.7, 36.2	<.001
Very important	104	55	52.9	47.7	36.5, 58.8	**<.001**	38.5	28.1	15.4, 40.8	<.001

(continued)

Table 3. (continued)

		Bivariate (Unadjusted) Results					Multivariate (Adjusted)[c] Results			
Variables	Total N = 623	Made Referrals, N = 193	%	Difference from Referent Category %	95% CI %	*P* Value	Predictive Margin %	Average Marginal Effect[d] %	95% CI %	*P* Value
Uses EHR to identify and manage patients with prediabetes										
No	286	51	17.8	Ref	—	—	25.0	Ref	—	—
Yes	337	142	42.1	24.3	17.4, 31.1	**<.001**	35.1	10.1	3.7, 16.3	.002
National DPP LCP available in their community or health system										
Don't know/Not sure	291	30	10.3	Ref	-	-	13.1	Ref	-	-
No	145	27	18.6	8.3	1.0, 15.5	**.017**	21.1	8.0	.09, 15.9	.047
Yes	187	136	72.7	62.4	55.1, 69.6	**<.001**	62.2	49.1	40.2, 57.9	<.001

EHR, Electronic Health Record.
National DPP LCP, National Diabetes Prevention Program Lifestyle Change Program.
[a]Note: There may be rounding errors present in the table and bold indicates statistical significance
[b]This model further narrows the sample because it only includes providers who responded to the question regarding using an EHR to identify and manage patients with prediabetes and indicated that they were very familiar or somewhat familiar with National DPP LCP (N = 623).
[c]Adjusted for age, gender, race/ethnicity, provider type, region of practice, familiarity with National DPP LCP, importance of referring to National DPP LCP specifically, use of EHR to manage patients with prediabetes, and reported knowledge of the availability of the National DPP LCP.
[d]The predicted change in the percentage of referrals to the National DPP LCP associated with a 1-unit change in the independent variable (eg, change between males and females or from 0 to 1).
[e]Other includes Native Hawaiian or other Pacific Islander, American Indian or Alaska Native, two or more races, and other.

question regarding reported program availability only included providers from the first model who were *very familiar* or *somewhat familiar* with the National DPP LCP (N = 623 of 1,239). For both models, additional covariates were included that had the potential to influence provider referrals, that is, age, race, gender, region of practice, and provider type. The analyses were carried out in 2020 using SAS Enterprise Guide, version 6.1 and Stata/IC, version 11.2.

Results

The providers in the sample (N = 1,503) were most often male (55%), non-Hispanic White (69%), between the ages of 35-44 (31%), internists (35%), and practicing in the South (34%) (Table 1). Only 15.2% of providers reported that they had made referrals to the National DPP LCP, and when provided with a list of options (Figure 1), they mostly selected that they *provide educational materials* to their patients to prevent type 2 diabetes. Nearly half of providers were *somewhat* (36%) or *very* (13%) *familiar* with the National DPP LCP. Among those who were familiar (N = 740), 27.8% reported that the National DPP LCP was available in their community or health system, while 24.7% reported that it was not and 47.4% did not know or were not sure. Most providers believed that there was value in making referrals to the National DPP LCP, with nearly 60% reporting that it was at least moderately important. Among providers who had integrated EHR capabilities (N = 1239), 43% indicated that they used that system to identify and manage their patients with prediabetes. Of providers who made referrals to the National DPP (N = 228), 58% used the EHR system to do so (Figure 2).

On the basis of the predictive margins from the model limited to providers who use EHRs in their practice (Table 2), results indicated that providers who had any familiarity with the program were much more likely to make referrals than those who were *not familiar* (average marginal effect [AME] = 18%, 95% CI: 13.9%, 21.1% for those *somewhat familiar*, and AME=36%, 95% CI: 29.1%, 42.8% for those *very familiar*). The average marginal effect estimates the change in the percentage of referrals associated with a 1-unit increase in the independent variable and provides the difference in the percentage of referrals from the reference group—in this case, 38% of those who were very familiar made referrals vs 2% of those who were not familiar (i.e., the reference group). Similarly, the likelihood of referral increased with perceived importance of referring to the program: providers who thought it was *very important* to refer to the National DPP LCP were much more likely to make referrals versus those who did not think it was important (AME = 20.7%, 95% CI: 14.4%, 27.0%). The researchers also found that providers who used EHR's to manage their patients with prediabetes were nearly twice as likely to make referrals versus those who did not (AME = 9.1%, 95% CI: 5.4%, 12.7%). In the model restricted to providers who use EHR's and were at least somewhat familiar with the National DPP, (Table 3), results indicate that providers who said the National DPP LCP was available in their community or health system were much more likely to make referrals in comparison to those who did not know or were not sure of its availability (AME = 49.1%, 95% CI: 40.2%, 57.9%). The effects of the other variables were similar in this second model to what they were in the first.

Discussion

The results indicate that making referrals to the National DPP LCP was strongly and independently associated with providers' knowledge of the program and its reported availability, their attitudes, and their use of the EHR system to manage patients with prediabetes. In contrast, making referrals had little or no association with providers' demographic characteristics. These findings are encouraging because they suggest that referrals might be increased by addressing changeable factors such as knowledge, attitudes, and practices. This study had several strengths, including a high response rate (65.1%) which was consistent with previous analyses of DocStyles.[19,30] Also, the current study builds upon a previous analysis[19] by adding pharmacists to the sample, asking providers specifically about the National DPP LCP, and including new variables to assess providers' attitudes toward the program and its reported availability. Finally, because provider demographics, knowledge, attitudes, and EHR use were included in the models, the relative importance of all these factors could be shown, thus providing valuable insight into where to focus new approaches to provider engagement. These factors will now be explored in more depth.

Providers' familiarity with the National DPP LCP and the reported the availability of the program were both shown to be highly associated with making referrals. To our knowledge, this is the first study to show the association between providers' reported knowledge of the availability of the National DPP LCP and making referrals to the program. In fact, this variable had the strongest association with referrals of all the variables examined. Other studies have found similar evidence showing that providers who had heard of a LCP[19] or reported knowledge of the availability of one[30] were more likely to make referrals. Despite these promising results, the additional analysis showed that when given the opportunity to select their preferred treatment choice for patients with prediabetes, few providers chose *National DPP LCP*. In addition, 50% of the sample reported not being familiar with the National DPP LCP and over 70% reported that the program was either not available or they were not sure if it was, results which are consistent with another study that assessed providers' awareness of the National DPP LCP.[22] Of note, although the multivariate results demonstrated a strong association between familiarity with the program and referrals, the predicted probability of referrals for those who were familiar was less than 40% when holding all other factors constant, indicating that it may be valuable to explore additional factors beyond familiarity with the program. Suggested strategies for increasing providers' referrals to health-related programs include providing professional development/training about the program that explains the referral

process, the benefits of referring their patients, and reinforces clinical guidelines[31-34]; encouraging positive referral behaviors through audit and feedback[31,35]; and increasing providers' awareness of locally available programs.[33,35,36] These results suggest that future marketing and engagement efforts may be beneficial if they include increasing providers' familiarity with the National DPP LCP in addition to increasing their awareness of the program's availability in their community or health system.

The current study showed that providers' attitudes about the importance of making referrals to the National DPP LCP was associated with making referrals. As providers' opinions of the importance of referral became more positive, the likelihood of referring increased, even after adjusting for other factors. To our knowledge, this is the first study to address providers' attitudes toward making referrals to the National DPP LCP specifically, whereas other studies have assessed attitudes toward prediabetes screening and treatment.[21-25] Although the multivariate results demonstrated that attitudes regarding the importance of making a referral was associated with the outcome, the majority of providers did not make a referral, even those who thought it was at least *important* to refer. This suggests that it may be valuable to explore additional factors that might influence providers referral behaviors. Another study found that providers' attitudes and beliefs are significant barriers to making referrals to intensive behavioral counseling programs, and recommended strategies that reinforce the importance and effectiveness of the program to overcome any potentially negative attitudes.[37] Strategies to engage providers in the National DPP LCP referral process could include methods to bolster positive attitudes toward referring such as reinforcing the importance and effectiveness of the program, in addition to identifying any other attitudes that could be influencing referral behaviors.

Health care providers who used the EHR system to identify and manage their patients with prediabetes were more likely to make a referral to the National DPP LCP than those who did not. These results are in line with other studies where an increase in referrals was observed once providers were trained on using an integrated EHR system to do so.[32,34] The additional analysis revealed that for providers who made referrals to the program, using the capabilities of the EHR system was their most common method of carrying out the referral. This indicates the potential benefits of encouraging the use of the EHR system to manage patients with prediabetes. Future strategies to increase provider referrals could consider promoting the use of the EHR system to manage patients,[31,32] ensuring referring providers are confident in their ability to use the EHR system,[25] using opt-out vs opt-in referral pathways,[38] and promoting a seamless automated referral process to prevent disruption of current workflow.[32-34] Doing so could increase the number of providers who use the EHR system to identify and manage their patients with prediabetes and subsequently make referrals to the National DPP LCP.

This study had several limitations. DocStyles consists of self-reported survey data, so recall bias could have affected the accuracy of the answers. Also, geographical bias could have influenced responses since approximately a third of the providers in the sample were practicing in the South region. In addition, social desirability bias may have led to providers responding that they were familiar with the program or made referrals even when those answers may not have been accurate. However, this seems unlikely to be highly prevalent since many providers indicated that they were not familiar with the program and had not made referrals. Also, because this was a cross-sectional survey, associations could only be viewed at a single point in time and the researchers cannot be sure that knowledge or attitudes predict future referral behaviors. Finally, selection bias could have occurred because the survey set a quota for number of provider types eligible to respond, so the responses collected may not reflect a generalizable sample of relevant health care providers.

So What?

What is already known on this topic?

Research has been done to understand primary care providers' knowledge, attitudes, and practices as they relate to prediabetes and lifestyle change programs.

What Does This Article Add?

Health care providers' familiarity with and reported knowledge of the National Diabetes Prevention Program (National DPP), as well as their attitude about the importance of referrals to the program, and their use of the EHR system to identify and manage their patients with prediabetes were independently associated with making referrals to the National DPP.

What are the Implications for Health Promotion Practice or Research?

This analysis gives credence to the need for provider engagement strategies that increase health care providers' knowledge of the National DPP and its availability, that promote both the importance and effectiveness of making referrals to the program, and the use of the EHR system to manage patients with prediabetes. Addressing these malleable factors could not only increase referrals but may also influence the uptake of the National DPP. This could ultimately lead to a reduction in the incidence rate of type 2 diabetes because of the integral role that providers play in managing their patients' health.

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Author Contributions

LH contributed to the development of the scope and design of the analysis, contributed to the analysis and interpretation of the data, drafted the manuscript, critically revised the manuscript for important intellectual content, read and approved the final version, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.XZ contributed to the development of the scope and design of the analysis, the interpretation of the data, critically revised the manuscript for important intellectual content, read and approved the final version, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.BN contributed to the analysis of the data, the interpretation of the results, critically revised the manuscript for important intellectual content, read and approved the final version, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.KN contributed to the design of the survey, the scope of the analysis, interpretation of data, and critically revised the manuscript for important intellectual content, read and approved the final version, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.TK contributed to the design of the survey, the scope of analysis, interpretation of data, and critically revised the manuscript for important intellectual content, read and approved the final version, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.MC contributed to the development of the scope and design of the analysis, interpretation of the data, critically revised the manuscript for important intellectual content, read and approved the final version, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Author's Note

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Ethical Approval

No individual identifying information was included in the survey dataset and therefore this analysis was deemed exempt from CDC's Institutional Review Board approval process.

Notes

1. Two surveys were conducted in 2018 and are designated A and B. This methodology covers survey A which captured the questions about diabetes.
2. Not mutually exclusive because more than one answer choice could be selected, N = 1,503.
3. Only asked of providers who indicated that they had made referrals to National DPP LCP, N=228.
4. Not mutually exclusive because more than one answer choice could be selected.

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References

1. Centers for Disease Control and Prevention. *National Diabetes Statistics Report*. Atlanta, GA: CDC; 2020. https://www.cdc.gov/diabetes/pdfs/data/statistics/national-diabetes-statistics-report.pdf. Accessed February 28, 2020.
2. American Diabetes Association. Economic costs of diabetes in the U.S. in 2017. *Diabetes Care*. 2018;41(5):917-928. doi:10.2337/dci18-0007.
3. Albright AL, Gregg EW. Preventing type 2 diabetes in communities across the U.S.: the national diabetes prevention program. *Am J Prev Med*. 2013;44(4):S346-S351. doi:10.1016/j.amepre.2012.12.009.
4. Li R, Zhang P, Barker LE, Chowdhury FM, Zhang X. Cost-effectiveness of interventions to prevent and control diabetes mellitus: A systematic review. *Diabetes Care*. 2010;33(8):1872-1894. doi:10.2337/dc10-0843.
5. Glechner A, Keuchel L, Affengruber L, et al. Effects of lifestyle changes on adults with prediabetes: A systematic review and meta-analysis. *Prim Care Diabetes*. 2018;12(5):393-408. doi:10.1016/j.pcd.2018.07.003.
6. Diabetes Prevention Program Research G. Long-term effects of lifestyle intervention or metformin on diabetes development and microvascular complications over 15-year follow-up: The diabetes prevention program outcomes study. *Lancet Diabetes Endocrinol*. 2015;3(11):866-875. doi:10.1016/S2213-8587(15)00291-0.
7. Pronk NP, Remington PL, Community Preventive Services Task F. Combined diet and physical activity promotion programs for prevention of diabetes: community preventive services task force recommendation statement. *Ann Intern Med*. 2015;163(6):465-468. doi:10.7326/M15-1029.
8. US Congress. *Diabetes Prevention Act of 2009*. USA: U.S. Congress; 2009. https://www.congress.gov/bill/111th-congress/house-bill/4124. . Accessed April 29, 2020.
9. Lifestyle change program details. Centers for Disease Control and Prevention Website. https://www.cdc.gov/diabetes/prevention/lcp-details.html. Accessed March 12, 2020.
10. Chaudhuri S, Le T, White C, Thompson H, Demiris G. Examining health information-seeking behaviors of older adults. *Comput Inform Nurs*. 2013;31(11):547-553. doi:10.1097/01.NCN.0000432131.92020.42.

11. The diagnosis difference. Pew Research Website. https://www.pewresearch.org/science/2013/11/26/the-diagnosis-difference/. Accessed April 1, 2020.
12. Smith D. Health care consumer's use and trust of health information sources. *J Commun Healthc*. 2011;4(3):200-210. doi:10.1179/1753807611Y.0000000010.
13. Ali MK, McKeever Bullard K, Imperatore G, et al. Reach and use of diabetes prevention services in the United States, 2016-2017. *JAMA Netw Open*. 2019;2(5):e193160. doi:10.1001/jamanetworkopen.2019.3160.
14. American Diabetes Association. 3. Prevention or delay of type 2 diabetes: standards of medical care in diabetes-2020. *Diabetes Care*. 2020;43(suppl 1):S32-S36. doi:10.2337/dc20-S003.
15. Siu AL. Screening for abnormal blood glucose and type 2 diabetes mellitus: U.S. preventive services task force recommendation statement. *Ann Intern Med*. 2015;163(11):861-868. doi:10.7326/M15-2345.
16. Scaling the national diabetes prevention program in underserved areas through pharmacies. American Pharmacists Association Foundation Website. https://www.aphafoundation.org/Scaling_Diabetes_Prevention_Program_Underserved_Areas. Accessed October 16, 2019.
17. Schmittdiel JA, Adams SR, Segal J, et al. Novel use and utility of integrated electronic health records to assess rates of prediabetes recognition and treatment: brief report from an integrated electronic health records pilot study. *Diabetes Care*. 2014;37(2):565-568. doi:10.2337/dc13-1223.
18. Mehta S, Mocarski M, Wisniewski T, et al. Primary care physicians' utilization of type 2 diabetes screening guidelines and referrals to behavioral interventions: a survey-linked retrospective study. *BMJ Open Diabetes Res Care*. 2017;5(1):e000406. doi:10.1136/bmjdrc-2017-000406.
19. Nhim K, Khan T, Gruss SM, et al. Primary care providers' prediabetes screening, testing, and referral behaviors. *Am J Prev Med*. 2018;55(2):e39-e47. doi:10.1016/j.amepre.2018.04.017.
20. Hafez D, Nelson DB, Martin EG, et al. Understanding type 2 diabetes mellitus screening practices among primary care physicians: A qualitative chart-stimulated recall study. *BMC Fam Pract*. 2017;18(1):50. doi:10.1186/s12875-017-0623-3.
21. Tseng E, Greer RC, O'Rourke P, et al. Survey of primary care providers' knowledge of screening for, diagnosing and managing prediabetes. *J Gen Intern Med*. 2017;32(11):1172-1178. doi:10.1007/s11606-017-4103-1.
22. Keck JW, Thomas AR, Hieronymus L, Roper KL. Prediabetes knowledge, attitudes, and practices at an academic family medicine practice. *J Am Board Fam Med*. 2019;32(4):505-512. doi:10.3122/jabfm.2019.04.180375.
23. Roper KL, Thomas AR, Hieronymus L, Brock A, Keck J. Patient and clinician perceptions of prediabetes: A mixed-methods primary care study. *Diabetes Educat*. 2019;45(3):302-314. doi:10.1177/0145721719845347.
24. Mainous AG 3rd, Tanner RJ, Scuderi CB, Porter M, Carek PJ. Prediabetes screening and treatment in diabetes prevention: The impact of physician attitudes. *J Am Board Fam Med*. 2016;29(6):663-671. doi:10.3122/jabfm.2016.06.160138.
25. Harry ML, Saman DM, Allen CI, et al. Understanding primary care provider attitudes and behaviors regarding cardiovascular disease risk and diabetes prevention in the Northern Midwest. *Clin Diabetes*. 2018;36(4):283-294. doi:10.2337/cd17-0116.
26. DocStyles 2018 methods. Deanne Weber; 2018. http://www.porternovelli.com. Accessed March 23, 2021.
27. SERMO. Global Medical Panelist; 2018. .https://www.sermo.com.
28. Norton EC, Dowd BE, Maciejewski ML. Marginal effects-quantifying the effect of changes in risk factors in logistic regression models. *JAMA*. 2019;321(13):1304-1305. doi:10.1001/jama.2019.1954.
29. Cummings JR, Wen H, Ko M, Druss BG. Geography and the Medicaid mental health care infrastructure: Implications for health care reform. *JAMA Psychiatry*. 2013;70(10):1084-1090. doi:10.1001/jamapsychiatry.2013.377.
30. Omura JD, Watson KB, Loustalot F, Fulton JE, Carlson SA. Primary care providers' awareness of physical activity-related intensive behavioral counseling services for cardiovascular disease prevention. *Am J Health Promot*. 2018;33(2):890117118784226. doi:10.1177/0890117118784226.
31. Centers for Disease Control and Prevention. *Strategies to Increase Health System Referrals to Type 2 Diabetes Prevention and Diabetes Management Programs*. Atlanta, GA: CDC; 2019. https://www.cdc.gov/diabetes/pdfs/programs/stateandlocal/Referral_Strategies_Cleared_final_508.pdf. Accessed March 1, 2020.
32. Chambers EC, Wylie-Rosett J, Blank AE, et al. Increasing referrals to a YMCA-based diabetes prevention program: Effects of electronic referral system modification and provider education in federally qualified health centers. *Prev Chronic Dis*. 2015;12:E189. doi:10.5888/pcd12.150294.
33. Clark RE, McArthur C, Papaioannou A, et al. "I do not have time. Is there a handout I can use?": combining physicians' needs and behavior change theory to put physical activity evidence into practice. *Osteoporos Int*. 2017;28(6):1953-1963. doi:10.1007/s00198-017-3975-6.
34. Holliday CS, Williams J, Salcedo V, Kandula NR. Clinical identification and referral of adults with prediabetes to a diabetes prevention program. *Prev Chronic Dis*. 2019;16:E82. doi:10.5888/pcd16.180540.
35. Mensa-Wilmot Y, Bowen SA, Rutledge S, et al. Early results of states' efforts to support, scale, and sustain the national diabetes prevention program. *Prev Chronic Dis*. 2017;14:E130. doi:10.5888/pcd14.170478.
36. Scott LB, Allen JK. Providers' perceptions of factors affecting women's referral to outpatient cardiac rehabilitation programs: an exploratory study. *J Cardiopulm Rehabil*. 2004;24(6):387-391. doi:10.1097/00008483-200411000-00005.
37. Omura JD, Bellissimo MP, Watson KB, et al. Primary care providers' physical activity counseling and referral practices and barriers for cardiovascular disease prevention. *Prev Med*. 2018;108:115-122. doi:10.1016/j.ypmed.2017.12.030.
38. Adusumalli S, Jolly E, Chokshi NP, et al. Referral rates for cardiac rehabilitation among eligible inpatients after implementation of a default opt-out decision pathway in the electronic medical record. *JAMA Netw Open*. 2021;4(1):e2033472. doi:10.1001/jamanetworkopen.2020.33472.