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RESEARCH BRIEF

Prevalence and Correlates of Diabetes Prevention Program Referral and Participation

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Introduction: As the burden of type 2 diabetes rises, there is increasing focus on improving the reach of evidence-based lifestyle interventions. Using nationally representative data, this study identifies how frequently at-risk adults are being referred to and participating in diabetes prevention programming, and explores correlates of referral, participation, and interest.

Methods: Data from the 2016 National Health Interview Survey, a cross-sectional survey of U.S. households, were analyzed in 2017. The study population consisted of adults (aged ≥18 years) without a self-reported diabetes diagnosis, who were likely eligible for diabetes prevention programming based on (1) self-reported diagnosis of prediabetes or gestational diabetes, and (2) meeting BMI criteria. Prevalence of self-reported referral and participation was determined, and sociodemographic correlates of referral, participation, and interest were characterized through multivariable logistic regression analyses.

Results: The study population consisted of 2,341 adults. The majority were female (63%), white (74.6%), non-Hispanic (83.4%), and aged ≥45 years (68.2%). A total of 4.2% reported ever being referred to a 12-month prevention program and only 2.4% reported ever participating. In multivariable logistic regression, race was correlated with referral (black and Asian adults more likely to report referral) and age was positively correlated with participation. More than 25% of adults who were never referred or participated reported an interest in engaging in programming.

Conclusions: Although more than one quarter of adults likely eligible for diabetes prevention programming express interest in participating, few are being referred and fewer still have participated. This underscores the need for efforts to enhance program referral and access.

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INTRODUCTION

Approximately one in three adults in the U.S. has prediabetes, a condition that places them at heightened risk for the development of diabetes, heart disease, and stroke.[1] Evidence-based lifestyle interventions can prevent or delay type 2 diabetes development, as demonstrated in the Diabetes Prevention Program (DPP) trial.[2,3] The DPP has been translated into a year-long, group-based lifestyle intervention that forms the core of the National Diabetes Prevention Program (National DPP), established by the Centers for Disease Control and Prevention to enhance dissemination of evidence-based prevention programming into clinical and community-based settings.[4]

Although characteristics of National DPP lifestyle intervention participants have been previously described,[5] relatively little is known about the extent to which eligible

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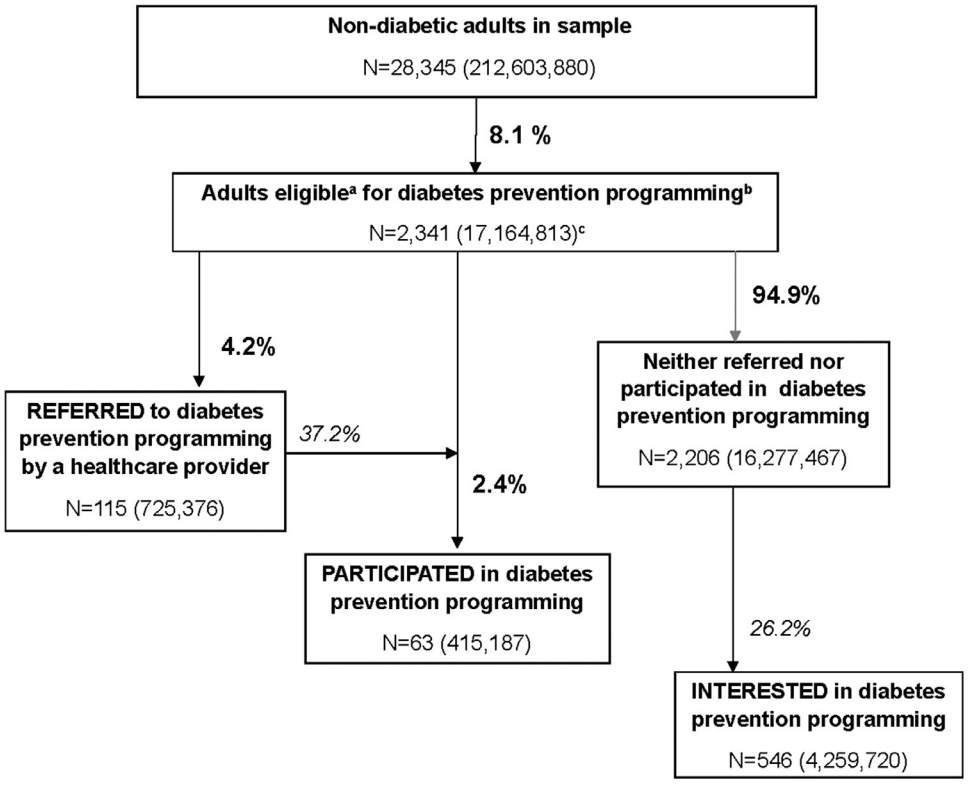

Figure 1. Diabetes prevention programming referral, participation, and interest among likely adults meeting approximation of Diabetes Prevention Program eligibility in analytic sample.

[a]Adults were considered eligible if they met Centers for Disease Control and Prevention (CDC) National DPP BMI criteria (BMI ≥24 kg/m^2 or ≥22 if Asian) and reported prediabetes or a history of gestational diabetes.

[b]Diabetes prevention programming was introduced as "*. . .a year-long program that can help people prevent Type 2 diabetes. This program has weekly sessions during the first 6 months and monthly sessions over the last 6 months. People in the program receive support from a lifestyle coach on achieving and maintaining a healthy lifestyle.*"

[c]Numbers in parentheses represented corresponding weighted Ns.

adults are being referred to or participating in prevention programming. Using nationally representative data, this study characterizes how frequently adults who are likely eligible for this programming (1) are referred by a healthcare provider, (2) participate in the program, and (3) report interest in participating.

METHODS

Data from the 2016 National Health Interview Survey (NHIS) were used in the analyses. In that year, Diabetes Primary Prevention Questions collected self-reported information on diabetes diagnoses, screening, risk factors, and referral, participation, and interest in diabetes prevention programming. Diabetes prevention programming was introduced as "*. . .*a year-long program that can help people prevent Type 2 diabetes. This program has weekly sessions during the first 6 months and monthly sessions over the last 6 months. People in the program receive support from a lifestyle coach on achieving and maintaining a healthy lifestyle."

The study population consisted of respondents aged ≥18 years without a self-reported diagnosis of diabetes and who would likely be eligible for diabetes prevention programming based on program eligibility criteria: (1) meeting National DPP 2015 BMI criteria (BMI ≥24 kg/m^2 or BMI ≥22 kg/m^2 if Asian) and (2) a self-reported diagnosis of prediabetes or self-reported history of gestational diabetes.[6] A limited percentage of group participants can meet eligibility criteria based on BMI and having high diabetes-risk test scores (e.g., on the American Diabetes Association Diabetes Risk Test); these individuals were included in sensitivity analyses to examine the prevalence of referral, participation, and interest.

In the survey, adults were asked if they had ever been referred or ever participated (additional options included *refusal to answer* and *don't know*). Program interest was gauged on a scale of *not interested*, *somewhat interested*, and *very interested*. Binary measures of program referral (ever versus never), participation (ever versus never), and program interest (any versus none) were created (refusal or don't know was coded as missing). Descriptive statistics were used to characterize the prevalence of self-reported referral, participation, and interest. Pearson chi-square analyses or Wald test of means were used to compare characteristics of those who reported referral, participation, and interest versus those who did not. Sociodemographic correlates of referral, participation, and

Table 1. Characteristics of Adults Eligible for Diabetes Prevention Programming, Overall and by Referral, Participation, and Interest in Programming[a]

Characteristics	Overall	Referred			Participated			Interested		
		Yes	No	*p*-value[b]	Yes	No	*p*-value	Yes	No	*p*-value
Unweighted N	2,341	115	2,226		63	2,278		546	1,660	
Weighted N[c]	17,164,813	725,376	16,439,437		415,187	16,749,626		42,59,720	12,017,747	
Gender, %[c]				0.18			0.12			0.36
Male	37.0	44.8	36.7		24.6	37.4		39.2	36.2	
Female	63.0	55.2	63.3		75.4	62.7		60.8	63.8	
Age, years, %				0.06			0.39			0.04
18–44	31.8	20.0	32.3		20.6	32.0		33.3	31.7	
45–64	44.3	44.8	44.3		50.9	44.2		48.0	43.1	
≥65	23.9	35.2	23.4		28.5	23.8		18.7	25.2	
BMI in kg/m^2, M (SE)	34.3 (0.40)	34.5 (2.14)	42.2 (0.41)	0.89	34.8 (1.91)	34.2 (0.41)	0.79	36.4 (0.96)	33.4 (0.43)	<0.01
Race, %				0.02			0.15			<0.01
White only	74.6	60.2	75.2		60.2	74.9		65.3	79.0	
Black only	14.4	22.4	14.1		18.4	14.3		20.7	11.7	
AI/AN only	1.6	2.7	1.5		1.7	1.6		2.2	2.3	
Asian only	6.7	14.1	6.4		9.4	6.7		7.9	5.8	
Multiple races	2.7	0.6	2.8		10.3	2.5		3.9	2.1	
Hispanic ethnicity, %	16.6	20.4	16.5	0.40	25.5	16.4	0.26	20.6	14.6	0.02
Family income,[d] %				0.94			0.09			0.12
<100% FPL[d]	12.4	12.3	12.4		23.7	12.1		14.1	11.5	
100% to <200% FPL	17.6	16.3	17.7		9.5	17.9		20.6	16.9	
≥200% FPL	70.0	71.4	69.9		66.8	70.0		65.4	71.6	
Insurance status, %				0.09			0.90			0.09
Uninsured	6.0	2.6	6.2		3.9	6.1		8.3	5.4	
Any private	64.8	65.8	64.8		64.9	64.8		63.6	65.2	
Medicaid/other public	12.4	6.6	12.6		12.8	12.4		14.9	11.7	
Medicare/dual eligible	11.7	1.5	11.5		10.7	11.7		9.8	12.2	
Other insurance	5.1	10.1	4.9		7.7	5.0		3.3	5.5	
Usual source of care[e]	93.7	97.9	93.5	0.11	86.9	93.9	0.26	92.9	94.1	0.45
Hypertension[f]	46.6	60.3	45.9	0.03	61.2	46.2	0.09	49.5	44.8	0.14
High cholesterol[g]	47.7	57.8	47.3	0.11	51.3	47.6	0.70	50.5	46.3	0.17
Additional self-reported lifestyle-related counseling and behaviors										
Counseled to decrease fat or caloric intake[h]	55.7	—	—	—	—	—	—	—	—	—
Counseled to increase physical activity[h]	50.2	—	—	—	—	—	—	—	—	—

(*continued on next page*)

Table 1. Characteristics of Adults Eligible for Diabetes Prevention Programming, Overall and by Referral, Participation, and Interest in Programming[a] (*continued*)

Characteristics	Overall	Referred			Participated			Interested		
		Yes	No	*p*-value[b]	Yes	No	*p*-value	Yes	No	*p*-value
Counseled to participate in a weight loss program[h]	16.8	—	—	—	—	—	—	—	—	—
Currently decreasing fat or caloric intake	63.6	—	—	—	—	—	—	—	—	—
Currently increasing physical activity	62.9	—	—	—	—	—	—	—	—	—
Currently in weight loss program	12.2	—	—	—	—	—	—	—	—	—

[a]Eligible adults defined as those with BMI ≥24 kg/m^2 or ≥22 kg/m^2 if Asian, AND either a self-reported diagnosis of prediabetes or gestational diabetes.
[b]*p*-value from Pearson χ^2 analyses or adjusted Wald test of means (for BMI) comparing referred versus not-referred, ever participated versus never participated, interested versus not interested eligible adults.
[c]All percentages are of weighted N.
[d]As % of FPL.
[e]Defined as having any usual source of care.
[f]Defined as ever having been told s/he has high blood pressure or hypertension during at least 2 visits.
[g]Defined as ever having been told s/he has high cholesterol.
[h]Counseling received from a doctor or health professional in the past 12 months.
AI/AN, American Indian/Alaskan Native; FPL, federal poverty level.

interest were characterized by using separate multivariable logistic regression analyses. Relevant sociodemographic characteristics were selected from prior literature.[7–9] Prevalence of receipt of general lifestyle counseling and behavior change were also explored. All analyses accounted for the NHIS's complex survey design by using appropriate sampling weights. Analyses were conducted in 2018 using Stata, version 13. This study was acknowledged as non-human subjects research by the Johns Hopkins School of Medicine IRB.

RESULTS

A total of 2,341 of 28,354 adults in the sample met the selected criteria for likely eligibility for diabetes prevention programming (Figure 1). As illustrated in Table 1, the majority were female (63.0%), white (74.6%), non-Hispanic (83.4%), and aged >44 years (68.2%). Among these individuals, 4.2% reported being referred by a healthcare provider. More than one third (37.1%) of those reporting referral to programming also reported program participation. Overall, only 2.4% of eligible adults participated in diabetes prevention programming. More than one quarter (26.2%) of eligible adults (who neither were referred nor participated) reported interest in engaging in diabetes prevention programming (Figure 1). In sensitivity analyses, which also included adults with high American Diabetes Association risk test scores (74,869,279 weighted adults), only 1.1% of respondents were referred and 1.3% participated.

In multivariable logistic regression analyses, race was associated with program referral, which appeared to be driven by increased referrals among black and Asian adults compared with white adults (Table 2). Age was positively correlated with participation; adults aged <44 years had lower odds of participation than those aged ≥65 years (Table 2). Adults with family incomes <100% of the federal poverty level were more likely to report participation than those with incomes >200% of the federal poverty level. Increasing BMI was associated with higher odds of expressing interest, as was being black and Hispanic.

DISCUSSION

A minority of American adults likely eligible for diabetes prevention programming reported program referral or participation (approximately 4% and 2%, respectively). At the same time more than one quarter of likely eligible adults reported interest in participating in a year-long lifestyle intervention to prevent type 2 diabetes. Overall, this suggests a need to improve both program access and referral efforts, the latter being suboptimal in the clinical setting.[10] The American Medical Association and

Table 2. Factors Associated With Diabetes Prevention Programming Referral, Participation, and Interest[a,b]

Characteristics	Referral, AOR (95% CI) N=2,237 unweighted, 16,298,817 weighted	Participation, AOR (95% CI) N=2,237 unweighted, 16,298,817 weighted	Interest, AOR (95% CI) N=2,107 unweighted, 15,444,266 weighted
Gender			
Male	ref	ref	ref
Female	0.85 (0.48, 1.49)	2.04 (0.89, 4.71)	0.79 (0.57, 1.08)
Age, years			
18–44	ref	ref	ref
45–64	1.51 (0.72, 3.13)	2.07 (0.95, 4.55)	1.22 (0.87, 1.71)
≥65	2.01 (0.88, 4.61)	**2.65 (1.09, 6.43)**	0.94 (0.60, 1.47)
BMI, kg/m^2	1.01 (0.98, 1.03)	1.00 (0.99, 1.02)	**1.02 (1.01, 1.03)**
Race, %			
White only	ref[c]	ref	ref[c]
Black only	**2.28 (1.23, 4.22)**	1.70 (0.76, 3.84)	**2.14 (1.44, 3.18)**
AI/AN only	1.97 (0.58, 6.64)	0.87 (0.14, 5.31)	1.79 (0.65, 4.93)
Asian only	**3.42 (1.21, 9.70)**	2.59 (0.60, 11.20)	1.73 (0.88, 3.40)
Multiple races	0.37 (0.09, 1.56)	**6.14 (1.05, 35.88)**	**2.55 (1.12, 5.79)**
Hispanic ethnicity, %	1.83 (0.96, 3.48)	2.33 (0.99, 5.46)	**1.56 (1.06, 2.29)**
Family income[d]			
≥200% FPL	ref	ref	ref
100% to <200% FPL	1.01 (0.51, 1.99)	0.65 (0.23, 1.82)	1.33 (0.93, 1.89)
<100% FPL	1.45 (0.65, 3.22)	**2.56 (1.22, 5.40)**	1.12 (0.70, 1.79)
Insurance status			
Any private	ref	ref	ref
Uninsured	0.42 (0.12, 1.38)	0.28 (0.03, 2.44)	1.17 (0.62, 2.22)
Medicaid/Other public	0.45 (0.17, 1.17)	0.48 (0.14, 1.69)	1.09 (0.68, 1.74)
Medicare/Dual eligible	0.93 (0.39, 2.19)	0.48 (0.20, 1.20)	0.78 (0.52, 1.18)
Other insurance	1.95 (0.78, 4.90)	1.53 (0.35, 6.66)	0.56 (0.23, 1.29)
Hypertension[e]			
No	ref	ref	ref
Yes	1.50 (0.89, 2.52)	1.87 (0.95, 3.65)	1.20 (0.88, 1.63)
High cholesterol[f]			
No	ref	ref	ref
Yes	1.02 (0.55, 1.89)	0.89 (0.39, 2.04)	1.21 (0.89, 1.66)

Note: Boldface indicates statistical significance ($p<0.05$).
[a]Among eligible adults, defined as having a BMI ≥24 kg/m^2 or ≥22 kg/m^2 if Asian, AND either a self-reported diagnosis of prediabetes or gestational diabetes.
[b]Outcomes included: ever referred (versus never); ever participated (versus never); any interest (versus none).
[c]Test of global significance for overall category with $p<0.05$.
[d]Income as % of Federal Poverty Level (FPL).
[e]Defined as ever having been told s/he has high blood pressure or hypertension during at least 2 visits.
[f]Defined as ever having been told s/he has high cholesterol.
AI/AN, American Indian/Alaskan Native.

Centers for Disease Control and Prevention have initiated a campaign to raise providers' awareness of diabetes prevention, in part to enhance referral practices.[11] (More generally, enhancing provider awareness of the role of behavioral change in prevention is also important, given only about half of eligible adults reported receiving counseling on lifestyle change.) Regarding access, the number of programs registered under the National DPP's recognition program continues to grow[11] and Medicare has begun covering the National DPP intervention for beneficiaries as of April 2018,[12] an important step toward extending the reach of the intervention, particularly among older adults. At the same time, these results and other studies[13] suggest a need to focus on younger at-risk adults, who are less likely to participate in prevention programming.

Despite demonstrated disparities in access to preventive services,[7,8] in this analysis racial minorities had higher odds of reported referral to diabetes prevention programming and low-income adults had higher odds of

participation. These groups bear a disproportionate burden of type 2 diabetes and related complications.[1] Racial and ethnic minorities engaged in the National DDP lifestyle intervention also demonstrate poorer program retention outcomes.[5] Thus, confirming these trends, and understanding the factors that drive referral, participation, and retention, are essential to inform efforts to promote health equity.

Limitations

Limitations of this study include the use of self-reported measures to determine program eligibility and outcomes (program referral, participation, and interest), which could be prone to recall and social desirability bias. Prior studies show that only 10% of adults with prediabetes are aware of their status.[1] Therefore, this study likely underestimates the number of eligible adults by a wide margin, thereby overestimating prevalence of referral and participation. The sample's predominance of females may reflect higher awareness of prediabetes status among women.[1]

Respondents may have reported referral or participation in a program similar to the National DPP intervention, leading to further overestimation of participation in diabetes prevention programming. This could limit the ability to ascribe factors associated with referral or participation to diabetes prevention programming specifically. An additional limitation is inability to account for concurrent health conditions that influence referral or participation, given lack of information on referral or participation timing.

CONCLUSIONS

Despite these limitations, this study represents an initial step in characterizing the reach of diabetes prevention programming among adults aware of their prediabetes status and likely eligible to participate and benefit from the intervention, supplementing existing literature describing current participant characteristics.[5,9] Low rates of referral and participation suggest that efforts to enhance identification, recruitment, and retention of high-risk adults from clinical and community-based settings will be essential to realizing the potential of lifestyle interventions for diabetes prevention.

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