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Race and gender differences in abnormal blood glucose screening and clinician response to prediabetes: A mixed-methods assessment

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Abstract

The projected three-fold increase in diabetes burden by 2060 in the United States will affect certain race and gender groups disproportionately. The objective of this mixed-methods study was to assess differences in prediabetes screening and clinician response to prediabetes by patient race and gender. We utilized data from 18,742 patients seen between 11/1/15 and 4/30/17 who met criteria for blood glucose screening by the 2015 US Preventive Service Task Force recommendation and had at least one visit to a primary care practice within a large, academic health system located in North Carolina. We utilized generalized estimating equations with logistic

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Author contributions

TT, CG, CSH and MSK contributed to study concept and design. TT conducted analyses, interpretation of data, and drafting of manuscript. TT, CG, CSH, MSK, SG, and AL reviewed/edited the manuscript.

Disclosures

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Guarantor

Tainayah Thomas takes full responsibility for the work as a whole, including the study design, access to data, and the decision to submit and publish the manuscript.

Declaration of Competing Interest

The authors declare that there is no conflict of interest.

regression to assess race and gender differences in two outcomes: prediabetes screening and clinician response to prediabetes. We conducted twenty in-depth interviews (October 2018–May 2019) with physicians to assess their approach to screening for and treating prediabetes.

Black patients had 11% higher odds (95% CI:1.02–1.20) of being screened for prediabetes than White patients. Men had 19% higher odds (95% CI:1.09–1.30) of being screened for prediabetes than women. There were no significant differences in clinician response to prediabetes by patient race or gender. Qualitatively, physicians reported a non-systematic approach to prediabetes screening and follow-up care related to: 1) System-level barriers to screening and treatment; 2) Implicit bias; 3) Patient factors; and 4) Physician preferences for prediabetes treatment. Targeted risk-based screening for prediabetes along with increased treatment for prediabetes are critical for preventing diabetes and reducing diabetes-related disparities.

Keywords

Prediabetes; Diabetes prevention; Health disparities

1. Introduction

Diabetes has reached epidemic proportions in the United States (US). As of 2018, approximately 34.2 million people had been diagnosed with diabetes in the US and the number of new cases is projected to increase (National Diabetes Statistics Report, 2020). Type 2 diabetes accounts for 90–95% of diabetes prevalence and henceforth, this paper will refer to type 2 diabetes as diabetes. Preventing new cases of diabetes through detection and treatment of prediabetes, an intermediate state of hyperglycemia, especially among populations at elevated risk, can slow the projected increase in diabetes incidence. Left untreated, prediabetes will result in an increase in already burdensome diabetes rates, with substantial economic and health impact (Dall et al., 2019).

Not only is diabetes highly prevalent, but race and gender disparities in its prevalence are well documented. Nationally, the number of adults with diagnosed diabetes is projected to nearly triple by 2060 with a projected rapid increase in diabetes prevalence among Blacks compared to Whites suggesting that racial disparities in diabetes burden will worsen if no action is taken (Lin et al., 2018). Projections indicate that approximately one in four Blacks would have diagnosed diabetes by year 2060 (Lin et al., 2018). In the Southern US, diabetes prevalence and related disparities are especially pronounced. (Signorello et al., 2007; Centers for Disease Control and Prevention, 2014; Walker et al., 2014) These disparities could potentially be explained, at least partially, by race and gender differences in diabetes screening and prediabetes follow-up care, yet little is known about variations in clinicians' screening for and response to prediabetes by patient race or gender. The objective of this study was to assess race and gender differences in prediabetes screening and primary care physicians' (PCP) clinical responses to prediabetes, and to examine PCPs' perceptions of diabetes prevention strategies and any screening or treatment considerations PCPs make based on patient race and gender. Our goal was to understand disparities in health services utilization that could contribute to racial and gender differences in diabetes health outcomes.

2. Methods

2.1. Study design

This study utilized a sequential, dependent mixed-methods triangulation design to combine two studies, a retrospective cohort study and qualitative interviews (Schoonenboom and Johnson, 2017). The retrospective cohort study was conducted in a large health system that includes primary care practices in rural, urban and suburban locations across North Carolina. The study included a secondary analysis of electronic health record (EHR) longitudinal data. The qualitative data collection was conducted with clinicians in two medical school-affiliated clinics within the health system.

As part of the mixed-methods approach, this study utilized the quantitative dataset to generate the clinician sampling frame for qualitative, in-depth interviews with physicians. Additionally, findings from the qualitative interviews informed the selection of covariates for the quantitative analyses. The study procedures and materials were reviewed and approved by the Institutional Review Board at the University of North Carolina at Chapel Hill (UNC).

2.2. Quantitative data

The retrospective cohort study utilized EHR data from patients seen in UNC Health affiliated primary care practices between 11/1/15 and 4/30/17. To build the study cohort, we identified 33,444 patients who: 1) had at least one visit to an affiliated primary care clinic between 5/1/14 and 4/30/17; and 2) met US Preventive Service Task Force (USPSTF) abnormal blood glucose screening criteria (i.e., body mass index ≥25 kg/m^2 and between ages 40–70 years) to allow for an 18-month washout period prior to baseline. We then excluded patients who had been screened for diabetes or diagnosed with diabetes or prediabetes prior to 11/1/2015, the start of the study period (21% of the cohort). Next, we excluded patients with missing, unknown, multi-race and non-Black or non-White race from analysis (10% of the cohort). Finally, patients were excluded if they no longer met inclusion criteria (e.g., between age 40–70, BMI ≥25), met exclusion criteria (e.g., diagnosis of abnormal blood glucose, diabetes, prediabetes, hyperglycemia, pregnancy), or did not have a primary care visit during the study period of 11/1/2015–4/30/2017. We excluded pregnant women, since the USPSTF recommendation for gestational diabetes screening and treatment are different than those for the general population.

2.3. Qualitative data

Primary qualitative data collection consisted of in-depth interviews with physicians from two medical school-affiliated clinics within the health system. To determine the sampling frame for the qualitative study, we queried the quantitative patient sample for the names of all physicians listed as a patient participant's PCP during the study period. The sampling frame of PCPs who were both currently employed by either of the two medical school clinics and listed as a PCP within the participant patient sample, consisted of 39 physicians. All 39 PCPs were invited to participate via email PCPs received a $20 gift card for participation in the 30-min phone interview.

2.4. Qualitative data collection

The interviewer's guide was informed by a conceptual model that integrated constructs from Atun's conceptual framework on the integration of interventions into health systems (Atun et al., 2010), the Awareness-to-Adherence Model of Clinical Guideline Compliance (Pathman et al., 1996), and Andersen's Behavioral Model of Healthcare Utilization (Andersen, 2007). Questions assessed concepts from our integrated model, including factors that might affect physicians' screening of and response to prediabetes (Appendix Table A).

2.5. Quantitative variables

Our main outcomes were whether patients were screened for prediabetes (i.e., had a screening test result in the EHR during the study period) and clinician response to prediabetes-range laboratory results. Screening tests results assessed included: Hemoglobin A1C (A1C), fasting blood glucose (FBG), or 75-g oral glucose tolerance test (OGTT). Any testing result was included; we did not distinguish between routine metabolic panels and specific referrals for HbA1c, FBG, or OGTT. To assess clinician response to prediabetes, we conducted analyses with the subset of patients who had a screening test result indicating prediabetes (A1c: 5.7%–6.4%, FBG: 100–125 mg/dL, 2-h PG on OGTT: 140–199 mg/dL) during the study period. Building off an existing measure of clinician responses to prediabetes (Schmittdiel et al., 2014), our definition of clinician responses to prediabetes included: 1) retest of blood glucose (screening test result in EHR after incident prediabetes-range test result); 2) recorded diagnosis of prediabetes, hyperglycemia, dysglycemia, impaired glucose tolerance or impaired fasting glucose (ICD-9 Code 790.2× or ICD-10 Code R73.0×) Metformin prescription order; 4) ambulatory referral to nutrition/registered dietitian or weight management program; or 5) billing codes related to preventive or obesity counseling (CPT codes: 9940×; G0447; 9780×).

Our main independent variables were self-reported patient race and gender from the EHR. Covariates for the analyses included patient race (for gender analysis) and gender (for race analysis), age and BMI identified from the literature (Schmittdiel et al., 2014; Zimmermann et al., 2012) and hypertension and type of health insurance (public vs private) identified in the qualitative interviews. Hypertension was defined as either a single ICD-9 or ICD-10 code OR at least two blood pressure readings of systolic blood pressure >135 or diastolic blood pressure >90. We used SAS Version 9.4 for all quantitative analyses and significance testing was performed at $\alpha < 0.05$.

2.6. Quantitative analyses

Logistic regression with Generalized Estimating Equations (GEE) was used to account for potential intra-class correlations among patients with the same physician to model the two dichotomous outcomes, screening and clinician response.

Logistic models for binary outcomes were used for analysis in SAS's procedure for GEE, PROC GENMOD (SAS Institute Inc, 2008). For the two outcomes of interest, we ran a model with the following predictors: a) Race only; b) Gender only; c) Race and identified covariates; d) Gender and identified covariates. The purpose of these analyses was to assess the contribution of race and gender, independently, to prediabetes screening and clinician

response to prediabetes. We included an interaction term between patient race and gender to understand the contribution of both race and gender together to our outcomes of interest, but the estimated coefficient of this interaction term was not statistically significant for either outcome and was therefore removed from the final models. All continuous covariates were mean centered in analyses.

2.7. Qualitative analyses

In-depth interviews were audio-recorded and transcribed. Interviews were conducted between October 2018 and May 2019. The interviewer collected demographic information utilizing forms that asked physicians about gender, years in practice, and percent of time spent seeing patients.

Data were managed with Atlas Ti® 8 software. Interviews were analyzed using methods informed by directed content analysis (Hsieh and Shannon, 2005). A coding guide was developed a priori based on the study's conceptual framework and interview guide. The first nine transcripts were read to derive additional codes by highlighting words from the text that appeared to capture key thoughts or concepts. Labels for codes were developed that were reflective of more than one key thought. Therefore, the final coding guide included codes reflecting topics from the conceptual framework, interview guide and de novo topics identified inductively.

Two investigators read all the transcripts and coded interviews using the final coding guide. All discrepancies between coders were reviewed and resolved through dialogue between the coders. Matrices were used to visually represent data and to facilitate analysis by organizing and reducing data and relationships between categories.

The purpose of utilizing both qualitative and quantitative methods in this mixed-methods triangulation design was to obtain complementary information contextualizing quantitative results with qualitative data (Creswell and Plano, 2006). To integrate qualitative and quantitative findings, we employed the "following a thread" method (O'Cathain et al., 2010). First, we conducted initial analysis of each component separately to identify key findings. Next, we identified questions that we wanted to explore further. We then selected one question, "what factors may explain race and gender disparities in the screening and treatment of prediabetes", from the quantitative findings and followed it across the qualitative component.

3. Results

3.1. Patient sample characteristics

Characteristics of the patient sample are shown in Table 1. In the full patient sample, the mean age was 55.5 years, 55% were women, 52% had BMI of ≥30 kg/m2, 33% had a diagnosis of hypertension, and 79% had private insurance. Black patients were younger, more likely to be women, and had higher prevalence of hypertension, obesity, and public insurance compared to White patients. Men had higher prevalence of hypertension (37.2% vs 30.2%) and lower prevalence of obesity (46.1% vs 57%) compared to women. Over 95% of screening tests in our sample were HbA1c.

3.2. Relationship of patient race to screening

There were significant differences in screening proportions between Black and White patients in both unadjusted and adjusted analyses (Table 2) with Black patients having a 11% higher odds (AOR: 1.11, 95% CI: 1.02–1.20, $p = .01$) of being screened for prediabetes than White patients, after adjusting for patient age, gender, BMI, hypertension diagnosis, and type of insurance.

3.3. Relationship of patient gender to screening

There were significant differences in screening proportions between men and women in both unadjusted and adjusted analyses (Table 2) with men having 19% higher odds of being screened for prediabetes than women (95% CI:1.09–1.30, $p = .0002$) in analyses adjusted for patient age, race, BMI, hypertension diagnosis, and type of insurance.

3.4. Characteristics of clinician response to prediabetes

We identified 3500 patients with screening test results indicating prediabetes. Characteristics of this patient sample are shown in Table 1. Table 3 shows the breakdown of clinician response to prediabetes by response type (e.g., retest, diagnosis, referrals, etc.) and by patient race and gender.

3.5. Relationship of patient race to prediabetes response

There were no statistically significant differences in clinician response to prediabetes between Black patients and White patients in either unadjusted or adjusted models (Table 2).

3.6. Relationship of patient gender to prediabetes response

There were no statistically significant differences in clinician response to prediabetes between men and women.

4. Clinician perspectives on diabetes prevention strategies

A total of 20 PCPs participated in interviews (52% response rate), 11 from internal medicine and 9 from family medicine clinic. PCPs were evenly split between men and women, 25% had less than 10 years in practice and 80% were less than full-time in clinic. Illustrative quotes related to qualitative themes are reported in Table 4. Overall, PCPs reported a non-systematic approach to prediabetes screening and treatment related to the following four themes: 1) System-level barriers to screening and treatment; 2) Race and gender implicit bias concerns; 3) Patient-level factors impacting screening and treatment decisions; and 4) PCP preference for initial treatment.

4.1. System-level barriers to screening and follow-up care

The most commonly reported barrier to prediabetes screening was health insurance coverage. In particular, PCPs cited difficulty screening Medicare patients with an A1c test as Medicare's diabetes screening benefit does not cover this test. As such, for Medicare patients, PCPs would have to use a fasting blood glucose test for screening, and this often meant a return visit for fasting labs.

Physicians often mentioned health system barriers to providing guideline-recommended (Siu, 2015) treatment for patients with prediabetes. PCPs reported that the health system did not currently offer the National Diabetes Prevention Program (NDPP) and there was no sytematic way to refer to external intensive behavioral interventions such as the NDPP. Physicians were unclear on which health insurance plans covered intensive behavioral programs, and were hestitant to refer to such programs and potentially cause out-of-pocket costs for their patients.

4.2. Race and gender implicit bias concerns

Most PCPs did not mention patient race as a factor they considered in deciding whether to screen for prediabetes. Only when asked explicitly by the inteviewer about whether they considered patient race when screening did physicians begin to discuss racial considerations. Many PCPs stated that they did not 'explicitly' consider patient race when screening for prediabetes although they expressed awareness that they may have 'unconscious biases.' They then explained that they had a desire to avoid any explicit bias which was a key reason for their not considering patient race. Asian race was discussed most frequently as PCPs cited that Asians tended to be at risk for diabetes at a lower BMI than other races but providers also mentioned Black and Latino patients as racial/ethnic groups that they may consider screening at lower BMI or earlier age than recommended by the USPSTF.

If gender considerations were mentioned at all, it was most often related to additional screening for women who had a history of gestational diabetes, as outlined in clinical guidelines. Overall, when asked explicitly, most physicians stated that they did not screen patients differently based on gender. Like racial considerations, many PCPs mentioned a desire to avoid any potential implicit bias when discussing gendered considerations for prediabetes screening. Regarding prediabetes treatment, many PCPs cited that men were less likely to engage in weight management-related referrals than women.

4.3. Patient-level factors affecting screening and follow-up care decisions

Since most PCPs did not report a systematic approach to screening based on clinical guidelines, physicians utilized their clinical judgement and considered a variety of individual, patient factors when deciding to screen for prediabetes. The most commonly cited approach to screening was to screen patients who "looked obese", were hypertensive or who had a family history of diabetes. When asked which guidelines they used for diabetes prevention, both the American Diabetes Association (ADA) and USPSTF guidelines were mentioned. Clinicians tended to look to the USPSTF for more general preventive guidelines and to the ADA for patient-level risk factors specific to diabetes for screening.

For prediabetes treatment, PCPs believed that patients trust them to make the right decision on their behalf and that their role was to assist patients in the most cost-effective way possible. Most providers were hesitant to make referrals to programs they felt patients could not complete, and half of clinicians stated that out-of-pocket costs for patients were a barrier to treating prediabetes. Many PCPs also cited time constraints, in the clinical encounter and in their patients' lives, as a barrier to prediabetes treatment. Competing priorities in the clinical encounter limited physicians time to address prediabetes and competing priorities in

patients' lives related to work and family limited patient time to engage in behavioral interventions.

4.4. Provider preference for initial treatment

Many physicians initially preferred to address prediabetes by offering brief lifestyle counseling, specifically addressing changes to diet aimed at weight reduction and increases to physical activity. Providers reported setting goals with patients and scheduling follow-up appointments to assess the implementation of lifestyle changes and weight loss achieved. PCPs reported that they would wait up to six months before offering a prescription for metformin or referral to nutrition, and that often patients would decline these offers to continue working with their provider on lifestyle modifications. Most providers did not refer to structured weight loss programs, as they were hesitant to recommend programs that were time-consuming or would result in any out-of-pocket cost for their patients. Many also expressed uncertainty about the efficacy of metformin for prediabetes treatment.

5. Discussion

In a cohort of 18,742 primary care patients meeting criteria for the 2015 US Preventive Services Taskforce recommendations for screening for abnormal blood glucose, we found significant differences in screening percentage based on patient race and gender. Black patients and men had higher odds of being screened than White patients. The greater odds of Black patients being screened for prediabetes remained significant after adjusting for factors related to screening such as hypertension, age, BMI, and insurance type indicating that this association does not appear to be fully explained by a greater prevalence of these risk factors among Black patients or health system factors. This is consistent with current diabetes screening approaches recommended by the USPSTF and the ADA that identify race as a factor to consider for screening as well as with previous research showing higher rates of diabetes screening for Black patients (Casagrande et al., 2015; Kiefer et al., 2015). Interestingly, in our in-depth interviews with PCPs regarding patient race often immediately resulted in PCPs discussing implicit and explicit bias although that was not the purpose of the interview. It seems possible that the uptick in literature assessing physician biases in patient care (Hall et al., 2015; Chapman et al., 2021; Fitzgerald and Hurst, 2017) may overly sensitize PCPs to these issues and affect how they consider certain patient characteristics in an effort to appear "unbiased" despite recommendations to consider race in this circumstance. While PCPs may not have discussed race and gender considerations freely in the qualitative interviews, our quantitative findings reflected clinician behaviors documented in the EHR.

In our qualitative interviews, many PCPs cited hypertension as a factor they considered for diabetes screening. This may be a reason that men in our quantitative sample were more likely to be screened as they had a higher prevalence of hypertension compared to women. Furthermore, hypertension is identified as a risk factor for screening in the ADA guidelines (Johnson et al., 2020) and the previous (2008) USPSTF abnormal blood glucose screening guideline (Siu, 2015) was hypertension based.

Our study adds to a growing body of research indicating low levels of identification and treatment of prediabetes (Schmittdiel et al., 2014; Zimmermann et al., 2012; Geiss et al., 2010; Karve and Hayward, 2010). Schmittdiel et al. found that in a retrospective cohort study of 358,120 adults meeting criteria for laboratory-defined prediabetes in a large, integrated health delivery system, only 43.5% of patients had evidence of a clinical response documented in the EHR within 6 months of a prediabetes-range laboratory value (Schmittdiel et al., 2014). A nationally representative sample of non-diabetic subjects (n = 1547) found that 35% of participants had laboratory-defined prediabetes while only 4.8% reported being informed of their diagnosis by their physician (Karve and Hayward, 2010). Taken together with our findings, it is clear that large proportions of eligible patients are not receiving treatment for prediabetes. It is important to note that time constraints in the clinical encounter is a key barrier to prediabetes screening and treatment. In qualitative interviews with PCPs, Kandula et al. found that competing demands during the clinical visit limited providers' abilities to address prediabetes (Kandula et al., 2015). Similarly, we also found that demands on PCPs' time during the clinical visit was cited as a barrier to prediabetes follow-up care.

Our study goes beyond current research by combining quantitative estimates of prediabetes screening and clinician response to prediabetes with qualitative insights about the factors that contributed to these rates and differences by patient race and gender. However, there are limitations to this study including risk of misclassification and potential for residual confounding. Our study was conducted in one, albeit large, health system, limiting the generalizability of our results and we only had data on patients' interactions with this healthcare system. Additionally, because we did not examine clinical notes as part of our quantitative dataset, it is possible that we missed instances of clinician response to prediabetes. Our analysis also did not to take account the perceived error rate of diabetes screening tests or clinical uncertainty of a prediabetes diagnosis, however, we included retesting as a clinician response which we believe accommodates PCPs with this concern as they may choose to retest a patient to have greater confidence in the test results.

6. Conclusion

In this large sample of patients with prediabetes, 33% had EHR documented hypertension and 52% had documented obesity, both risk factors for diabetes, cardiovascular disease and COVID-19. An insufficient focus on diabetes prevention in healthcare delivery likely has critical effects on other patient outcomes, and health disparities in particular (Marhl and Grubelnik, 2020; Dhindsa et al., 2020; Gianchandani et al., 2020). Of note, the Black patients in this sample had higher prevalence of obesity, hypertension and prediabetes and research has already demonstrated marked health disparities in COVID-19 prevalence among Blacks, some of which is related to these risk factors (Tai et al., 2020). While it may appear that disparities could be closing since Black patients in our cohort were more likely to be screened for diabetes, we did not find evidence of increased clinician response to prediabetes for Black patients although they had higher rates of prediabetes. Given the projection that racial disparities in diabetes burden will worsen if no action is taken, health system policies and interventions that promote clinician response to prediabetes, particularly for high risk groups, are needed.

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Appendix A.: Appendix

Appendix Table A

Theoretical constructs (Atun et al., 2010; Pathman et al., 1996; Andersen, 2007) and sample interview guide questions

Construct	Definition (Atun et al., 2010; Pathman et al., 1996; Andersen, 2007)	Sample interview guide question(s)	Theoretical framework
Problem	Adopting stakeholders' perceptions of the urgency of the problem and its economic and other burdens	• Thinking about the patients you see and their medical issues, where would you rank prediabetes in terms of clinical importance?	Atun et al.'s framework
Intervention	Adopting stakeholders' perceptions of intervention complexity, relative advantage, and cost	• Once a patient screens positive for prediabetes, what generally are your next steps? Why?	Atun et al.'s framework
Adopting system	Stakeholders who decide whether to adopt and the distribution of decision-making power among them	• To what extent do you think other providers you work with screen for abnormal blood glucose according the guideline? To what extent do you think that other providers you work with refer to or provide intensive behavioral counseling to patients with prediabetes? • To what extent do others you work with support you following this recommendation? • To what extent do you feel under pressure from anyone to do this? Or not to do it?	Atun et al.'s framework
Health system charateristics	Regulatory, organizational, and financial factors that constrain or support intervention adoption	• What are the incentives for following these recommendations? • Are there systems in place that support you following this recommendation?	Atun, et al.'s framework
Context	Interplay of demographic, economic, socio-cultural, and technological factors in the broader community	• To what extent might you offer different services to different patients? What factors influence this decision?	Atun et al.'s framework

Construct	Definition (Atun et al., 2010; Pathman et al., 1996; Andersen, 2007)	Sample interview guide question(s)	Theoretical framework
Environment	Organizational resources and physical, political and economic factors	• Do you or your clinic currently have an established referral relationship with community resources for diabetes prevention services?	Andersen' s behavioral model
Evaluated need	Professional judgement about people's health status and their need for medical care	• How do you decide which patients you screen for prediabetes? • How do you decide which service or services you will offer your patient?	Andersen' s behavioral model
Predisposing demographics	Socio-demographic predispositions such as race, gender, age	• How do you decide which patients you screen for prediabetes? Probes: To what extent do you consider patient age in deciding who to screen? To what extent do you consider patient gender? How about race—To what extent do you consider patient race in deciding who to screen? What other factors do you consider when deciding whether to screen a patient for prediabetes?	Andersen' s behavioral model
Enabling resources	Factors SUCH as health insurance coverage, health system reimbursement and incentives or other factors that support intervention use	• What are the incentives for following these recommendations? • Are there systems in place that support you following this recommendation?	Andersen' s behavioral model
Awareness	Providers' awareness of any clinical guideline related to diabetes prevention and specifically the 2015 USPSTF abnormal blood glucose recommendation	• There are several diabetes-related screening guideline recommendations. Now I would like to ask you about your views of a specific practice guideline recommendation. In late 2015, the USPSTF revised their abnormal blood glucose guidelines, how familiar are you with this recommendation? Can you tell me about this recommendation?	Awareness-to-adherence model
Agreement	Providers' agreement (or disagreement) with published clinical guidelines for diabetes screening and prediabetes treatment	• What are your general views of these guideline recommendations? To what extent do you agree or disagree with them?	Awareness-to-adherence model
Adoption	The extent to which providers follow the guideline/ recommendation in their clinical practice	• What factors do you think exist that might make it more or less likely for you to follow these guidelines with a given patient?	Awareness-to-adherence model
Adherence	The extent to which providers succeed in adhering to it (or follow it consistently at appropriate times).	• To what extent would you say, as a percentage, you adhere to the screening part of the recommendation? How about the prediabetes treatment recommendations? • What is your sense of strategies that could be used to increase the proportion of clinicians in the UNC health system who adhere to these recommendations regularly?	Awareness-to-adherence model

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Table 1

Characteristics of patient sample.

	Full patient sample			Prediabetes subsample		
	Total	**White**	**Black**	**Total**	**White**	**Black**
	***N* = 18,742**	***N* = 14,219**	***N* = 4523**	***N* = 3500**	***N* = 2160**	***N* = 1340**
Mean age, years	55.5	56.0	53.9	57.4	58.3	55.8
Gender						
Women, %	55	51	65	57	51	65
Body mass index						
25–29.9, %	48	53	32	28	32	22
30>, %	52	47	68	72	68	78
Hypertension						
Yes, %	33	30	46	56	65	51
Insurance						
Any private, %	79	81	73	78	80	75
Public only, %	21	19	27	22	20	25

Table 2

Relationship of patient race and patient gender to screening, clinician response.

	Mean %	Screening				Clinician response				
		OR	95% CI	AOR	95% CI	Mean %	OR	95% CI	AOR	95% CI
Patient race										
White	10.4	REF	REF	REF	REF	76.6	REF	REF	REF	REF
Black	14.0	1.41	1.28–1.54	1.11	1.02–1.20	79.0	1.15	0.97–1.37	1.11	0.92–1.34
Patient gender										
Women	10.5	REF		REF	REF	78.5	REF	REF	REF	REF
Men	12.5	1.21	1.11–1.33	1.19	1.09–1.30	76.1	0.87	0.73–1.03	0.91	0.77–1.09

*Adjusted for patient's age, BMI, type of insurance, hypertension diagnosis, race (gender analysis), gender (race analysis).

Table 3

Clinician responses to prediabetes, by patient race and gender.

	Prediabetes subsample				
	Total	**White**	**Black**	**Women**	**Men**
	***N* = 3500**	***N* = 2160**	***N* = 1340**	***N* = 1984**	***N* = 1516**
	% of patients with prediabetes				
	18.7	15.2	29.6	19.3	17.9
Clinician responses	% of patients with response				
Retest	42.96	40.53	46.70	45.16	39.93
Recorded diagnoses related to prediabetes/hyperglycemia	18.48	19.54	16.85	18.09	19.02
Metformin prescription	30.87	30.80	30.98	32.64	28.39
Referral to nutrition or weight management program	2.56	2.24	3.06	3.11	1.79
Preventive/obesity counseling billing code	1.57	1.42	1.67	1.89	1.13
Any clinician response	77.54	79.00	76.59	78.57	76.11

*Percentages do not total to 100 as patients could have multiple clinician responses.

Table 4

Physician perspectives on diabetes prevention: themes and illustrative quotes.

Theme 1. System-level barriers to screening and treatment
Provider 16: Nowadays, 'cause most people don't come in fasting, if they're – This is gonna sound terrible. If they're non-Medicare then I can get hemoglobin A1C.[…] unfortunately if they're Medicare, Medicare won't pay for hemoglobin A1C, so I have to ask them to come back fasting so that I can kind of get a fasting glucose Provider 1: The available resources vary so tremendously from provider or from insurance to insurance […] that makes implementation hard.
Theme 2. Race and gender implicit bias concerns
Provider 3: Obviously I probably have unconscious biases […]. I'm trying to think actually demographically if I have noticed a difference in my patient population between various races and diabetes.[…]
Provider 18: I mean I think it may be more prevalent in women but I'm not even sure about that. I mean I think I look at it – I'm not sure that I have a gender bias when it comes to making that decision.
Theme 3. Patient-level factors affecting screening and treatment decisions
Provider 8: Well, there are a lot of variables, including access to care, money, time, availability, knowing the patients, so I know a lot of my patients, so I know what they're gonna say, almost. So yeah, so if someone has limitations in financing or coming in because they don't want to miss work then I usually give them some counseling here in person
Provider 20: […]I think that if you were talking with primary care providers, most of us would say that we just are limited a lot in our time that we have with patients, and so yes, it would be wonderful to be able to block off 40 min to talk to them about diet and nutrition and carb counting and glucose checks
Theme 4. PCP preference for initial treatment
Provider 10: We usually just talk about lifestyle modifications. I rarely have ever put someone on something like metformin.