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Original research

COVID-19 impacts and inequities among underserved communities with diabetes

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ABSTRACT

Background: People with diabetes have higher COVID-19 morbidity and mortality. These risks are amplified for underserved communities including racial/ethnic minorities and people with lower socioeconomic status. However, limited research has examined COVID-19 outcomes specifically affecting underserved communities with diabetes.

Methods: From November 2021 to July 2022, adults with insulin-requiring diabetes at federally qualified health centers in Florida and California (n = 450) completed surveys examining COVID-19 outcomes and demographics. Surveys assessed COVID-19 severity, vaccination uptake, mask-wearing habits, income changes, and healthcare access changes. Surveys also included the full Coronavirus Anxiety Scale (CAS-19). Descriptive statistics were computed for all outcomes. Between-group comparisons for state and race/ethnicity were evaluated via Chi-Squared, Fisher's Exact, Cochran-Mantel-Haenszel, One-Way ANOVA, and *t*-tests. Logistic regression determined factors associated with COVID-19 vaccination uptake. Data were self-reported and analyzed cross-sectionally.

Results: Overall, 29.7 % reported contracting COVID-19; of those, 45.3 % sought care or were hospitalized. Most (81.3 %) received ≥ 1 vaccine. Hispanics had the highest vaccination rate (91.1 %); Non-Hispanic Blacks (NHBs) had the lowest (73.9 %; p =.0281). Hispanics had 4.63x greater vaccination odds than Non-Hispanic Whites ([NHWs]; 95 % CI = [1.81, 11.89]). NHWs least often wore masks (18.8 %; p <.001). Participants reported pandemic-related healthcare changes (62 %) and higher costs of diabetes medications (41 %). Income loss was more frequent in Florida (76 %; p <.001). NHBs most frequently reported "severe" income loss (26.4 %; p =.0124). Loss of health insurance was more common among NHBs (13.3 %; p =.0416) and in Florida (9.7 %; p =.039). COVID-19 anxiety was highest among NHBs and Hispanics (IQR = [0.0, 3.0]; p =.0232) and in Florida (IQR = [0.0, 2.0]; p =.0435).

Conclusions: Underserved communities with diabetes had high COVID-19 vaccine uptake but experienced significant COVID-19-related physical, psychosocial, and financial impacts. NHBs and those in Florida had worse outcomes than other racial/ethnic groups and those in California. Further research, interventions, and policy changes are needed to promote health equity for this population.

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Introduction

In January 2020, the 2019 coronavirus (COVID-19) began spreading, initiating the most widespread pandemic in a century [1]. Caused by coronavirus, COVID-19 is an infectious disease with airborne transmission that typically presents with influenza-like symptoms [2]. COVID-19 can lead to severe illness involving hospitalization with intubation, prolonged symptoms referred to as "Long COVID", and death [2]. As of May 8, 2023, more than 104.3 million and 1.1 million people in the U.S. have contracted and died from COVID-19, respectively [3]. The COVID-19 pandemic has also resulted in increased unemployment rates, healthcare access barriers, and mental health issues such as anxiety and depression [4–6]. The risk of severe COVID-19 outcomes is higher among people with immunocompromising conditions such as diabetes, older adults, and underserved communities including racial minorities, those with lower incomes, and those living in under-resourced areas [7].

Extensive research demonstrates that public health measures such as social distancing, wearing masks, handwashing, and receiving approved vaccines produced by Pfizer-BioNTech, Moderna, Johnson & Johnson, and Novovax reduce the spread of COVID-19 [8]. However, the public expressed hesitancy with regards to following these measures [9]. Factors associated with hesitancy include misinformation, political and cultural views, and social stigmas such as that people wearing masks are weak and that older and immunocompromised people are disposable [10,11]. Among racial minorities, another contributor to vaccine hesitancy is distrust in the government and healthcare system attributable to discrimination and historical maltreatment in medical care and research, such as the Tuskegee Study [12]. Furthermore, COVID-19 vaccines and treatments such as Paxlovid have been inequitably distributed, with rural areas and cities with higher percentages of racial minorities receiving lower quantities [13,14].

As noted previously, people with diabetes are among those who experienced especially poor outcomes throughout the pandemic [15]. A national study from July 2020 found that approximately 40 % of people who died from COVID-19 in the U.S. had diabetes [16]. COVID-19 risks are particularly high for people with type 2 diabetes (T2D) and comorbid conditions such as obesity and cardiovascular disease [15]. However, all people with diabetes, including those with type 1 diabetes (T1D), gestational diabetes, latent autoimmune diabetes in adults (LADA), and maturity-onset diabetes in the young (MODY), were encouraged to follow extensive safety precautions [17]. Research also indicates that people with diabetes reported elevated stress, diabetes distress, and anxiety during the COVID-19 pandemic [18]. Furthermore, people with diabetes had higher unemployment rates (18 %) than the general population (12 %) during the pandemic [19].

Given that underserved communities with diabetes consistently experience worse outcomes, including higher hemoglobin A1c (HbA1c) levels, diabetes distress, and mortality rates, and lower diabetes technology utilization, it is anticipated that they also experienced worse outcomes from COVID-19 [20–23]. Research demonstrates that underserved communities in general reported worse COVID-19 outcomes in the U.S.; for example, Non-Hispanic Blacks (NHBs) and Hispanics were more likely than Non-Hispanic Whites (NHWs) to become ill and experience distress, trauma, and wage loss [24–26]. However, limited research has examined impacts of the COVID-19 pandemic specifically affecting underserved communities with diabetes. Additionally, limited research has assessed COVID-19 vaccine coverage and mask-wearing habits among underserved communities with diabetes.

To fill these gaps, we conducted a survey to determine COVID-19 outcomes affecting underserved adults with diabetes enrolled in the Project Extension for Community Healthcare Outcomes (ECHO) Diabetes program, which utilizes a hub-and-spoke approach and is based in California and Florida. We assessed this patient population's COVID-19 illness severity, vaccination uptake, mask-wearing habits, COVID-19-related anxiety, financial stability, and access to healthcare, health insurance, and diabetes medications throughout the COVID-19 pandemic. We stratified differences in these outcomes by participants' race/ethnicity (Hispanic, NHB, NHW, or other/multiple), and state of residence (California or Florida). As such, this survey also aimed to identify differences in COVID-19 outcomes among underserved adults with diabetes residing in two states with differing health policies, such as Medicaid expansion in California and lack of Medicaid expansion in Florida [6].

Material and Methods

Study Design and Participants

Our survey was administered between November 2021 and July 2022 as part of a larger research effort through the Project ECHO Diabetes program. Project ECHO Diabetes trains primary care providers employed at federally qualified health centers (FQHCs) throughout Florida and California on specialty care practices for underserved patients who lack access to endocrinologists [27]. Project ECHO Diabetes has enrolled 33 FQHCs across both states, including community health centers and centers for residents of public housing. These FQHCs were recruited using the National Deprivation Index and geocoding efforts focused in areas with high poverty and few endocrinologists, resulting in a geographically diverse sample [28,29]. Project ECHO Diabetes provides the FQHCs with resources such as diabetes support coaches, who work with underserved patients, and online education materials for physicians.

To qualify for enrollment in Project ECHO Diabetes and this survey, patients with diabetes at the 33 FQHCs needed to be $\geq$ 18 years of age and use multiple daily injections of insulin. There were no limitations on recruitment based on patients' type of diabetes or duration of diabetes diagnosis.

Procedure

As part of the broader Project ECHO Diabetes research effort, participants were recruited via phone and on-site in-person outreach at the FQHCs. Call lists of patients meeting the research selection criteria were provided by the FQHCs. Reminder phone calls and follow-up mailings were completed to ensure adequate enrollment numbers. Diabetes support coaches and research coordinators bilingual in English and Spanish recruited participants.

To enroll, participants completed an electronic consent form and identified their preference for survey completion: mailed paper copy, over the phone, or online, and language: English or Spanish. In Florida, signed informed consent was obtained using Research Electronic Data Capture ([REDCap®]; Nashville, TN), an online data management platform. In California, informed consent was obtained verbally. Surveys in the requested language were sent to participants by research staff via their indicated preferred method. Return postage was prepaid for those who received paper copies via mail. Participants each received a $20 Amazon gift card following receipt of the completed survey. All study procedures were approved by the University of Florida and Stanford University Institutional Review Boards.

Measures

This study analyzed Project ECHO Diabetes' survey data focused on COVID-19 outcomes and demographic characteristics. All data were self-reported, and all questions were optional. Demographic survey questions captured participants' age, sex at birth, race/ethnicity, diabetes type, state of residence, type of insurance coverage, and educational attainment. COVID-19-related survey questions assessed participants' illness severity, preventive behaviors, access to healthcare, and financial stability. Three questions were used from the Centers for Disease Control and Prevention (CDC)'s Vaccine Confidence Survey

Bank [30]; these questions asked participants whether they currently or previously had COVID-19 (yes/no), what level of care they received if they contracted COVID-19 on a 3-point scale (did not seek medical care, received medical care but was not hospitalized, or was hospitalized), and whether they received a COVID-19 vaccine (yes/no/unsure). A follow-up question developed by the lead author asked if participants were fully vaccinated, which was defined at the time of survey development as having received at least two doses of the Pfizer-BioNTech vaccine or Moderna vaccine, or one dose of the Johnson & Johnson vaccine (yes/no). This survey definition remained the same throughout the study. Two questions were modified from Gallup polls [31,32]; these asked participants how often they wore a mask outside their homes and the extent to which the costs of their diabetes medications changed since the pandemic began, using 5-point Likert scales. Two questions were used from the Coronavirus Impact Scale [33]; these asked how much the pandemic affected participants' family income/employment and access to medical care, using 4-point Likert scales. The question assessing income/employment included the following options: no change; mild to small change = able to meet all needs and pay bills; moderate change = having to make cuts but able to meet basic needs and pay bills; and severe change = unable to meet basic needs and/or pay bills, while the question assessing access to medical care included the following options: mild = appointments moved to telehealth; moderate = delays or cancellations in appointments and/or delays in getting prescriptions resulting in minimal impact on health; severe = unable to access needed care resulting in moderate to severe impact on health. Other items developed by the lead author asked participants whether they lost access to health insurance during the pandemic (yes/no), why they did not get vaccinated (free-text; if applicable), and to describe their experiences as a person with diabetes during the pandemic (free-text).

The full Coronavirus Anxiety Scale (CAS-19) [34] was incorporated into the survey to measure participants' anxiety pertaining to COVID-19. The CAS-19 is a validated scale comprising five items examining how often people experience COVID-19-specific anxiety symptoms over a 2-week period, specifically dizziness, feeling paralyzed by fear, difficulty sleeping, decreased appetite, and digestive issues [34]. The items follow a 5-point Likert scale. Participants' total anxiety is calculated by adding together each item score, with higher scores indicating higher anxiety [34]. Although the CAS-19 is relatively new, it has strong reliability (r = 0.87–0.93) [34,35]. It also has high predictive validity, as evidenced by its positive associations with scales measuring related conditions such as disability and distress [34].

Analysis

All data management and analysis were conducted using SAS 9.4® (Cary, NC). Demographic characteristics were summarized overall and by state descriptively (frequencies/percentages or mean ± standard deviation [STD]). Between-group comparisons for participants' state of residence (California or Florida) and race/ethnicity (Hispanic, NHB, NHW, or other/multiracial; the latter included Asian, Native HI/Pacific Islander, and American Indian/AK Native) were evaluated via Chi-Square and Cochran-Mantel-Haenszel (CMH) General Association testing methods for categorical data. *T*-tests were used to compare the two states with respect to continuous data. Similarly, COVID-19 outcomes were stratified by state of residence and race/ethnicity via CMH or Chi-Square testing methods. Logistic regression was used to characterize independent associations between state, race/ethnicity, diabetes type, insurance type, and receipt of at least one COVID-19 vaccine. Total CAS-19 scale scores were calculated for participants who responded to all scale items. For the CAS-19, medians and interquartile range (IQR) were examined instead of means and STD due to skewed data. Welch's One-Way Analysis of Variance (ANOVA) was used to evaluate racial/ethnic differences in total CAS-19 scores. A *t*-test assessed for state differences in total CAS-19 scores; the Sattherwaite method was used to account for unequal variances. Statistical significance was determined a priori; p-values < 0.05 were considered significant. The free-text survey data will be analyzed in subsequent qualitative research.

Results

Participant Demographics

Out of all participants enrolled in Project ECHO Diabetes (n = 872) [29], 450 participants completed the COVID-19 survey and are considered this study's sample (response rate = 51.6 %). Participants' mean age was 52.7 years (SD = 14.1 years; n = 443). More than half had T2D (58.7 %; n = 261); 37.1 % had T1D (n = 165), 3.4 % had LADA (n = 15), and 0.9 % reported having other types of diabetes (n = 4). The majority were female (54.2 %, n = 243). Participants were predominantly NHW (47.5 %; n = 210), Hispanic (22 %; n = 97), or NHB (21.3 %; n = 94). Educational attainment varied, with 29.3 % (n = 129) having received a high school diploma or GED; 22 % (n = 97) attended some college but did not receive a degree; 14.3 % (n = 63) received a Bachelor's degree; and 13.8 % (n = 61) attended some high school but did not receive a diploma. More than half (53.8 %; n = 242) received care at clinics in Florida. Participants most frequently used Medicare (30.2 %; n = 131), Medicaid (25.8 %; n = 112), or commercial insurance (23 %; n = 100).

Participants' demographics significantly differed by their state. In California, the mean age was 54.8 years (SD = 15.9 years; n = 208), while in Florida, the mean age was 50.9 years (SD = 12 years; n = 242; p =.0045). In California, more participants were male (51.9 %; n = 108), in contrast to Florida where they were predominantly female (59.6 %; n = 143; p =.0148). In California, most were NHW (62.8 %; n = 130) or Hispanic (16.9 %; n = 35), in contrast to Florida participants who were predominantly NHB (36.2 %; n = 85) or NHW (34 %; n = 80; p <.0001). T2D was more prevalent among those in Florida compared to those in California (67.1 %; n = 159 vs. 49 %; n = 102, respectively; p =.0003). T1D was more prevalent among those in California compared to Florida (43.8 %; n = 91 vs. 31.2 %; n = 74, respectively; p =.0003). Most California participants used Medicare (40.7 %; n = 83), commercial insurance (22.1 %; n = 45), or Medicaid (19.1 %; n = 39), while most Florida participants used Medicaid (31.7 %; n = 73), commercial insurance (23.9 %; n = 55), or Medicare (20.9 %; n = 48; p <.0001). Participants' educational attainment did not significantly differ based on their state of residence. Table 1 displays all demographic data.

COVID-19 Illness Severity

Nearly one-third of all participants (29.7 %; n = 129) reported currently or previously having COVID-9. Among those who reported contracting COVID-19, 54.8 % (n = 69) did not seek medical care for it, 30.2 % (n = 38) received medical care for it but were not hospitalized, and 15.1 % (n = 19) were hospitalized for it. There were no significant associations between COVID-19 illness or level of medical care received and participants' race/ethnicity nor state. Data pertaining to COVID-19 illness and all other outcomes are shown in Tables 2 and 3.

COVID-19 Vaccination Status

Most participants (81.3 %; n = 356) reported being vaccinated against COVID-19. Among those vaccinated, 97.5 % (n = 344) reported being fully vaccinated. Hispanics were the most vaccinated racial/ethnic group (91.1 %; n = 82), followed by other/multiracial (80.5 %; n = 33), and NHWs (80.2 %; n = 166); NHBs were the least vaccinated (73.9 %; n = 68; p =.0281). State differences in vaccination status were not statistically significant. Being fully vaccinated was not significantly associated with participants' race/ethnicity nor state. However, results from the logistic regression model (n = 393) demonstrated that Hispanics had 4.63 higher odds than NHWs to have received a COVID-19 vaccine (95 % CI = [1.81, 11.89]). No other demographic characteristics included in the logistic regression model were significantly associated with receipt

Table 1
Participant Demographic Characteristics.

	All (N = 450)		CA (N = 208)		FL (N = 242)		
	n	n(%), mean ± STD	n	n(%), mean ± STD	n	n(%), mean ± STD	p-value
Age	443	52.7 ± 14.1	208	54.8 ± 15.9	235	50.9 ± 12.0	0.0045*
Sex at Birth:	448		208		240		0.0148*
Male		205 (45.8)		108 (51.9)		97 (40.4)	
Female		243 (54.2)		100 (48.1)		143 (59.6)	
Diabetes Type:	445		208		237		0.0003*
Type 1 Diabetes		165 (37.1)		91 (43.8)		74 (31.2)	
Type 2 Diabetes		261 (58.7)		102 (49.0)		159 (67.1)	
Latent Autoimmune Diabetes		15 (3.4)		12 (5.8)		3 (1.3)	
Other		4 (0.9)		3 (1.4)		1 (0.4)	
Insurance Coverage:	434		204		230		<0.0001*
Commercial		100 (23.0)		45 (22.1)		55 (23.9)	
Medicare		131 (30.2)		83 (40.7)		48 (20.9)	
Medicaid		112 (25.8)		39 (19.1)		73 (31.7)	
Dual Eligible Medicare/Medicaid		29 (6.7)		18 (8.8)		11 (4.8)	
Indian Health Service		8 (1.8)		8 (3.9)		–	
Uninsured/Self-Pay		54 (12.4)		11 (5.4)		43 (18.7)	
Race/Ethnicity:	442		207		235		<0.0001*
White		210 (47.5)		130 (62.8)		80 (34.0)	
Black		94 (21.3)		9 (4.4)		85 (36.2)	
Hispanic		97 (22.0)		35 (16.9)		62 (26.4)	
Asian		7 (1.6)		3 (1.5)		4 (1.7)	
Native HI/Pacific Islander		2 (0.5)		2 (1.0)		–	
American Indian/AK Native		11 (2.5)		11 (5.3)		–	
Other/Multiple		21 (4.8)		17 (8.2)		4 (1.7)	
Education:	441		204		237		0.0501
Some high school, no diploma		61 (13.8)		26 (12.8)		35 (14.8)	
High school diploma or GED		129 (29.3)		50 (24.5)		79 (33.3)	
Some college, no degree		97 (22.0)		51 (25.0)		46 (19.4)	
Associate's degree		50 (11.3)		19 (9.3)		31 (13.1)	
Bachelor's Degree		63 (14.3)		37 (18.1)		26 (11.0)	
Master's degree		21 (4.8)		11 (5.4)		10 (4.2)	
Professional degree		3 (0.7)		3 (1.5)		–	
Don't know or do not wish to provide		17 (3.9)		7 (3.4)		10 (4.2)	

Statistical Methods: Continuous data: A *t*-test was used for continuous variables; Satterthwaite method to accommodate unequal variances for age. Categorical data: CMH General Association; CHISQ used for 2x2 tables –Sex at Birth. *Denotes statistical significance (p <.05).

of a COVID-19 vaccine. All odds ratios are presented in Table 4.

Mask-Wearing Habits

Nearly one-third of participants reported "always" wearing a mask outside their homes (32 %; n = 140), while 24.2 % (n = 106) "sometimes" wore masks, 21.2 % (n = 93) "very often" wore masks, 16 % (n = 70) "rarely" wore masks, and 6.6 % (n = 29) "never" wore masks during the COVID-19 pandemic. Multiracial and other racial/ethnic groups most frequently reported "always" wearing masks (46.3 %; n = 19), followed by Hispanics (45.6 %; n = 41) and NHBs (39.1 %; n = 36); NHWs least often reported "always" wearing masks (18.8 %; n = 39; p <.0001). Multiracial/other racial/ethnic groups also most frequently reported never wearing masks (12 %; n = 5), followed by NHWs (7.7 %; n = 16), Hispanics (5.6 %; n = 5), and NHBs (3.3 %; n = 3; p <.0001). There were no significant state differences in mask-wearing habits.

Family Income

Nearly two-thirds of participants (64.9 %, n = 281) reported losing earnings during the pandemic, with 29.3 % (n = 127) reporting "moderate" income cuts, having lost some income but still being able to meet basic needs and pay bills; 18.5 % (n = 80) reporting "mild" income cuts, having a small change in income but still being able to meet all needs and pay bills; and 17.1 % (n = 74) reporting "severe" income cuts, being unable to meet basic needs or pay bills. More than double the percentage of participants in Florida reported "severe" income cuts (23 %; n = 53) compared to in California (10.3 %; n = 21; p <.0001). In California, nearly half reported no income cuts (47.8 %; n = 97; p <.001). Stratified by race/ethnicity, NHBs reported the highest rate of "severe" income cuts (26.4 %; n = 24), while NHWs most frequently reported no income cuts (41.5 %; n = 85; p =.0124).

Access to Medical Care

Most participants indicated that the COVID-19 pandemic affected their access to medical care (62 %; n = 266). Of these, 30.5 % (n = 131) reported "mild" changes in healthcare access, such as their appointments being held virtually via telehealth instead of in-person. Nearly one-fourth reported "moderate" changes in access that had minimal impacts on their health, such as appointment or prescription delays (24 %; n = 103). "Severe" changes in access were reported by 7.5 % of participants (n = 32); these changes prevented them from accessing care and resulted in severe health impacts. Access to care was not significantly associated with participants' race/ethnicity nor state.

Access to Health Insurance

Few participants reported losing health insurance during the pandemic (7.2 %; n = 31); however, significantly more participants in Florida (9.7 %; n = 22) lost health insurance than in California (4.5 %; n = 9; p =.039). Furthermore, NHBs most frequently reported losing health insurance (13.3 %; n = 12), followed by multiracial/other racial/ethnic groups (7.5 %; n = 3), NHWs (5.4 %; n = 11), and Hispanics (3.4 %; n = 3; p =.0416).

Costs of Diabetes Medications

Nearly half of participants (41 %; n = 176) indicated the costs of their diabetes medications increased during the pandemic. Seventeen percent (n = 73) reported the costs increased "a lot", while 24 % (n = 103) reported the costs increased "a little". Few participants (3 %; n =

Table 2
COVID-19 Outcomes: All Participants and State Comparisons.

	All (N = 450)		CA (n = 208)		FL (n = 242)		p-value
	N	n(%)	N	n(%)	N	n(%)	
To your knowledge, do you or have you had COVID-19?	435		203		232		0.0844
Yes		129 (29.7)		52 (25.6)		77 (33.2)	
[If Yes] Describe the level of care you received, or are receiving:	126		51		75		0.0604
Did not seek medical care		69 (54.8)		31 (60.8)		38 (50.7)	
Received medical care but was not hospitalized		38 (30.2)		17 (33.3)		21 (28.0)	
Was hospitalized		19 (15.1)		3 (5.9)		16 (21.3)	
Did you get the COVID-19 vaccine?	438		205		233		0.2801
No		80 (18.3)		31 (15.1)		49 (21.0)	
Yes		356 (81.3)		173 (84.4)		183 (78.5)	
Not sure		2 (0.5)		1 (0.5)		1 (0.4)	
[If Yes] Are you fully vaccinated?	353		170		183		0.5049
Yes		344 (97.5)		167 (98.2)		177 (96.7)	
How often do you wear a mask when outside your home?	438		205		233		0.7779
Never		29 (6.6)		15 (7.3)		14 (6.0)	
Rarely		70 (16.0)		36 (17.6)		34 (14.6)	
Sometimes		106 (24.2)		50 (24.4)		56 (24.0)	
Very Often		93 (21.2)		44 (21.5)		49 (21.0)	
Always		140 (32.0)		60 (29.3)		80 (34.3)	
Rate how much the COVID-19 pandemic has affected your family income:	433		203		230		<0.0001*
No change		152 (35.1)		97 (47.8)		55 (23.9)	
Mild: Small change, able to meet all needs and pay bills		80 (18.5)		39 (19.2)		41 (17.8)	
Moderate: Having to make cuts but able to meet basic needs and pay bills		127 (29.3)		46 (22.7)		81 (35.2)	
Severe: Unable to meet basic needs and/or pay bills		74 (17.1)		21 (10.3)		53 (23.0)	
Rate how much the COVID-19 pandemic has affected your medical care access:	429		201		228		0.3520
No change		163 (38.0)		82 (40.8)		81 (35.5)	
Mild: Appointments moved to telehealth		131 (30.5)		63 (31.3)		68 (29.8)	
Moderate: Delays or cancellations in appointments and/or delays in getting prescriptions, changes have minimal impact on health		103 (24.0)		45 (22.4)		58 (25.4)	
Severe: Unable to access needed care resulting in moderate to severe impact on health		32 (7.5)		11 (5.5)		21 (9.2)	
Have you lost health insurance during the COVID-19 pandemic?	429		201		228		0.0390*
Yes		31 (7.2)		9 (4.5)		22 (9.7)	
Since the COVID-19 pandemic began, do you think that the costs of your diabetes medications have changed?	430		201		229		0.4404
Increased a lot		73 (17.0)		27 (13.4)		46 (20.1)	
Increased a little		103 (24.0)		48 (23.9)		55 (24.0)	
Remained the same		241 (56.1)		119 (59.2)		122 (53.3)	
Decreased a little		9 (2.1)		5 (2.5)		4 (1.8)	
Decreased a lot		4 (0.9)		2 (1.0)		2 (0.9)	
Coronavirus Anxiety Scale (CAS-19) Score: Median [IQR]	429	0 [0.0, 1.0]	198	0 [0.0, 1.0]	231	0 [0.0, 2.0]	0.0435*

Statistical Methods: CMH General Association test used for all items except first item (CHISQ), fourth item – full vaccination (Fisher's Exact test), and CAS-19 (*t*-test; Sattherwaite method used to accommodate unequal variances; median and IQR reported due to skewed means and STD). *Denotes statistical significance (p <.05).

13) reported that their diabetes medication costs decreased. There were no significant racial/ethnic nor state differences in reported changes to diabetes medication costs.

COVID-19 anxiety

Most participants did not report COVID-19 anxiety (median = 0.0; IQR = [0.0, 1.0]; n = 429); however, there were statistically significant differences in anxiety based on race/ethnicity and state. Florida participants had higher COVID-19 anxiety (IQR = [0.0, 2.0]; n = 231) than those in California (IQR = [0.0, 1.0]; n = 198; p =.0435). NHBs and Hispanics also had higher COVID-19 anxiety (IQR = [0.0, 3.0]; n = 89) than other/multiracial groups (IQR = [0.0, 1.0]; n = 39), while NHWs had the lowest anxiety (IQR = [0.0, 0.0]; n = 204; p =.0232).

Discussion

This study investigated COVID-19 outcomes affecting underserved

Table 3
COVID-19 Outcomes: Racial/Ethnic Comparisons.

	White	Black	Hispanic	Other	p-value
Racial/Ethnic Group: N (%)	210 (47.5)	94 (21.3)	97(22.0)	41(9.3)	
To your knowledge, do you or have you had COVID-19?	205	91	90	41	0.0737
Yes	49 (23.9)	30 (33.0)	34(37.8)	14 (34.2)	
Describe the level of care you received, or are receiving:	48	30	32	14	0.1249
Did not seek medical care	27 (56.3)	11 (36.7)	22(68.8)	8(57.2)	
Received medical care but was not hospitalized	14 (29.2)	10 (33.3)	8(25.0)	5(35.7)	
Was hospitalized	7(14.6)	9(30.0)	2(6.3)	1(7.1)	
Did you get the COVID-19 vaccine?	207	92	90	41	0.0281*
No	41 (19.8)	23 (25.0)	8(8.9)	7(17.1)	
Yes	166 (80.2)	68 (73.9)	82(91.1)	33 (80.5)	
Not sure	–	1(1.1)	–	1(2.4)	
[If Yes] Are you fully vaccinated?	164	68	81	33	0.4715
Yes	162 (98.8)	65 (95.6)	78(96.3)	32 (97.0)	
How often do you wear a mask when outside your home?	207	92	90	41	<0.0001*
Never	16(7.7)	3(3.3)	5(5.6)	5(12.0)	
Rarely	49 (23.7)	8(8.7)	6(6.7)	7(17.1)	
Sometimes	53 (25.6)	21 (22.8)	24(26.7)	7(17.1)	
Very Often	50 (24.2)	24 (26.1)	14(15.6)	3(7.3)	
Always	39 (18.8)	36 (39.1)	41(45.6)	19 (46.3)	
Rate how much the COVID-19 pandemic has affected your family income:	205	91	88	41	0.0124*
No change	85 (41.5)	29 (31.9)	23(26.1)	14 (34.2)	
Mild: Small change, able to meet all needs and pay bills	41 (20.0)	16 (17.6)	13(14.8)	7(17.1)	
Moderate: Having to make cuts but able to meet basic needs and pay bills	52 (25.4)	22 (24.2)	39(44.3)	12 (29.3)	
Severe: Unable to meet basic needs and/or pay bills	27 (13.2)	24 (26.4)	13(14.8)	8(19.5)	
Rate how much the COVID-19 pandemic has affected your medical care access:	204	90	88	40	0.5197
No change	80 (39.2)	38 (42.2)	33(37.5)	11 (27.5)	
Mild: Appointments moved to telehealth	60 (29.4)	26 (28.9)	28(31.8)	13 (32.5)	
Moderate: Delays or cancellations in appointments and/or delays in getting prescriptions, changes have minimal impact on health	52 (25.5)	17 (18.9)	18(20.5)	14 (35.0)	
Severe: Unable to access needed care resulting in moderate to severe impact onhealth	12 (5.9)	9 (10.0)	9(10.2)	2(5.0)	
Have you lost health insurance during the COVID-19 pandemic?	204	90	88	40	0.0416*
Yes	11 (5.4)	12 (13.3)	3(3.4)	3(7.5)	
Since the COVID-19 pandemic began, do you think that the costs of your diabetes medications have changed?	206	90	86	40	0.2366
Increased a lot	38 (18.5)	10 (11.1)	14(16.3)	7(17.5)	
Increased a little	47 (22.8)	21 (23.3)	29(33.7)	5(12.5)	
Remained the same	114 (55.3)	55 (61.1)	43(50.0)	26 (65.0)	
Decreased a little	4(1.9)	3(3.3)	–	2(5.0)	
Decreased a lot	3(1.5)	1(1.1)	–	–	
Coronavirus Anxiety Scale (CAS-19) Score	204	89	89	39	0.0232*
Median [IQR]	0 [0.0, 0.0]	0 [0.0, 3.0]	0 [0.0, 3.0]	0 [0.0, 1.0]	

Statistical Methods: CMH General Association test used for all items except CAS-19 (Welch's One-Way ANOVA – non-homogeneity of variance). *Denotes statistical significance ($p < .05$).

Table 4
Odds of Having Received at Least 1 Vaccination for COVID-19.

Outcome: COVID-19 Vaccine = Yes	Point Estimate	95 % CI
State:		
Florida (Ref: California)	0.53	(0.27, 1.01)
Race/Ethnicity:		
Black (Ref: White)	1.22	(0.61, 2.44)
Hispanic (Ref: White)	4.63*	(1.81, 11.89)
Other/Multiple/Unknown (Ref: White)	1.71	(0.60, 4.86)
Diabetes Type:		
Type 1 Diabetes (Ref: Type 2 Diabetes)	0.62	(0.36, 1.08)
Insurance Type:		
Medicaid (Ref: Commercial)	0.46	(0.22, 0.99)
Medicare (Ref: Commercial)	1.40	(0.60, 3.26)
Dual-Eligible Medicare/Medicaid (Ref: Commercial)	0.97	(0.28, 3.36)
Indian Health Service (Ref: Commercial)	0.14	(0.02, 0.81)
Uninsured/Self-Pay (Ref: Commercial)	0.66	(0.26, 1.67)

Logistic Regression Model Inclusion Parameters: positively or negatively endorsed receipt of a COVID-19 vaccine, type 1 or type 2 diabetes, non-missing: state, race/ethnicity, and insurance type (Model N = 393). *Denotes statistical significance ($p < .05$).

adults with insulin-requiring diabetes at FQHCs in Florida and California, as well as preventive measures taken by this patient population to reduce their exposure to COVID-19. Overarching findings convey that underserved communities with diabetes experienced pervasive health issues throughout the COVID-19 pandemic. Approximately one-third of respondents reported contracting COVID-19. Nearly half of those who contracted COVID-19 were hospitalized or sought other medical care due to the disease. Despite the majority of respondents not reporting

severe COVID-19 illness, this finding demonstrates that some underserved adults with diabetes experienced severe COVID-19 symptoms and complications that were not manageable through home-based treatment alone. Most respondents reported low COVID- 19 anxiety; however, this was likely due to the CAS-19 measuring anxiety symptoms over a 2-week period and data collection starting more than a year after the pandemic began. It is important to note that NHBs, Hispanics, and participants in Florida reported higher COVID-19 anxiety levels, while NHWs had the lowest anxiety levels. Potential explanations for higher COVID-19 anxiety among those in Florida include lower health insurance coverage and limited COVID-19 safety restrictions in the state [6,11]. Furthermore, COVID-19 anxiety among NHBs, Hispanics, and participants in Florida could be due to stigma, racial/ethnic discrimination, and concerns related to insulin access [12,18]. It is also important to consider that participants' anxiety could have been influenced by physiological aspects of blood glucose variation or other factors.

Regarding COVID-19 prevention, our study found that underserved adults with diabetes had high COVID-19 vaccine uptake but varied mask-wearing habits. More than 80 % of respondents received at least one vaccine dose, and nearly all participants who received at least one dose also reported being fully vaccinated. Hispanics had $>$ 4 times higher odds than NHWs of having received a COVID-19 vaccine. Potential explanations for this include increased culturally tailored vaccination campaigns targeting Hispanics in the summer of 2021, COVID-19 education led by Spanish-speaking community health workers called promotores de salud, and a strong sense of community among the Hispanic population [36]. In contrast, NHBs were the least vaccinated racial group. This disparity is likely due to multilevel factors, including distrust in the government and medical research due to historical maltreatment, racism within healthcare institutions, and the inequitable distribution of vaccines [12,13,37]. Based on the success of culturally-tailored vaccination campaigns targeting Hispanics [36], similar efforts targeting NHBs may be one effective strategy for increasing their vaccination uptake. Regarding masks, approximately half of respondents "always" or "very often" wore masks when outside their homes, while the others "sometimes", "rarely", or never wore them. NHWs comprised the lowest percentage who "always" wore masks. Furthermore, the percentage of NHWs who reported "always" wearing masks was less than half that of all other racial groups who reported doing so. This discrepancy may be attributed to NHWs having lower perceived COVID-19 susceptibility and severity and being more likely to express anti-mask views [38].

Lastly, our survey found that underserved communities with diabetes experienced profound financial difficulties and barriers to accessing diabetes care throughout the COVID-19 pandemic. Approximately 65 % of respondents reported losses in family income, with nearly half reporting "moderate" or "severe" income reductions. For people with diabetes, maintaining steady income is vital due to the high costs of care [39]. It is alarming that increases in diabetes medication costs were reported by more than 40 % of respondents. Additionally, more than 60 % of participants reported changes in healthcare access, and over one-third indicated that these changes negatively affected their health. Although most did not lose health insurance, it is important to note that those who did were mostly NHB and resided in Florida. This finding aligns with research indicating people in states with low Medicaid expansion such as Florida more frequently lost health insurance coverage during the pandemic [6]. Limited Medicaid expansion likely contributed to lower health insurance access for underserved groups, especially NHBs, who have also reported higher unemployment rates during the pandemic [25].

This study serves as a first step toward understanding COVID-19 inequities affecting underserved communities with diabetes in the U.S. Its findings provide a foundation for subsequent research and interventions designed to reduce and ultimately alleviate these inequities. The causes of COVID-19 inequities are complex and interrelated; as such, multilevel interventions are needed [7]. At the patient level, disparities among people with diabetes stem from differences in knowledge, attitudes, and perceived severity and susceptibility. To address these gaps, culturally tailored education and social support programs may strengthen their knowledge, improve their attitudes regarding COVID-19 prevention, and enhance their self-efficacy. However, interventions must extend beyond the individual level, as most COVID-19 inequities stem from macro-level factors outside of patients' control. Cultural competency and implicit bias training should be administered to healthcare providers to reduce discrimination toward racial minorities and build capacity to educate underserved patients with diabetes about COVID-19. Policy changes are needed to expand health insurance coverage, reduce unemployment rates among marginalized groups, and overcome systemic racism in the health system [40]. Of paramount importance is the need for equitable distribution of vaccines and treatments to reduce COVID-19 morbidity and mortality. Policy changes that streamline the diabetes supply chain and reduce the costs of diabetes medications are also needed, especially since the costs of these medications and supplies have continued to increase in recent years [41].

Strengths and Limitations

Strengths of this study include its focus on inequities among historically underrepresented adults with insulin-requiring diabetes. Participants were recruited from FQHCs in Florida and California; as such, this study yields insights into COVID-19 outcomes affecting underserved and high-risk communities in states with opposite political handlings of COVID-19 [11]. The survey also incorporated the validated CAS-19 and items from the Coronavirus Impact Scale and CDC's Vaccine Confidence Survey Bank.

Regarding this study's limitations, all data were self-reported. Outcomes may have been under- or overreported due to bias, error, or low health literacy. The survey did not ask participants to specify the exact date(s) they contracted COVID-19 or were vaccinated, which diabetes medications changed in cost, or the exact cost amounts. Participants completed the surveys at varied time points; however, our analysis was cross-sectional and did not account for changes in COVID-19 vaccine availability, new COVID-19 treatments such as Paxlovid, or other societal factors occurring during this time. The analysis also did not account for potential confounding factors through the Project ECHO Diabetes intervention. Furthermore, since participants were recruited from two states, this study's findings may not be generalizable to people with diabetes in other locations. Some means and STD values in the data were skewed; in these instances, we used medians and IQR values for analyses. Lastly, data analysis was fully quantitative; however, this limitation will be resolved in subsequent qualitative research that analyzes data from the open-ended survey questions.

Conclusions

Underserved communities with diabetes reported high COVID-19 vaccine uptake, but experienced pervasive health and financial challenges resulting from the COVID-19 pandemic. These challenges included severe COVID-19 illness requiring hospitalization, anxiety, income cuts, loss of health insurance, changes in access to medical care, and higher costs of diabetes medications. COVID-19 outcomes were especially disparate for NHBs and those in Florida. Further research that employs longitudinal, qualitative, and community-based participatory methods and centralizes racism and other structural issues is needed to address these inequities. Multilevel interventions and policy changes are also needed to improve the well-being of underserved communities with diabetes.

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CRediT authorship contribution statement

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Declaration of competing interest

JLM, AA, SLF, MJG, SW, BND, LF, MH, KGM, and AFW have nothing to declare. MJH has the following disclosures: Board Member for SAB Biotherapeutics, Inc. and Consultant for Sanofi and MannKind Corporation. DMM has the following disclosures: Advisory Panel for Medtronic, LifeScan Diabetes Institute, and MannKind Corporation; Consultant for Abbott; and Research Support from Dexcom, Inc. RAL has the following disclosures: Advisory Panel for Provention Bio, Inc. and Consultant for Abbott, Biolinq, Capillary Biomedical, Inc., Deep Valley Labs, Gluroo, Tidepool, PhysioLogic Devices, and Morgan Stanley.

Data Availability.

Some or all datasets generated during and/or analyzed during the current study are not publicly available but are available from the corresponding author on reasonable request.

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Author Contributions

JLM conceptualized the study, developed the survey, recruited participants, collected and analyzed data, and wrote the manuscript. MJH, DMM, SW, BND, AA, RAL, and AFW conceptualized the study, edited the survey, and edited the manuscript. SLF and MJG conducted data analysis and edited the manuscript. LF recruited participants, collected data, and edited the manuscript. MH and KGM recruited participants and collected data. JLM and AFW are the guarantors of this work and take responsibility for its integrity.

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