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Article

Clinical and Demographic Attributes of Patients with Diabetes Associated with the Utilization of Telemedicine in an Urban Medically Underserved Population Area

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Abstract: Marginalized populations often experience health disparities due to the significant obstacles to care associated with social, economic, and environmental inequities. When compared with advantaged social groups, these populations frequently experience increased risks, poorer health outcomes, and reduced quality of life (QoL). This research examines the clinical and demographic characteristics—age, gender, and race—related to patients with varying stages of type 2 diabetes mellitus (T2DM), comparing the utilization of telemedicine (TM) with traditional healthcare face-to-face (F2F) appointments in an urban medically underserved population area (UMUPA). A logistic regression model, was used to analyze retrospective electronic patient health records (EHRs) from 1 January 2019 to 30 June 2021 of 265 patients with T2DM who had 3357 healthcare appointments. The overall percentage of healthcare provider appointments using TM was 46.7%, in comparison with 53.3% traditional F2F visits. Compared to patients with prediabetes, those with uncontrolled diabetes were more likely to utilize the TM mode of care rather than the traditional F2F mode (adjusted odds ratio (AoR), 1.33; confidence interval (CI), 1.07 to 1.64) after controlling for the other covariates in the model. Compared to patients in the age group 20–49 years, those in the age groups 50–64 years and ≥65 years had significantly lower odds (AoR, 0.78; CI, 0.65 to 0.94 and AoR, 0.71; CI, 0.58 to 0.88, respectively) of utilization of TM than the traditional F2F mode of care. White patients had significantly higher odds of using telemedicine rather than the traditional F2F mode (AoR, 1.25; CI, 1.07 to 1.47) when compared to the Black patients. Gender differences did not exist in the care utilization mode. As healthcare and public health continue to strive for health equity by eliminating health disparities within marginalized populations, it is essential that the mode of care for patients, such as those with T2DM, must evolve and adapt to the needs and resources of the patients. Multisectoral partners have the opportunity to employ a systems thinking approach to improve the technological elements related to the global health disparities crisis. An essential goal is to to create a user-friendly interface that prioritizes easy navigation, affordability, and accessiblity for populations in medically underserved regions to improve overall population health outcomes.

Keywords: telemedicine; traditional face-to-face (F2F); informatics; digital health technology; healthcare access; health inequities; disparities; digital divide; medically underserved populations; type 2 diabetes mellitus (T2DM)

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1. Introduction

Telemedicine, a part of the broader field of informatics technology comprising various components, has been an essential life-saving informatics technology that is frequently reported as a sine qua non [1,2] for preserving the continuity of care in the United States (US) during the COVID-19 pandemic [1–3]. Telemedicine, or virtual care, is a term used in this study to describe the synchronous, real-time, two-way communication between healthcare practitioners and patients to manage diabetes [1,4].

While the utilization of telemedicine services during the COVID-19 pandemic provided healthcare services for many people with access barriers [1], the stark contrast in medically underserved populations exposed the disparate utilization of technology [5]. The COVID-19 pandemic heightened awareness of health inequities, disparities, and the digital divide in the United States (US), primarily among racial and ethnic minority populations [5]. According to the Centers for Disease Control and Prevention (CDC), medically underserved areas (MUAs) are characterized by social determinants of health (SDoH) factors that significantly contribute to health challenges by impeding access to healthcare services [6]. Populations residing in MUAs frequently suffer from poorer health outcomes due to SDoH exacerbated by limited access to healthcare services [1–3,6], resulting in disproportionate morbidity and mortality rates [6].

This paper refers to the digital divide, as a technological disparity gap among medically underserved populations and includes geographical constraints, insufficient internet connectivity, digital literacy challenges, accessibility and affordability of internet services and devices [1,7,8]. The knowledge, capacity, and skills to access and use technology efficiently are referred to as digital literacy [9,10].

The term "digital divide" was adopted in the United States during the latter part of the 20th century that characterized the widening disparity gap that existed between people who had access to technology, internet services, and electronic devices and those who did not [1,9,10]. According to studies, marginalized communities in geographically isolated locations with unequal access to technology were considered disadvantaged groups based on socioeconomic status (SES), education or literacy skills, race, ethnicity, gender, and age, contributing to health disparities [1,10,11].

Studies that focus on healthcare access challenges among people living in rural areas fail to recognize the profundity of systemic obstacles experienced by populations residing in urban medically underserved areas [1,6–9]. The significance of this research lies in its capacity to offer valuable perspectives on the utilization of telemedicine technology among diverse age groups, racial backgrounds, and gender in a medically underserved area. These findings contribute to existing research on health inequities and disparities and support the development of targeted interventions aimed at promoting greater technological adoption among marginalized communities.

Health inequities and disparities exist worldwide and are prevalent both within and between nations [12–14]. These disparities and inequities are progressively expanding on a global level, with notable distinctions arising among different social groups in countries with low, middle, and higher incomes [14]. Social groups exhibit significant disparities, marked by varying economic positions (wealth and poverty), gender, geographical locations (urban, rural, indigenous territories, and remote regions), educational attainment, age, access to resources, and other relevant factors [12–15].

Health disparities are present throughout the United States (US) as a result of inequities in social determinants of health, often influenced by privileges such as wealth, power, and/or status [1,6,12,13]. Individuals in the top 1% SES category in the US have a life expectancy that is ten years higher than those in the lowest 1% SES category [1,12,13]. Minority populations suffer disproportionately from the economic gap between wealth and income inequality [1,8,13]. The COVID-19 pandemic heightened awareness of health disparities associated with the widening socioeconomic gap among medically underserved minority communities affected by chronic diseases like diabetes. Consequently, these populations experienced increased morbidity and mortality rates [1,13–15].

Type 2 diabetes mellitus (T2DM) is a highly prevalent chronic disease that can be effectively managed [14]. Type 2 diabetes mellitus (T2DM) accounts for 90–95% of all cases of diabetes compared to the other two types: Type 1 diabetes and gestational diabetes (diabetes while pregnant) [16]. Individuals with uncontrolled hemoglobin A1c (HbA1c) levels frequently experience microvascular and macrovascular complications that impair functionality, increase morbidity, decrease quality of life, and may incur higher financial burdens from direct and indirect costs [17,18].

In 2019, the estimated global diabetes mortality rate was 9.3% of the population, accounting for 4.2 million deaths, equivalent to eight deaths every minute, with 46% occurring in individuals under the age of 60 [18]. Recent studies conducted by the International Federation of Diabetes (IDF) [19] report that diabetes prevalence is higher in urban areas (10.8%) compared to rural (7.2%) areas and higher in higher-income (10.4%) countries than in lower-income countries (4.0%) [19–21]. In middle-income nations, the prevalence of complications due to diabetes was higher in adults aged 20 to 79 [20–22]. Current projections suggest that working-age individuals in developing nations will bear a growing financial burden due to complications arising from diabetes [19,22]. According to reports, approximately 500 million individuals around the globe are currently afflicted by diabetes, and this figure is expected to increase by 25% by the year 2030 and by 51% by the year 2045 [22].

Informatics technology can provide vital information for international and US domestic organizations, alerting them to the emergence of chronic diseases in their respective regions [23]. By harnessing informatics' technological capacities for monitoring, investigating, analyzing, and reporting [23,24], nations can respond to newly detected outbreaks by promptly deploying upstream interventions. The adoption and expansion of informatics technology is essential in proactively confronting the rising trend of chronic disease incidence rates and can potentially avert a new global health crisis.

In 2021, the National Clinical Care Commission (NCCC) submitted a report to the United States Congress recommending virtual care/telemedicine, an informatics technology, as an alternative method for preventing and controlling diabetes due to the geographic and systemic limitations of traditional in-person care [25] (pp. 133, 137).

The NCCC report serves as a platform emphasizing the importance of unilateral collaboration for the advancement of informatics technologies. The Health in All Policies (HiAP) approach [25,26] is a collaborative framework that integrates socioecological and environmental factors with telemedicine informatics.

The World Health Organization (WHO), Pan American Health Organization (PAHO), Centers for Disease Control (CDC), and National Academy of Medicine (NAM) endorse HiAP [27–30] as a collaborative strategy for developing public policies centered on health and healthcare systems to address disparities. Mitigating negative health consequences among populations at risk requires intersectoral collaboration [25]. HiAP recognizes that health is created by multiple factors beyond the scope of traditional healthcare and public health (PH) activities [26–30]. Informatics technology coupled with HiAP intersectoral collaboration supports an integrative paradigm for tackling global health inequities and improving population health [26].

Research indicates that utilizing telemedicine extends beyond traditional face-to-face (F2F) healthcare models [31–35]. Healthcare services delivered through telemedicine enable populations living in remote regions to receive life-saving care, improve clinical outcomes, and reduce the costs associated with tertiary care expenses from delayed treatment [1,35–37]. Telemedicine, does not require patients to physically visit a healthcare provider in contrast with traditional in-person, face-to-face (F2F) care.

In-person consultations offer several benefits to patients and providers. Traditional F2F visits allow for comprehensive physical examinations, enabling healthcare providers to thoroughly assess the patient's condition and administer treatments or medications on-site. It also provides a safe place for patients to confidentially discuss sensitive issues. Furthermore, non-verbal cues such as pain or discomfort, body language, facial expressions, and mental health issues can provide valuable insights for healthcare practitioners to assess the patient's well-being [38]. In-person healthcare services are necessary for laboratory testing and diagnostic imaging techniques, including CT and PET scans, X-rays, and MRIs, which play a crucial role in diagnosing and treating various conditions and in urgent or emergency situations.

However, the in-person F2F mode of healthcare has certain disadvantages that can create financial burdens and inconveniences, especially for individuals managing chronic diseases [1]. Various factors contribute to these challenges, including limited financial resources, mental and physical challenges, chronic health conditions, inadequate transportation options, a shortage of healthcare providers, geographical limitations, and difficulties with appointment scheduling [1]. Additionally, in-person healthcare visits may be discriminatory for people with disabilities if the clinical environment lacks appropriate modifications for individuals with visual, hearing, physical or mobility limitations.

Telemedicine emerged as a viable solution to overcome access barriers associated with systemic, structural, financial, and logistical challenges in diabetes management [1]. This alternative also has the potential of reducing costly emergency room treatments for individuals managing diabetes and its complications. In this study population, telemedicine provided an alternative to healthcare services and regular primary care visits for patients with type 2 diabetes facing limitations and challenges.

It is worth emphasizing that telemedicine and F2F healthcare both have their unique benefits and challenges. An individuals' unique circumstances will determine the best type of healthcare modality required to effectively manage care. People living in various geographical settings, transportation limitations, physical mobility or other challenges, literacy and/or technological disparities–digital divide [39], scheduling complications, in areas with low provider-to-patient ratios, and challenges managing chronic diseases may benefit more from having the option of utilizing either F2F or telemedicine healthcare service modality.

This study examines patient visits and the utilization of telemedicine compared with F2F visits for patients with type 2 diabetes mellitus in a medically underserved area. The clinical diagnosis for diabetes was classified into three stages of development based on the hemoglobin A1c levels and identified as prediabetes, controlled, and uncontrolled.

2. Materials and Methods

This study analyzed retrospective electronic patient health records (EHRs) from 1 January 2019 to 30 June 2021 of patients with type 2 diabetes mellitus from a University of Florida community-based clinic located in Jacksonville, Florida.

2.1. Ethical Approval

The study protocol was conducted following the Declaration of Helsinki and approved by the Institutional Review Board's Ethics Committee at Georgia Southern University's (# H22044) and the University of Florida Health System (# IRB-202102147). Exempt status for chart reviews was approved for secondary PHR data collection. The data collected were archival, retrospective electronic health records, and originally collected by the University of Florida Health System for "healthcare operations" or for "public health activities and purposes" [1].

2.2. Study Population

This research included 265 patients with T2DM who had 3357 visits with healthcare providers. The unit of analysis for this research is the number of visits (and not the number of patients). The utilization rates were recorded as the number of appointments/visits for telemedicine and traditional F2F modes of care differed for each patient. In order to examine and compare the utilization rates of the two types of healthcare service modalities, our study analyzed the clinical appointment/visit rates according to race, gender, and age group.

The majority of participants in this analysis resided in a medically underserved area in Duval County, a sub-county in Jacksonville, Florida. Diabetes-related health issues were prominent in the study population, such as high emergency room utilization rates [40], and were exacerbated by social determinants of health, high obesity rates, the prevalence of food deserts [1], as well as socioeconomic and literacy challenges [39,40].

2.3. Study Variables

2.3.1. Dependent Variable

The dichotomous dependent variable mode of care represented the healthcare service delivery modalities, which included (a) traditional F2F on-site visits (coded as 0) and (b) telemedicine consultations based on synchronous, real-time, audio/video interactions (coded as 1).

2.3.2. Independent Variables

We operationalized the independent variable of all patients with a clinical diagnosis of type 2 diabetes mellitus (T2DM). The patients were classified according to their hemoglobin A1c (HbA1c) levels, which were defined as follows: prediabetes (HbA1c $\geq$ 5.7–6.8%), controlled (HbA1c $\geq$ 6.9–7.9%), and uncontrolled (HbA1c $\geq$ 8.0%); age $\geq$ 18; birth gender—male and female; and race—Black and White.

2.4. Statistical Analyses

To model the dichotomous dependent variable mode of care, we performed logistic regression. Our data met the assumptions of the logistic regression analysis, including the distribution of the dependent variable (binomial), absence of strong outliers, and absence of strong associations among independent variables (indicating no multicollinearity). Since our logistic regression model did not include any continuous variables, the assumption of linearity in the logit (for continuous variables) was not applicable. The adjusted odds ratios allowed us to examine the association between each independent variable and the dependent variable after controlling for covariates in the model, including patients' age groups, gender, race, clinical diagnosis for diabetes, and telemedicine versus traditional healthcare utilization. To provide context to the multivariable analysis results, descriptive statistics were computed for all variables.

3. Results

3.1. Descriptive Statistics for All Patients with Type 2 Diabetes Mellitus

Female patients received 62.7% (n = 2104) of the healthcare provider visits, while 37.3% (n = 1253) of visits were received by male patients (Figure 1). Black patients comprised 74.2% of the total healthcare provider visits (n = 2492), followed by 25.5% comprised by White patients (n = 865), and Asian patients (n = 101) made up less than 3.0% of the healthcare visits and were excluded from this analysis due to the low percentage, resulting in the final study population of 265 patients having received 3357 healthcare provider visits.

Patients were categorized according to the clinical diagnoses based on hemoglobin A1c (HbA1c) levels: patients with prediabetes HbA1c $\geq$ 5.7–6.8% (n = 450, 13.4%), controlled HbA1c $\geq$ 6.8–7.9% (n = 1047, 31.2%), and uncontrolled HbA1c $\geq$ 8.0% (n = 1860, 55.4%). Patients were grouped into three age categories: 20–49 years (n = 740, 22.0%), 50–64 years (n = 1754, 52.2%), and $\geq$65 years (n = 863, 25.7%); the mean age was 57. Patients that utilized telemedicine for their healthcare service comprised 46.7% (n = 1568) of the visits, whereas 53.3% (n = 1789) of the visits were by patients that utilized the traditional F2F office visits.

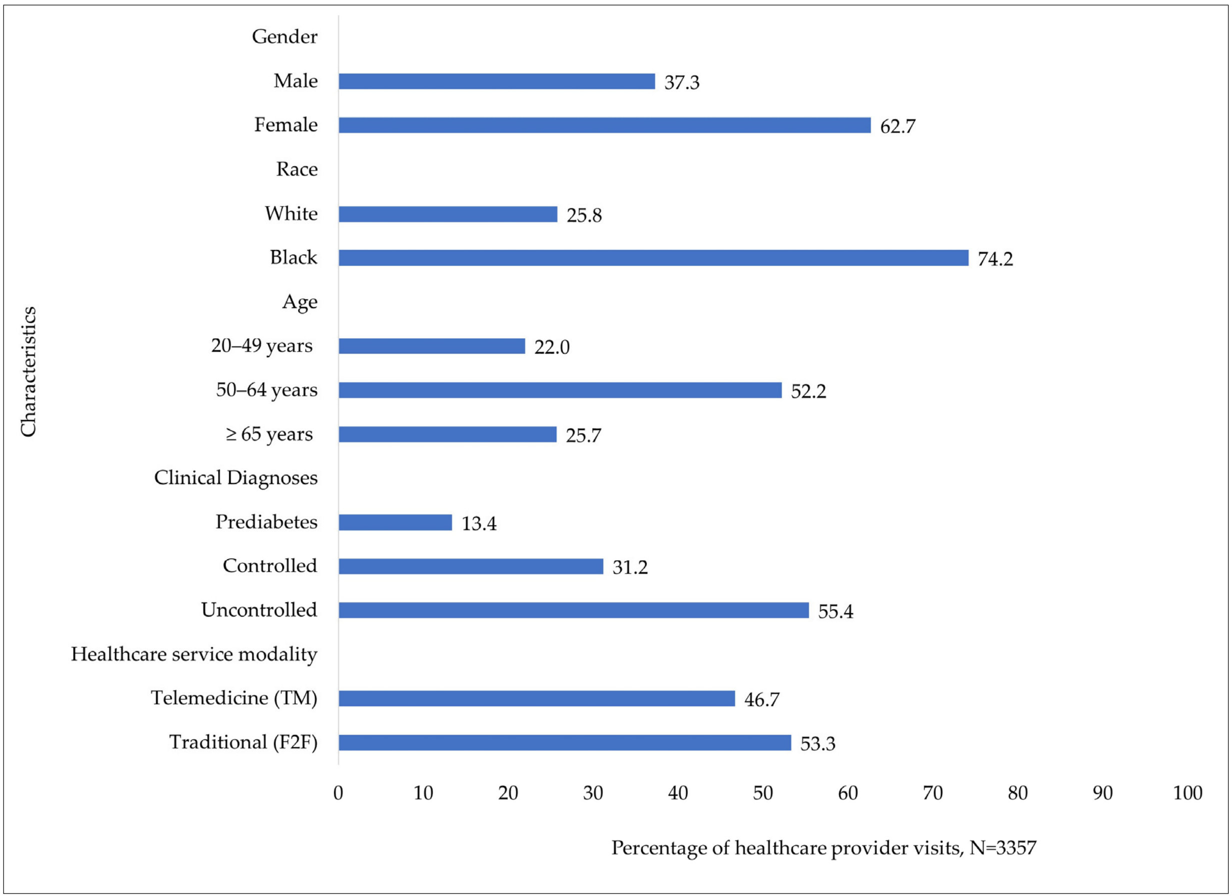

Figure 1. Descriptive statistics for the study variables.

3.2. Logistic Regression of Telemedicine as the Mode of Care

The results of the logistic regression model for patients with type 2 diabetes mellitus for the mode of care (telemedicine visits vs. traditional F2F) as the dependent variable show three significant predictors: stages of diabetes based on clinical diagnoses based on HbA1c, age groups, and race (Table 1). Compared to patients with prediabetes, patients with uncontrolled diabetes had significantly higher odds of using telemedicine rather than the F2F mode of care (adjusted odds ratio (AoR), 1.33; confidence interval (CI), 1.07 to 1.64) after controlling for the other covariates in the model. Those with controlled diabetes did not have significantly different odds of utilizing telemedicine.

The results also show that age was a strong predictor of the utilization of telemedicine as opposed to traditional F2F. Younger patients favored the utilization of telemedicine over the traditional F2F mode of care, whereas older adults were more likely to use the traditional F2F mode of care. Compared to patients in the age group 20–49 years, those in the age group 50–64 years had significantly lower odds (AoR, 0.78; CI, 0.65 to 0.94) of the utilization of telemedicine rather than the traditional F2F mode of care. Patients 65 years of age and older had even lower odds of utilizing telemedicine rather than the traditional F2F mode of care (AoR, 0.71; CI, 0.58 to 0.88) compared with patients in the age group 20–49 years. There were disparities in the utilization of telemedicine according to race, with Black patients at a disadvantage concerning their usage of TM. Compared to Black patients, White patients had significantly higher odds of using telemedicine rather than the traditional F2F mode (AoR, 1.25; CI, 1.07 to 1.47) after controlling for the other covariates in the model. Gender did not significantly predict the tendency to use the telemedicine mode of care.

Table 1. Logistic Regression of Telemedicine as the Mode of Care (vs. Traditional F2F).

Patient Characteristics	AoR	95% C.I. for AoR		*p*
		Lower	Upper	
Clinical diagnosis based on HbA1c				
Prediabetes §				
Controlled Diabetes	0.96	0.77	1.20	0.734
Uncontrolled Diabetes	1.33	1.07	1.64	**0.009**
Age group				
20–49 years §				
50–64 years	0.78	0.65	0.94	**0.008**
65–91 years	0.71	0.58	0.88	**0.002**
Birth gender				
Woman §				
Man	0.91	0.78	1.05	0.198
Race				
Black §				
White	1.25	1.07	1.47	**0.006**

Abbreviations: C.I., confidence interval; AoR, adjusted odds ratio; L, lower; U, upper; F2F, face-to-face. Note: Logistic Cox & Snell, $R^2 = 0.105$. The bold *p* indicates significance (vs. reference category) at $p < 0.05$. The symbol § indicates the reference category.

4. Discussion

In this study, patient visits were studied concerning clinical diagnoses of type 2 diabetes and differentiated by HbA1c levels and the use of online health services provided through telemedicine, primarily in a medically underserved population. The demographic variables (age groups, gender, and race) were analyzed to compare the utilization of telemedicine (an informatics technology) with that of traditional F2F care. Populations living in medically underserved areas face significant personal and systemic barriers when attempting to access adequate healthcare services [1,6,7,9,39]. These barriers are extremely problematic for people with chronic illnesses, often leading to complications in disease management and adverse health outcomes [10,13,15].

As a result of the COVID-19 pandemic, digitized healthcare systems such as telehealth (specifically TM) have come to the forefront as a means of expanding healthcare services to communities previously limited by access barriers [1–3]. Our study has shown that even among people living in urban medically underserved areas, White patients are advantaged compared to Black patients when it comes to the utilization of TM. Telemedicine has the potential of mitigating disparities and inequities in healthcare utilization by eliminating geographical barriers to care by supporting and connecting patients with practitioners and by increasing access to additional resources and services [31–33]. However, the digital divide—varying access to and utilization of technology and the internet based on racial/ethnic and SES demographics—is still very prevalent in sub-populations within urban medically underserved areas [5,7,39].

Regarding patient age and utilization mode, the results of our study are similar to other recent studies that found that patients that are aged 50 or older have lower utilization rates of telemedicine appointments compared to traditional F2F appointments [7,34]. While telemedicine can decrease the wait time for appointment day/time, decrease patient costs, provide additional tools such as screen readers and closed captioning, and increase patient confidence and provide greater feelings of empowerment and support [35–39], older patients still tend to be hesitant to use telemedicine for treatment and disease management [41–43].

When primary care physicians and other healthcare providers were asked, they stated that the hesitancy seems to come from challenges such as limitations in sensory and cognitive functions, low technological literacy, mistrust of computers, and lack of desire to change their healthcare utilization mode [42]. These are all challenges that are currently being researched in order to find evidence-based solutions and thus increase the utilization of telemedicine among all age groups.

While other studies reported hesitancy in the utilization of telemedicine, our study found that patients with uncontrolled diabetes (HbA1c $\geq$ 8.0%) tended to utilize telemedicine more than the traditional F2F mode of care. There is limited research comparing the effects of telemedicine on a clinical diagnosis associated with patients' HbA1c levels. However, recent studies found that when patients utilize telemedicine and telehealth services, the patients reported better glycemic control and experienced a decrease in HbA1c levels [41,44].

A single consultation and telemedicine appointment alone does not lead to a significant decrease in HbA1c levels for patients with uncontrolled diabetes. However, when patients consistently engage in multiple telemedicine appointments (two or more) for treatment, education, and disease management, there is a notable improvement in their HbA1c levels [41,43,44]. Therefore, providing access to telemedicine healthcare services and resources for populations facing access barriers and health disparities related to demographic factors such as race, gender, culture, ethnicity, socioeconomic status, and geographical location, particularly those residing in medically underserved and disadvantaged areas, holds significant potential for improving hemoglobin A1c levels in patients with diabetes and improving overall quality of life.

Limitations

The study's generalizability may be limited due to retrospective data from a single clinic in an urban setting. The timeframe ranged from before the COVID-19 pandemic to during it; therefore, the conclusions might not be entirely applicable in other contexts. Data from all healthcare providers in urban and rural areas may have increased the representation of the target population. Future research should aim to replicate the study in a non-pandemic era across multiple geographic locations and include a broader range of demographic characteristics in order to improve external validity.

5. Conclusions

Although previous studies focus on the healthcare access equity gap among rural White populations, there is a lack of substantial research on effective interventions that address issues specific to populations residing in urban medically underserved minority areas (UMUPAs). Through the examination of technology utilization and demographic factors such as age, race, gender, and other relevant variables within clinical settings, researchers can detect gaps in the delivery of services. It is important to examine this research gap to understand the utilization preferences for the two types of healthcare service modalities—telemedicine versus traditional face-to-face care—in medically underserved areas.

To address the health disparities of the 21st century, it is essential to move beyond the traditional tertiary care model, which mainly focuses on managing the consequences of diseases once significant damage has already occurred, such as diabetes-related microvascular and macrovascular complications.

The existing body of research on diabetes management frequently overlooks primordial prevention, which focuses on tackling systemic factors and underlying conditions that function as early indicators of disease. An approach that addresses systemic conditions is the utilization of digital health technologies such as mHealth, eHealth, and telemedicine. Technology has proven effective in various aspects of disease management, including early detection, addressing disease precursors, monitoring environments, implementing preventive measures, and optimizing treatment strategies [45–47].

Informaticians, researchers, and other stakeholders have the opportunity of collaborating in the development of a user-friendly technological interface that prioritizes patients' ease of navigation. This approach would enable individuals with diverse levels of technological proficiency to effectively utilize digital health services. This advancement would represent a significant milestone in expanding the utilization of digital health services. Broadening the adoption of digital health services offers practical solutions in tackling access challenges, thus improving health outcomes while making progress towards reducing disparities and inequities in healthcare.

However, to effectively tackle the extensive complexity of globally pervasive health disparity challenges, additional strategies are required that incorporate a systems thinking approach through multisectoral collaborative partnerships. Future research may explore other novel approaches that support technological availability and access for all geographical regions. The achievement of this goal can be facilitated through the expansion of broadband connectivity and affordable devices and internet services for populations in medically underserved regions with limited resources.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board (or Ethics Committee) of Georgia Southern University and the University of Florida (UF) for studies involving humans. Ethical approval was granted by institutional review boards (IRBs) at the UF Health System (IRB 01) on 18 October 2021, and Georgia Southern University exemption 4 (limited review) approved the study protocol on 20 October 2021. Exemption status for chart reviews was approved for secondary PHR data collection. The data collected were archival and retrospective and were originally collected by the UF Health system EPIC for "healthcare operations" according to 45 CFR 164.512(b). The UF IRB 01 exemption status is defined as secondary research for which consent was not required. The study did not involve participants enrolled in experimental protocols and should pose minimal risk to administrative health professionals or patients. No patient-identifiable information was received, and the data were analyzed anonymously.

Informed Consent Statement: Secondary research did not require patient consent. The research involves only information collection and analysis involving non-identifiable health information for the purposes of "health care operations, research, or "public health activities and purposes" when that use is regulated under 45 CFR–160, 164.501, or 164.512(b).

Data Availability Statement: Not applicable.

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