ABSTRACT

Title of Thesis: RACIAL/ETHNIC DISPARITIES IN DIABETES CARE
                                    AND MANAGEMENT

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Today type 2 diabetes ranks as a global pandemic, endangering the health and well-being of

nearly 34 million people in the United States. In this article, I examined the most recent literature

and identified 47 relevant research articles, ten of which matched the inclusion criteria. All

studies concur that racial and ethnic minorities bear a disproportionate portion of the overall

burden of diabetes. The causes of racial/ethnic disparities in diabetes care and management are

complicated and multifaceted. However, it is assumed that the interplay of elements such as poor

social determinants of health (SDOH), environmental, and hereditary factors is the cause of

diabetes disparities. Having said that, the ensuing disparities have lasting negative impacts on

both individuals and communities and can be mitigated by digital health interventions.

Therefore, these interventions should be studied and examined further.

Keywords: racial/ethnic disparities, diabetes care, diabetes care and social determinants of health,

diabetes self-management.

RACIAL/ETHNIC DISPARITIES IN DIABETES CARE AND MANAGEMENT

by

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Dedication

I dedicate this thesis to my parents,
Mr. and Mrs. Yaqubi.
Eternally grateful.

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Executive summary

Introduction: Diabetes mellitus is a group of medical conditions characterized by elevated blood glucose levels. This etiology of diabetes is complex, but the primary disease mechanism is marked by abnormalities in insulin production or action. Untreated diabetes can lead to serious complications including premature death. These complications are long-term and can affect both the smaller and larger blood vessels in the body. Today, diabetes affects 34 million or 13% of the population in the United States. In addition to the human costs of Diabetes, the total direct and indirect healthcare costs of diagnosed Diabetes was slightly over $300 billion in 2017. Furthermore, research suggests that diabetes increases the risk of heart attack and mortality rate nearly two times in persons with diagnosed diabetes. Other studies have shown that diabetes is the not only the seventh leading cause of death in the United States but also the leading cause of kidney failure, non-traumatic lower-limb amputations, and adult-onset blindness.

Aim: This report systematically reviews current literature, highlights gaps in the receipt of diabetes care, identifies opportunities, and discusses interventions for better diabetes care among the medically disadvantaged populations.

Methods: I used the PubMed database for studies published in the last five years from 2016-2021 using the terms "racial disparities" and "diabetes care." The inclusion criteria were 1) Original research articles and secondary research articles such as literature reviews 2) were peer-reviewed 3) written in the English language 4) addressed racial/ethnic disparities in diabetes care. Exclusion criteria were studies that 1) do not address racial disparities directly, 2) discuss Type 1 diabetes mellitus, gestational diabetes, or prediabetes, and 3) were not conducted in the United States. We identified 47 articles and excluded 37 based on a review of titles and abstracts.

In the end, I had ten research articles examining racial/ethnic disparities in the management of type 2 diabetes mellitus.

Results: In this literature review we have identified three main themes. 1) Disparities in the prevalence of Diabetes, 2) Disparities in diabetes care and outcomes in racial/ethnic minorities, 3) The role of social determinants of health (SDOH) in racial disparities in diabetes prevalence, management, and outcomes.

Theme 1: Disparities in the prevalence of Diabetes: In sum, Kim et al. (2018) and Lindberg et al. (2019) identify high-risk groups for undiagnosed hyperglycemia & hypertension where Asian Americans have the highest rates, followed by low-income, overweight/obese Hispanic women.

Theme 2: Diabetes quality of care.

Subsection 2.1.1: Taylor et al. (2018): Taylor et al. (2018) demonstrated that non-Hispanic Blacks and Hispanic patients had higher odds of receiving diabetes preventive care such as HbA1C, LDL, and blood pressure screenings compared to non-Hispanic Whites. To illustrate further, non-Hispanic Blacks had 44% higher odds of receiving a foot exam and a 22% higher likelihood of receiving an eye exam than non-Hispanic Whites. Hispanic patients in this study had a 34% higher likelihood of receiving a foot exam compared non-Hispanic Whites.

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Subsection 2.3.1: Heitkemper et al. (2017): Heitkemper et al. (2017) conclude that health information technology (HIT) diabetes self-management education (DSME) programs positively impact glycemic control in medically underserved patients with substantial effects at six months of participation in DSME interventions. collectively, the findings from this study suggest that HIT DSME programs in vulnerable populations are as effective as face-to-face DSME interventions in the broader population. This health education program is the most effective when delivered through telemedicine/telehealth channels.

Subsection 2.3.2: Mayberry et al. (2019): The review by Heitkemper et al. (2017) reports that internet-based interventions demonstrated the most significant reductions in A1C levels at both 6

and 12 months. In comparison, the mid-and long-term impacts of cellular and automated telephone interventions on A1C levels were the least.

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Subsection 3.1.2: Taylor et al. (2018), Mayberry et al. (2019): A mixed-methods study of the disparities in diabetes care and outcomes by Taylor et al. (2018) highlights the importance of improving patient-provider interaction, quality of patient experiences, and better engagement of patients in decisions concerning their treatment. Additionally, a thorough analysis of the underlying causes of health disparities shows that these causes are multifaceted and multi-level, comprising of patient-level factors community-level factors, healthcare-level factors, and system-level factors (Mayberry et al., 2019). Having said that, the author believes that health disparities

are the result of an interaction between several systems and, therefore, has not been identified in this review.

Subsection 3.1.3: Mayberry et al. (2019), Heitkemper et al. (2017): Both authors, Mayberry et al. (2019) and Heitkemper et al. (2017), caution against exclusively using internet-based health interventions for diabetes self-management education because this can lead to an increased gap between the sociodemographic strata. On the other hand, basic mobile phones are broadly available, making health-promotion messages more easily accessible.

Discussion: In sum, Kim et al. (2018) and Lindberg et al. (2019) identify high-risk groups for undiagnosed hyperglycemia & hypertension where Asian Americans have the highest rates, followed by low-income, overweight/obese Hispanic women. The difference is: 1) Majority (56%) of Asian Americans had normal BMIs compared to Hispanic women. (2) Asian Americans are more likely to have Diabetes at lower BMIs and, therefore, (3) are at higher risk for undiagnosed hyperglycemia and hypertension.

Additionally, seven articles studied the disparities present in the care, management, and outcomes of type 2 diabetes among racial/ethnic minority adults with Diabetes. These studies systematically describe diabetes quality of care markers, diabetes-related complications, digital interventions for Diabetes self-management, and the lack of scientific evidence on the use of newer antidiabetic drugs in racial and ethnic minority adults and highlight the common feature among all studies being the disproportionate burden of Diabetes in racial and ethnic minority populations. The last theme in our current review of Diabetes disparities is understanding the role of the social determinants of health. To begin with, both Canedo et al. (2017) and A.M. Butler (2017) investigate the role of SDOH in racial disparities observed in minority populations.

However, the first article focuses on the impact of sociodemographic characteristics of patients on the receipt of the five recommended services for type 2 diabetes in clinical settings. In contrast, the second article analyzes the distribution, prevalence, and complication patterns of T2DM and the social determinants of health present among minority youth on a population level.

Conclusion: In conducting the current literature review, we have identified and included ten scholarly articles and explored the concept of diabetes care and management and summarized recent literature on the existing racial and ethnic disparities in diabetes prevalence, diabetes quality of care, diabetes diagnosis, and diabetes-related complications. Furthermore, we have outlined studies that examine the long-term impacts of digital interventions on glycemic control in medically underserved populations and the paucity of drug trials involving more recent antidiabetic medications and racial and ethnic minority populations.

Limitations

1. The exclusion of grey literature could have resulted in a failure in testing the review for "publication bias" and this might have resulted in biased conclusions.

2. Traditional reviews such as this, often lack appropriate critical appraisal of study "validity" and treats all evidence as equally valid. Needless to say, this too can lead to drawing incorrect conclusion.

3. The use of self-reported data in some studies might be affected by "recall bias" or influenced by factors such as "social desirability".

Recommendations

1. Significant need to develop disease-specific outreach and screening programs tailored for the vulnerable populations under study.

2. A need for future research regarding racial/ethnic variations in the receipt of Diabetes preventive care to confirm either of the findings, especially regarding the receipt of HbA1C tests.

3. Need for research assessing the long-term impacts of mHealth interventions on diabetes control, healthcare utilization, and spending in vulnerable PWDs.

4. Need for future research addressing the multilevel barriers that minority populations may face when accessing diabetes preventive or secondary care, such as the patient-level factors, community-level factors, healthcare-level factors, and system-level factors.

5. Canedo et al. (2017) confirmed that individuals with private insurance were more likely to receive all five recommended diabetes services than uninsured adults. Therefore, we can correct this by increasing health insurance coverage by retaining the Affordable Care Act reforms, implementing Medicaid expansion in more states, and addressing physician shortages.

Introduction

Diabetes Mellitus is a group of metabolic disease characterized by chronic hyperglycemia or elevated blood glucose levels, creating abnormalities in insulin secretion, insulin action, or both. Clinically, hyperglycemia has a varied presentation and results in carbohydrate, fat, and protein metabolic dysfunctions. Long-term hyperglycemia often leads to various microvascular and macrovascular diabetic complications, mainly responsible for diabetes-associated morbidity and mortality (Banday et al., 2020).

However, in 1994, the Centers for Disease Control and Prevention's (CDC) diabetes program announced that diabetes mellitus cases had risen to pandemic levels and should, therefore, be considered a public health priority. To fully appreciate the burden of Diabetes and its impact on health and the economy, it helps to know the latest estimates of the burden of Diabetes in the United States. Today, 34 million, or 10.5% of the population in the United States, have Diabetes. Furthermore, Diabetes was the seventh leading cause of death in the United States in 2017. In addition to the human costs of Diabetes, the total direct and indirect estimated healthcare costs of diagnosed Diabetes was $327 billion in 2017.

It is essential to study Diabetes so we can estimate its burden and take measures to manage and reduce its long-term complications including premature death caused by untreated Diabetes. Research shows that the presence of Diabetes increases the all-cause mortality rate by two times in persons with diagnosed diabetes. Diabetes also increases the risk of heart attack by two times. Moreover, Diabetes is the leading cause of kidney failure, lower-limb amputations, and adult-onset blindness (CDC, 2015; Egede, 2006; Spanakis & Golden, 2006). Studies have been recording

ethnic disparities in disease management for a long time. Multiple studies have recorded ethnic disparities in diabetes care and management, which show that Diabetes disproportionately affects vulnerable populations. The purpose of this study is to review recent literature on the racial and ethnic disparities in care and management for diabetic patients in the United States.

Aim

Based on my research, studies examining type 2 diabetes in minority populations in the United States were conducted as early as the 1960s. An article titled "ethnic distribution of diabetes mellitus in Hawaii," by Sloan NR, was published in the journal of American medical association (JAMA) in 1963. Additionally, based on the current literature review, the oldest cited study examining non-insulin dependent or type 2 diabetes mellitus in minorities in the USA was conducted by Carter et al., (1996). The second study examining racial/ethnic disparities was in 1999. The third cited study was in 2000 titled racial injustice in healthcare by freeman et al., (2000). The fourth cited study conducted on ethnic disparities was by Karter et al. (2002), titled "ethnic disparities in diabetic complications in an uninsured population".

In addition to the individual studies conducted in the 1990s, the institute of medicine (IOM) published a report titled "Unequal Treatment" in 2002 which explored the racial and ethnic disparities in healthcare. This report confirmed that racial and ethnic disparities exist in healthcare and are associated with worse health outcomes. The CDC reports that African American, African, Hispanic, and Asian people are statistically more likely to have type 2 diabetes than White Americans. A study by Spanakis et al. (2013) affirms that people of color are more likely to experience complications of Type 2 diabetes. This report systematically reviews current literature focused on racial/ethnic disparities in diabetes management, highlights the gaps in receipt of

diabetes care, identifies opportunities, and discusses interventions for better diabetes care among medically disadvantaged populations.

Methods

We used the PubMed database for studies published in the last five years from 2016-2021 using the terms "racial disparities" and "diabetes care." The inclusion criteria were 1) Original research articles and secondary research articles such as literature reviews 2) were peer-reviewed 3) written in the English language 4) addressed racial/ethnic disparities in diabetes care. Exclusion criteria were studies that 1) do not address racial disparities directly, 2) discuss Type 1 diabetes mellitus, gestational diabetes, or prediabetes, and 3) were not conducted in the United States.

We identified 47 articles and excluded 37 of them based on a review of titles and abstracts. Two focused on prediabetes and gestational diabetes. At the same time, four articles studied diabetes management programs implemented in other countries, focused on topics marginally related to diabetes care, or did not study racial/ethnic differences. We excluded only one article assessing racial/ethnic disparities in diabetes management due to combining both type 1 and 2 diabetes outcomes. The remaining 30 excluded articles investigated different topics such as obesity, cardiovascular disease, chronic kidney disease, end-stage renal disease, sleep, and oral health. In the end, we had ten research articles examining racial/ethnic disparities in the management of type 2 diabetes mellitus. Some of these studies are original research articles, while others are secondary literature.

Results

In the past, sociologists thought that racial and ethnic health disparities had biological origins. However, sociologists today argue that race is a social construct and does not confer a biologically valid concept. This review integrates and synthesizes current literature by identifying three main themes in the broader diabetes discussion. 1) Disparities in the prevalence of Diabetes, 2) Disparities in diabetes care and outcomes in racial/ethnic minorities, 3) The role of social determinants of health (SDOH) in racial disparities in diabetes prevalence, management, and outcomes.

Disparities in Diabetes Prevalence:

Based on CDC's National Diabetes Statistics Report (2020), of the 34.2 million Americans affected by Diabetes, nearly 78% (26.8 million) had diagnosed diabetes, while another 22% remained undiagnosed. Additionally, the rates of diagnosed diabetes in American adults differ by race/ethnicity: 7.5% of non-Hispanic Whites, 9.2% of Asian Americans, 12.5% of Hispanics, 11.7% of non-Hispanic blacks, and 14.7% of American Indians/Alaskan Natives are diagnosed with Diabetes. These statistics reveal persisting gaps in the distribution of Diabetes between minority populations and non-Hispanic Whites. This section reviews two studies, one by Lindberg et al. (2019); and another by Kim et al. (2018). Both studies investigate the prevalence of Diabetes in racial/ethnic minority populations.

Section 1.1: Diabetes prevalence.
Subsection 1.1.1: Kim et al. (2018).

First off, a retrospective analysis of a multi-year survey, Kim et al. (2018) studied the racial/ethnic differences in the prevalence of chronic diseases such as undiagnosed hypertension,

Diabetes, and kidney disease. In this study, the authors found that Asian Americans have higher undiagnosed hypertension and Diabetes. At the same time, non-Hispanic blacks and Hispanics had an increased likelihood of having undiagnosed diabetes compared to non-Hispanic Whites. The main reason behind a higher rate of undiagnosed medical conditions in Asian Americans might be the lack of screening stemming from the belief that Asians have lower diseases like hypertension and Diabetes. Other factors could be limited English proficiency and the acculturation process. This study also found other determinants affecting the higher rates of undiagnosed chronic medical conditions in minorities, including lack of health insurance, being obese, and belonging to an older age group. Therefore, the authors suggest that studies concluding self-reported survey data and similar sources may not be reliable and, therefore, should be reassessed.

Subsection 1.1.2: Lindberg et al. (2019).

Similarly, a randomized pragmatic trial by Lindberg et al. (2019) examined the prevalence of undiagnosed diabetes in a group of overweight or obese Hispanic women. Additionally, the researchers, citing earlier studies, reported that the prevalence of obesity, diabetes, and prediabetes had increased among Hispanic women in the last 15 years (Romero and Romero, 2011; Flegal et al., 2012). Other studies estimate that the rates of diabetes and prediabetes among Hispanic adults were two times higher than in non-Hispanic Whites (Cowie et al., 2009; Cowie et al., 2010)

As a result, the study finds that from a sample of low-income, overweight Hispanic women receiving care at a safety net clinic, 36% had diagnosed Diabetes, 20% had a diagnosis of prediabetes, and the remaining 44% had neither diagnosis. Among the undiagnosed study participants, 63% had at least one test indicating the onset of prediabetes, and 13% had at least one test indicating Diabetes. These statistics provide us with valuable information about the prevalence

of undiagnosed hyperglycemia in Hispanic women. Similarly, Menke et al. (2015) used the National Health and Nutrition Examination Survey (NHANES). They extrapolated a 10% prevalence rate of undiagnosed Diabetes, a 35% prevalence rate of undiagnosed prediabetes in Hispanic individuals. These studies call our attention to the prevalence of metabolic disorders such as diabetes and their risk factors among Hispanic adults, focusing on low-income overweight or obese Hispanic Women receiving care at Federally Qualified Health Centers.

Furthermore, Asians had higher undiagnosed hypertension and Diabetes (Kim et al., 2018). In contrast, obesity, diagnosed Diabetes, and prediabetes rates have increased significantly in Hispanic women in the past 15 years (Lindberg et al., 2019). Therefore, it helps to focus on Hispanic women who are overweight or obese and live beneath the federal poverty line to assess rates of undiagnosed hyperglycemia in Hispanic adults. In conclusion, these studies help us identify the high-risk groups for undiagnosed hyperglycemia in the United States, where the highest undiagnosed Diabetes and hypertension rates were among Asian Americans. This is followed by high rates of undiagnosed hyperglycemia in overweight/obese Hispanic women. The difference is that majority (56%) of Asian Americans with higher risks of conditions such as diabetes and hypertension had normal BMIs compared to Hispanic women. Therefore, Asian Americans are more likely to have Diabetes at lower BMIs and higher risk for undiagnosed hyperglycemia and hypertension. Furthermore, we think there is a significant need to develop disease-specific outreach and screening programs tailored for the vulnerable populations under study.

Diabetes Care and Outcomes in Racial/Ethnic Minorities:

We have included seven studies to understand better the racial/ethnic disparities associated with diabetes care and outcomes. Given the higher burden of diabetes among minority populations, we must assess the diabetes care processes (i.e., eye and foot exams, regular check-ups of blood glucose, cholesterol, and blood pressure) and intermediate outcomes (i.e., control of blood glucose, cholesterol, and blood pressure) in ethnic minority groups. In a mixed-methods study, Taylor et al. (2018) found that minority populations like non-Hispanic Blacks and Hispanic patients had higher chances of receiving preventive care for Diabetes but had lower chances of reaching the targets for reasonable glycemic and cholesterol control.

Section 2.1: Diabetes quality of care.
Subsection 2.1.1: Taylor et al. (2018).

To illustrate this, Taylor et al. (2018) demonstrated that non-Hispanic Blacks and Hispanic patients had higher odds of receiving HbA1C, LDL, and blood pressure screenings compared to non-Hispanic Whites. Non-Hispanic Blacks had 44% higher odds of receiving a foot exam and a 22% higher likelihood of receiving an eye exam than non-Hispanic Whites. Hispanic patients in this study had a 34% higher likelihood of receiving a foot exam compared non-Hispanic Whites. However, the findings related to diabetes outcomes by race and ethnicity reveal the opposite trend. Non-Hispanic Blacks had 25% lower odds of reasonable glycemic control and a 35% lower chance of achieving normal blood pressure levels. Additionally, non-Hispanic blacks, Hispanics, and patients of other races had a significantly lower likelihood of achieving targets for cholesterol control than non-Hispanic Whites.

Furthermore, there is an evident disparity in diabetes outcomes that fall on minority populations. To improve diabetes outcomes in minority populations, we need to increase diabetes

self-management, education, and support, address the SDOH, and use clinical information systems to flag and reach patients for their recommended level of care based on their lab values (American Diabetes Association, 2017).

Section 2.1: Diabetes quality of care.
Subsection 2.1.2: Canedo et al. (2017).

A cross-sectional study by Canedo et al. (2017) examined racial/ethnic disparities in five diabetes quality of care recommendations among racial/ethnic minority adults with T2DM. These included HbA1C twice yearly, yearly foot exam, dilated eye exam, blood cholesterol test, and flu vaccinations. The adjusted models, in this study, found that the receipt of two or more HbA1C tests in the past year was inconsistent for all three racial/ethnic minority groups (Blacks, Hispanics, and Asians) compared to non- Hispanic Whites. Additionally, Hispanics were 35.0% less likely than Whites to obtain an annual foot exam. Moreover, Blacks were 32.0% less likely to receive the flu vaccine compared to Whites.

In conclusion, using ethnically diverse samples from an ambulatory setting and MEPS survey data, each Taylor et al. (2018) and Canedo et al. (2017) found contradictory results for the receipt of HbA1C in minority populations. There is a need for future research regarding racial/ethnic variations in the receipt of Diabetes preventive care to confirm either of the findings. And lastly, there is need for future research exploring the disparity in the receipt of HbA1C test so we can address the barriers facing minority groups in attaining recommended diabetes testing.

A primary goal of diabetes treatment and management is to prevent diabetes-related complications. Untreated Diabetes and abnormal glucose levels can affect normal bodily functions and result in complications. The long-term outcomes of untreated Diabetes can manifest in two forms: macrovascular complications (i.e., peripheral arterial disease, stroke, and coronary artery disease) and microvascular complications (i.e., retinopathy, neuropathy, and nephropathy).

Given the higher rates of diagnosed and underdiagnosed hyperglycemia in minority adults, a reviewed study by Haw et al. (2021) confirms that minority populations experience a higher burden of diabetes-related complications. Several studies have reported that almost 12% of adults with type 2 diabetes mellitus suffered from blindness or retinopathy, and 37% had chronic kidney disease (CDC, 2020). in other words, non-Hispanic Blacks and Hispanic adults with diabetes experience higher microvascular complications rates than non-Hispanic White adults. However, the rates of macrovascular complications such as cardiovascular morbidity, ischemic heart disease, and stroke in adults with Diabetes have decreased across all ethnic groups in the United States from 1988 to 2015 (Cheng et al., 2018). Nevertheless, non-Hispanic Black adults with Diabetes have a higher incidence of cerebrovascular events.

Furthermore, the healthcare utilization for diabetes complications, such as the rates of emergency department use, hospitalization, and hospital costs for these admissions, tend to be higher in black and Hispanic patients compared to non-Hispanic Whites (Haw et al., 2021). Drawing on the findings from Haw et al. (2021), we conclude that there is a disproportionate burden of microvascular diabetic complications in non-Hispanic Blacks and Hispanic adults, with

higher rates of cardiovascular events among non-Hispanic Blacks. Additionally, healthcare utilization and costs tend to be higher for both.

Subsection 2.2.2: Gerber et al. (2018).

In addition to this study, a randomized controlled trial (RCT) by Gerber et al. (2018) examined the incidence and progression of chronic kidney disease in Black individuals with type 2 diabetes compared to non-Hispanic Whites. Because RCTs minimize the risk of confounding factors influencing the results, Gerber et al. (2018) found that the black race was not associated with rapid eGFR decline (normal range> 60 ml/min) and had lower rates of chronic kidney disease (CKD) events during a median follow-up period of 4-5 years compared to non-Hispanic White participants.

Despite the higher rates of micro-and macroalbuminuria in black adults at the baseline visit, there were no racial/ethnic differences in the development of albuminuria during the follow-up time of 4-5 years. Gerber et al. (2018) also did not spot specific racial and ethnic differences in the risk of advancement of an established CKD into kidney failure (or serum creatinine >3.3 mg/dl; normal range: 0.5-1.2). These findings support earlier epidemiological studies into the history of albuminuria, early kidney function decline, and rapid progression to End-Stage Kidney Disease (ESKD) among non-Hispanic Black adults. With similar results in diabetes-related kidney outcomes among black and white participants, the study sheds light on the role of effective delivery of standard Type 2 Diabetes care in eliminating racial/ethnic differences in the incidence and progression of diabetic nephropathy.

Section 2.3: Digital interventions for diabetes.
Subsection 2.3.1: Heitkemper et al. (2017).

Furthermore, a systemic review and meta-analysis by Heitkemper et al. (2017) examine the effects of technology-based diabetes self-management education (DSME) interventions on blood glucose control in medically underserved adults with Diabetes. The medically underserved population is an umbrella term used to define consumers of health services who are racial/ethnic minorities, have low income, and live in rural areas. Researchers explain that effective diabetes management involves lifestyle modifications, long-term behavior change combined with individual or group-based diabetes self-management education (DSME) (Burnisholz et al., 2014; Chatterjee and Davis, 2015).

However, studies have found that those most impacted by Diabetes cannot take advantage of Diabetes self-management education or DSME programs (Li et al., 2014). The barriers facing these populations are multifaceted and consist of language and literacy barriers, health beliefs and cultural considerations, competing obligations, and poor access (Attridge et al., 2014; Hawthorne et al., 2010; Nam et al., 2013; Kahn et al., 2011 and Horigan et al., 2016). Therefore, to respond to these problems, we must attempt to build effective and affordable DSME interventions. One of the solutions is using health information technology (HIT) in the design and delivery of these programs (Heitkemper et al., 2017). The growing acceptance of technology among the masses, such as increased mobile phone ownership and internet use, makes HIT an increasingly practical method of DSME program delivery. Studies show that four out of five Americans used the internet in 2011. This data includes African Americans and Hispanics as likely as non-Hispanic Whites to have used the internet (Zickuhr and Aaron, 2012).

Finally, Heitkemper et al. (2017) conclude that HIT DSME programs positively influence glycemic control and correction in medically underserved patients with Diabetes with substantial effects at six months of participation in DSME interventions. Altogether, the findings from this systemic review and meta-analysis suggest that HIT DSME programs in vulnerable populations are as effective as face-to-face DSME interventions in the context of the broader population. This health education program is the most effective when delivered through telemedicine/telehealth channels due to the patient-educator interaction incorporated in these programs.

Subsection 2.3.2: Mayberry et al. (2019).

The findings extracted by Heitkemper et al. (2017) are later supported by Mayberry et al. (2019), assessing the efficacy of mHealth interventions on Diabetes self-management and glycemic control. For context, which defined mHealth as all medical and public health practices supported by various wireless devices such as mobile phones, patient monitoring devices, personal digital assistants, and others (WHO, 2011). Mayberry et al. (2019) reviewed mHealth interventions for disadvantaged persons with Diabetes (PWDs). They reported that although most of the reviewed mHealth interventions reported within-group improvements in A1C levels, only half of all interventions requiring a control group showed between-group A1C improvements. In addition to improvements in A1C levels, these interventions improved several secondary outcomes such as diabetes distress, diabetes self-management, and reduced emergency room (E.R.) visits and hospitalizations. Further, Mayberry et al. (2019) suggested that we must combine human capital and technological interventions to get the optimal results to meet all diabetes care and management needs among disadvantaged PWDs. This statement agrees with the findings from the Heitkemper et al. (2017) study, affirming that the most effective digital interventions for Diabetes

self-management and education were delivered in a telemedicine/telehealth format based around patient-educator communication.

While many studies covered by Mayberry et al. (2019) noted a reduction in A1C levels in the initial stages of intervention, few studies had evaluated their long-term effects. Additionally, there is much heterogeneity in the observed long-term effects of mHealth interventions among the studies. Despite that, most studies report a within-group improvement in A1C levels, whereas less than half of all studies involving a control group show between-group A1C improvements. Moreover, other studies outline a reduction in the emergency room (E.R.) visits and rates of hospitalizations in the follow-up period. Therefore, we can infer that few studies assess the long-term impacts of mHealth interventions on diabetes control, healthcare utilization, and spending in vulnerable PWDs. Thus, we need more studies that evaluate digital interventions long term. Likewise, the review by Heitkemper et al. (2017) reports that internet-based interventions demonstrated the most significant reductions in A1C levels at both 6 and 12 months. In comparison, the mid-and long-term impacts of cellular and automated telephone interventions on A1C levels were the least.

Subsection 2.3.3: Rodriguez and Campbell (2017).

In addition to the digital interventions, there are pharmacological treatments for diabetes. In the early 1990s, they were limited to Insulin, metformin, and sulfonylureas. However, today as many as 12 different drug classes exist for Diabetes (Cavaiola and Pettus, 2017). Unlike the older drugs, the new diabetes medications do not cause side effects such as hypoglycemia and weight gain in patients undergoing treatment (ADA, n.d.). Similarly, according to mayo clinic-led research, DPP-4 inhibitors, GLP-1 receptor agonists, and SGLT inhibitors, which are relatively

new drugs, do not cause hypoglycemia and weight gain in patients. Additionally, GLP-1RA and SGLT -2 inhibitors use are associated with cardiovascular and renal benefits.

The American Diabetes Association (ADA) confirms that diabetes patients who are members of racial/ethnic minority groups, poor, or not covered through commercial insurance are less likely to be prescribed new medications. Furthermore, a reviewed study by Rodriguez and Campbell (2017) affirm that despite Asians, Blacks, and Latinos all having higher rates of type 2 diabetes than non-Hispanic Whites, only four drug classes that makeup lesser than 20% of all available diabetes medications have been tested in all three populations in the United States. While affordable medications such as metformin and sulfonylureas have been widely tested in minority populations, few clinical trials study newer antidiabetic medications. Consequently, in the absence of clinical trials and research evidence, the treatment process could involve more experimentation with the new drugs, giving rise to adverse drug reactions, increased healthcare costs and utilization, and possibly death among the already disadvantaged populations.

Social Determinants of Health: Access to Healthcare and Socioeconomic Status

According to the WHO, social determinants of health (SDOH) are a set of non-medical factors that influence health outcomes in a population such as income and social protection, education, unemployment, and job security, working life conditions, food insecurity, housing, basic amenities, and the environment, early childhood development, social inclusion and non-discrimination, structural conflict, and access to affordable healthcare services of decent quality. Many studies have established the connection between racial/ethnic background and diabetes quality of care.

Section 3.1: Social determinants of health.
Subsection 3.1.1: A.M. Butler (2017).

Similarly, a literature review by A.M. Butler (2017) explores the relation between SDOH and racial disparities and its impact on minority youth affected by type 2 diabetes mellitus (T2DM). This study also describes disparities in the prevalence of youth-onset T2DM, where as much as eighty percent of all diabetes cases affect minority youth. This review also reveals that in minority youth with T2DM, optimum glycemic control is often poorly achieved. Furthermore, psychosocial functioning suffers in both non-Hispanic Black and Hispanic patients. African American youth with Diabetes report poorer quality of life relative to non-Hispanic White youth with Diabetes, and Hispanic households suffer from a higher burden due to the care and management undertaken for affected Hispanic youth.

According to a secondary analysis of 2013, Medical Expenditure Survey (MEPS) data by Canedo et al. (2017), poverty status or income levels in adults with T2D does not affect diabetes quality-of-care indicators. However, higher levels of educational attainment were linked with the higher likelihood of receiving all quality-of-care indicators in racial and ethnic minority groups. Overall, between 15-35% of adults with Diabetes in the USA did not receive at least one recommended quality-of-care indicator in the past year. Additionally, as a dimension of SDOH, access to healthcare was operationalized by enrollment in health insurance coverage. The study findings confirmed that individuals with private insurance were more likely to receive all five recommended diabetes services than uninsured adults (Canedo et al., 2017). We can rectify this by increasing health insurance coverage by retaining the Affordable Care Act reforms, implementing Medicaid expansion in more states, and addressing physician shortages which could lead to decreased health disparities in medically underserved populations.

Additionally, a mixed-methods study of the disparities in diabetes care and outcomes by Taylor et al. (2018) highlights the importance of improving patient-provider interaction, quality of patient experiences, and better engagement of patients in decisions concerning their treatment. While some studies conclude that significant disparities remain in the prevalence, self-management, and outcomes of Diabetes (Golden et al., 2012; Nelson et al., 2019; Zimmerman et al., 2019), others such as Mayberry et al. (2019) take a step further and explore the social determinants of health present in vulnerable adults with Diabetes. According to these studies, "disadvantaged /vulnerable populations" is a public health designation that consists of persons with low socioeconomic status (SES), members of racial/ethnic minority groups, persons with limited literacy and numeracy skills, and persons living in rural areas or low- and middle-income countries. This explains the higher rates of substandard glycemic control, diabetes-related hospitalizations and complications, and untimely death in disadvantaged populations with type 2 diabetes. A thorough analysis of the underlying causes of health disparities shows that these causes are multifaceted and multi-level, comprising of patient-level factors (less adherence to self-management, lower participation in Diabetes education), community-level factors (limited access to healthy food and places for physical activity), healthcare-level factors (disparities in healthcare delivery, and provider bias), and system-level factors (i.e., lower rates of health insurance, differential access to medical care, and health and social policies) (Mayberry et al., 2019).

In the review by Mayberry et al. (2019), several studies find that disadvantaged persons with Diabetes (PWDs) used text messaging interventions more than internet-dependent programs. They argue that the cost of accessing a particular technological service is a significant hurdle in the technology's usage, its continuous engagement, and the accurate assessment of its long-term

impacts. Therefore, we need to focus on designing interventions based on readily available technology to disadvantaged PWDs. Additionally, several studies focused on making mHealth intervention models more culturally appropriate for users either by using recorded personal data or by employing personnel familiar with the study population. Despite the differences in intervention utilization, all disadvantaged/vulnerable PWDs described high satisfaction levels for all types of interventions. This proves that the vulnerable PWDs, who often report having negative experiences in the healthcare system, strongly prefer to feel supported and cared for by their healthcare team.

Subsection 3.1.3: Mayberry et al. (2019), Heitkemper et al. (2017).

Both authors, Mayberry et al. (2019) and Heitkemper et al. (2017), caution against exclusively using internet-based health interventions for diabetes self-management education because this can lead to an increased gap between sociodemographic strata. Despite the diminishing "digital divide" in the USA in recent years, the argument is that socioeconomic disparities in possession of internet and internet-enabled devices persist. On the other hand, basic mobile phones are broadly available, making health-promotion messages more easily accessible. Moreover, flexibility, ease of use, and cost-effectiveness benefit digitally delivered health interventions. Given the rapid adoption of technology among all strata of society, it is a convenient and cost-effective approach to Diabetes self-management. Additionally, the use of information technology ensures the incorporation of user-friendly options that fit each patient's individual needs, such as adapting to different learning styles, levels of literacy, and cultural/linguistic considerations. Similarly, the widespread use of mobile phones and internet surfing in the present time reduces costs associated with the design and delivery of health education programs such as the DSME.

Discussion

In this literature review, we have covered a total of ten research articles, comprised of original and secondary research, and examined the existing racial/ethnic disparities in diabetes management and care. We identified three recurring themes in these research articles. These were 1) Disparities in the prevalence of Diabetes, 2) Disparities in diabetes care and outcomes in racial/ethnic minorities, 3) The role of social determinants of health (SDOH) in racial disparities in diabetes prevalence, management, and outcomes.

Theme 1: Disparities in the prevalence of Diabetes:

The first two studies by Kim et al. (2018) and Lindberg et al. (2019) investigating the prevalence of Diabetes among ethnic minority populations arrive at similar conclusions by demonstrating the higher rates of type 2 diabetes among ethnic and racial minority populations. At the same time, Kim et al. (2018) describe the higher prevalence of several comorbid conditions such as undiagnosed hypertension, Diabetes, and kidney disease in racial/ethnic minority adults. They further substantiate their claim by demonstrating that Asians had an increased likelihood of having undiagnosed hypertension and Diabetes. In contrast, Blacks and Hispanics had a higher chance of having undiagnosed Diabetes than White adults. On the other hand, Lindberg et al. (2019) explore the prevalence of undiagnosed hyperglycemia (Diabetes and prediabetes) among a sample of low-income, overweight, or obese Hispanic women. The authors further explain by concluding that insufficient knowledge of Diabetes risk and cultural/linguistic barriers, among other factors, could help explain the low patient compliance with diabetes screening recommendations.

In sum, Kim et al. (2018) and Lindberg et al. (2019) identify high-risk groups for undiagnosed hyperglycemia & hypertension where Asian Americans have the highest rates, followed by low-income, overweight/obese Hispanic women. The difference is: 1) Majority (56%) of Asian Americans had normal BMIs compared to Hispanic women. (2) Asian Americans are more likely to have Diabetes at lower BMIs and, therefore, (3) are at higher risk for undiagnosed hyperglycemia and hypertension.

Theme 2: Disparities in diabetes care and outcomes in racial/ethnic minorities:

In addition, seven articles designed as experimental trials, mixed-methods studies, or systemic reviews studied the disparities present in the care, management, and outcomes of type 2 diabetes among racial/ethnic minority adults with Diabetes. These studies systematically describe diabetes quality of care markers, diabetes-related complications, digital interventions designed for Diabetes self-management, and the lack of scientific evidence on the use of newer antidiabetic drugs in racial and ethnic minority adults and highlight the common feature among all studies being the disproportionate burden of Diabetes in racial and ethnic minority populations. All studies are marked by crucial findings that substantiate our claim of persisting disparities in the care and management of Diabetes in racial/ethnic minority adults in the USA. These findings are crucial because they help us appreciate the gap that exists between different sociodemographic groups in their disease status and therefore encourage us to take the initiative and address public health problems such as the diabetes epidemic.

Theme 3: The role of social determinants of health (SDOH) in racial disparities in diabetes:

The last theme in our current review of Diabetes disparities is understanding the role of the social determinants of health. To begin with, both Canedo et al. (2017) and A.M. Butler (2017)

investigate the role of SDOH in racial disparities observed in minority populations. However, the first article focuses on the role of sociodemographic characteristics of patients in the receipt of the five recommended services for type 2 diabetes in clinical settings. In contrast, the second article analyzes the distribution, prevalence, and complication patterns of T2DM and the social determinants of health present among minority youth on a population level. Thus, these almost identical studies examine the role of SDOH in two different contexts, making them similar. Other than that, Taylor et al. (2018) make an interesting observation regarding the role of SDOH, contextualized as the patient-provider dynamic, to improve the healthcare experience for disadvantaged persons with Diabetes.

The Heitkemper et al. (2017) and Mayberry et al. (2019) are interdependent studies that analyze the effects of digital interventions on different dimensions of diabetes management such as glycemic control, healthcare utilization, and healthcare costs in vulnerable populations. Although both studies are complementary and support each other, Heitkemper et al. (2017) examine the relative efficacy of the four main types of digital interventions in controlling Diabetes. On the other hand, Mayberry et al. (2019) investigate the usability and long-term impacts of affordable digital interventions on glycemic control, healthcare utilization, and cost in medically underserved populations.

Conclusion

In conducting the current literature review, we have identified and included ten scholarly articles and explored the concept of diabetes care and management from all different angles. This review summarizes the existing literature on the existing racial and ethnic disparities in diabetes prevalence, diabetes quality of care, diabetes diagnosis, and diabetes-related complications. We

also summarized studies examining the long-term impacts of digital interventions on glycemic control in medically underserved populations and the paucity of drug trials involving newer antidiabetic medications in racial and ethnic minority populations. In the same fashion, the IOM report defines disparities in health care as "racial or ethnic differences in the quality of health care that are not due to access-related factors or clinical needs, preferences, and appropriateness of intervention" (Stith and Nelson, 2002).

Holistically, a combination of negative SDOH, environmental, and genetic factors is speculated to give rise to disparities in Diabetes among different racial/ethnic subgroups in the USA. The resulting racial disparities negatively impact diabetes care on both individual and population levels. The accessibility of HIT-based digital interventions improves glycemic control in these populations, and therefore digital health interventions should be further studied and examined.

Limitations

4. The exclusion of grey literature can result in a failure in testing the review for "publication bias" and this may result in incorrect conclusions.

5. Traditional reviews, such as this, often lack appropriate critical appraisal of study "validity" and treats all evidence as equally valid. Needless to say, this, too, leads to incorrect conclusions.

6. The use of self-reported data in some studies might be affected by "recall bias" or influenced by factors such as "social desirability".

Recommendations

6. (Lindberg et al., 2019): We think there is a significant need to develop disease-specific outreach and screening programs tailored for the vulnerable populations under study.

7. Since each Taylor et al. (2018) and Canedo et al. (2017) found contradictory results for the receipt of HbA1C in minority populations. There is a need for future research regarding racial/ethnic variations in the receipt of Diabetes preventive care to confirm either of the findings.

8. Mayberry et al. (2019): From this study, I inferred that few articles assess the long-term impacts of mHealth interventions on diabetes control, healthcare utilization, and spending in vulnerable PWDs. Thus, we need more studies that evaluate digital interventions long term.

9. A thorough analysis of the underlying causes of health disparities shows that these causes are multifaceted and multi-level, comprising of patient-level factors community-level factors, healthcare-level factors, and system-level factors (Mayberry et al., 2019), therefore, there is need for future research addressing the multilevel barriers that minority populations may face when accessing diabetes preventive or secondary care.

10. Canedo et al. (2017): The study findings confirmed that individuals with private insurance were more likely to receive all five recommended diabetes services than uninsured adults (Canedo et al., 2017). We can correct this by increasing health insurance coverage by retaining the Affordable Care Act reforms, implementing Medicaid expansion in more states, and addressing physician shortages which could lead to decreased health disparities in medically underserved populations.

Table:

Title	Content: 1. Prevalence 2. Management 3. SDOH	Sample/ Population	Questions Asked	Methods	Main findings
Racial and Ethnic Disparities in Prevalence and Care of Patients with Type 2 Diabetes by Rodriguez and Campbell (2017)	2. Diabetes Management	N/A	N/A	Narrative review	A reviewed study by Rodriguez and Campbell (2017) affirms that despite Asians, Blacks, and Latinos all having higher rates of type 2 diabetes than non-Hispanic Whites, only four drug classes, that make up <20% of all available diabetes medications, have been tested in all three populations in the United States. While affordable medications such as metformin and sulfonylureas have been widely tested in minority populations, there are not enough clinical trials studying newer antidiabetic medications.
Incidence and Progression of Chronic Kidney Disease in	2. Diabetes Management	1937 Black and 6372 White participants (8309 participants	It is uncertain if racial disparities in type 2 diabetes-associated CKD are driven by	Randomized parallel treatment trial or the ACCORD trial	Because RCTs minimize the risk of confounding factors that influence the results, contrary to their initial hypothesis,

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Black and White Individuals with Type 2 Diabetes by Gerber et al. (2018)		in total) research material obtained from the National Health, Lung, and Blood Institute	biological factors that influence the propensity to CKD or by differences in type 2 diabetes care.		Gerber et al. (2018) found that the black race was not associated with rapid eGFR decline (normal range> 60 ml/min) and had lower rates of chronic kidney disease (CKD) events during a median follow-up period of 4-5 years compared to the non-Hispanic White participant.
Diabetes Complications in Racial and Ethnic Minority Populations in the USA by Haw et al. (2021)	2. Diabetes management	N/A	This narrative review highlights the epidemiologic trends in diabetes complications specific to racial and ethnic minorities and underscores differences in microvascular and macrovascular complications of diabetes, health care utilization, and diabetes prevention efforts and also reviews interventions	Narrative review	Haw et al. (2021) further explain that non-Hispanic blacks and Hispanic adults with diabetes experience higher microvascular complications than non-Hispanic White adults. However, the rates of cardiovascular morbidity, ischemic heart disease, and stroke in adults with Diabetes have decreased across all ethnic groups in the United States between 1988 and 2015. Nevertheless, non-Hispanic black adults with Diabetes have a higher incidence of cerebrovascular events. Furthermore, the healthcare utilization for diabetes-related

			aimed to reduce racial/ethnic disparities and their limitations.		complications, the rates of emergency department use, hospitalization, readmissions, and hospital costs for all mentioned admissions tend to be higher in black and Hispanic patients compared to non-Hispanic Whites.
High Prevalence of Undiagnosed Hyperglycemia in Low-Income Overweight and Obese Hispanic Women in Oregon by Lindberg et al. (2019)	1: Diabetes prevalence	200 participants completing the baseline clinic visit for the study	We examined the prevalence of undiagnosed hyperglycemia among a group of low-income overweight or obese Hispanic women who were receiving care at a Federally Qualified Health Center (FQHC).	Randomized pragmatic trial	As a result, the study finds that from a sample of low-income, overweight Hispanic women receiving care at a safety net clinic, 36% had diagnosed Diabetes, 20% had a diagnosis of prediabetes, and the remaining 44% had neither diagnosis. Among the undiagnosed study participants, 63% had at least one test indicating the onset of prediabetes, and 13% had at least one test indicating Diabetes. This provides us with valuable information about the prevalence of undiagnosed hyperglycemia in Hispanic women

mHealth Interventions for Disadvantaged and Vulnerable People with Type 2 Diabetes by Mayberry et al. (2019)	2. diabetes management, and 3. SDOH and diabetes disparities	N/A	N/A	Narrative review	Mayberry et al. (2019) found that although many digital interventions found within-group A1c improvements (16 of 21 studies), only seven of the seventeen studies with a control group found between-group differences in A1c. Three studies found reductions in emergency room (E.R.) visits and hospitalizations. We synthesize this information and provide recommendations for increasing access and improving the design and
Do health information technology self-management interventions improve glycemic control in medically underserved adults with Diabetes? A systematic review and meta-analysis	2. diabetes management, and 3. SDOH	N/A 13 studies included	N/A	Systemic review and meta-analysis	Findings suggest that medically underserved patients with Diabetes achieve glycemic benefit following HIT DSME interventions, with dissipating but significant effects at 12 months. Telemedicine/telehealth interventions were the most successful HIT type because they incorporated interaction with educators similar

by Heitkemper et al. (2017)					to in-person DSME. Both authors Mayberry et al. (2019) and Heitkemper et al. (2017), caution against exclusively focusing on internet-based health interventions as a method of health services provision, as it can lead to an increased gap between sociodemographic strata. The argument is that despite the diminishing "digital divide" in the USA in recent years, socioeconomic disparities in possession of internet and internet-enabled devices persist.
Social Determinants of Health and Racial/Ethnic Disparities in Type 2 Diabetes in Youth by Butler AM, (2017)	3. Social Determinants of Health (SDOH)	N/A	Given that racial / ethnic minority child and families in the general population also have disproportionate social, economic, and environmental disadvantages, there may be pervasive disparities in youth onset T2DM. Yet, no literature has	Literature review	Minority youth have disparities in the onset of T2DM, quality of life, and family burden. Low family income and parental education, and high youth stress are common negative SDOH among families of youth with T2DM. No studies have examined the role of SDOH in racial/ethnic disparities in youth-onset T2DM.

			summarized studies that have examined racial/ethnic differences in youth onset T2DM outcomes.		
Racial and Ethnic Disparities in Diagnosis of Chronic Medical Conditions in the USA by Kim et al. (2018)	2: Diabetes prevalence	Adults 18 years and older who participated in the National Health and Nutrition Examination Survey during 2011–2014 (n = 10,403	There exist racial and ethnic disparities in the prevalence of chronic medical illnesses. However, it is unclear if the disparities arise from patients' self-reported estimates on these diseases and whether there is an association between healthcare utilization and diagnosis.	Retrospective analysis of multi-year survey data.	In a nationally representative cohort, Asians had higher rates of undiagnosed hypertension and Diabetes and all minorities were more likely to have undiagnosed Diabetes compared to Whites. Healthcare utilization was associated with undiagnosed medical conditions. Our study showed that reliance on self-reported data may systemically underestimate the prevalence of chronic illnesses among minorities and further research is needed to understand the significance of healthcare utilization in health outcomes.

| Racial/Ethnic Disparities in Diabetes Care and Outcomes: A Mixed Methods Study by Taylor et al. (2018) | 2. diabetes management, and 3. SDOH | Using data from 62,149 adults with Diabetes who received care within Atrium Health in 2013 | Limited research has examined racial/ethnic differences in diabetes care and outcomes among primary care patients. This study examined racial/ethnic differences in diabetes care and outcomes among an ambulatory patient population and explored patient perceptions of the patient-provider relationship to inform strategies to improve care delivery. Also, we hypothesized that non-Hispanic Blacks and Hispanics would have worse diabetes outcomes compared to non-Hispanic Whites after | We used a mixed-methods approach that involved analysis of cross-sectional quantitative data on healthcare use and outcomes and qualitative data from focus groups. Focus groups explored patient perceptions of the patient-provider relationship in diabetes care and the similarities and differences in those perceptions by race/ethnicity. | In this mixed-methods study, our primary finding was that while non-Hispanic Black and Hispanic patients had higher odds of preventive care for Diabetes; they had lower odds of achieving targets for reasonable glycemic and cholesterol control. We also learned that regarding perceptions of diabetes care and the patient-provider relationship, both non-Hispanic Black and non-Hispanic White patients valued having a consistent provider to help them manage their Diabetes, being included in decisions regarding their treatment, and having providers who help them to understand information by using words that are easy to understand. Non-Hispanic Black patients also reported an interest in learning more from their providers about the impact of Diabetes |

			adjustments for patient characteristics and that Hispanics would have less preventive care for Diabetes.		on patients who share their racial/ethnic background.

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