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Diabetes Complications in Racial and Ethnic Minority Populations in the USA

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Abstract

Purpose of Review—Racial and ethnic minority populations have a higher burden of diabetes-related complications. There have been many epidemiologic studies to better define these racial/ethnic disparities in diabetes outcomes with additional studies offering interventions to mitigate them. 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 aimed to reduce racial/ethnic disparities and their limitations.

Recent Findings—While we have seen in general an overall improvement in complication rates for all people with diabetes, the disparities between Black and Hispanic compared to non-Hispanic White people with diabetes seem to persist.

Summary—There is a continued need to better understand the underlying causes of and strategies to mitigate race/ethnicity disparities in diabetes complications in the USA.

Keywords

Diabetes complications; Minority; Epidemiology; Disparities

Introduction

Diabetes mellitus (diabetes) disproportionately affects minority populations in the USA: while 13% of the general adult population has diabetes, disproportionately high rates of diabetes are found among American Indians/Alaska Natives (14.7%), Hispanics (12.5%), and non-Hispanic Blacks (NHB) (11.7%) while lower rates are seen among non-Hispanic Asians (9.2%) and non-Hispanic Whites (NHW) (7.5%) [1]. In US children and adolescents (10–19 years), the overall incidence of type 2 diabetes has significantly increased between

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2002 and 2015 [1, 2]. When stratified by race and ethnicity, however, the changes in incidence were stable among NHW but increased significantly for all other racial and ethnic groups, particularly in non-Hispanic Black children and adolescents [1].

Minority populations also experience a higher burden of diabetes-related complications. Non-Hispanic Black and Hispanic adults with diabetes have higher rates of albuminuria, retinopathy, and worse glycemic control compared to non-Hispanic Whites [3•, 4]. Despite the higher prevalence of diabetes in racial and ethnic minorities, minority patients are less likely to receive recommended diabetes preventive care, such as hemoglobin A1c (HbA1c) testing, annual cholesterol screening, and retinal examinations [5]. While the overall rate of diabetes-related complications such as myocardial infarctions, stroke, lower extremity amputations, and end-stage-renal disease has declined since 1990, minority patients still experience these complications at a higher rate than do non-Hispanic White patients [6••].

There is a growing body of literature on disparities in diabetes prevention, quality of care, and outcomes among racial and ethnic minority groups. The objective of this narrative review is to compile and summarize key literature examining the prevalence and trends of diabetes-related micro- and macro-vascular complications, healthcare utilization for diabetes-related conditions, and prevention efforts specifically in racial and ethnic minority populations in the U.S. We also evaluate programs and strategies used to mitigate diabetes-related disease burden in minority populations and offer suggestions for further improvement in overall diabetes care and outcomes for minority populations in the United States.

Microvascular Complications

Microvascular complications of diabetes are a major contributor to diabetes-related morbidity. Overall, among US adults with type 2 diabetes, 11.7% reported retinopathy or blindness and 37% had chronic kidney disease (CKD), over half of whom had moderate to severe CKD [1]. Black and Hispanic adults with diabetes disproportionately experience microvascular complications compared to White adults.

Retinopathy

Diabetic retinopathy is the most common microvascular complication of diabetes and is responsible for over 10,000 cases per year of blindness in people with diabetes in the USA [7]. By 2050, it is estimated that 16 million Americans over 40 years old will have diabetic retinopathy, with nearly 25% having manifestations severe enough to threaten vision [8]. Diabetic retinopathy is more prevalent in racial and ethnic minorities: in an analysis of 2005–2008 NHANES data, Zhang et al. estimated the prevalence of diabetic retinopathy among non-Hispanic Black individuals with diabetes to be 38.8%, Hispanic individuals to be 31.0%, and non-Hispanic white individuals to be 26.4% [9]. The INSIGHT study described the rates of diabetic retinopathy in patients with type 1 or type 2 diabetes in 4 urban clinics in the USA with majority African-American (62.4%) or Hispanic (14.8%) patients and found that 1 in 5 study participants screened positive for diabetic retinopathy [10].

Nephropathy

Diabetic nephropathy is the leading cause of renal failure in the USA and disproportionately impacts minority populations [11, 12]. A study of over 62,000 insured patients with diabetes found increased incidence rates of end-stage renal disease (ESRD) in Black, Hispanic, and Asian patients compared to Whites (Black 6.8 patients/1000 person-years, Hispanic 4.3 patients/1000 person-years, Asian 4.5 patients/1000 person-years, White 3.2 patients/1000 person-years) [13]. In US population-based studies, Black people with diabetes had ESRD at twice the rate of Whites. Additionally, among select diabetes complications examined between 1990 and 2010 (coronary artery disease, stroke, lower-extremity amputation, and death from hyperglycemic crisis), the rate of nephropathy had the lowest decline; this was attributed to the increase in proportion of diabetes seen in Blacks [6••]. A study using NHANES data shows the overall prevalence of diabetic kidney disease (defined as either reduced eGFR, albuminuria, or both) between 1988 and 2014 remained unchanged, but with significant decline in albuminuria and increase in reduced eGFR [11]. When stratified by race/ethnicity, the decline in albuminuria was only observed among non-Hispanic Whites and there were no differences by race in the increased prevalence of reduced eGFR [11].

Lower Extremity Amputations

Similar trends are seen in nontraumatic lower limb amputations. Black people with diabetes have the highest rate of nontraumatic lower limb amputations [13, 14]. The incidence rates in Black people with diabetes was shown in one study to be 4.7/1000 person-years, compared to Latinos at 4.8 amputations/1000 person-years, Whites at 3.2/1000 person-years, and Asians at 1.5/1000 person-years [13]. Among all patients admitted for diabetic foot infections, analyses of the National Inpatient Sample (NIS) from 2002 to 2015 showed an overall decline in major amputations but an increase in minor amputations [15]. Despite these trends, Black and Hispanic patients remained significantly more likely to get a major amputation compared to White patients (Black OR 1.4, 95% CI 1.4, 1.5 and Hispanic OR 1.3, 95% CI 1.3, 1.4) [14, 15].

Numerous explanations for differences in rates of microvascular complications between ethnic groups have been offered and range from the highly individual, for example, differences in genetics due to selection or drift, to systemic issues such as disparities in access to preventive care and provider bias against minority patients [13, 16]. Overall, the trends in retinopathy, nephropathy, and non-traumatic lower-extremity amputations seem to be improving for all patients, though the burden of these complications still falls disproportionately on patients in racial and ethnic minority groups.

Macrovascular Complications

Cardiovascular and cerebrovascular diseases (CVD) are major causes of morbidity and mortality among people with diabetes in the USA [17, 18]. The Multi-Ethnic Study of Atherosclerosis (MESA) recognized that people living with diabetes are two times more at risk for developing heart failure than those without diabetes [17, 19]. In evaluating CVD risk reduction, a study using National Health and Nutrition Examination Survey (NHANES) data, only 7.2–8.4% of people with diabetes were able to meet recommended “ABC”

metrics for cardiovascular disease risk reduction: HbA1c (< 7.0%), blood pressure (< 130/80 mmHg), LDL-C (< 100 mg/dL) [20, 21]. Black and Mexican Americans are less likely to meet all three ABC goals of care [22]. Multiple studies have demonstrated a higher prevalence of poor glycemic control, hyperlipidemia, and hypertension in non-Hispanic Black individuals compared to other ethnic groups [20–24]. Whether these gaps in diabetes care among minority populations lead to disparate long-term effects in regard to cardiovascular disease is yet to be definitively elucidated, as published studies have produced varying results.

In the Diabetes & Aging Study, a prospective multi-ethnic cohort study of older, insured patients with diabetes ≥ 60 years old, the prevalence rates of heart failure were equal between White and Black patients (15%), but overall higher than Latino (10%), Filipino (9%), and Asian (8%) patients [25]. However, relative to their White counterparts, who had a greater chance of suffering from myocardial infarctions (MI), Black (RR = 0.64 (95% CI 0.53, 0.80)), Latinos (RR = 0.76 (95% CI 0.62, 0.92)), and Asians (RR = 0.79 (95% CI 0.64, 0.98)) had lower risk of MI(s) and Filipino and mixed race-ethnicity patient did not differ from White patients [25]. Based on the TREAT controlled study, with similar access to care and medications across ethnic groups, the Black population with diabetes had less prior CVD (MI, heart failure, and coronary revascularization) and continued to have lower risk for MIs and coronary revascularization than the White population throughout the study [23]. However, in contrast to these study results, the SUPREME-DM observational cohort study shows a disproportionate burden of heart failure incidence in Black adults with diabetes (12.1–17.6/1000 person-years), which was double that of White (6.2–8.8/1000 person-years) and Hispanic (6.6–8.9/1000 person-years) individuals with diabetes [26]. Similarly, another study shows the Black population has higher rates of hospitalization due to heart failure but lower rates of hospitalization for acute coronary syndrome relative to their White counterparts [27].

Based on NHANES data, Mexican Americans with diabetes have a greater prevalence of metabolic syndrome, characterized by higher HbA1c and triglyceride levels, compared to non-Hispanic Whites and non-Hispanic Blacks [19, 20]. Yet, in other studies, the prevalence of CVD in the Hispanic population is less than what is observed in White and Black populations [23, 25, 28]. A study of Kaiser Permanente patients show that some Asian groups such as Pacific Islanders, South Asian, and Filipinos currently have the highest prevalence of diabetes. It has also been observed that Asian Americans have a similar LDL-C and blood pressure profile to their non-Hispanic white counterparts despite having lower BMIs on average [20, 29].

There has been a decline in cardiovascular morbidity, ischemic heart disease, and stroke among all people with diabetes across all US ethnic groups from 1988 to 2015 [30••]. However, Black individuals with diabetes remain disproportionately affected by cerebrovascular disease [19, 26, 30••]. In a study using NHANES data, the prevalence of undiagnosed prediabetes and diabetes in people with prior stroke history was greater in Black people (37.8% and 7.5%) than both White people (31.6% and 3.1%) and people of Mexican descent (26.3% and 4.4%) [31]. An analysis of the NIS found that Black patients experienced a drop in ischemic stroke-related hospitalization rates (11.0 to 9.0) between

1998 and 2014, yet Black Americans are still hospitalized at a higher rate compared to Whites and Mexican Americans [27].

Cardiovascular disease continues to be the leading cause of death for people living with diabetes. Major CVD mortality in adults with diabetes (8.2 per 1000 person-years) is more than twice that in adults without diabetes (3.9 per 1000 person-years), though this gap has narrowed significantly over the past 30 years and both populations with and without diabetes have seen a decline in overall CVD mortality since 2003 [30••, 32]. Overall diabetes-attributable deaths were higher among non-Hispanic Black, American Indian/Alaska Native, and Hispanic populations compared to the non-Hispanic White population [32]. A recent study comparing age-adjusted mortality rates (AAMR) between 1999 and 2017 showed Black women with diabetes had a 2-fold higher AAMR compared to White women with diabetes [33]. While epidemiologic trends show an overall decline in CVD mortality rates among individuals with diabetes, the disparity gap by race and ethnicity persists [30••, 33]. As newer antihyperglycemic agents show cardiovascular protection in people with diabetes, more research is needed to evaluate changes in these disparity trends and whether minority populations with diabetes are able to equally access these medications and/or if these agents have equitable benefits in real-world effectiveness studies.

Healthcare Utilization

A diagnosis of diabetes impacts health care use across all settings of care. In 2013, National Health Interview Survey (NHIS) data revealed that 90% of adults with diabetes reported having contact with a doctor or other health care provider in the previous 6 months [34]. There have been numerous studies examining the impact of different patient-level factors on healthcare utilization for diabetes and its common complications across primary care, emergency department, and inpatient settings.

The oldest study to investigate the association between race/ethnicity and diabetes healthcare use examined nationally representative data sources including NHIS and the National Hospital Discharge Survey (NHDS) from 1980 to 1987 to capture national incidence and prevalence of diabetes as well as specific diabetes-related outcomes [35]. The outcomes related to healthcare utilization that they examined were hospitalization for lower-extremity amputations and DKA. They found that the overall number of discharges for nontraumatic amputations among patients with diabetes increased over the study period, from 36,000 in 1980 to 56,000 in 1987. Among Black patients, the age-standardized rate of hospital discharges following a nontraumatic lower limb amputation was 9.0/1000 individuals while it was 6.3/1000 for White individuals. The trends were similar for DKA: the number of hospital discharges increased from 70,000 in 1980 to 110,000 in 1987. The rate of DKA hospitalization was highest for Black males throughout the study period (24.7/1000 people).

Bazargan et al. interviewed 349 adult patients with diabetes who sought care at seven clinics in South Central Los Angeles, California, in 1998 [36]. Of this cohort, 67.3% were Hispanic and the remaining 32.7% were African-American. When asked about ED use, 68.5% reported never having been to the ED in the past year, 20.1% had been once, and 11.5% had been more than once. Patients were not asked why they had visited the ED. Patients were

more likely to have accessed the ED if they had diabetes-related complications, required insulin, were younger, were Black, had lower educational attainment, or were female.

Jiang et al examined racial/ethnic and payer differences associated with the risk of readmission at 30 and 180 days after the initial discharge from five states (California, Missouri, New York, Tennessee, Virginia) [37]. In the 30-day follow-up period, Hispanic adults with Medicare were the only group to have a significantly higher risk of readmission than the comparison group (White patients). In the 180-day follow-up period, Black adults with Medicare had a significantly higher risk of read-mission, as did all Hispanic groups.

Seyoum and Berhanu examined a cohort of predominantly Black adults admitted with DKA to their Detroit hospital between 1999 and 2003 ($n = 847$) [38]. DKA was responsible for 6.5% of all diabetes-related admissions, and 1.3% of all admissions. 14.9% ($n = 94$) of patients required multiple admissions for DKA during the study period.

Kim et al. used the California SID for 2006 to examine planned and unplanned readmissions within 90 days following an admission for diabetes in adults 50 years old and older. Of the 124,967 patients identified, 26.3% ($n = 32,857$) had readmissions, of which 87.2% were unplanned [39]. The authors found that Black and Hispanic patients were more likely to have unplanned readmissions than White patients (ORs 1.17, 95% CI 1.11–1.23; 1.10, 95% CI 1.07–1.14, respectively).

Randall et al. conducted a cross-sectional study in which they performed chart reviews on and qualitative interviews with 164 patients admitted with DKA to a county hospital in Atlanta, GA [40]. Of these patients, 96% where Black. 46.4% ($n = 91$) had recurrent DKA admissions at the time of enrollment, while the remaining patients were experiencing their first DKA admission.

Ma and Fisher used the Pennsylvania Health Care Cost Containment Council dataset for 2001–2011 to examine charges associated with diabetes-related hospitalizations [41]. Overall, mean charges increased by about 8.6% each year, from $19,167 in 2001 to $41,246 in 2011. Unadjusted mean charges were nearly 60% higher for non-Hispanic Black patients than they were for non-Hispanic white patients ($43,117 v. $27,156) and they were 51% higher for Hispanic patients than for non-Hispanic white patients ($40,943 v. $27,156). In adjusted models, hospital charges for non-Hispanic Black (12% higher) and Hispanic patients (21% higher) were still higher than for non-Hispanic white patients ($p < 0.0001$).

Bradford et al. performed a retrospective case-control study of 367 patients with a diagnosis of DKA or hyperglycemic hyperosmolar non-ketotic state (HHS) cared for at a tertiary academic medical center between 2008 and 2013. The overwhelming majority had DKA (96.7%, $n = 355$) [42]. They examined 6 risk factors for DKA/HHS readmission: age < 35, history of depression, HbA1c > 10.6%, history of alcohol/substance abuse, ethnic minority status, and self-pay/publicly funded insurance. 18.3% of patients were from ethnic minorities. Ethnic minority status was not found to be a risk factor of DKA/HHS admission (OR 0.742, 95% CI 0.396–1.389); however, the authors acknowledge the study was not powered to examine this outcome.

In the examination of healthcare utilization for DKA and other diabetes complications among ethnic minority patients, the rates of ED use and hospitalization, as well as hospital charges for these admissions, tend to be higher among Black and Hispanic patients. Notably, while many studies include race/ethnicity as descriptive, demographic factors, few directly examined the association between ethnicity and healthcare use, limiting the studies included in this review. An additional challenge is that many of the risk factors for increased healthcare utilization examined by the included studies may be colinear with race/ethnicity. For example, Bradford et al. found that being uninsured or having public insurance was associated with readmission for DKA or HHS [42]. However, patients from ethnic minorities may be more likely to have public insurance or be uninsured. Teasing out this collinearity represents an additional challenge for investigators interested in understanding the reasons for these differential healthcare utilization rates.

Diabetes Prevention

Given the burden of diabetes among racial and ethnic minority populations in the USA, there is a vital need to focus on primary prevention to address the current and projected growth of new cases of diabetes among vulnerable populations. Thirty-four percent of the US population has prediabetes, with a disproportionate burden among minority populations (Whites 33.9%, Blacks 36.9%, Hispanic 35.4%) [1]. Among those with prediabetes, the risk of developing type 2 diabetes may be 5 to 10% annually and 70% over a lifetime [43]. Thus, given the disproportionate burden of prediabetes among racial and ethnic minority populations, clinical and population-based strategies have been used to screen, identify, and treat those with prediabetes. This includes guidance on screening for diabetes by the US preventive task force among all adults 40–70 years old who are overweight or obese [44].

Several barriers exist in addressing primary prevention of diabetes among racial and ethnic minority groups. For example, among individuals with prediabetes, more than 80% of racial and ethnic minority groups are unaware of their diagnosis [1]. Access to care may be one factor that limits screening. While expansion of health coverage through the Affordable Care Act increased the proportion of Americans with health insurance, individuals in racial and ethnic minorities are still less likely to have a usual source of care than are White individuals [45]. Second, racial and ethnic variation in quality of care may also prevent these groups from being identified as high risk. For example, a study in 2017 found that less than half of Asian-Americans who met criteria for diabetes screening received testing [43]. This may be due to system-level factors in which dissemination of guidelines has not been well adopted nationwide. A 2015 survey of primary care providers reported that less than 10% of providers correctly identified all risk factors for prediabetes screening [46].

Fortunately, a large body of evidence has established that diabetes can be prevented or delayed among those with prediabetes. Evidence from 5 large-scale randomized controlled trials using interventions including healthy eating, physical activity, and weight loss has demonstrated a 30–60% reduction in diabetes incidence, with intervention effects persisting long after the intervention has ended [47–51]. Although scaling these interventions to real-world settings to meet the needs of diverse populations has been challenging, there are several examples of successful implementation of such programs. Cultural and linguistic

adaptations have greatly improved the reach of the Diabetes Prevention Program (DPP) and similar interventions [52]. For example, the Fit Body and Soul study, a church-based DPP program for older African-Americans, demonstrated feasibility and significant weight reduction, though only 13% achieved the goal of 7% bodyweight loss [53]. Furthermore, format adaptations to include peer support, lay health educators, and community leaders have demonstrated feasibility and acceptability in minority communities, without significant differences in outcomes [54, 55]. In the PREVENT-DM trial, a promotora (lay Hispanic community member)-led DPP was compared to a metformin-only group and to a usual care group of Hispanic women. At the end of study, the promotora-led group demonstrated the greatest amount of weight loss when compared to the other 2 groups [56].

Lessons from assessments of screening and referrals for diabetes and previous adaptions of the DPP demonstrate the need for a multi-tiered, culturally appropriate approach to prevent diabetes in minority populations. This includes policy and marketing to increase screening and uptake of lifestyle programs, training of the appropriate work force to meet the needs of diverse, high-risk populations, and payment reform to incentivize enrollment and utilization of lifestyle programs for diabetes prevention [57].

Successful Strategies and Limitations

While evidence shows that racial and ethnic minority populations have a higher burden of diabetes-related complications compared to non-Hispanic White people with diabetes, studies have also shown examples of effective programs and strategies to partially address these inequities. These strategies include culturally tailored education programs as well as health system and population health management changes.

In the latest Cochrane reviews and meta-analyses, culturally adapted diabetes education interventions for ethnic minority groups show short and medium-term effectiveness in both glycemic control and diabetes-related knowledge [58, 59]. There were no sustained differences in intermediate process measures of care, however, including systolic and diastolic blood pressure, lipid profile, and body mass index (BMI) [59]. Longer duration of intervention, delivery by community health workers (vs nurses or dieticians), and group education settings seemed to be more effective as well. The reduction in HbA1c in these studies ranged from 0.1–0.7%, the upper limit of which may be clinically significant for some patients [59]. Studies evaluating community-based interventions in Black communities also show the positive impact of community health workers on glycemic control [60].

Other studies have focused on the effects of health care system policy level changes in reducing disparities in diabetes complications. These interventions include employee-based incentives for diabetes screening, weight loss, and adherence to doctor visits, using electronic health record tools for decision-support and feedback, and incorporating a multidisciplinary provider team model of diabetes care [61, 62]. Many of these interventions did demonstrate improvement in rates of diabetes screening and screening for complications, weight loss, and blood pressure control in minority populations.

The major limitation of these studies is that the outcomes measured are intermediate process measures of diabetes (i.e., HbA1c or BMI changes, screening rates, lipid profiles, blood pressure) instead of differences in complication rates. Additionally, the improvement in these measures is mild to moderate, at best. While the reasons for such lackluster effects on improving racial and ethnic disparities are not yet fully elucidated, the evidence continues to point to the importance of delineating race from social determinants of health (SDH) as the influencing variable on disparate outcomes [63–66]. Race and ethnicity have been used in much of the scientific literature as a proxy for underlying differences in genetic susceptibility, socioeconomic status (SES) (e.g., education, income, health care access), neighborhood, and environment [67–69]. Using 2013 Medical Expenditure Panel Survey (MEPS) data, one study showed that lack of insurance coverage and education explained some of the racial and ethnic disparities in care quality indicators such as dilated eye exams, foot exams, and flu vaccination uptake, though did not explain disparities in HbA1c testing frequency [3•]. Another study using self-reported data on diabetes complications showed macro socioeconomic indicators (e.g., income and education) mediated racial differences in retinopathy between White and Black individuals, and both micro (e.g., owning a home, having a checking account) and macro SES indicators mediated differences between Whites and Hispanics in cardiovascular disease [4]. Additionally, a study on the risk of major amputation in adults with diabetes demonstrates that Black race was independently associated with higher risk of amputation within the same SES strata compared to White race, signifying the impact of determinants other than income [70]. With more research focused on specific SDH indicators, it is becoming evident that race and ethnicity are inadequate substitutes for the complex interconnections of SDH, race/ethnicity, and disease.

Conclusion

Epidemiologic trends in the prevalence of diabetes complications in all patients have in general improved over the past ~ 20 years, but the proportionate disparities among minority populations have remained unchanged. The underlying mechanisms driving racial and ethnic disparities are not yet fully understood. Various strategies to mitigate disparities have shown us that tailored interventions are needed, as cultural and community/neighborhood-based granularity are increasingly being recognized as essential components to a successful diabetes intervention. More research is needed on multilayered approaches targeting health care system-level policies, provider-level competencies, and patient behaviors. In order to more accurately understand the drivers of racial and ethnic disparities in diabetes outcomes, we need research that moves beyond stratification by race and ethnicity alone and fully investigates all the social determinants of health that impact health and disease.

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