RACIAL/ETHNIC DISPARITIES IN THE RECEIPT OF PRESCRIPTIONS FOR ANTIDIABETIC MEDICATIONS BY NON-INSTITUTIONALIZED INDIVIDUALS DIAGNOSED WITH DIABETES

A DISSERTATION

SUBMITTED ON 17 MARCH 2014 TO

THE DEPARTMENT OF GLOBAL HEALTH SYSTEMS AND DEVELOPMENT

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS OF

THE SCHOOL OF PUBLIC HEALTH AND TROPICAL MEDICINE

TULANE UNIVERSITY

FOR THE DEGREE OF DOCTOR OF SCIENCE

by

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ABSTRACT

Background

An ongoing public policy concern in the United States is disparities in health care for racial/ethnic minority populations. The National Healthcare Disparities Report (NHDR) addresses these disparities for chronic diseases such as diabetes that impose economic and health burdens on society that need to be partly managed by health care policies. One understudied aspect of diabetes care is racial/ethnic disparities in the pharmacological management of the disease.

Objective

The objective of this study was to determine whether racial/ethnic disparities exist in the pharmacological treatment of diabetes, and if so, how do individual characteristics such as socioeconomic status (SES) influence the differences.

Methods

This study used national survey data collected through the 2010 Medical Expenditure Panel Survey (MEPS). Racial/ethnic disparities in diabetes treatment were examined using a methodology based on the Institute of Medicine (IOM) definition of disparity that adjusts for health status factors while allowing SES factors to mediate differences. The

effects of independent variables on receipt of antidiabetic medication prescriptions among individuals who self-reported a diagnosis of diabetes were examined. Regression analyses were performed on unadjusted data and on data transformed by a rank-and-replace method to approximate the IOM definition.

Results

Among 1,844 survey respondents with self-reported diabetes, significant differences were found for race/ethnicity, education, health insurance, and the co-morbidities of heart disease and eye problems/retinopathy. Race/ethnicity was a significant predictor of the receipt of antidiabetic prescriptions, with Hispanics being more than 2 times as likely as non-Hispanic whites to have received a prescription. This difference was magnified in the IOM model that controlled for health status. In the IOM model, no significant differences were observed between non-Hispanic whites and non-Hispanic blacks or other minorities. Having health insurance, higher education, or eye problems/retinopathy were also significant predictors of receiving antidiabetic prescriptions.

Conclusion

Using a methodology that adjusts for factors related to health status while allowing factors related to SES to mediate racial/ethnic differences, disparities were observed between non-Hispanic whites and minorities, particularly Hispanics, in the likelihood of receiving a prescription for antidiabetic medication. The agreement of these results with the few studies on the pharmacological management of diabetes is mixed, and suggests the need for additional studies. Application of a rigorous definition of racial/ethnic

disparities and the implementation of methodologies that adjust for health status while allowing mediation by SES factors are needed to address important gaps in the treatment of diabetes.

ACKNOWLEDGEMENTS

My greatest appreciation goes out to those who guided, supported, and contributed to this dissertation. Most importantly, I am indebted to my dissertation committee chair, Dr. Lizheng Shi, and committee members Dr. Claudia R. Campbell, Dr. Tina K. Thethi, and Dr. Beth Nordstrom. Their patient review of the many drafts, and thoughtful advice on the scientific content of this dissertation helped me fully appreciate the collaboration necessary to produce a quality analysis of complex data.

I would also like to sincerely thank others who helped me collect, present, and correctly interpret the huge volume of data available to me for this project: Dr. Benjamin LeCook for his enlightening conversations about methods for measuring racial/ethnic disparities in health care, and Sarah Peskoe for her enthusiastic assistance with statistics and programing. This dissertation could not have been completed without them.

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List of Abbreviations

ACE	angiotensin converting enzyme
AHRQ	Agency for Healthcare Research and Quality
AIDS	acquired immune deficiency syndrome
ADA	American Diabetes Association
CAPI	computer assisted personal interviewing
CDC	Centers for Disease Control and Prevention
CI	confidence interval
CPS	Current Population Survey
DCS	Diabetes Care Survey
HbA1c	glycated hemoglobin
HC	Household Component
HMO	health maintenance organization
HS	health status
ICD	International Statistical Classification of Diseases
IOM	Institute of Medicine
MEPS	Medical Expenditure Panel Survey
MPC	Medical Provider Component
MSA	metropolitan statistical area
N/A	not available and/or not applicable
NCHS	National Center for Health Statistics
NDC	national drug code
NHDR	National Healthcare Disparities Report
NHIS	National Health Interview Survey
NHQR	National Healthcare Quality Report
NMCES	National Medical Care Expenditure Survey
NMES	National Medical Expenditure Survey
PC	Pharmacy Component
PPO	preferred provider organization
RDE	residual direct effect

SAQ	Self-administered Questionnaire
SES	socioeconomic status
SD	standard deviation
US	United States

BACKGROUND AND SIGNIFICANCE

Background

Disparities in patient access to and utilization of quality health care have been ongoing public policy concerns for many years. To address this problem, the United States (US) Congress, through the Health Care Research and Quality Act of 1999, assigned to the Agency for Healthcare Research and Quality (AHRQ) the task of producing an annual report on the state of disparities in health care in the US. The AHRQ then commissioned the Institute of Medicine (IOM), which was independently working on its own analysis of health care disparities, to provide guidance in designing the report.[1,2] As mandated by the US Congress, the report is to focus on "prevailing disparities in health care delivery as it relates to racial factors and socioeconomic factors in priority populations" (42 U.S.C. 299a-1(a)(6));[3] these priority populations include racial and ethnic minorities. The first report, officially titled the National Healthcare Disparities Report (NHDR), was submitted to Congress in December 2003 and provided an overview of racial, ethnic and socioeconomic disparities in health care delivery among rural and urban populations.[3,4] Each year since 2003, the AHRQ has reported on progress and opportunities for improving health care quality and reducing health care disparities. In conjunction with the NHDR, the AHRQ also began producing the National Healthcare Quality Report (NHQR) to focus on "national trends in the quality of health care provided to the American people" (42 U.S.C. 299b-2(b)(2)), and this report is released simultaneously with the annual NHDR. Upon later recommendations by the IOM, and beginning with

the 2010 reports, integrated findings from the NHQR and NHDR have been included as a single summary chapter in both reports.

One specific area of concern highlighted by the initial NHDR, and reiterated in subsequent reports, was the issue of “inequality in quality”; thus, the framework upon which the NHDR is based has a focus on safety, effectiveness, patient centeredness, and timeliness.[4] Cutting across all these factors is the dimension of equity, defined by the IOM as "the provision of health care of equal quality based solely on need and clinical factors”, a topic earlier brought to the top of the national health care agenda by a previous IOM report.[5] In 2010, more than one-third of the US population was comprised of racial or ethnic minority groups, and it is projected that by 2050 these groups will account for almost 50% of the population.[6 7] Therefore, the potential impact of patient access to and quality of health care among minority populations is significant, and will become more so in the decades ahead. Unfortunately, as pointed out by the NHDR, health care quality and access are suboptimal for these growing minority populations in spite of gains that have been made in certain areas, and urgent attention is needed to reduce the extent of the health disparities.[6] Furthermore, due to the recent downturns in the US economy, health disparities might worsen for minority groups, which are more likely than non-minority groups to be affected adversely by economic recession.

Health disparities are differences in health outcomes and their determinants between segments of the population defined by social, demographic, environmental, and geographic attributes.[8] Health disparities are important indicators of community health

that provide information for making decisions and implementing interventions to reduce preventable morbidity and mortality. Numerous studies have documented and evaluated the prevalence of racial and ethnic disparities across a wide spectrum of health care providers and chronic diseases.[9,10,11,12,13] These reports consistently showed that minority populations generally have reduced access to quality medical services and receive lower quality of care. The most recent NHDR, issued in May 2013, emphasized that health care quality and access in the US were suboptimal, especially for minority and low-income groups, and although quality was improving, access and disparities were not improving. [67] Across all measures of health care quality tracked in the report, approximately 60% showed improvement, while 40% worsened. Few disparities in quality of care related to race/ethnicity showed significant improvement, although the number of disparities that were getting smaller exceeded the number of disparities that were getting larger. Across the measures of health care access tracked in the report, only one showed improvement and almost half were getting worse. More concerning is the finding that few of the core measures for disparities in quality of care and access to care are getting smaller in minority populations, i.e., the disparities are widening. For example, of the 10 quality measures that were worsening at the fastest pace, 3 were related to diabetes care.[67] Furthermore, the quality of care for diabetes increased among whites, but decreased among Hispanics, and Hispanics also saw a slower increase in access to a usual source of health care than did whites.[14]

Further complicating the efforts to improve the quality of and access to health care is the growing challenge to meet the demands of a rapidly aging society. As the US population

ages, health care systems will have to treat the growing numbers of older adults, many with chronic diseases. By the year 2025, the number of Medicare beneficiaries is expected to reach 69.3 million, representing 20.6% of the US population, with people over the age of 80 years comprising the fastest growing segment of the population.[15] Along with this increased number of older Americans, the older population is becoming increasingly diverse, and by the year 2030, it is expected that 1 in 4 people over the age of 65 will be from a racial or ethnic minority.

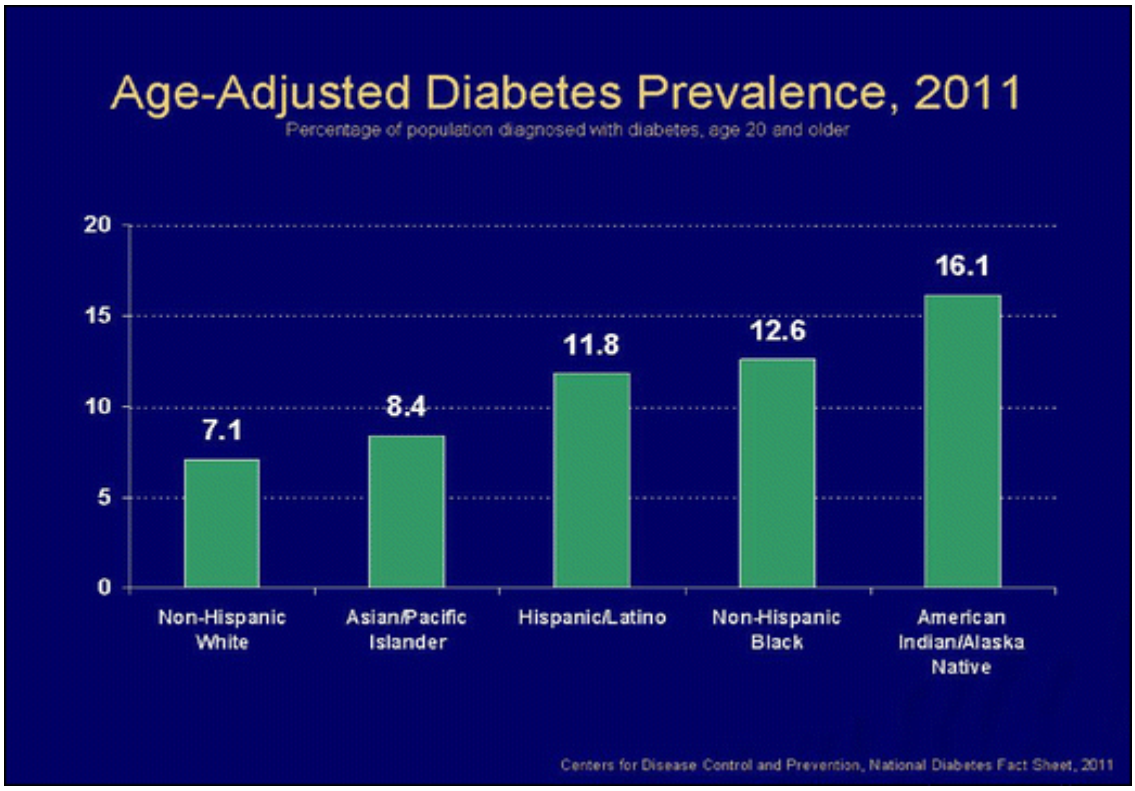
The chronic disease burden in the US has continued to increase over the past several decades, and sizable proportions of chronically ill patients are not receiving effective therapy and/or have poor disease control.[16] Chronic diseases such as diabetes, heart disease, and cancer are the leading causes of death and disability in the US, accounting for about 70% (1.7 million) of deaths each year, as well as decreased quality of life for millions of people.[17] The incidence and outcome of chronic and debilitating diseases are greater among minorities than whites.[11,18,19] Studies have shown that blacks are less likely than whites to receive proven therapy and achieve recommended treatment targets in the areas of diabetes, hypertension, cancer, cardiovascular disease, AIDS, and mental illness.[11,20,21,22]

Type 2 diabetes is one of the fastest growing chronic diseases in the US. The prevalence of diabetes has increased substantially over the past years, and the prevention and treatment of the disease and its complications have become significant public health challenges, particularly in the context of a growing elderly population, among whom

diabetes is especially common.[23 24 25], and an increasing frequency of type 2 diabetes reported in children and adolescents.[26] According to the Centers for Disease Control and Prevention (CDC), the prevalence of self-reported diabetes in the US has increased at least 120% since 1980.[27] As of January 2011, over 25 million children and adults in the US, or 8.3% of the population, had diabetes, and it was the seventh leading cause of death;[28] another 79 million Americans had prediabetes.[29] Persons with diabetes are at increased risk of health complications such as hypertension, heart disease, stroke, kidney disease, eye damage and foot problems, particularly if their disease is uncontrolled,[30 31] and they have a lower quality of life with increased morbidity and mortality.[27]

Population-based studies have suggested that the burden of diabetes is greater for racial and ethnic minorities than for the white population. As shown in Figure 1, the incidence of diagnosed diabetes was 7.1% in non-Hispanic whites compared with 11.8% in Hispanics and 12.6% in non-Hispanic blacks.[32] Blacks, Hispanics and Native Americans with diabetes experience a 50% to 100% higher burden of illness and mortality than whites.[45] According to the 2011 fact sheet by the CDC, the risk of diagnosed diabetes was estimated to be 18% higher among Asian Americans, 66% higher among Hispanics, and 77% higher among non-Hispanic blacks.[28] Racial and ethnic minorities with diabetes receive lower quality of care[33,34] and have poorer diabetes outcome than whites,[35,34,36] including an increased incidence of diabetes-related complications such as kidney disease and cardiovascular disease,[37,38] and poorer glycemic control.[39,40,] A recent large-scale study of nearly 100,000 patients with diabetes concluded that, in spite of equal access to health care, disparities in the incidence of diabetic complications were race-specific.[41]

Figure 1 Age-adjusted Diabetes Prevalence in the US by Race/Ethnicity



A key element of the treatment of chronic diseases, including diabetes, is pharmacological therapy. In the last decade, much research has focused on the inappropriate prescribing of medications to minorities, including the elderly, who frequently suffer from chronic diseases. Studies have consistently demonstrated that racial and ethnic minorities are more likely to receive inadequate pharmacological treatment for several chronic conditions such as arthritis,[42] cancer,[43] and cardiac disease.[44] On the other hand, the relatively few studies examining the pharmacological treatment of diabetes have produced mixed evidence on whether there are racial differences in diabetes pharmacotherapy.[45,46] Although several studies have demonstrated that blacks with diabetes have worse glycemic control than whites,[47,48] it is

unclear how much this disparity is due to differences in treatment with antidiabetic medications, or whether blacks receive less aggressive treatment for diabetes than do whites.[49] In some cases, these disparities have been explained in part by demographic characteristics, socioeconomic status, insurance coverage, access to medical care, medication adherence, and comorbidities.[47,50] Furthermore, there has been relatively little research on the comprehensive measurement of the quality of pharmacological management of diabetes.[51] Considering that the majority of patients with diabetes in the US are among the rapidly growing elderly population,[52] and that larger numbers of individuals with diabetes are developing this chronic disease in childhood,[26] the inconsistent results from studies on the pharmacological management of diabetes suggest the need for additional research.

While several studies have investigated the racial disparities in rates of hospitalizations due to diabetes and diabetic complications,[2,4,53,54,55] less research has focused on these trends in non-institutionalized populations. Similarly, there has been less attention focused specifically on prescription drug use. Studies have generally examined racial and ethnic disparities in the aggregate use of all prescription drugs in some settings, and the use of some drug classes, often with a focus on medication adherence.[56,57,58,59] In particular, many studies have examined prescription drug use in subgroups of populations such as the elderly, children, and Medicare and Medicaid beneficiaries in local areas of the US.[14,46] Residents with diabetes in long-term care facilities, who are predominantly elderly, provide a convenient source of centralized data, and are therefore often studied.[60,61] Hospitalized patients with diabetes have also been closely studied because

they are frequently admitted to hospitals for treatment of conditions other than their diabetes.[62,47] In contrast, studies that have examined the pharmacological treatment of diabetes at a national level are few in number and not comprehensive.

This research project will focus on a broader national estimate of the pharmacological treatment of diabetes by using large-scale survey data collected from households across the US that participated in the Medical Expenditure Panel Survey (MEPS). Data in the MEPS are drawn from a nationally representative subsample of households that participated in the prior year's National Health Interview Survey (conducted by the National Center for Health Statistics).[63] The MEPS is a set of large-scale surveys of families and individuals, their medical providers, and employers across the US, and is the most complete source of data on the cost and use of health care and health insurance coverage among the non-institutionalized population. Data from the MEPS have been widely used to study racial disparities in a health services.[64] For example, there have been a small number of studies that have used the MEPS database to examine racial and ethnic disparities in the use of essential new prescription medications, expenditures on prescription medications among children, and the economic implications of racial and ethnic disparities in the use of certain classes of drugs among adults.[14] However, because the MEPS is a national survey covering several cross sections of US citizens, and because it facilitates research on relationships between individual characteristics and health care utilization through an overlapping survey panel design that allows for analysis of change over time, data from the MEPS can play an even more significant role in studying racial and ethnic disparities in the pharmacological treatment of diabetes.

Significance

This project utilized data collected through the MEPS during 2009 through 2010 to evaluate patterns of care among non-institutionalized individuals with diabetes. Because the MEPS is a survey of persons, certain population groups such as minorities that are or may become of special health care policy concern can be identified and analyzed. MEPS collects information about specific medical conditions, like diabetes, that have been identified by the AHRQ as "priority conditions" due to their prevalence, expense, and/or relevance to public health care policy.

The primary objective of this research project was to determine whether racial differences existed in the pharmacological treatment (i.e., prescribed medications) of diabetes among a nationally representative sample of the US civilian non-institutionalized population. Identification of such disparities, and elucidation of the extent of the disparities, is the first step towards understanding the importance of undertreatment of diabetes conditions in minority populations, and exploring and implementing procedural and policy changes to address this potential public safety issue.

LITERATURE REVIEW

Burden of Diabetes

Chronic diseases are the leading cause of death and disability in the US, accounting for 7 of 10 deaths, and causing severe limitation in the daily activity of at least 10% of Americans.[11,16,17] The economic impact of chronic diseases is huge, with at least three-quarters of the US health care costs of 1.4 trillion dollars going towards treatment of such diseases, in addition to the loss of potential income due to the loss of productive life. In the US, over 75 million people have 2 or more chronic medical conditions.[65] Diabetes is a prototype of this situation because patients with diabetes have to maintain glycemic control and concomitantly manage the chronic comorbid cardiovascular disease risk factors of hypertension and hyperlipidemia. Diabetes has long been classified as one of the common chronic diseases seen in the US population. However, even though its diagnosis has been possible for many decades, and treatment was available before 1950, the prognosis for diabetes was generally poor until recently. Thus, it can be considered a more recent addition to the list of treated chronic diseases in the US.[11]

The high prevalence and incidence of diabetes, as well as its chronic nature, has significant long-term implications for health outcomes and health care costs in the US, especially in the context of an aging population. According to the CDC, the prevalence of diabetes in the US has increased at least 120% since 1980, and as of January 2011, over 25 million children and adults in the US, or 8.3% of the population, had diabetes.[28,66,67] A recent CDC press release on chronic diseases noted that the prevalence

of diagnosed diabetes increased in all US states, the District of Columbia, and Puerto Rico between 1995 and 2010, and increased by more than 50% or more in 42 states, and by 100% or more in 18 states.[68] Additionally, there are 79 million American adults who have pre-diabetes, a condition in which individuals have blood glucose or glycated hemoglobin (HbA1c) levels higher than normal but not high enough to be classified as diabetes.[28] People with pre-diabetes are now known to be at increased risk of developing type 2 diabetes, heart disease, and stroke. These high numbers are especially alarming because they represent a significant increase over the past few years. Some researchers have projected that the prevalence of diabetes could increase to 21% of the US adult population by the year 2050, or even to 33% if the incidence of diabetes continues to increase and diabetes mortality ratios continue to decrease.[69,70]

Much of the morbidity and mortality associated with diabetes treatment and management is attributed to various chronic complications such as hypertension, cardiovascular disease, stroke, eye problems (blindness, retinopathy), nervous system disease, amputations, and kidney disease.[71] These long-term complications develop gradually over years, and generally, the earlier a person develops diabetes, the higher their risk of experiencing diabetes-related complications, particularly if blood sugar levels are uncontrolled. According to the CDC National Diabetes Fact Sheet for 2011, adults with diabetes have heart disease death rates and a risk of stroke that are approximately 2 to 4 times higher than adults without diabetes.[28] Approximately 67% of adults with diabetes have hypertension or use prescription medications for hypertension. Diabetes is the leading cause of new cases of blindness among adults, and over 28% of people with

diabetes aged 40 years or older have diabetic retinopathy. About 60% to 70% of persons with diabetes have mild to severe forms of nervous system damage that can cause impaired sensation or pain in the feet or hands, slowed digestion of food in the stomach, carpal tunnel syndrome, erectile dysfunction, or other nerve problems. Severe forms of diabetic nerve disease are a major contributing cause of lower-extremity amputations. Diabetes is the leading cause of kidney failure, accounting for approximately 44% of all new cases of kidney failure.[28]

These statistics have significant implications not only for the burden placed on the health of Americans, but also on the financial burden of treating diabetes and its complications. Studies have shown that medical costs for patients with diabetes are higher because they visit physicians' offices, hospital outpatient departments, and emergency rooms more frequently than persons without diabetes, and they are more likely to be admitted to the hospital.[17] The cost of diabetes care is estimated to have risen from $174 billion in 2007 to $245 billion in 2012, an approximate 41% increase over a 5-year period.[72,67] This figure includes $176 billion in direct medical expenses, which reflects costs for hospital and emergency care, with an additional $69 billion attributed to indirect costs such as disability, work loss, and lost productive capacity due to premature mortality.[66,72] These costs are projected to increase to $500 billion by the year 2020.[73] Furthermore, during the 2011 to 2020 period, overall national health spending on diabetes is predicted to be $3.4 trillion, 80% of which will be due to spending for both people with diagnosed and undiagnosed diabetes, and the remaining spending on pre-diabetes related health care expenses. Individuals with diabetes have medical expenditures that are approximately

2.3 times higher than the expenditures would be in the absence of diabetes.[54] People with diagnosed diabetes incur average expenditures of $11,744 per year, of which $6,649 is attributed to care for their diabetes.[74] Approximately 50% of these expenditures are attributed to hospital inpatient care, 12% are attributed to diabetes medication and supplies, 11% are attributed to prescriptions for treating the complications of diabetes, and 9% are for physician office visits.[75] Health care costs attributable to prediabetes and diabetes for US adults are predicted to grow from approximately $194 billion in 2010, or 7% of health spending, to almost $500 billion in 2020, or 10% of health spending.[73] These health care expenses and their associated loss of productivity have a profound impact on not only patients with diabetes, but also on their families, as well as on federal and state governments.

Pharmacological Treatment of Diabetes

A key element of the treatment of chronic diseases is pharmacological therapy. One important but relatively unexplored problem affecting the quality of health care for chronic conditions is the underuse of medications, particularly among the elderly and minority populations. As many as 50% of older adults, who frequently suffer from chronic conditions, receive no or suboptimal medication therapy, and a similar percentage of racial/ethnic minorities receive the recommended medication treatment for their health conditions.[76] Although studies have consistently demonstrated that racial and ethnic minorities are more likely to receive inadequate pharmacological treatment for chronic conditions such as arthritis;[42] cancer,[43] and cardiac disease,[44] in those areas that have received the most public scrutiny, such as treatment (including pharmacotherapy) of

cardiac conditions, progress towards reducing disparities among minority populations has been significant.[7] For example, studies in older adults have documented a decline in racial disparities in the pharmacological treatment of cardiac conditions.[76,77]

On the other hand, few studies have focused on racial disparities in the pharmacological treatment of diabetes. Although there is some evidence of racial disparities in medication therapy management of antidiabetic agents,[78] the data are inconsistent.[77,79,80] This ambiguity is important to explore because the American Diabetes Association (ADA) regards glycemic control as one the most important strategies for managing diabetes,[48] and treatment with antidiabetic medications is a critical element in achieving that control. A study in long-term care facility residents found that blacks and Hispanics had lower rates of diabetic medication use than whites, while Asians had higher rates.[81] In a National Health and Nutrition Examination Survey, black women, Hispanic men, and patients treated with insulin and oral agents were disproportionately represented among those with poor glycemic control.[82] Compared to whites, a higher proportion of blacks were treated with insulin and a higher proportion of Hispanics were treated with oral agents, although the majority (>70%) of adults in each racial/ethnic group had received pharmacological treatment for their diabetes. In a study of physician performance in treating patients with diabetes, white patients were significantly more likely than black patients to achieve glycemic control, although the authors could not fully assess the role that insulin regimens had on this difference.[83] In contrast, observational studies of patients treated for diabetes in Veterans Administration medical centers found no significant racial difference in glycemic control.[45,84] Similarly, in a large-scale

epidemiologic study of insulin resistance in a multiethnic cohort population, comparable rates of antidiabetic medication use were seen in whites, blacks and Hispanics.[85] More recent data show that among persons with diabetes, rates of glycemic control were significantly lower for blacks and Hispanics than for whites, and these differences have increased from 1999 to 2006.[86] Studies that looked at long-term adherence to oral antidiabetic medications also found racial gaps in glycemic levels, but observed no significant difference between blacks and whites in the initiation of medication, although racial differences quickly became evident in discontinuation and adherence over time.[87,88] In contrast, a study of Medicaid patients showed that blacks were less likely than whites to be initiated on one type of antidiabetic agent (thiazolidinediones).[89] Although studies have continued to suggest that glycemic control among persons with diagnosed diabetes has steadily improved over the last decade, nationally, sociodemographic disparities in glycemic control among persons with diagnosed diabetes persist.[90]

A primary goal of treating patients with diabetes is to maintain normal glucose levels to prevent the development of diabetic complications. Medication adherence is a key component in the management of diabetes, and there is no doubt that it can lead to significant glycemic control. The ADA recommends that patients with diabetes receive care from a physician-coordinated team that centers on glycemic control.[81] Such control can greatly reduce the risk of microvascular complications associated with diabetes such as retinopathy, nephropathy and neuropathy, as well as cardiovascular events.[48] Of course, glycemic control is influenced by factors other than pharmacologic treatment, so these results often present only part of the picture. For example, a recent study explored

the racial differences in diabetic medication use from the perspective of patients' medication-related beliefs and found that negative beliefs were more prevalent among black patients compared to white patients.[91] Another study observed that self-reported racial/ethnic discrimination health care was associated with worse diabetes care and outcomes.[92] However, both of these studies concluded that other factors beyond the patients' control might be the cause of the racial differences in outcomes.

Additionally, diabetes care is complex and requires that many issues beyond glycemic control be addressed. Although the pharmacological treatment of hypoglycemia is a critical component of diabetes management, the prevention and management of diabetes complications are also important parts of the overall treatment plan. Cardiovascular disease is the major cause of morbidity and mortality for individuals with diabetes, and it is the largest contributor to the direct and indirect costs of diabetes.[93] Morbidity and mortality from cardiovascular disease are 2 to 5 times higher in persons with diabetes than in those without diabetes, and heart disease and stroke account for 65% of deaths in patients with diabetes.[93,94] These increased risks are in part due to the frequency of associated cardiovascular risk factors such as hypertension (high blood pressure) and dyslipidemia (high blood cholesterol).[95] Hypertension and dyslipidemia are common conditions that coexist with diabetes, and both are significant risk factors for cardiovascular disease. The prevalence of coexistent hypertension and diabetes is 2 to 3 times greater among blacks and Hispanics than among non-Hispanic whites, and both conditions are independently and concomitantly more common among patients with lower socioeconomic status.[96,97] Furthermore, up to 75% of diabetic complications can be

attributed to hypertension. Studies have shown that controlling such individual cardiovascular risk factors helps prevent or slow cardiovascular disease in people with diabetes, which is why the ADA has specific recommendations for pharmacologic treatment to lower blood pressure and reduce cholesterol levels.[93]

Therefore, because of the large variation in results described above from the few studies that have partially addressed racial disparities in the pharmacological treatment of diabetes, further research is warranted. To date, there continues to be little research focused specifically on measurement of the quality of pharmacological management of diabetes and how that quality varies across racial/ethnic populations, particularly the non-institutionalized civilian population.

Measuring Racial and Ethnic Disparities in Health Care

Long before the US government enacted the Medicare and Medicaid programs in the 1960's to guarantee health insurance for the elderly and the poor, disparities in health care were recognized and being studied. Data analyzed in these earlier studies, and therefore the associated designs of the studies, were usually derived from the following 3 sources of information.[98]

Nationally Representative Household Surveys

These large surveys, which include the MEPS, collect extensive and detailed information about race, ethnicity and socioeconomic status (SES) of multiple households across the US annually. Health care utilization rates can be generated for those services that have

relatively high rates of use, including medication use, preventive services, health care provider visits, or hospitalizations, and these rates can be compared for trends over time. A weakness of survey data is that some specific health care services that are not common cannot be analyzed due to the small numbers of cases that can be identified.

Administrative Databases

Administrative databases are frequently used in studies of health care because of their large size and available medication and outcome data from health care facility records. Advantages to these databases are that they contain consistent data elements, they are available in a timely manner, they are relatively inexpensive to obtain and use, and they provide information about large numbers of individuals. The large number of records in these databases is often sufficient to develop population-based utilization rates for many different types of health care services. On the other hand, their use in studies of racial/ethnic disparities is limited because of their lack of adequate information about race and ethnicity, and their lack of clinical information about the need for certain services, such as medication use. Furthermore, in the US, there is no administrative dataset that covers the entire population.

Patient-based Studies

Patient-based studies generally utilize data collected from health care facility medical records that include detailed clinical information. This clinical information is the primary strength of a patient-based study, and is very useful for analyzing quality of care in discrete populations. The primary limitations to this study type are that the data are not

likely to be nationally representative, and the studied population may not reflect the population that is at risk of needing the treatment.

Most of the earlier studies using these 3 data sources looked at barriers to health care, especially the barrier of not having health insurance or a regular source of health care, and it was thought that removal of this barrier would lead to equal access to health care.[98] However, during the few decades since publicly funded health care programs were implemented in the US, continuing disparities have led to the realization that there are other barriers to health care that are related to race and ethnicity, and consistent strategies, methods and tools for studying these barriers are still needed.[99100] The recently introduced Affordable Care Act acknowledged these needs and made a commitment to improve strategies for health data collection and analysis, noting that past methods to identify disparities and effectively monitor efforts to reduce them were limited by lack of specificity, uniformity, and quality in data collection and reporting procedures.[101] Researchers widely agree that new and improved health care policies and systems are needed to achieve sustainable reductions in disparities, and that changes must occur within and across health care facilities and communities.[102] Key to these changes is the need for consistent methods for collecting and reporting health data, which will help us better characterize the nature of health problems in underserved populations.

A crucial step towards the consistent analysis of racial/ethnic disparities is defining the term disparity.[100,103] A review of the literature on methods by which racial and ethnic disparities in health care have been evaluated is complicated by the many definitions of

disparity used in previous studies. These definitions tend to fall along a continuum from a difference between groups that reflect a simple inequality to differences that result from an overt injustice, i.e., a disparity.[103] In general, where a difference lies on this continuum is relative to how much control individuals have over the factor that is causing the difference. According to a group of researchers studying trends in racial/ethnic health care disparities, methods used in previous studies in this area can generally be categorized into 3 groups, with each group having a different definition of disparity.[104]

Definition 1: AHRQ - A Disparity Is the Total Difference between Racial/Ethnic Groups

In the NHDR publications over the last several years, the AHRQ defined disparities as "all differences among populations in measures of health and healthcare".[67] Analyses of AHRQ data generally compare health care utilization, quality of care, and access to care among racial/ethnic groups by comparing differences in means, thereby making the assessment of disparities and the tracking of trends in disparities a relatively straightforward analytical task that does not require statistical modeling.

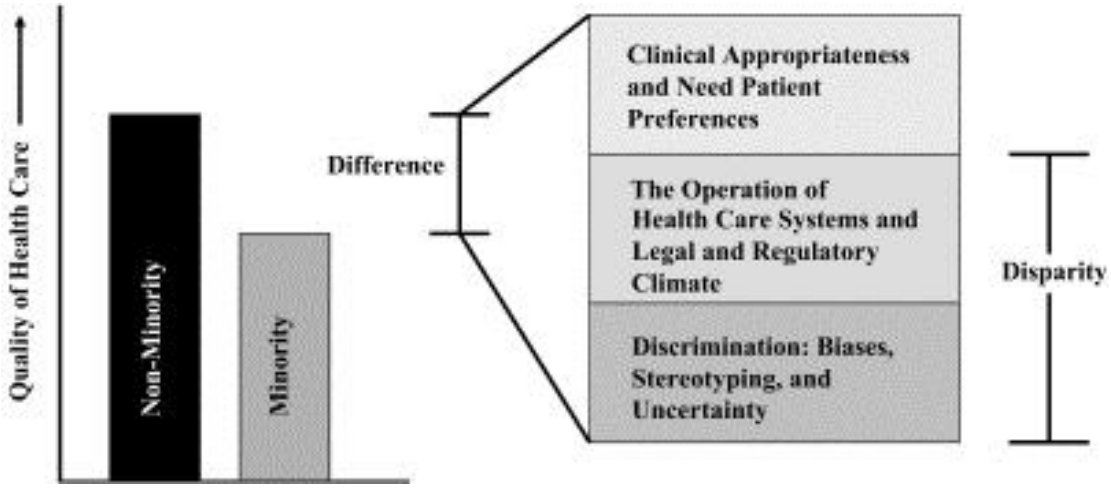
Definition 2: Residual Direct Effect (RDE) of Race/Ethnicity

An alternative definition of racial disparities is any difference between racial/ethnic groups that remain after controlling for as many of the factors available in the data that affect health care utilization. This definition typically underlies studies that focus on the race/ethnicity coefficient in a multivariate regression model. Because the race coefficient measures the effect of race after adjusting for all other variables in the model, this is called the residual direct effect (RDE) definition.

Definition 3: IOM—A Disparity Is All Differences Except Those Due to Health Status

A third definition of disparity, and the one that was applied to the present research project, is based on the definition of racial/ethnic health care disparities as put forth in a 2002 IOM consensus report, *Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care*.[105] In that report, the IOM defined disparity 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", as illustrated below in Figure 2. The IOM definition of health care disparities can be summarized as all differences not due to health status or preferences; as such, the IOM definition of disparity considers only the differences that persist after accounting for the contribution of health status, while recognizing the role of socioeconomic status (SES) differences associated with race/ethnicity as mediators of disparities.

Figure 2 IOM Definition of Racial/Ethnic Health Care Disparities



Source: Institute of Medicine (2002)[104]

These 3 definitions of disparity were recently compared in an analysis of trends in racial/ethnic disparities using 1996-2005 MEPS data.[104] Although analyses of the MEPS data using each of the 3 definitions resulted in essentially the same conclusion, i.e., disparities in broad indicators of health care use increased between Hispanics and whites but remained roughly constant between blacks and whites, important differences between the 3 definitions were seen in the magnitude of disparities and changes over time. Overall, the authors favored use of the IOM definition because it adjusted for health status but allowed for mediation of racial/ethnic disparities through SES factors. In follow-up studies, these same authors compared different methods of implementing the IOM definition for measuring disparities in the use of mental health care through an analysis of 2002-2006 and 2004-2008 MEPS data.[106,107] They evaluated 4 statistical methods of implementing the IOM definition that adjusted for racial/ethnic differences due to health status variables but not for differences due to SES variables. The reasoning behind such adjustment was that the IOM definition explicitly specifies the sources of racial/ethnic health care differences and distinguishes which should be considered to contribute to a disparity. Excluding differences due to clinical need and appropriateness (which are assessed by health status variables) from disparities more accurately reflects that these differences are allowable, whereas including differences due to SES variables more accurately reflects that these differences are unjustifiable and health systems should be accountable for such differences. Therefore, the 4 evaluated statistical methods modified the MEPS data to construct minority and non-minority populations that had similar distributions of health status but maintained observed differences in SES variables. Data were modified by using a regression-based methodology developed by

Blinder and Oaxaca that decomposes differences in a dependent variable between 2 groups into an explained component and an unexplained component.[114,132] Results of the study showed that all 4 methods accurately identified disparities, although the magnitude of the disparity estimates varied, and 2 of the methods (rank-and-replace, and propensity score) maintained SES distributions of each group, making them fully concordant with the IOM definition.

Such SES factors are important to consider, and their potential impact on observed racial disparities in the prevalence of diabetes and other diseases, as well as in the awareness, treatment and control of these diseases, continues to be researched and debated.[108,109,110,111] Several recent studies have provided valuable information about the role of SES factors in explaining racial/ethnic disparities in disease burden. Osborne *et al*. examined differences in self-reported diabetes complications and the role of macro (e.g., income, education) and micro (e.g., owning a home or having a checking account) SES indicators in explaining racial/ethnic differences.[112] The authors found significant disparities in the rates of complications between non-Hispanic whites, African Americans, and Hispanics, with Hispanics having the highest rates of nephropathy, retinopathy, and cardiovascular disease. In the analysis of SES variables, they found that macro SES indicators mediated significant racial differences between non-Hispanic whites and African Americans in self-reported retinopathy, and that a combination of macro and micro SES indicators mediated racial/ethnic differences between non-Hispanic whites and Hispanics in self-reported cardiovascular disease. On the other hand, only micro SES indicators mediated differences between lower-income SES racial/ethnic

minority groups (African Americans compared with Hispanics) in self-reported retinopathy and cardiovascular disease. The authors concluded that indicators of SES must be sensitive to both the outcome of interest and the racial/ethnic groups that are being compared.

Frierson *et al*. explored the relationship between sociodemographic factors including race and higher SES on the cardiovascular disease risk burden in African Americans and whites who had access to a preventive medical examination through participation in the Cooper Center Longitudinal Study.[113] In this large study, African Americans had a greater prevalence of self-reported chronic diseases, and greater odds of prevalent hypertension and diabetes, compared to whites. Even though the authors statistically controlled for SES, racial health disparities were still evident, and African Americans had more self-reported chronic disease and cardiovascular risk factors than whites. From these findings, the authors cautioned researchers against making the assumption that higher SES levels buffer poorer health outcomes, and suggested that minority populations deserve a careful evaluation of their disease risk factors despite their SES level.

A recent study by Mehta *et al*. (2013) examined racial/ethnic disparities in antiobesity medication use among non-Hispanic Blacks versus non-Hispanic Whites, and Hispanics versus non-Hispanic whites, in a MEPS survey population.[114] To the best of my knowledge, this is the first and only published study to examine the disparity in medication use between MEPS racial/ethnic populations, and is also the first study to use the nonlinear Blinder-Oaxaca decomposition method to explain such disparities in relation to SES and other factors. This regression regression-based model was the basis

for the IOM transformed model used in my study. Originally developed for continuously distributed variables, the model has since been modified into a nonlinear model that can evaluate categorical variables and estimate the contribution of individual observed characteristics to overall differences between groups.[114,132] Several studies have adapted the model to investigate racial/ethnic disparities in health care issues such as antidepressant use, antiobesity medication use, health insurance coverage, prescription drug expenditures, access to cardiac care, and mental health care.[114,131,132,133]

Medical Expenditure Panel Survey (MEPS)

Data for this research study were derived from the MEPS, one of several data sources managed by the AHRQ. The MEPS is the third in a series of nationally representative surveys of medical care use and expenditures sponsored by the AHRQ.[115] The first of these surveys, called the National Medical Care Expenditure Survey (NMCES), was conducted in 1977, and the second, called the National Medical Expenditure Survey (NMES), was conducted in 1987. The MEPS, which is co-sponsored by the National Center for Health Statistics (NCHS), began in 1996 and continued the original series of surveys while adding design enhancements and efficiencies that more accurately reflect the changing dynamics of the health care delivery and insurance system. In particular, the MEPS provides information about the state of the health care system in the US since the introduction and expansion of managed care arrangements such as health maintenance organizations (HMOs), preferred provider organizations (PPOs), and other provider networks that are working to minimize increases in health care costs.

The MEPS is a set of large-scale surveys of families and individuals, their medical providers (including doctors, hospitals, pharmacies), and employers across the US that provides nationally representative estimates of sociodemographic characteristics, health status, health care use, and health expenditures associated with the use of medications and health services for the civilian non-institutionalized population.[116] The MEPS currently has two major components: the Household Component and the Insurance Component. The Insurance Component is a survey of employers that provides data on employer-based health insurance. The Household Component (HC), which was the source of data for the present research study, provides data from individual households and their members. The HC data are supplemented by another MEPS component, the Medical Provider Component (MPC), which includes data from a sample of hospitals, physicians, home health care providers, and pharmacies identified by respondents to the initial HC survey.

Additionally, the MEPS collects information about specific medical conditions that have been identified by the AHRQ as "priority conditions" due to their prevalence, expense, or relevance to public health care policy.[116] Diabetes is one of those specified conditions. Diabetes information is collected through the Diabetes Care Survey (DCS), a self-administered paper and pencil supplement to the MEPS HC questionnaire that collects data on the status of diabetes care and diabetes treatment strategies such as oral medications and diet, from respondents who reported that they have been diagnosed with diabetes. Households receive a DCS based on their response to a question in the priority condition section of the MEPS HC questionnaire that asks whether or not the respondent

was ever told by a doctor or health care professional that he/she had diabetes. Diabetes is also identified by the condition code associated with medical events that are reported during a reference period of the survey.

The set of households selected for each panel of the MEPS HC is a subsample of responding households in the previous year's National Health Interview Survey (NHIS) conducted by the National Center for Health Statistics.[115] Each annual MEPS HC sample size is about 15,000 households. The NHIS sampling frame provides a nationally representative sample of the US civilian non-institutionalized population, and reflects an oversample of blacks, Hispanics and Asians. The panel design of the MEPS HC includes 5 rounds of personal household interviews covering 2 full calendar years. This design allows for the production of annual estimates for 2 calendar years, and also permits the tracking of changes in employment, income, health status, medical care use, and expenditures over the 2 consecutive years during which the households are interviewed. Additionally, because the NHIS baseline data are available for persons in the MEPS panels, they can be used as a data point for comparisons of change over time. Therefore, the MEPS extends the previous NMES series of data on medical expenditures and health insurance and provides, for the first time, data that are suitable for detailed analyses of trends and changes in these areas. And because the MEPS is a survey of persons, population groups that are or may become of special policy concern, such as minority populations, can be identified and analyzed. The MEPS HC data have been weighted to produce national estimates.

Mail and telephone contacts take place prior to the first MEPS interview with the NHIS participating households selected for each MEPS panel (Round 1).[115] The purpose of the preliminary contact is to enlist the household respondent into MEPS and plan for the delivery of record-keeping materials before the study observation period begins on January 1st of the survey year. In December, an advance letter announcing MEPS is mailed to the family respondent at the address where the NHIS interview was conducted. An interviewer follows up with a telephone call to confirm the letter's arrival, verify the identity of the household, identify the MEPS family respondent (if different from the NHIS respondent), and announce the future mailing of interview materials (a study calendar and record file). These materials are then sent in preparation for the Round 1 interview, and an interviewer telephones a second time to confirm the arrival of the materials and arrange a time to conduct the Round 1 interview. Households that do not have a telephone or cannot be reached using the telephone number from NHIS are contacted by mail and asked to return a postcard identifying a telephone number where they can be contacted.

To accommodate the extensive array of questions covered in the MEPS HC, yet minimize the number of questions asked of each respondent, data are collected using an intricate system of skip patterns and questionnaire modules grouped into sections. This complex data collection process is possible through the use of computer assisted personal interviewing (CAPI) technology, which collects information about each household member.[116] The data collection instrument consists of sections that are composed of a series of computer screens containing questions, interviewing instructions, and skip

pattern directions, as well as computer programming notes embedded along with each data item. Data collection in a given round consists of different sections. Some sections are included in every round of data collection, while other sections are only included in 1 or 2 rounds (also referred to as a supplement). Any single question must be considered within the context of the skip patterns incorporated into the questionnaire, but some questions will appear in several CAPI screens because of the variety of skip patterns that lead to the question. A question is only asked when the skip pattern determines that it should be asked of that respondent. Items asking the same question of various respondents typically map back to a single variable in the database.

Table 1 shows the sections that comprised the MEPS survey questions relevant to this research project, which included data from Rounds 1, 2 and 3 of Panel 15, and Rounds 3, 4 and 5 of Panel 14; all data were collected in 2010.[117]

Table 1: Data Collection Sections for Relevant Rounds of Panels 14 and 15

Panel Number and Year Panel Began	**Panel 14 2010**			**Panel 15 2010**		
Round	**R3**	**R4**	**R5**	**R1**	**R2**	**R3**
Supplemental Sections						
Access to care (AC)		X			X	
Assets (AS)			X			
Child Preventive Health (CS)		X			X	
Income (IN)	X		X			X
Preventive care (AP)	X		X			X
Priority Conditions (Quality) (PC)	X		X			X
Satisfaction with Health Plan (SP)		X			X	
Question Groups within Sections						
Other Medical Expenses (OM) - glasses/contact lenses	X					X
Event Roster (EV) - additional other medical expenses	X		X			X
Health Status (HE) - problems with functional and physical activities	X		X	X		X
Health Status (HE) - vision and hearing		X			X	

Panel Number and Year Panel Began	Panel 14 2010			Panel 15 2010		
Round	**R3**	**R4**	**R5**	**R1**	**R2**	**R3**
Priority Conditions Enumeration (PE) - standard enumeration	X		X	X		X
Priority Conditions Enumeration (PE) - new RU members		X			X	
Paper Instruments						
Adult self administered questionnaire (SAQ)		X			X	
Diabetes Care Survey (DCS)	X		X			X
Permission Forms and Booklets						
IC sample identification	X			X		X
Medical Provider Component (MPC) permission forms-all eligible events	X	X	X		X	X
Medical Provider Component (MPC) permission forms-hospital based events only				X		
Pharmacy permission forms	X	X	X		X	X

The survey builds on this information from interview to interview.[116] All data for a sampled household are reported by a single household respondent. A core survey is administered in each of the first 5 rounds of data collection, with periodic supplements added in selected subsequent rounds to deal with specific topics in greater detail. The core instrument collects data about all persons in sampled households, and includes questionnaires on demographics, health status and conditions, use, charges and payments, prescribed and over-the-counter medicines purchased, employment, and health insurance. All adults in households complete a self-administered questionnaire in Round 2 of the survey, which collects information about health behaviors and opinions that would be difficult, if not impossible, to collect on a proxy basis from the family respondent. Similar information is collected for children as part of the regular interview with the household survey respondent, usually the mother.

After completing the HC survey, and upon obtaining permission from the household survey respondents, a sample of medical providers is contacted by telephone to collect

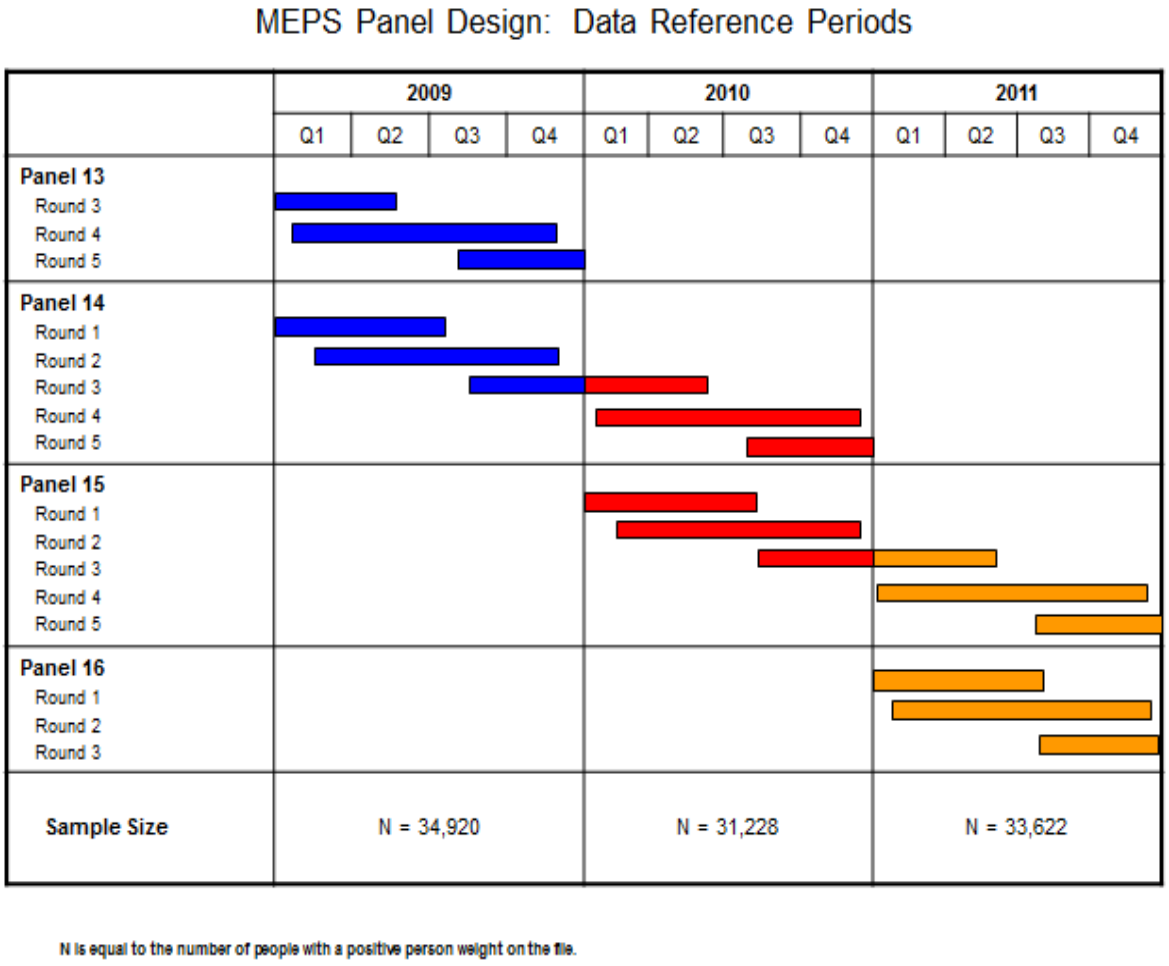
specific information that household respondents cannot provide. This is an additional component of the MEPS, called the MPC, and contains information on visit dates, diagnosis and procedure codes, charges, and payments.[118] The purpose of the MPC is to supplement, verify, and/or replace information provided by respondents in the HC survey about the charges, payments, and sources of payment associated with specific health care encounters. This is important because people cannot always accurately answer questions about the health services they received and about the cost of those services. The data collected from the MPC are not designed to be a nationally representative sample, but are used solely for editing and imputation purposes on the HC; therefore, these data are not released as a stand-alone file. The MPC data are collected from providers identified during the HC interview as having provided health care for reported medical events, and only those providers who sign a permission form are eligible for data collection in the MPC. One of the key providers of MPC data is pharmacies, which include establishments such as drug stores, grocery stores, discount stores, mail order pharmacies, online pharmacies, clinics, HMOs, and hospitals that fill prescriptions for outpatient prescription drugs. The Pharmacy Component (PC), a subcomponent of the MPC, collects from these identified pharmacies drug detail information that includes the National Drug Code (NDC) and medicine name, dates prescriptions were filled, prescription sources, quantity and dosage of prescription, and amounts of prescription payments. Most pharmacies have the requested information available in electronic format and can provide a computer generated printout of the patient's prescription information. If the computerized form is unavailable, the pharmacy can report their data to a telephone interviewer.

Through dependent interviewing methods, respondents are asked to confirm or revise data collected in earlier surveys in order to update information in several of the core questionnaires.[116] This process provides data for examining person-level changes in selected variables such as demographic characteristics, health conditions, health status, use of prescribed medicines, use of medical services, charges and source of payments, access to care, satisfaction with care, health insurance coverage, income, and employment. The series of data collection rounds is launched each subsequent year on a new sample of households to provide overlapping panels of survey data and, when combined with other ongoing panels, can provide continuous and current estimates of health care expenditures and use.

As noted earlier, a new panel of sample households is selected each year, and data for each panel are collected for 2 calendar years. The 2 years of data for each panel are collected in 5 rounds of interviews that take place over a 2½-year period. This provides continuous and current estimates of health care expenditures at both the person and household level for 2 panels for each calendar year. The chart below (Figure 3) illustrates the timing and relationship between panels, rounds, and calendar years for 2009 through 2011.[119120,121] For example, looking at the data collection by panel, Panel 14 consists of 5 rounds of interviews, with Rounds 1 to 3 providing data for 2009 and Rounds 3 to 5 providing data for 2010. Looking at the data collection by year, data for the year 2010 consists of data collected from Rounds 3, 4 and 5 of Panel 14, and Rounds 1, 2 and 3 of Panel 15. It should be noted that in order to increase the statistical

power of annual estimates, Round 3 for each MEPS panel overlaps 2 calendar years, thus combining data across 2 distinct nationally representative samples. Each round of the MEPS HC interviews collects information pertaining to a specific time period called a reference period. Again, as an example, the reference period for the first interview of Panel 14 began on January 1, 2009 and ended on the date of each reporting unit's Round 1 interview, conducted from March through June 2009. The reference periods for Rounds 2, 3, and 4 varied from household to household and covered the time between interview dates of the previous round and the current round. The last reference period of Panel 14 (Round 5) ended on December 31, 2010 (December 31 of the second calendar year is always the end of the last reference period).

Figure 3. Example of the MEPS Household Component Overlapping Panel Design



Although MEPS data are collected in multiple rounds across 2 years, each survey respondent has a unique identification number, and the data from each year for each person can be summarized as 1 data point in the analysis.[116] Therefore, there are typically 2 data points for each respondent, and each data point corresponds to 1 year. Nationally representative estimates can be derived from data collected through this complex survey design because the design incorporates primary sampling units, sampling weight, and stratum.[14] Using this revolving panel design, data from 2 panels in a year

can be combined to provide national estimates on health expenditures and health services utilization, including prescription drug use. Additionally, this overlapping panel design can provide both continuous and current estimates on prescription drug utilization.

HYPOTHESIS AND RESEARCH QUESTIONS

This research project asked the following questions in a sample of non-institutionalized individuals with diabetes selected from the 2010 MEPS HC-138 dataset:

(1) Are there racial/ethnic disparities in the receipt of antidiabetic medications by individuals diagnosed with diabetes?

(2) If racial/ethnic disparities exist, how do individuals' SES characteristics influence the differences?

The null hypothesis for this research project is therefore:

(H_0) = Racial/ethnic minorities diagnosed with diabetes are as likely to receive prescriptions for antidiabetic medications as are non-minorities (whites) diagnosed with diabetes.

METHODS AND MATERIALS

Data Source: 2010 MEPS HC

For this study, respondents in the 2010 MEPS HC dataset (HC-138), which was the most recently available full dataset for this research project, were identified based on those who had a diagnosis of diabetes. To identify and select these respondents, data from the

following MEPS HC-138 full-year and event files for 2010 were utilized: (1) the Full-Year Consolidated Data File, in association with the MPC provider sample file, (2) the Medical Conditions File, and (3) the Prescribed Medicines File.[117] These files are described in more detail below.

Person-Level Weights

Because of the sample design of the MEPS, individuals who participate in MEPS represent only a fraction of the overall population that the survey is intended to reflect. As with most surveys, it is the case with MEPS that some groups are over-represented in the raw data and others are under-represented. Thus, in order to calculate national estimates that represent the overall population, responses from surveyed individuals are weighted by the proportion of the population they represent.[122] There is a single full year person-level weight assigned to each record for each in-scope person who responded to MEPS for the full period of time that he/she was in-scope during the survey year. A person is in-scope whenever he/she is a member of the civilian non-institutionalized portion of the US population. Each individual in the MEPS dataset is assigned a weighting factor in such a way that the weighted frequency of groups matches the overall population. Additionally, adjustments to the data are made to account for non-responses. Therefore, each MEPS file contains appropriate weight variables that are applied to the data to generate national estimates of totals, means, percentages, and rates for persons and families in the civilian non-institutionalized population.

The sum of the person-level weights across all persons assigned a positive person-level weight in the 2010 MEPS HC-138 dataset (i.e., for the civilian, non-institutionalized or in-scope population over the course of the year) was 308,573,977 (Table 2).[117] The corresponding total for the population that was in-scope on December 31, 2010 was 304,842,384.

Table 2: Number of Person-Level Respondents and Corresponding Population Estimates for the 2010 MEPS Full Year Consolidated File

Populations of Interest	Panel 14	Panel 15	Combined	Population Estimate (weighted total of combined samples)
Civilian, non-institutionalized population over the course of 2010	16,055	15,173	31,228	308,573,977
Civilian, non-institutionalized population on December 31, 2010	15,890	14,997	30,887	304,842,384

Additionally, for data collected in the MEPS supplements, including the DCS administered to adults identified as having diabetes, a specific weight variable is produced in lieu of the full year person-level weight used for the overall population. The following is an overview of the procedure used to develop the special supplement weight variable for DCS data, which has been applied to all data on individuals with diabetes in this study.

The initial step to construct the DCS weight variable begins with the Self-administered Questionnaire (SAQ) that is completed by each adult in the overall MEPS survey in Panel 15, Round 2 and Panel 14, Round 4.[117] A final full year person-level SAQ weight for 2010 was then constructed as follows. First, the weight variable was developed by

adjusting for questionnaire non-response; variables used in the non-response adjustment process were region, metropolitan statistical area (MSA) status, family size, marital status, level of education, health status, health insurance status, age, sex, and race/ethnicity. Then the weights were raked to Current Population Survey (CPS) estimates corresponding to December 2010, and the variables used to form control figures were education level, region, MSA status, age, sex, and race/ethnicity. The final 2010 SAQ weight for this consolidated data file was then obtained by raking the preliminary weight to CPS estimates that were based on poverty status as well as the aforementioned variables, but not including education level.

A person-level weight was then developed for use with data obtained from the DCS, and this weight was assigned to each person with a SAQ weight who was also classified as having diabetes.[117] Prior to Panel 12, the identification of people eligible to receive the DCS questionnaire was focused on the Rounds 3/5 interview. During the Rounds 3/5 regular MEPS interview, each respondent was asked to complete a "conditions" question to identify all current/deceased/institutionalized reporting members of any age who had been diagnosed with diabetes, and those members were then eligible to receive the DCS questionnaire. To determine which DCS respondents actually had diabetes, each DCS respondent was asked if she/he was told by a physician that she/he had diabetes. In Round 1, the respondent was asked to identify all unit members over the age of 17 with diabetes. In Rounds 2/4, the same screening information was gathered but only for new unit members over the age of 17 (as long as they did not die during the round). In Rounds 3/5 the screening questions were asked of the respondent for all unit members

over the age of 17 who were: (a) in scope sometime during the round but had not died prior to the date of interview, and (b) had not been identified as having diabetes in a previous round (this included people with non-response data and/or classified as not having diabetes in all previous rounds of MEPS, plus all new members of the unit in Rounds 3/5). Any unit member who was identified by the respondent as having diabetes at any time during the MEPS was asked to complete a DCS questionnaire. This process was designed to help ensure that all unit members with diabetes were given a DCS questionnaire to complete. However, this process might understate the total number of persons with diabetes because occasionally a family member with diabetes may not have been identified by the unit respondent.

In all, this 2-step process identified 1909 people who were assigned a DCS weight in the 2010 MEPS dataset. The sum of the DCS weights was 20,970,670, an estimate of the adult population self-reporting as having been diagnosed with diabetes.[117]

Full-Year Consolidated Data File (MEPS HC-138): This file was used to obtain data on individuals' sociodemographic characteristics including race/ethnicity and health-related characteristics.[123,117] Race and ethnicity questions were asked of each survey participant during the interview. If the information was not obtained in Round 1, the questions were asked in subsequent rounds. If available, the data collected were used to determine race and ethnicity. If race and/or ethnicity were not reported in the interview, then data obtained from the originally collected NHIS data were used. If still not ascertained, the race and/or ethnicity were assigned based on relationship to other

members of the surveyed household using a priority ordering that gave precedence to blood relatives in the immediate family. Race/ethnicity groups for this research project were classified as the following: non-Hispanic white, non-Hispanic black, non-Hispanic Asian, Hispanic, and other single/multiple race non-Hispanic.

- This file consists of MEPS survey data obtained in Rounds 3, 4, and 5 of Panel 14 and Rounds 1, 2, and 3 of Panel 15 (i.e., the rounds for the MEPS panels covering calendar year 2010), which consolidates all of the final 2010 person-level variables into 1 file.
- Contained within this file are the following coded variables:
    - Unique person identifiers and survey administration variables;
    - Geographic variables;
    - Demographic variables (including race/ethnicity);
    - Income and tax filing variables;
    - Person-level priority condition variables;
    - Health status variables;
    - Disability days variables;
    - Access to care variables;
    - Employment variables;
    - Health insurance variables;
    - Utilization, expenditure, and source of payment variables;
    - Weight and variance estimation variables.

MPC Sample File: Providers for the MPC sample each year are identified in 3 rounds of HC data collection for 2 HC panels, covering 2 full calendar years.[124,125] The basic sample unit in the MPC is a person-provider pair where the person is a member of a household participating in the HC survey, and the provider is identified in the HC survey as someone associated with a medical event, that is, an office visit, a hospital stay, a prescription for medicine, or other health care event. Respondents in the HC are asked to identify all medical providers associated with health care services received by each member of the household, and are asked to sign an authorization form indicating their agreement to allow providers to release information about the event to the MPC. For this research project, providers of interest were pharmacies where household respondents obtained or purchased prescriptions medicines.

- This file includes data extracted in 4 waves from the sample pharmacy: Panel 15, Round 2; Panel 14, Round 5 (1st cut); Panel 15, Round 3; and Panel 14, Round 5 (final cut).
- Contained within this file are the following data elements, which are necessary to define a person-provider pair, a key data collection unit of the MPC:
    - Unique person and Provider IDs used to link the data collected through the MPC back to the household-generated data for the matching process;
    - Identifying information of the household member, such as name, address, gender, and date of birth, parent name if person under age 18 years, spouse name (if married), and policy holder name for insured persons;
    - Identifying information about each provider, such as name, address, and telephone number;

- At the person-provider pair level, the number of each type of event identified for the person for that provider and any other HC variables necessary to assign priority flags.

Medical Conditions File (MEPS HC-137): This file contains information on the medical conditions of survey respondents, which are reported as International Statistical Classification of Diseases (ICD-9) codes. This file was used to identify individuals who have diabetes, as described below.

- This file provides information on household-reported medical conditions reported in the 2010 portion of Round 3 and Rounds 4 and 5 for Panel 14, as well as Rounds 1 and 2 and the 2010 portion of Round 3 for Panel 15 (i.e., rounds for MEPS panels covering the calendar year 2010).[117]
- Variables in this file include the ICD-9 code for the diagnosis of primary diabetes (ICD code 250).
- Contained within this file are the following coded variables:
  - Unique person identifiers;
  - Unique condition identifiers;
  - Medical condition variables;
  - Utilization variables;
  - Weight and variance estimation variables.

Prescribed Medicines File (MEPS HC-135A): This file, which is one of the public use event files from the MEPS HC and MPC, was used to provide supplementary information

about those individuals that received pharmacological treatment for their diabetes, i.e., they filled at least 1 prescription for an antidiabetic medicine. When diabetic supplies, such as syringes and insulin, were mentioned in the MEPS-HC, the interviewer was directed to collect information on these items in the Prescribed Medicines section of the MEPS questionnaire. In addition, for those individuals who received a prescription for an antidiabetic medication, this file was used to identify whether they received a prescription for any antihypertensive or antilipemic medication. The Prescribed Medicines File provides detailed information on household-reported prescribed medicines and includes information for each prescribed medicine event and when a prescribed medicine was purchased or otherwise obtained.[126] Antidiabetic medication classifications in this file include insulin, sulfonylureas, non-sulphonylureas, alpha-glucosidase inhibitors, thiazolidinediones, meglitinides, biguanides, or antidiabetic combinations.

- This file provides detailed information on household-reported prescribed medicines. Each record in this file represents 1 household-reported prescribed medicine that was purchased during the calendar year 2010. Data for this research project were collected during the 2010 portion of Round 3 and Rounds 4 and 5 for Panel 14, as well as Rounds 1, 2 and the 2010 portion of Round 3 for Panel 15 of the MEPS HC (i.e., the rounds for MEPS panels covering the calendar year 2010). Persons with no prescribed medicine use for 2010 are not included in this file.[117]

- Each record in this event file represents a unique prescribed medicine event, i.e., a prescribed medicine reported as being purchased or otherwise obtained by the household survey respondent, and includes the following:
    - An identifier for each unique prescribed medicine;
    - Detailed characteristics associated with the event (e.g., national drug code [NDC], medicine name, etc.);
    - Selected Multum Lexicon variables (the NDC codes allow the linkage between MEPS and other databases that contain information on drug approval time, such as the Multum Lexicon database;
    - Medical conditions associated with the medicine;
    - Date on which the person first used the medicine;
    - Total expenditure and sources of payments;
    - Types of pharmacies that filled the household's prescriptions;
    - Full-year person level weight.
- For each variable in this file, both weighted and unweighted frequencies are provided. Contained within this file are the following coded variables:
    - Unique person identifiers;
    - Unique prescribed medicine identifiers;
    - Other survey administration variables;
    - Prescribed medicine characteristics variables;
    - ICD-9 codes for medical conditions;
    - Clinical Classification Software codes for medical conditions;
    - Multum Lexicon variables;

- Expenditure variables;
- Weight and variance estimation variables.

Subject Selection

Survey respondents identified as having diabetes were selected from the full survey population based on the assumption that the analytic models would be looking only at overall diabetes medication use, i.e., whether respondents received prescriptions for insulin and/or oral medication. Respondents with diabetes in the HC-138 dataset were identified by the variable code DSDIA53, which indicated that the respondent had (1) self-reported a diagnosis of diabetes in the initial survey round, thus prompting him/her to complete the self-administered DCS questionnaire, and (2) then confirmed on the DCS that he/she had been told by a health professional that he/she had diabetes or sugar diabetes. From the respondents that met these first criteria, the final diabetes population was determined by selecting only those who had complete medical information in the dataset, i.e., those who had also provided complete responses to DCS questions on the use of insulin or oral medication.

Dependent and Independent Variables

The ADA's 2012 Standards of Medical Care in Diabetes highlights the clear benefits of intensive glycemic control in the management of diabetes and its complications, which includes a pharmacologic approach based on modification of medication therapy in response to the achievement of HbA1c target levels.[127] Therefore, for this research project, the dependent variable was the receipt of a prescription antidiabetic medication, recorded as a binary indicator (yes/no). In keeping with the ADA guidelines for

pharmacologic treatment, antidiabetic medications were identified from the Prescribed Medicines File (HC-135A) described earlier, and included medications in the following categories:

- Insulin (and other injectables)
- Oral antidiabetic medication (biguanides, sulfonylureas, non-sulphonylureas, thiazolidinediones, alpha-glucosidase inhibitors, meglitinides, antidiabetic combinations)

The key independent variable for analyses of data was self-reported race/ethnicity. In the MEPS HC database, any person whose main national origin of ancestry is reported in one of the Hispanic groups (Puerto Rican, Cuban, Mexican, Mexicano, Mexican American, Chicano, other Latin American, or other Spanish), regardless of racial background, is classified as Hispanic. [117] Since the Hispanic groupings can include black Hispanic, white Hispanic, and other Hispanic, the race categories of black, white, and other do not include Hispanics. Therefore, for my study, race/ethnicity was classified into 4 mutually exclusive categories:

- Non-Hispanic white (the reference group for analyses)
- Non-Hispanic black
- Hispanic
- Other (other non-Hispanic including Asian, American Indian/Alaska Native, Native Hawaiian/Pacific Islander, multiple races reported).

Based on results from previous research, there are many factors in addition to race/ethnicity that are known to be associated with differences in the quality of health care.[35,92,104,155] It is important to evaluate the potential confounding effect of these factors on racial/ethnic differences in the receipt of antidiabetic medication prescriptions. Therefore, these factors, which can generally be classified into 2 broad categories that reflect the IOM definition of disparity described earlier, were additional independent variables considered in this research project:

Socioeconomic (SES) Factors

- Education (less than high school, high school graduate, some college, college graduate)
- Poverty status (below poverty line, near poverty, low income, middle income, high income); because of the long-debated but growing trend towards considering race and income (class) as co-determinants of disparities in health care,[128, 129,130] both the independent and interactive effects of race and income were considered
- Geographic region of the country (Northeast, Midwest, South, West)
- Health insurance (private insurance, public insurance [Medicare, Medicaid], uninsured)

Health Status Factors

- Age (continuous)
- Gender (male or female)
- Marital status (married or unmarried)
- Self-reported health status (excellent, very good, good, fair, poor)

- Comorbid conditions (yes or no; conditions include heart disease, stroke, hyperlipidemia, hypertension, cancer, dementia, eye problems/retinopathy, kidney/renal disease)
- Limitation of activity (any or none)
- Body mass index (BMI), as calculated by MEPS for adults 18 years of age,[117] where Underweight = BMI less than 18.5, Normal Weight = BMI between 18.5 to 24.9 inclusive, Overweight = BMI between 25.0 to 29.9 inclusive, and Obesity = BMI greater than or equal to 30.0.

Analytical Strategy

As described earlier, the IOM's definition of health care disparity distinguishes between "differences" and "disparities" in the quality of health care.[105] Racial differences include 3 distinct categories of effects: (1) clinical appropriateness and need (which are health status factors), and treatment preferences; (2) the operation of health care systems, and the legal and regulatory climate: and (3) discrimination.[131] According to the IOM definition, disparities exclude differences due to health status and treatment preferences, but include differences that are attributable to SES factors, health care systems, the legal/regulatory climate, and discrimination. In other words, health care disparities are differences not justified by health status or patient preferences. This interpretation of health care disparities has been applied to several recent studies on the measurement of racial disparities using national survey data, including MEPS data.[104,106,132,133, 134]

In order to implement the IOM definition of racial/ethnic disparity, a method was employed that adjusts for variables related to health status and incorporates the mediating effects of SES factors. This was done by using a "rank and replace" method previously described in the literature.[132,133,134] The rank and replace method transforms the entire distribution of minority health status values (not just the mean) to match the non-minority (white) distribution, while preserving the rank order within the minority group. For each continuous health status variable, the data for each racial/ethnic group were sorted by each of the health status variables to be transformed. Then the value for each minority individual was replaced with the value for the equivalently ranked white individual such that the minority distribution for each health status variable was equivalent to the white distribution. Dichotomous health status variables (which are binary, i.e., 0 or 1) were transformed as follows. For each variable, if there were proportionally more 1's in the white group than in the comparison minority racial group, an individual in the minority group was randomly selected and that individual's value was changed from 0 to 1. This process was repeated until the frequencies of 1's in both the white and minority groups were equivalent. Similarly, if there were proportionally fewer 1's in the white group, an individual in the minority group was randomly selected, the individual's value was changed from 1 to 0, and the process was then repeated until frequencies in both groups were equivalent. The resulting transformed values of health status for minority groups were then applied to the IOM model described below to predict the receipt of antidiabetic medication for each of the racial/ethnic groups, and these in turn were compared to values for the white group. Values for SES variables were not transformed but were allowed to differ among individuals and across racial/ethnic groups, and the differences

that were attributed to SES factors were therefore allowed to enter the disparity calculations.

The first analysis of data summarized the baseline characteristics of all survey respondents in the 2010 MEPS HC-138 Full Year Consolidated Data File, as well as the target population of individuals with self-reported diabetes included in this file. The weighted frequencies of respondents were calculated for the dependent variable (receipt of antidiabetic medication), the key independent variable (self-reported race/ethnicity), and the other independent variables listed above (SES and health status factors). Descriptive statistics for respondents who had self-reported diabetes were also produced for the distribution of independent variables according to race/ethnicity categories.

Next, the unadjusted proportions of respondents with diabetes in each of the independent variable groups were compared according to whether they did or did not receive a prescription for antidiabetic medications (oral antidiabetic, insulin, or either). Because the dependent variable (receipt of antidiabetic medication prescription) is dichotomous, and the key independent variable can take any form, simple logistic regression was performed to determine whether the probability of receiving a prescription for antidiabetic medication was associated with self-reported race/ethnicity, without other potential confounding factors being considered. The statistical model for this simple logistic regression is represented by the following formula:

$$\log(p/1\text{-}p) = \beta_0 + \beta_1 x$$

where p is the probability of receiving a prescription for antidiabetic medication, and x is self-reported race/ethnicity. The parameters of the model are β_0 and β.

Chi-square tests (X^2), with a significance level conservatively set at less than 10% (P-value <0.10), were performed on the results of the analyses to assess whether race/ethnicity, without considering other potential confounding factors, significantly affected the receipt of antidiabetic medications.

This same process was repeated separately for each of the other unadjusted independent variables, i.e., self-reported race/ethnicity was replaced in the simple regression model with each of the individual SES and health status factors described earlier. Chi-square tests were performed for each of these analyses, and variables with P-values <0.10 were selected for inclusion in a final multivariate regression model to explore their relationship with the dependent variable, receipt of a prescription for antidiabetic medication. This unadjusted model adequately describes the relationship between receipt of antidiabetic medication and race/ethnicity, health status, and SES.

Those variables from the above analyses that had significantly different distributions based on receipt of antidiabetic medication (oral antidiabetic or insulin) were then selected for analysis in a multivariable regression model to describe the relationship between receipt of antidiabetic medication and race/ethnicity, as well as other independent variables. The statistical model for this multivariable regression is represented by the following formula:

$$\log(p/1\text{-}p) = \beta_0 + \beta_1 (x1) + \beta_2 (x2) + \beta_3 (x3) + \ldots + \beta_K (xK)$$

where p is the probability of receiving a prescription for antidiabetic medication and xK includes self-reported race/ethnicity and other independent variables.

Regressions were first performed on crude (unadjusted) values where each independent variable previously identified as having a significantly different distribution according to receipt of any antidiabetic medication was entered by itself into a simple logistic regression model, producing unadjusted OR values for each variable. Next, multivariable logistic regression was performed with all previously identified significant independent health status and SES variables entered into the model, producing adjusted OR values (referred to hereafter as SES/HS adjusted). As a final step, the distributions of previously identified significant health status values for minority groups were then transformed, as described earlier for the IOM model, to be equivalent to those of whites, while leaving SES values unchanged. This data transformation adjusted for health status differences while allowing the SES factors to mediate differences, which reflects the IOM definition of disparity that adjusts for health status and allows for mediation of racial/ethnic disparities through SES factors.[133] These transformed data (hereafter referred to as IOM transformed values) were then run through the same multivariate regression model. Results from the unadjusted model, the adjusted model, and the IOM transformed model were compared to determine the actual disparities calculated in accordance with the IOM definition.[132,133,134]

Findings from the logistic regressions are presented first for the primary independent variable, race/ethnicity, and followed by results for the secondary independent variables related to health status and SES factors.

SPECIFIC FINDINGS/RESULTS

Population Characteristics

Table 3 summarizes the demographic and health characteristics of the diabetes population and overall population age 18 years and older in the 2010 MEPS HC-138 survey dataset. Respondents with a zero person-level weight did not contribute information to the dataset, and are therefore not included in this sample population (see Methods and Materials). Because the models used for analysis only considered overall diabetes medication use (insulin and/or oral antidiabetics), the selection of respondents with diabetes was limited to those who had a confirmed diagnosis of diabetes and answered both diabetes medication components on the questionnaire, i.e., complete diabetes medication information was available for both insulin and oral antidiabetic use in the dataset. Of the 32,846 persons who participated in the 2010 MEPS HC, 22,290 overall respondents met the sample selection criteria, and 1,844 (8.3%) of these respondents had self-reported diabetes (with full diabetes medication information in the MEPS dataset).

Among the diabetes sample population, 77.3% were white, 15.5% were black, 3.8% were Asian, and 3.4% were in other racial categories; 14.1% were of Hispanic ethnicity. In the combined race/ethnicity groups, where any person claiming a main national origin or ethnicity in one of the Hispanic groups, regardless of racial background, is classified as

Hispanic, 67.6% of respondents were non-Hispanic white, 11.5% were non-Hispanic black, 14.1% were Hispanic, and 6.7% were other (non-Hispanic). Similar percentages of males and females were represented in the sample. The mean age of respondents was 60.5 years, and the majority (86.4%) were 45 years of age or older. Almost three-fourths (74.1%) of respondents were college graduates, while 20.4% had less than a high school degree. Based on the 2010 CPS poverty statistics, most respondents (64.0%) were categorized as middle or high income, whereas 15.2% were low income and 20.8% were below the low income poverty status. Typical for a diabetes population,[135] the majority (84.6%) of respondents were overweight or obese, as indicated by higher than normal (≥25.0) BMI levels.

In general, the demographic characteristics of the overall survey population and the diabetes sample population were similar. The exception was age, where the presence of diabetes was under-represented among younger respondents (age 44 years or less) and over-represented among older respondents (age 45 years or more). However, this is not surprising considering that type 2 diabetes occurs most commonly in adults aged 40 years or older, and the prevalence of the disease increases with advancing age.[136]

Additionally, other differences in health-related characteristics between the diabetes and overall populations were apparent. Mean BMI levels were higher among individuals with diabetes than in the general population (31.2 and 27.0, respectively), and obesity (BMI ≥30.0) was observed in 54.6% of the diabetes population compared to 28.7% of the overall population. Perceived health status across all categories was worse among

individuals with diabetes, with only 24.0% rating their health as very good or excellent compared to 59.1% of the overall population, and 11.0% reporting poor health compared to 3.3% of the overall population. This finding reflects that fact that patients with chronic medical conditions are more likely to report a perceived unmet health care need (i.e., perceived health status), a commonly used indicator of inadequate access to care.[137] Furthermore, it has been demonstrated that a substantially higher percentage of minorities also report fair or poor health compared to non-minorities.[138]

Comorbidity (defined as the occurrence of one or more chronic conditions in the same person with an index-disease) occurred frequently among respondents with diabetes, which was expected based on the well-documented knowledge that other chronic conditions are common among people with diabetes.[139,140] All comorbid conditions commonly seen in patients with diabetes were more prevalent among the MEPS respondents with diabetes than among those without diabetes, and most were at least two-fold higher in frequency. High cholesterol, high blood pressure, and heart disease were the most frequent comorbidities, reported by 72.1%, 78.5%, and 33.6% of respondents with diabetes, respectively.

Table 3: Demographic and health characteristics of adult survey respondents, overall population and diabetes population, 2010 MEPS HC-138[a]

Variable	Respondents with Diabetes[b] N = 1,844	Overall Respondent Population N = 22,290
Race (%)		
White	77.3	81.0
Black	15.5	11.8
American Indian/Alaska Native	1.3	0.8
Asian	3.8	4.8
Native Hawaiian/Pacific Islander	0.7	0.5
Multiple races reported	1.4	1.2
Ethnicity (%)		
Hispanic	14.1	14.1
Not Hispanic	85.9	85.9
Race / Ethnicity (%)[c]		
Non-Hispanic White	63.8	67.6
Non-Hispanic Black	15.3	11.5
Hispanic	14.1	14.1
Other (non-Hispanic)	6.9	6.7
Age Category (years) (%)		
18 to 24	0.5	12.8
25 to 44	13.1	35.0
45 to 64	47.4	35.0
65 to 85	39	17.2
Age (years: mean ± SE)	60.5 ± 0.4	46.4 ± 0.2
Gender (%)		
Male	49.1	48.4
Female	50.9	51.6
Marital Status (%)		
Married	57.0	53.2
Unmarried	43.0	46.8
BMI Category (%)		
Underweight	2.3	4.3
Normal	13.0	33.2
Overweight	30.0	33.9
Obese	54.6	28.7
BMI (kg/m2: mean ± SE)	31.2 ± 0.2	27.0 ± 0.1
Perceived Health Status (%)		
Excellent	4.5	25.0
Very good	19.5	34.1
Good	40.4	27.8
Fair	24.6	9.7

Variable	Respondents with Diabetes[b] N = 1,844	Overall Respondent Population N = 22,290
Poor	11.0	3.3
Poverty Status (%)		
Poor/Negative	14.4	12.7
Near poor	6.4	4.3
Low income	15.2	13.3
Middle income	31.9	30.3
High income	32.1	39.3
Education (%)		
Less than high school	20.4	14.8
High school graduate	4.9	3.6
College graduate	74.1	81.0
No answer[d]	0.6	0.6
Health Insurance (%)		
Any private	58.0	67.6
Public only	33.0	17.1
Uninsured	9.0	15.3
Geographic Region (%)		
Northeast	16.8	18.5
Midwest	22.3	21.7
South	41.6	36.7
West	19.2	23.1
Activity Limitation (%)		
Yes	48.0	20.3
No or Unknown	52.0	79.7
Comorbid conditions		
Heart disease (%)		
Yes	33.6	13.9
No or Unknown	66.4	86.1
Stroke (%)		
Yes	12.4	3.6
No or Unknown	87.6	96.4
High cholesterol (%)		
Yes	72.1	30.7
No or Unknown	27.9	69.3
High blood pressure (%)		
Yes	78.5	32.8
No or Unknown	21.5	67.2
Cancer (%)		
Yes	18.2	10.1
No or Unknown	81.8	89.9
Dementia/Cognitive limits (%)		
Yes	16.7	6.3

Variable	Respondents with Diabetes[b] N = 1,844	Overall Respondent Population N = 22,290
No or Unknown	83.3	93.7
Eye problem/Retinopathy (%)		
Yes	19.9	1.6
No or Unknown	80.1	98.4
Kidney/Renal disease (%)		
Yes	11.0	0.9
No or Unknown	89.0	99.1

BMI = body mass index; SE = standard error
[a] To represent national estimates, the MEPS survey design complexities need to be taken into account by applying MEPS survey weights to produce estimates. Therefore, data presented in this table represent weighted frequencies.
[b] Respondents with a confirmed diagnosis of diabetes who answered both diabetes medication components on the questionnaire.
[c] Any person claiming a main national origin or ethnicity in one of the Hispanic groups, regardless of racial background, is classified as Hispanic.
[d] Includes responses of 'Not Ascertained' 'Don't Know', and 'Refused'.

Table 4 presents descriptive statistics for the distribution of independent variables by race/ethnicity among the survey population respondents who had self-reported diabetes. For this analysis and future analyses, due to the small numbers of respondents in some racial/ethnic groups, results are categorized as non-Hispanic whites (the reference population), non-Hispanic blacks, Hispanics, and Other (American Indian/Alaska Native, Asian, Native Hawaiian/Pacific Islander, Multiple Races).

There were significant differences in frequency distribution between the populations for many of the variables, including those related to health status and SES. For the SES factors of poverty status, education, health insurance, and geography, the distribution of non-Hispanic blacks, Hispanics and other minority groups was significantly different than that of non-Hispanic whites, with the exception of poverty status in the other

minorities group. In general, non-Hispanic whites were better educated and had higher incomes than non-Hispanic blacks and Hispanics, and non-Hispanic blacks and Hispanics were more likely to be poor (20.8% and 27.1%, respectively) than were non-Hispanic whites (10.3%). Non-Hispanic blacks and Hispanics were also less likely to have earned a college degree (72.8% and 3.5%, respectively) than were their non-Hispanic white counterparts (81.4%). Additionally, more non-Hispanic whites had private insurance (64.1%) than non-Hispanic blacks (52.7%) or Hispanics (36.0%).

Similarly, for most health status variables, there were significant differences in frequency distributions between non-Hispanic whites and all the minority groups. Interestingly, despite having better education, higher incomes, and more private insurance, non-Hispanic whites did not seem to have an overall better perception of their health status than minorities. Non-Hispanic blacks (26.4%) and other minorities (32.9%) were more likely to consider their health very good or excellent compared to non-Hispanic whites (23.0%), while more Hispanics (46.1%) and non-Hispanic blacks (36.6%) than non-Hispanic whites (34.0%) reported fair or poor health. Although these results are in keeping with findings from previous AHRQ analyses,[67,71] a recent study found that even though Hispanics rated their health more pessimistically than non-Hispanic whites, their subsequent risk of mortality was similar to non-Hispanic whites, leading the authors to caution against relying on self-reported health to explain health disparities between non-Hispanic whites and Hispanics in the US.[141]

The frequency of heart disease among respondents with diabetes was significantly different between non-Hispanic whites and all the minority groups, with more non-Hispanic whites (37.7%) reporting heart disease than the other groups (all <30%). There was also a lower frequency of strokes among Hispanics (9.1%) and other minorities (6.0%) than among non-Hispanic whites (13.6%). On the other hand, the only group that had a significantly different frequency of high blood pressure than non-Hispanic whites (78.4%) was the non-Hispanic blacks (84.2%). There was also a significantly different distribution of cancer frequency among the racial/ethnic groups, with non-Hispanic whites having a higher prevalence (23.8%) than any other group (all 10.7% or less).

Table 4: Distribution of independent variables in diabetes population by race/ethnicity, 2010 MEPS HC-138[a]

Variable	Non-Hispanic White (n=804)	Non-Hispanic Black (n=441)	Hispanic (n=433)	Other (n=166)
Age Category (years, %)				
18 to 24	0.2	0.2	1.4	1.5
25 to 44	10.6	17.1	20.2	13.5
45 to 64	46.0	49.1	48.7	54.7
65 to 85	43.2	33.6	29.7	30.3
P	--	0.0038	<0.0001	0.04
Gender (%)				
Male	51.9	41.2	44.9	49.4
Female	48.1	58.8	55.1	50.6
P	--	0.0005	0.03	0.61
Marital Status (%)				
Married	60.7	40.5	54.5	63.8
Unmarried	39.3	59.5	45.5	36.2
P	--	<0.0001	0.11	0.52
BMI Category (%)				
Underweight	2.1	4.1	2.1	1.3
Normal	13.8	8.3	9.0	25.0
Overweight	28.1	27.8	37.8	36.6
Obese	56.0	59.7	51.1	37.1
P	--	0.03	0.0016	0.0002
Perceived Health Status (%)				
Excellent	4.9	3.4	3.4	5.1
Very good	18.1	23.0	18.2	27.8

Variable	Non-Hispanic White (n=804)	Non-Hispanic Black (n=441)	Hispanic (n=433)	Other (n=166)
Good	43.0	37.0	32.3	41.2
Fair	21.3	29.3	36.6	19.5
Poor	12.7	7.3	9.5	6.4
P	--	0.0006	<0.0001	0.02
Poverty Status (%)				
Poor/Negative	10.3	20.8	27.1	11.7
Near poor	5.5	7.1	7.9	10.0
Low income	13.7	15.9	21.1	15.2
Middle income	32.5	32.4	30.8	28.3
High income	38.0	23.8	13.1	34.7
P	--	<0.0001	<0.0001	0.28
Education (%)				
Less than high school	13.1	20.6	0.6	20.8
High school graduate	5.2	5.9	53.1	3.1
College graduate	81.4	72.8	3.5	72.9
No Answer*	0.3	0.6	42.8	3.2
P	--	0.0130	<0.0001	0.0002
Health Insurance (%)				
Any private	64.1	52.7	36.0	57.4
Public only	29.7	38.7	43.7	29.3
Uninsured	6.2	8.7	20.2	13.3
P	--	0.0013	<0.0001	0.02
Geographic Region (%)				
Northeast	18.4	14.8	14.6	10.9
Midwest	28.0	17.5	6.4	13.0
South	38.5	59.8	37.5	39.2
West	15.1	7.9	41.4	37.0
P	--	<0.0001	<0.0001	<0.0001
Activity Limitation (%)				
No or Unknown	47.8	53.5	60.8	70.40
Yes	52.2	46.5	39.2	29.60
P		0.11	0.0001	<0.0001
Comorbid Conditions (%)				
Heart disease (%)				
Yes	37.7	29.7	23.3	25.30
No or Unknown	62.3	70.3	76.7	74.70
P	--	0.0052	0.0001	0.0049
Stroke (%)				
Yes	13.6	13.7	9.1	6.00
No or Unknown	86.4	86.3	90.9	90.4
P	--	0.95	0.02	0.002
High cholesterol (%)				
Yes	26.0	30.5	31.50	32.90
No or Unknown	74.0	69.5	68.50	67.10
P	--	0.17	0.06	0.08
High blood pressure (%)				

Variable	Non-Hispanic White (n=804)	Non-Hispanic Black (n=441)	Hispanic (n=433)	Other (n=166)
Yes	78.4	84.2	73.1	77.2
No or Unknown	21.6	15.8	26.9	22.80
P	--	0.008	0.05	0.74
Cancer (%)				
Yes	23.8	10.7	6.7	6.1
No or Unknown	76.2	89.3	93.3	93.90
P	--	<0.0001	<0.0001	<0.0001
Dementia/Cognitive limits (%)				
Yes	17.6	17.8	13.7	12.10
No or Unknown	82.4	82.2	86.3	87.90
P	--	0.94	0.11	0.16
Eye problem/Retinopathy (%)				
Yes	18.3	25.6	22.2	19.8
No or Unknown	81.7	74.4	77.8	80.20
P	--	0.0043	0.10	0.66
Kidney/Renal disease (%)				
Yes	11.1	11.1	11.6	8.10
No or Unknown	88.9	88.9	88.4	91.90
P	--	0.98	0.77	0.22

BMI = body mass index

[a] To represent national estimates, the MEPS survey design complexities need to be taken into account by applying MEPS survey weights to produce estimates. Therefore, data presented in this table represent weighted frequencies.

P values are calculated by Chi-square test for the distribution of the variable in each race/ethnicity category, with non-Hispanic whites as reference group.

A logistic regression analysis was then performed on the distribution of each independent variable according to whether or not respondents received a prescription for antidiabetic medication. Table 5 presents the frequency distributions of all independent variables (unadjusted values) among respondents with diabetes, stratified by oral antidiabetic medication use, insulin use, or any antidiabetic medication use. Each variable has Chi-squared values for significant differences between respondents who took antidiabetic medication and respondents who did not take antidiabetic medication, with respect to the independent variables.

There were significant differences ($P<0.10$) between respondents who took antidiabetic medication and those who did not for the variables of race/ethnicity ($P=0.007$), age ($P<0.0001$), BMI ($P=0.06$), education ($P=0.005$), health insurance $P=0.04$), and the co-morbidities of heart disease ($P=0.04$), stroke ($P=0.08$), high blood pressure ($P=0.06$), and eye problems/retinopathy ($P=0.0005$). These variables were therefore selected for inclusion in the final multivariate regression models.

Table 5: Distribution of independent variables by receipt of antidiabetic prescription, 2010 MEPS HC-138[a]

Variable	Oral Antidiabetic			Insulin			Oral Antidiabetic or Insulin		
	No Meds	Meds	*P*	No Meds	Meds	*P*	No Meds	Meds	*P*
Race/Ethnicity (%)									
Non-Hispanic White	71.2	61.7	0.004	62.4	66.4	0.003	68.6	63.0	0.007
Non-Hispanic Black	13.9	16.0		15.2	16.5		14.5	15.7	
Hispanic	9.3	15.0		14.3	13.0		7.2	14.6	
Other	5.6	7.3		8.1	4.1		9.7	6.7	
Age category (years: %)									
18 to 24	1.7	0.2	<0.0001	0.1	1.5	0.0004	--	0.5	<0.0001
25 to 44	20.6	11.4		12	16.1		20.7	12.4	
45 to 64	42.4	48.5		48.5	44.6		44.3	47.7	
65 to 85	35.2	39.9		39.4	37.8		35.1	39.4	
Gender (%)									
Male	47.7	49.5	0.58	49.2	49.0	0.95	47.1	49.4	0.57
Female	52.3	50.5		50.8	51.0		52.9	50.6	
Marital status (%)									
Married	48.5	59.2	0.002	59.7	50.9	0.002	54.1	57.5	0.39
Single	51.5	40.8		40.3	49.1		45.9	42.5	
BMI category (%)									
Underweight	2.2	2.4	<0.0001	2.5	2.1	0.97	1.7	2.5	0.06
Normal	21.8	11.3		13.4	13.1		19.7	12.7	
Overweight	35.4	28.9		30.5	29.3		34.0	29.7	
Obese	40.6	57.4		53.6	55.5		44.6	55.2	

Variable	Oral Antidiabetic			Insulin			Oral Antidiabetic or Insulin		
	No Meds	Meds	*P*	No Meds	Meds	*P*	No Meds	Meds	*P*
Perceived health status (%)									
Excellent	7.5	3.9		5.2	3.1		9.6	4.1	
Very good	18.1	20.3		22.8	12.6		23.0	19.5	
Good	35.6	41.1	0.004	40.1	39.8	<0.001	35.0	40.6	0.16
Fair	22.9	24.8		23.2	27.2		22.4	24.6	
Poor	15.9	10.0		8.6	17.4		10.0	11.3	
Poverty status (%)									
Poor/Negative	15.7	14.2		14	15.7		15.3	14.4	
Near poor	7.1	6.1		5.3	8.8		6.4	6.3	
Low income	12.2	15.8	0.54	14.3	17.1	0.03	11.8	15.5	0.95
Middle income	34.4	31.5		32.1	32.1		32.9	32.0	
High income	30.5	32.3		34.3	26.3		33.6	31.8	
Education (%)									
Less than high school	15.9	21.4		20.9	18.8		13.9	21.0	
High school graduate	5.6	4.7	0.03	4.8	5.0	0.70	6.0	4.8	0.005
College graduate	77.2	73.5		73.7	75.6		78.5	73.8	
No Answer*	1.3	0.4		0.6	0.5		1.7	0.5	
Health insurance (%)									
Any private	54.5	58.7		59.8	53.3		56.8	58.0	
Public only	34.7	32.6	0.40	30.5	39.2	0.0004	29.1	33.4	0.04
Uninsured	10.8	8.7		9.7	7.5		14.1	8.6	
Geographic region (%)									
Northeast	15.7	17.0	0.67	15.5	19.9	0.13	8.7	17.6	0.13

Variable	Oral Antidiabetic			Insulin			Oral Antidiabetic or Insulin		
	No Meds	Meds	*P*	No Meds	Meds	*P*	No Meds	Meds	*P*
Midwest	19.6	22.7		23.3	19.2		21.2	22.2	
South	44.3	41.2		41.8	41.7		48.6	41.1	
West	20.4	19.1		19.4	19.3		21.5	19.1	
Activity Limitation (%)									
Yes	49.2	47.6	0.58	44.1	57.3	<0.001	44.1	48.3	0.45
No or Unknown	50.8	52.4		55.9	42.7		55.9	51.7	
Co-morbid conditions									
Heart disease (%)									
Yes	33.3	33.8	0.78	29.6	43.7	<0.001	26.8	34.4	0.04
No or Unknown	66.7	66.2		70.4	56.3		73.2	65.6	
Stroke (%)									
Yes	15.3	11.7	0.07	10.2	18.0	<0.001	8.1	12.9	0.08
No or Unknown	84.7	88.3		89.8	82.0		91.9	87.1	
High cholesterol (%)									
Yes	62.9	73.8	0.0002	71.2	73.1	0.49	65.5	72.4	0.17
No or Unknown	37.1	26.2		28.8	26.9		34.5	27.6	
High blood pressure (%)									
Yes	75.8	79.0	0.36	77.5	80.7	0.15	71.2	79.1	0.06
No or Unknown	24.2	21.0		22.5	19.3		28.8	20.9	
Cancer (%)									
Yes	19.1	18.1	0.91	18.7	17.2	0.49	22.0	17.9	0.36
No or Unknown	80.9	81.9		81.3	82.8		78.0	82.1	
Dementia (cognitive limitations) (%)									

Variable	Oral Antidiabetic			Insulin			Oral Antidiabetic or Insulin		
	No Meds	**Meds**	***P***	**No Meds**	**Meds**	***P***	**No Meds**	**Meds**	***P***
Yes	20.5	15.9	0.10	14.9	21.4	0.002	15.6	16.9	0.64
No or Unknown	79.5	84.1		85.1	78.6		84.4	83.1	
Eye problem/Retinopathy (%)									
Yes	24.9	18.4	0.03	14.0	33.6	<0.001	9.0	20.8	0.0005
No or Unknown	75.1	81.6		86.0	66.4		91.0	79.2	
Kidney/Renal disease (%)									
Yes	15.1	10.0	0.01	7.2	20.1	<0.001	7.5	11.3	0.30
No or Unknown	84.9	90.0		92.8	79.9		92.5	88.7	

BMI = body mass index

[a] To represent national estimates, the MEPS survey design complexities need to be taken into account by applying MEPS survey weights to produce estimates. Therefore, data presented in this table represent weighted frequencies.

P values are calculated by Chi-square test.

Analysis of Primary Independent Variable

Logistic regressions were performed to evaluate the use of antidiabetic medication by race/ethnicity and by other independent variables for which the frequency distributions were significantly different between respondents who took antidiabetic medication and those who did not (as shown in Table 5). Results are first presented as odds ratios (ORs) for the unadjusted (crude) values calculated from simple logistic regression of each variable individually. All SES and health status variables were then entered into a multivariate logistic regression model to produce adjusted OR values (hereafter referred to as the SES/HS adjusted model). As a final step, all the selected health status variables were transformed by the rank and replace methodology to conform with the IOM definition of disparity and then entered into the same multivariable logistic regression model to produce IOM transformed OR values, thereby allowing SES factors to mediate the differences in antidiabetic medication use (hereafter referred to as the IOM definition model).

As shown in Table 6, the primary independent variable of race/ethnicity was a significant predictor of antidiabetic medication use in this survey population. For all regression analyses, there were statistically significant differences ($P<0.001$) between Hispanics and non-Hispanic whites in the receipt of antidiabetic medication prescriptions, with Hispanics being more than 2 times as likely to have received a prescription. The unadjusted OR was 2.22 (95% CI: 1.30-3.78), and the differences became even greater when values were adjusted in the SES/HS model (OR: 2.44; 95% CI: 1.35-4.40) or

transformed and adjusted according to the IOM definition of disparity model (OR: 2.38; 95% CI: 1.31-4.31). There also appeared to be a slight trend for non-Hispanic blacks to be more likely than non-Hispanic whites to have received antidiabetic prescriptions, although the differences were not statistically significant for any of the analyses. The OR was 1.18 (95% C: 0.78-1.79) in the unadjusted analysis, which was almost identical to the OR in the SES/HS adjusted analysis (OR: 1.19; 95% CI: 0.76-1.86), and even though the difference was of greater magnitude in the IOM definition model (OR: 1.44; 95% CI: 0.89-2.32), it did not reach the level of statistical significance. For the category of other minorities, although respondents were 25% less likely to have received antidiabetic prescriptions than non-Hispanic whites (OR: 0.75; 95% CI: 1.29-1.43) in the unadjusted comparison, this significant difference was not maintained when values were adjusted in the SES/HS model (OR: 0.85; 95% CI: 0.47-1.53) or transformed and adjusted in the IOM definition model (OR: 0.87; 95% CI: 0.48-1.61).

Table 6: Primary analysis: logistic regression models for receipt of any antidiabetic prescription, by race/ethnicity, 2010 MEPS HC-138

	Unadjusted[a]		SES/HS Adjusted[b]		IOM Definition[c]	
Race/Ethnicity	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***
Non-Hispanic White (n=804)	(reference)	--	(reference)	--	(reference)	--
Non-Hispanic Black (n=441)	1.18 (0.78-1.79)	0.98	1.19 (0.76-1.86)	0.74	1.44 (0.89-2.32)	0.61
Hispanic (n=433)	2.22 (1.30-3.78)	0.001	2.44 (1.35-4.40)	0.003	2.38 (1.31-4.31)	0.008
Other (n=166)	0.75 (0.43-1.29)	0.02	0.85 (0.47-1.53)	0.07	0.87 (0.48-1.61)	0.07

CI = confidence interval; HS = health status; IOM = Institute of Medicine; OR = odds ratio; SES = socioeconomic status

[a] Unadjusted = Each independent variable entered by itself into a simple logistic regression model.

[b] SES/HS Adjusted = All independent socioeconomic status and health status variables entered into a multivariable logistic regression model.

[c] IOM Definition = All independent health status variables transformed through rank and replace process and then entered into multivariable logistic regression model along with socioeconomic variables.

P values are calculated by Chi-square test.

To determine whether the likelihood of receiving a prescription was influenced by the type of antidiabetic medication prescribed, an ad hoc analysis was performed according to whether individuals with diabetes received a prescription for insulin or for oral medication. In all models, ad hoc analysis results suggested that the significant differences in ORs between Hispanics and non-Hispanic whites seen in the primary analysis were driven by a greater likelihood of receiving a prescription for oral medication (data on file). The OR values for receipt of oral antidiabetic medication for the Hispanic group were 1.87 in the unadjusted model, 2.16 in the SES/HS adjusted model, and 2.02 in the IOM definition model, all of which were significantly different

(greater) than the non-Hispanic white group (data on file). On the other hand, in the other minorities group, OR values for receipt of insulin were significantly lower in all models (0.47, 0.46, and 0.44, respectively) compared to the non-Hispanic white group, suggesting that other minorities were less likely to receive insulin than their non-Hispanic white counterparts.

Analysis of Other (Secondary) Independent Variables

Among other independent variables that entered the regression models (secondary analyses), having health insurance significantly influenced the receipt of antidiabetic medication prescriptions (Table 7). Unadjusted analysis showed that respondents with diabetes who were uninsured were 40% less likely to have received antidiabetic prescriptions (OR: 0.60; 95% CI: 0.36-0.99) compared to the referent group who had private insurance. This difference increased to 47% when the data were adjusted in the SES/HS model (OR: 0.53; 95% CI: 0.31-0.92) or transformed and adjusted in the IOM definition model (OR: 0.53; 95% CI: 0.30-0.93). Education was also a significant predictor of the receipt of antidiabetic prescriptions. In the unadjusted model, respondents with diabetes who had graduated from high school were over 5 times more likely to have received antidiabetic prescriptions than those with less than a high school education (OR: 5.42; 95% CI: 1.51-19.40). This significant difference persisted, but was slightly less pronounced, when the data were adjusted in the SES/HS model (OR: 4.61; 95% CI: 1.33-15.98) or transformed and adjusted in the IOM definition model (OR: 4.72; 95% CI: 1.34-16.68). And although the ORs in all analyses suggested that college graduates were also more likely to have received antidiabetic prescriptions than

respondents who did not graduate from high school, the differences were not significant. Having a comorbidity of eye problems/retinopathy was also significantly associated with the receipt of an antidiabetic prescription. The respondents with diabetes who had eye problems/retinopathy were over 2 times more likely to have received antidiabetic prescriptions than were those without this comorbid condition in the unadjusted model (OR: 2.33; 95% CI: 1.35-4.02), with a slightly lower risk when values were adjusted in the SES/HS model (OR: 2.0695% CI: 1.15-3.67) or transformed and adjusted in the IOM definition model (OR: 2.17; 95% CI: 1.19-3.97).

Other independent variables that entered the regression models including age, BMI, and the comorbid conditions of heart disease, stroke, and high blood pressure did not demonstrate significant differences in the odds of receiving antidiabetic prescriptions, even when the values were adjusted or transformed and adjusted according to the IOM definition of disparities.

Table 7: Secondary analyses: logistic regression models for receipt of antidiabetic prescription, other independent variables, 2010 MEPS HC-138

	Unadjusted[a]		SES/HS Adjusted[b]		IOM Definition[c]	
Variable	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***
Age						
1-year increase	1.01 (1-1.02)	0.14	1.00 (0.99-1.02)	0.72	1 (0.99-1.02)	0.69
BMI (reference = Normal)						
Underweight	3.42 (0.31-16.39)	0.092	3.54 (0.67-12.80)	0.60	2.72 (0.34-12.44)	0.09
Overweight	2.66 (0.42-11.17)	0.75	2.23 (0.33-10.40)	0.82	2.34 (0.77-12.35)	0.69
Obese	3.38 (0.39-9.85)	0.51	3.22 (0.68-13.00)	0.39	3.14 (0.93-13.58)	0.27
Health Insurance (reference = Any private)						
Public only	1.13 (0.71-1.80)	0.08	0.86 (0.51-1.44)	0.52	0.85 (0.51-1.41)	0.55
Uninsured	0.60 (0.36-0.99)	0.01	0.53 (0.31-0.92)	0.03	0.53 (0.30-0.93)	0.04
Education (reference = Less than high school)						
High school graduate	5.42 (1.51-19.40)	0.0004	4.61 (1.33-15.98)	0.006	4.72 (1.34-16.68)	0.04
College graduate	2.87 (0.62-13.17)	0.85	2.99 (0.67-13.39)	0.72	3.31 (0.72-15.25)	0.62
No answer	3.38 (0.89-12.85)	0.31	3.57 (0.98-13)	0.19	3.84 (1.03-14.38)	0.17
Heart Disease (reference = No)						
Yes	1.43 (0.99-2.08)	0.06	1.22 (0.81-1.83)	0.34	1.25 (0.86-1.80)	0.25
Stroke (reference = No)						
Yes	1.69 (0.95-3.01)	0.08	1.26 (0.67-2.39)	0.47	1.28 (0.70-2.35)	0.42
High Blood Pressure (reference = No)						
Yes	1.54 (1.00-2.37)	0.05	1.38 (0.88-2.17)	0.16	1.32 (0.84-2.09)	0.23
Eye Problem/ Retinopathy (reference = No)						
Yes	2.33 (1.35-4.02)	0.003	2.06 (1.15-3.67)	0.01	2.17 (1.19-3.97)	0.01

BMI = body mass index; CI = confidence interval; HS = health status; IOM = Institute of Medicine; OR = odds ratio; SES = socioeconomic status

[a] Unadjusted = Each independent variable entered by itself into a simple logistic regression model.

[b] SES/HS Adjusted = All independent socioeconomic status and health status variables entered into a multivariable logistic regression model.

[c] IOM Definition = All independent health status variables transformed through rank and replace process and then entered into multivariable logistic regression model along with socioeconomic variables.

P values are calculated by Chi-square test.

DISCUSSION

General Discussion of Results

Disparities in diabetes are well documented, and the huge economic costs associated with diabetes and its multiple complications continue to increase. To achieve the IOM's recommended health care policy goal of eliminating the unequal treatment of patients based on their race/ethnicity or other minority status, it is important to identify and evaluate tools that can be used to measure progress toward this goal. The present study applied a methodology developed and refined by a group of Harvard researchers that is based on the IOM definition of a racial disparity.[104,106,107,132,133,134] The methodology adjusts for variables related to health status while allowing variables related to SES to mediate racial/ethnic differences.

Using this method on data selected from the 2010 MEPS HC files, race/ethnic disparities in the receipt of antidiabetic medications were identified between non-Hispanic whites and minorities in a nationally representative population of individuals with diabetes, and the disparities were larger when the strict IOM definition was applied. Results from the unadjusted analysis indicated that Hispanics were significantly more (greater than 2 times) likely than non-Hispanic whites to receive a prescription for antidiabetic medication. When the health status variables were adjusted (transformed) using a method based on the IOM definition of racial disparity, the difference persisted and actually increased in magnitude. The results also suggested that non-Hispanic blacks were slightly more likely than non-Hispanic whites to receive a prescription for

antidiabetic medication, but this difference was not significant, and even though the OR value increased in magnitude when the IOM definition of disparity was used, it did not reach the level of statistical significance. In the pooled category of other minorities, unadjusted analyses indicated that respondents were significantly less likely to receive a prescription for antidiabetic medication than their non-Hispanic white counterparts, but the difference became non-significant when health status variables were transformed by application of the IOM definition model.

Results from the present study are consistent with findings from a variety of studies in which researchers found higher rates of antidiabetic medication use by racial minorities, including several published analyses of MEPS data. A 2010 MEPS report examined trends in the use of oral antidiabetic medications, insulin, and non-insulin injectables over the years 1997 to 2007.[142] During that period, Hispanics were more likely to use oral anti-diabetic medications compared to non-Hispanic whites, non-Hispanic blacks, and other race/ethnic groups. On the other hand, non-Hispanic blacks were more likely to use insulin than non-Hispanic whites or Hispanics. The study also concluded that survey respondents with public insurance and with less than a high school education were more likely to report pharmacological treatment for diabetes, findings that conform to results seen in my study. Similar findings were presented in a statistical brief on MEPS data that showed a higher percentage of Hispanics (83.8%) reported taking oral medications to control their diabetes than did non-Hispanic blacks (77.4%) and non-Hispanic whites (78.1%).[143] And as in the previous MEPS study, more non-Hispanic blacks reported using insulin to treat their diabetes than did other race/ethnic groups. Another earlier

MEPS study that used survey data to examine racial and ethnic differences in diabetes care and health care use and costs found increased ORs for use of oral medication use among Hispanics and blacks compared to whites in an analysis adjusted for several SES and health status factors, but the values were not significantly different.[155] However, the multivariate analyses of drug utilization in that study used count data methods (count variables), which differs from the use of distribution data for multivariate analyses in my study, direct comparisons of outcomes are difficult to make.

In their research on the pharmacologic management of diabetes in long-term care facility residents, Allsworth and colleagues found that blacks reported greater use of any antidiabetic medication compared to whites, but it was not clear whether this difference reflected poorer disease course or an earlier failure rate on other antidiabetic medications.[81] In a long-term study of patients with diabetes enrolled in the Insulin Resistance Atherosclerosis Study, similar rates of antidiabetic medication use between whites, blacks and Hispanics were observed,[85] and in a study of veterans with diabetes using survey data, a greater percentage of blacks than whites were on insulin therapy.[45] Kim *et al*.[46] recently observed that certain racial/ethnic groups (American Indian/Alaska Native) were significantly more likely to use insulin and oral diabetic medications than were non-Hispanic whites, and although African Americans and Hispanics did show a tendency toward higher use of insulin or oral antidiabetics than non-Hispanic whites, which is similar to results from my study, the differences were not significant.

On the other hand, results from my study contradict findings from a recent retrospective review of VA hospital medical records that identified no disparities in the receipt of insulin therapy between white and nonwhite patients.[50] However, the higher frequency of antidiabetic medication use by Hispanics in my study appears to be driven primarily by receipt of oral antidiabetics, not insulin (see Table 5). My results are also different than some findings from an earlier retrospective study by Allsworth and colleagues[81] that looked at racial/ethnic disparities in the pharmacological management of diabetes among residents in nursing homes. They found that after adjusting for sociodemographic characteristics and severity, blacks and Hispanics had lower rates of any antidiabetic medication use than whites, while Asians had higher rates. However, they also noted that while Hispanics were less likely than whites to receive sulfonylureas, they were more likely to receive insulin. It is worth noting that Allsworth's study was conducted on patients residing permanently in long-term care facilities where access to antidiabetic medications could be influenced by factors not comparable to those that exist in a non-institutionalized population such as that used in my study.

Another study, utilizing data from the large cross-sectional NHIS survey of US non-institutionalized residents, assessed racial/ethnic disparities in diabetes to determine whether SES factors such as insurance coverage, income, and education accounted for observed racial/ethnic differences. [144] Unlike the model used in the present research study, these authors did not specifically adjust for health status variables, although they did control for potential confounders by use of multivariable logistic regression. Their results demonstrated that the observed racial/ethnic variations in diabetes between

African Americans and whites were not explained by differences in the distribution of life style and SES factors. These authors suggested that there is a continued need to explore potential risk factors in diabetes other than SES.

The results from these studies highlight the variability in findings from the very few previous studies on racial/ethnic disparities in medication use by patients with diabetes. This variability is also evident from the larger volume of literature addressing glycemic control, a measure of the quality of diabetes care. For example, in a recent study using MEPS data, Pu *et al*.[64] found racial differences with respect to receiving HbA1c testing. In another study looking at data from a national cohort of veterans, Egede *et al*.[40] found racial/ethnic disparities in HbA1c levels and HbA1c control that were largely explained by adjustment for demographic characteristics, medication adherence, type of antidiabetic medication, and comorbidities. A study in a national cohort of veterans with type 2 diabetes looked at the association between HbA1c, medication use/adherence, and mortality stratified by race/ethnicity.[145] In that study, the prevalence of medication non-use was much higher in Hispanics than in non-Hispanic whites or non-Hispanic blacks, and racial/ethnic differences were apparent in the association between glycemic control and mortality, which varied by medication use/adherence. Furthermore, the results provided evidence that race and medication status (medication use and adherence) modified the association between HbA1c and mortality and should therefore be considered when setting individualized HbA1c targets during diabetes treatment. However, the authors also reported that medication non-adherence, non-initiation of antidiabetic medications, and comorbidity burden were stronger predictors of mortality

than poorly controlled diabetes across all race/ethnic groups examined. They concluded that quality improvement initiatives should therefore target improvements in medication adherence, identification and early initiation of appropriate diabetes medications, and aggressive management of comorbid conditions in patients with diabetes.

In contrast, Lee *et al*.[155] did not see any racial differences in receipt of HbA1c tests among respondents with diabetes in the 2000 MEPS database. Similarly, Bullock *et al*. investigated whether patients of minority races in a VA institution were less likely to receive insulin therapy for treatment of poorly controlled diabetes than white patients.[146] Among the patients with poor glycemic control (A1C>10%), there were no evident disparities in the receipt of insulin therapy between the white and non-white patients. In addition, neither clinic status nor provider type was found to have an impact on insulin initiation. Furthermore, a thorough discussion of the literature on HbA1c levels and racial disparities recently concluded that although adjustment for SES factors, access to treatment such as antidiabetic medications, and quality of care did attenuate racial/ethnic differences in HbA1c, it did not fully explain those disparities.[147] In a large ongoing study of patients from geographically and ethnically diverse clinics affiliated with an academic health center investigating racial disparities in diabetes, Kaplan *et al* (2013)[148] recently concluded that despite substantial efforts to reduce disparities, diabetes outcomes remain suboptimal among poor and underserved minority patients. Glycemic control was measured as HbA1c levels, patient, provider and system characteristics evaluated included demographics, access to care, quality of process of care, quality of interpersonal care, illness burden, and adherence to treatment. Results showed that unadjusted HbA1c

values were significantly higher for Hispanics compared with non-Hispanic whites, but no significant differences in HbA1c values were detected between Vietnamese Americans and non-Hispanic whites. After statistical adjustment for multiple measures of access, as well as for quality of process and interpersonal care, there were no statistically significant group differences in glycemic control. Therefore, the authors suggested that simple explanations for these disparities, such as differences in adequate access to health care or quality of care, were insufficient to explain disparities in diabetes treatment and control. Instead, they proposed that effective solutions would only be the result of balancing the need for generalizable interventions to reduce disparities and the need to specifically tailor those interventions to address relevant barriers within each racial/ethnic group.

Considering the broad variation in findings from previous studies that either support or contradict my results, one must consider the possibility that minorities (particularly Hispanics) appeared to actually get better pharmacologic treatment for their diabetes than whites. Is it possible that common treatment practices are such that Hispanics are more likely to be simply provided with a prescription for their diabetes, while whites are more likely to receive broader health evaluations of their disease status and more treatment options, such as lifestyle changes that include diet, exercise, and weight loss? Such practices would certainly constitute racial/ethnic discrimination that fits the IOM definition of disparities. However, the little data available on this issue do not seem to support this theory. For example, a study of prescribing decisions made by primary care physicians concluded that racial differences in outpatient prescribing patterns for diabetes

were attributable to factors other than prescribing decisions.[149] Sequist and colleagues evaluated possible variations in the treatment of diabetes patients by primary care physicians and found that racial differences in outcomes were not related to black patients differentially receiving care from physicians who provided a lower quality of care, but rather the differences were due to within-physician effects such that individual physicians achieved less favorable outcomes among their black patients than their white patients.[83] However, to better understand the relationship between race/ethnic characteristics and their potential influence on providers' pharmacologic treatment patterns, additional research is needed.

In the present study, disparities were seen between non-Hispanic whites and minorities in health insurance coverage, with significantly fewer minorities in all groups having coverage. There was also a strong correlation between having insurance and receipt of antidiabetic medications: individuals with diabetes who were uninsured were 40% less likely to have received antidiabetic medication compared to those with private insurance, and this difference increased to 47% when the data were transformed in the IOM model. These findings are similar to those of Cook *et al.*[104] in their analysis of MEPS data from 2000 to 2004, and Peek *et al.*[79] in a systematic review of health care interventions, in which both groups concluded that high uninsurance rates contributed to racial disparities. An analysis of elderly patient data from a nationally representative VA database found that patients with diabetes who had public insurance or were uninsured were less likely to have received appropriate quality of care compared to those who had private health insurance.[33] In another recent study of MEPS data, Pu and Chewning concluded that

among the potential contributors to racial disparities in diabetes care, insurance coverage was the strongest predictor for receiving diabetes care.[64] In their study a large proportion of variability in racial disparities was attributed to the insurance status of patients, and those without insurance were less likely to receive important elements of diabetes preventive care. It could be speculated from findings such as these that the lack of insurance, and thus the lack of medical care, could result in a situation whereby some patients have diabetes but are either not aware of it or do not have it confirmed by a physician. If so, such patients would likely have different patterns of care and treatment than insured patients, and these patterns would also likely differ by race/ethnicity. Considering that 15.3% of all respondents in the 2010 MEPS population were uninsured compared to 9.0% in the diabetes population (see Table 3) in my study, it is possible that some respondents with undiagnosed diabetes were excluded from the target population.

Education was also a significant predictor of antidiabetic medication use in the present study. Overall, individuals with diabetes who had a high school degree were almost 5 times more likely to receive antidiabetic medication than those with less than a high school education. Across the racial/ethnic groups, the distribution of non-Hispanic blacks, Hispanics and other minority groups was significantly different than that of non-Hispanic whites, who in general were better educated than their minority counterparts. Non-Hispanic whites and Hispanics were also less likely to have earned a college degree than non-Hispanic whites. Similar findings were presented by Richard *et al*.[33] in a study of elderly VA patients, who were more likely to receive appropriate medical care if they had higher education.

Having eye problems/retinopathy was the only comorbidity in this study that was significantly associated with the receipt of antidiabetic medication. Individuals with diabetes who had eye problems/retinopathy were over 2 times more likely to have received antidiabetic medication than were those without this condition. This is not particularly surprising, considering the well-known fact that the longer someone has diabetes, the more likely they are to get diabetic retinopathy. In the present study, non-Hispanic blacks were the only minority group with a significantly higher incidence of eye problems/retinopathy than non-Hispanic whites. This finding differs from recent prevalence data compiled by the National Eye Institute that showed Hispanics with the highest prevalence rate in the US population, and blacks with a prevalence rate only slightly higher than whites.[150]

It was unexpected that no other comorbid condition in this study had a significant association with the receipt of antidiabetic medications, considering that the cardiovascular disease risk factors of hypertension and hyperlipidemia are common in patients with diabetes. It is worth noting that a large, retrospective cohort study of patients with diabetes, hypertension, and hyperlipidemia evaluated the achievement of simultaneous control of these comorbid diseases and whether SES factors and other clinical characteristics were associated with such control.[65] The authors found that patients who received fewer antidiabetic medications or did not receive insulin were more likely to achieve simultaneous disease control, whereas patients who received any type of medication for hyperlipidemia were also more likely to achieve control. Clinical

characteristics and SES factors were not predictive of who did or did not attain simultaneous disease control. How these findings relate to the association between comorbid disease and the likelihood of receiving antidiabetic medication in the present study are not clear. It is possible that lifestyle changes such as diet and exercise, which are certainly related to comorbid conditions like hypertension, hyperlipidemia, and cardiac disease, could influence an individual's choice of treatment between medication or non-pharmacologic options. Many studies have shown that lifestyle changes can reduce the progression of diabetes and help minimize other risk factors as well, such as high blood pressure and blood cholesterol.[151] Treatment options for diabetes other than medication were not assessed in the present study, and a more specific analysis of comorbid conditions and their associated medications would have to be undertaken to further elucidate any potential relationships between these factors.

The IOM's seminal 1999 publication, *To Err is Human: Building a Safer Health System*, resulted in increased awareness of US medical errors through its focus on patient safety, and emphasized that error resulting in patient harm was not a property of health care professionals' competence, good intentions, or hard work, but instead was a property of health care systems.[5] This was followed by another IOM publication in 2002, *Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care*, which described a consistent body of research that demonstrated significant variation in the rates of medical procedures by race, even when factors such as age, income, insurance status, and severity of conditions were comparable across racial groups, and concluded that racial and ethnic minorities in the US were less likely to receive even routine medical procedures and

experienced a lower quality of health services.[105] The numerous studies and political conversations that occurred in the wake of these IOM publications led to the consensus that health care policy should have a major goal of eliminating the unequal treatment of patients based on their race/ethnicity or other minority status (e.g., gender) – in other words, a goal of eliminating disparities.

The IOM's efforts to improve patient safety and eliminate racial disparities in access to health care was recently highlighted in its 2012 report on living with chronic illness, which included a focus on disparities in the occurrence and treatment of chronic illnesses such as diabetes, an illness that is twice as likely to be diagnosed in African Americans as in whites.[152] The report called for public health programs to be evaluated for their ability to reach and treat people with chronic illness, especially disadvantaged populations such as racial minorities that are disproportionately affected by those illnesses. A necessary step in advancing the treatment of a chronic illness like diabetes through health care programs and policies is to identify and address the differences in quality of health care that are due to racial/ethnic variations, which can persist even in the absence of financial barriers.[81] To eliminate such disparities, patient, treatment and system factors that possibly contribute to the disparities must be explored.

A significant problem with much of the research on health care disparities is that there has been little consensus on what constitutes a disparity, or when does a difference between groups become a disparity. To help resolve this problem, the IOM proposed a definition of disparities that has been increasingly used to standardize research methods

in this field. Recent studies have compared the application of the IOM definition with other commonly used definitions by the AHRQ and the WHO, and concluded that the IOM approach provided more accurate measurement of racial disparities in health care by adjusting the data for health status and allowing SES factors to mediate the differences.[103,133,134,132] For example, a recent study by Mehta *et al*. (2013) examined racial/ethnic disparities in antiobesity medication use between racial/ethnic minorities in a MEPS survey population.[114] This study appears to be the only published study to date that examined disparities in medication use between MEPS racial/ethnic populations, and is also the first study to use the nonlinear Blinder-Oaxaca decomposition method to explain such medication disparities. The Blinder-Oaxaca methodology was the basis for the IOM model used in my study to evaluate potential determinates for the pharmacological treatment of diabetes, and has been used in several investigations of racial/ethnic disparities in health care issues.[114,131,132,133] The study by Mehta *et al*. was similar to my research in its use of the rank and replace method and multivariable regression models to control for certain predisposing (i.e., health status) and need factors, and in its use of a nationally representative MEPS population. And similar to what was observed in my study, results of their analyses showed that differences in predisposing and need characteristics did not completely explain the racial/ethnic disparity in medication use.

The MEPS dataset is particularly useful for application of the IOM definition of health care disparities because it contains subsets of the variables that can be readily matched to constructs described in the IOM model (see Figure 2).[107,153] This is because variables or

characteristics that describe or predict health status represent "Clinical Appropriateness and Need Patient Preferences" in the IOM model, and these should not be considered as part of the disparities. On the other hand, SES variables that are possible predictors of actual health care disparities represent "The Operation of Health Care Systems and Legal and Regulatory Climate", and should be included in the calculation of disparities. For example, a lower rate of pharmacological treatment of diabetes in minorities because they are younger or have a higher self-perceived health status than whites would not be considered a health care disparity under the IOM definition, and both factors would therefore be held constant (adjusted for) in an analysis of disparities. Conversely, if minorities are less educated and have lower income, each of which is an SES variable under the IOM definition, these factors should not be held constant across racial/ethnic groups in estimates of treatment disparities. Utilizing such a process for holding health status variables constant across racial/ethnic groups in order to focus on non-health variables has become common practice in health care research.[134,154]

Potential Limitations of the Study

Analysis of information in the MEPS database is limited because it is household-reported and not verified by clinical records. The MEPS uses a self-reported doctor diagnosis of diabetes as opposed to using other indicators such as a fasting plasma glucose test, which could underestimate racial/ethnic differences in prevalence rates.[46] Additionally, all MEPS data are reported by 1 designated household respondent, thus, reporting detailed information on other household members can sometimes be problematic. More specifically, diabetes process-of-care measures including diabetes treatments are self-

reported in the MEPS and may therefore be subject to recall bias. However, health care use is validated by direct contact with medical providers, pharmacies, and health insurance companies identified by household respondents in MEPS.

Because the analysis of pharmacological treatment using MEPS data is based in part on records of acquiring prescription drugs, those individuals who did not report to have acquired any prescription drugs are not included in the study sample.[14] In particular, because the diabetes population in this analysis was restricted to only those respondents with complete diabetes medication information in the dataset, i.e., those who answered questions about both insulin and oral medication use, a small number of respondents (28) were excluded from the analysis. However, even without these few individuals, the database can still be used to evaluate whether there are racial and ethnic disparities among prescription users. Some important factors are not included in the MEPS survey data, such as the duration, type, and severity of a respondent's diabetes, and adjustment for these factors can be important when comparing differences in diabetes care and treatment. Furthermore, individuals with undiagnosed diabetes are not included in the MEPS database, and it is possible that racial/ethnic disparities for these individuals might be more substantial than for those with diagnosed diabetes.[155]

The IOM definition of health care disparities distinguishes between health status and preferences, and suggests that these factors should be adjusted for. However, with the MEPS data, it is not feasible to identify those variables that directly measure patient preferences because patients are rarely fully informed about their health care

options.[131,132,134] Therefore, this study did not interpret any independent variable as a measure of preferences, and did not adjust the disparity calculations for preferences. If some of these measures, such as education or geography, are related to preferences, then differences mediated by these factors might not be considered unfair and would therefore not by actual disparities according to the IOM definition.

Another potential statistical limitation of the method used in this study to implement the IOM definition is that the method detects differences between racial/ethnic groups at the middle (mean) of the sample group, which could have been influenced by outliers at the upper ends of the distributions of antidiabetic medication use. Disparities at these upper ends of antidiabetic medication use could be important if they represented undertreatment of racial/ethnic minorities or overtreatment of the comparison white population.[107] Additionally, the method used in this study could only detect whether there were differences between antidiabetic medication use in the comparison groups, but could not assess whether such differences reflected clinically inadequate levels of medication use by the groups.[107] Lastly, this study was not able to examine the effect of cultural barriers, such as health beliefs regarding chronic disease, which likely have a significant effect on the treatment choices and outcomes of diabetes.[46,156,157]

CONCLUSIONS AND RECOMMENDATIONS

To this author's best knowledge, the present study is the first to look specifically at racial/ethnic disparities in the receipt of antidiabetic medication prescriptions among a non-institutionalized population of individuals with diabetes by utilizing the IOM's

rigorous definition of racial/ethnic disparities that requires a method to adjust for health status factors while allowing SES factors to play a role in mediating the disparities. Adjusting for health status is difficult because it is often highly correlated with SES characteristics. By implementing the IOM definition through a novel model that transformed health status factors such that their distributions among minority populations were identical to white distributions, this study contributes to the research on racial/ethnic disparities in the quality of care and treatment for patients with diabetes.

Results from this study suggest that the likelihood of receiving a prescription for antidiabetic medications (oral medication and/or insulin) differs between non-Hispanic whites and other racial/ethnic minorities. In particular, Hispanics had a significantly greater (more than two-fold) likelihood of receiving antidiabetic prescriptions than non-Hispanic whites, and the magnitude of this difference increased when adjustments were made to health status factors in the IOM model. There also appeared to be a slight trend towards non-Hispanic blacks being more likely than non-Hispanic whites to have received antidiabetic prescriptions, but the differences were not statistically significant even though the ORs increased when the IOM model was used. In the other minorities category, respondents were significantly less likely to have received a prescription for antidiabetic medication than non-Hispanic whites in the unadjusted analysis, but this significant difference was not maintained when health status values were transformed in the IOM model. However, because this study seems to be the first of its kind to apply a novel and rigorous method of adjusting for health status to medication data collected in

the MEPS, additional studies using this IOM framework should be conducted to assess its usefulness for assessing racial/ethnic disparities.

As noted by Le Cook *et al*.,[107] excluding racial/ethnic disparities not caused by health status (i.e., clinical appropriateness and need, per the IOM definition) places the responsibility for reducing the disparities on the health care system. There is overwhelming evidence that persistent inequalities in SES factors such as such education, income, and health insurance disproportionately affect minority populations and contribute to their poorer health outcomes in diabetes. Therefore, changes in social policies may be needed, in addition to changes in health care policy and clinical treatment, to eliminate what the NHDR refers to as "inequality in quality".

REFERENCES

[1] Poker A, Hubbard, Collins BA. The first national reports on United States healthcare quality and disparities. J Nurse Care Qual 2004;19(4);316-321.

[2] Siegel S, Moy E, Burstein H. Assessing the nation's progress toward elimination of disparities in health care. J Gen Intern Med 2004;19:195-200.

[3] Agency for Healthcare Research and Quality. National Healthcare Disparities Report. July 2003, http://archive.ahrq.gov/qual/nhdr03/nhdr2003.pdf.

[4] Institute of Medicine, Committee on Guidance for Designing a National Healthcare Disparities Report. Swift EK, ed. Washington D.C, The National Academies Press, 2002.

[5] Institute of Medicine. To Err is Human: Building a safer health system. Washington, D.C. National Academy Press, 2000.

[6] Agency for Healthcare Research and Quality. 2010 National Healthcare Disparities Report. AHRQ Publication No. 11-0005, March 2011, www.ahrq.gov/qual/qrdr10.htm.

[7] Agency for Healthcare Research and Quality. 2011 National Healthcare Disparities Report. AHQR Publication No. 12-0006, March 2012, www.ahrq.gov/qual/nhdr11.pdf.

8 Centers for Disease Control and Prevention. CDC Health Disparities and Inequalities Report — United States, 2011. MMWR 2011;60(Suppl):1-113.

9 Coffey RM, Andrews RM, Moy E. Racial, ethnic and socioeconomic disparities in estimates of AHRQ patient safety indicators. Med Care 2005;43(3)(Supp):I-48-I-57.

[10] Mead H, Cartwright-Smith L, Jones K, Ramos C, *et al*. Racial and Ethnic Disparities in U.S. Healthcare: A Chartbook. The Commonwealth Fund, 2008.

[11] Crook ED, Peters M. Health disparities in chronic diseases: where the money is. Am J Med Sci 2008;335(4):266-270.

[12] Messinger-Rapport B. Disparities in long-term healthcare. Nurs Clin North Am 2009;44(2):179-185.

[13] Bodenheimer T, Chen E, Bennett HD. Confronting the growing burden of chronic disease: can the U.S. health care workforce do the job? Health Aff 2009;28(1):64-74.

[14] Wang J, Mullins CD, Zuckerman IH, *et al*. Medical Expenditure Panel Survey: A valuable database for studying racial and ethnic disparities in prescription drug use. Res Social Adm Pharm 2008;4:206–217.

[15] Agency for Healthcare Research and Quality. Improving the Health Care of Older Americans. A report of the AHRQ Task Force on Aging. AHRQ Publication No. 01-0030, May 2001. http://www.ahrq.gov/research/olderam/oldam1.htm.

[16] Obot SS, Health Care Disparities and Chronic Disease Burden: Policy Implications for NGOs" (2010). Public Health Theses. Paper 88. Available at: http://digitalarchive.gsu.edu/iph_theses/88. Accessed on December 5, 2011.

[17] National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention. Chronic disease prevention and health promotion. Updated October 28, 2011. http://www.cdc.gov/chronicdisease.

[18]Halle M, Lewis CB, Seshamani M. Health disparities: A case for closing the gap. U.S. Department of Health and Human Services, HHS Web Communications and New Media Division. Revised June 12, 2009. http://www.healthreform.gov/reports/healthdisparities/sources/index.html.

[19] Centers for Disease Control and Prevention Office of Minority Health and Health Disparities. Definitions of racial & ethnic populations. Available at http://www.cdc.giv/omdh/populations/definitionsREMP.htm. Accessed 24 January 2013.

[20] Trivedi AN, Zaslavsky AM, Schneider EC, *et al*. Trends in the quality of care and racial disparities in Medicare managed patients. N Engl J Med 2005;353:692-700.

[21] Trivedi AN, Zaslavsky AM, Schneider EC, *et al*. Relationship between quality of care and racial disparities in Medicare health plans. JAMA 2006;296(16):1998-2004.

[22] Pandhi N, Smith MA, Kind AJH, *et al.* The quality of diabetes care following hospitalization for ischemic stroke. Cerebrovasc Dis 2009;27(3):235-240.

[23] Wild S, Roglic G, Green A, *et al*. Global prevalence of diabetes: Estimates for the Year 2000 and projection for 2030. Diabetes Care 2004;27:1047–1053.

[24] Agency for Healthcare Research and Quality. Factsheet. Diabetes Disparities among Racial and Ethnic Minorities. AHRQ Pub. No. 02-P007, November 2001.

[25] Centers for Disease Control and Prevention. National Center for Chronic Disease Prevention and Health Promotion Division of Diabetes Translation. Crude and Age-Adjusted Percentage of Civilian, Noninstitutionalized Population with Diagnosed Diabetes, United States, 1980–2009. Last reviewed: March 20, 2011. http://www.cdc.gov/diabetes/statistics/prev/national/figage.htm.

[26] Centers for Disease Control and Prevention. Children and diabetes – more information. National Center for Chronic Disease Prevention and Health Promotion, Division of Diabetes Translation. Last updated: April 3, 2012. http://www.cdc.gov/diabetes/projects/cda2.htm.

[27] Wang J, Thomas J, Byrd D, *et al*. Status of diabetes care among community pharmacy patients with diabetes: analysis of the Medical Expenditure Panel Survey. J Am Pharm Assoc 2010;50:478-484.

[28] Centers for Disease Control and Prevention. National diabetes fact sheet: national estimates and general information on diabetes and prediabetes in the United States, 2011. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, 2011.

[29] Chow EA, Foster H, Gonzalez V, *et al*. The disparate impact of diabetes on racial/ethnic minority populations. Clin Diabetes 2012;30(3):130-133

[30] American Association of Clinical Endocrinologists. State of Diabetes Complications in America: A Comprehensive Report Issued by the American Association of Clinical Endocrinologists. 2007.

[31] Mayo Clinic Staff. MayoClinic.com. Type 2 diabetes. Mayo Foundation for Medical Education and Research, May 24, 2011.

[32] Betancourt JR, Duong JV, Bondaryk MR. Strategies to reduce diabetes disparities: an update. Curr Diab Rep 2012;12:762-768.

[33] Richard P, Alexandre PK, Younis MZ, *et al*. Racial and ethnic disparities in the quality of diabetes care for the elderly in a nationally representative sample. Ageing Int 2012;37:155:164.

[34] Moy E, Greenberg LG, Borsky AE. Community variation: disparities in health care quality between Asian and white Medicare beneficiaries. Health Affairs 2008;27(2):538-549.

[35] Richard P, Alexandre PK, Lara A, *et al*. Racial and ethnic disparities in the quality of diabetes care in a nationally representative sample. Prev Chronic Dis 2011;8(6):A142. http:www.cdc.gov/pdc/issues/2011/nov/10_0174.htm. Accessed on 25 March 2012.

[36] Chou AF, Brown AF, Jensen RE, Shih S, *et al*. Gender and racial disparities in the management of diabetes among Medicare patients. Women's Health Issues 2007;17(3):150-161.

[37] Cummings DM, Doherty L, Howard G, *et al*. Blood pressure control in diabetes: temporal progress yet persistent racial disparities: national results from the Reasons for Geographic And Racial Differences in Stroke (REGARDS) study. Diabetes Care 2010;33(4):798-803.

[38] Seck A, Rees C, Ayers E, *et al*. Racial and ethnic differences in diabetes characteristics: the VA Pathway Study. Ethnicity & Disease 2008;18(Supp 1):12-13.

[39] Adams AS, Trinacty CM, Zhang F, *et al*. Medication adherence and racial differences in A1C control. Diabetes Care 2008;31(5):916-921.

[40] Egede LE, Gebregziabher M, Hunt KJ, *et al*. Regional, geographic, and racial/ethnic variation in glycemic control in a national sample of veterans with diabetes. Diabetes Care 2011;34:938-943.

[41] Wang Y, Katzmarzyk PT, Horswell R, Li W, Xiao K, *et al*. Racial disparities in diabetic complications in an underinsured population. J Clin Endocrinol Metab 2012;97(12):4446-4453.

[42] Dominick KL, Bosworth HB, Jeffreys AS, *et al*. Racial/ethnic variations in non-steroidal anti-inflammatory drug (NSAID) use among patients with osteoarthritis. Pharmacoepidemiol Drug Saf 2004;13:683-694.

[43] Gross CP, Smith BD, Wolf E, *et al*. Racial disparities in cancer therapy: Did the gap narrow between 1992 and 2002? Cancer 2008;112(4):900-908.

[44] Mountford WK, Lackland DT, Soule JB, *et al*. Racial disparities in trends for cardiovascular disease and procedures among hospitalized diabetic patients. Ethn Dis 2008;18:131-135.

[45] Heisler M, Smith DM, Hayward RA, *et al*. Racial disparities in diabetes care processes, outcomes, and treatment intensity. Med Care 2003;41:1221-1232.

[46] Kim G, Ford KL, Chiriboga DA, *et al*. Racial and ethnic disparities in healthcare use, delayed care, and management of diabetes mellitus in older adults in California. J Amer Geriatr Soc 2012;60(12):2319-2325.

[47] Egede LE, Mueller M, Echols CL, *et al*. Longitudinal differences in glycemic control by race/ethnicity among veterans with type 2 diabetes. Med Care 2010;48:527-533.

[48] Saydah S, Cowie C, Eberhardt MS, *et al*. Race and ethnic differences in glycemic control among adults with diagnosed diabetes in the United States. Ethn Dis 2007;17:529–535.

[49] Van Houtven CH, Voils CI, Oddone EZ. Perceived discrimination and reported delay of pharmacy prescriptions and medical tests. J Gen Intern Med 2005;20:578-583.

[50] Bullock KC, Edwards KL, Greene RS, *et al*. Race as a factor for intensification of diabetes medications. The Diabetes Educator OnlineFirst, published on March 8, 2013 as doi:10.1177/0145721713479145; accessed on June 12, 2013.

[51] Higashi T, Shekelle PG, Solomon DH, *et al*. The quality of pharmacologic care for vulnerable older patients. Ann Int Med 2004;140(9):714-720.

[52] Spooner JJ, Lapane KL, Hume AL, *et al*. Pharmacologic treatment of diabetes in long-term care. J Clin Epidemiol 2001;54:525-530.

[53] Cook CB, Naylor DB, Hentz JG, *et al*. Disparities in diabetes-related hospitalizations: relationship of age, sex, and race/ethnicity with hospital discharges, lengths of stay, and direct inpatient charges. Ethn Dis 2006;16(1):126-131.

[54] Kirk JK, Bell RA, Bertoni AG, *et al*. A qualitative review of studies of diabetes preventive care among minority patients in the United States, 1993-2003. Am J Manag Care 2005;11(6):349-360.

[55] Russo CA, Andrews RM, Coffey RM. Racial and ethnic disparities in potentially preventable hospitalizations, 2003. HCUP Statistical Brief #10. July 2006. Agency for Healthcare Research and Quality, Rockville, MD. http://www.hcup-us.ahrq.gov/reports/statbriefs/sb10.pdf.

[56] Saffar D, Williams K, Lafata JE, *et al*. Racial disparities in lipid control in patients with diabetes. Am J Manag Care 2012;18(6):303-311.

[57] Osborne CY. How can we reduce racial/ethnic disparities in diabetes medication adherence? Diabetes Manag 2012;2(5):357-360.

[58] Adams AS, Trinacty CM, Zhang F, *et al*. Medication adherence and racial differences in HbA1c control. Diabetes Care 2008;31(5):916-921.

[59] Zhu VJ, Tu W, Marrero DG, *et al.* Race and medication adherence and glycemic control: findings from an operational health information exchange. AMIA Annual Symposium Proceedings 2011;20111649-20111657.

[60] Johnson EL, Brosseau JD, Soule M, *et al*. Treatment of diabetes in long-term care facilities: a primary care approach. Clinical Diabetes 2008;26(4):152-156.

[61] Kirkman MS, Briscoe VJ, Clark N, *et al*. Diabetes in older adults. Diabetes Care 2012;35(12):2650-2664.

[62] McCulloch DK, Inzucchi SE. Management of diabetes mellitus in hospitalized patients. Available at: http://www.uptodate.com/home/about/index.html. Accessed December 3, 2011.

[63] Agency for Healthcare Research and Quality. Medical Expenditure Panel Survey. Available at http://meps.ahrq.gov/mepsweb.

[64] Pu J, Chewning B. Racial difference in diabetes preventive care. Res Soc Adm Pharm 2012. Available at http://dx.doi.org/10.1016/j.sapharm.2012.11.005. Accessed on 10 January 2013.

[65] Schroeder EB, Hanratty R, Beaty BL, *et al*. Simultaneous control of diabetes mellitus, hypertension, and hyperlipidemia in 2 health systems. Circ Cardiovas Qual Outcomes 2012;5:1-9.

[66] Hennessy M. The economic burden of diabetes. Available at: http://www.cdc.gov/chronicdisease/resources/press_room.htm#a. Accessed on January 30, 2013.

[67] Agency for Healthcare Research and Quality. National Healthcare Disparities Report 2012. AHRQ Publication No. 13-0003, May 2013. Available from: www.ahrq.gov/research/findings/nhqrdr/index.html. Accessed on August 13, 2013.

[68] Centers for Disease Control and Prevention, Division of News and Electronic Media. Diagnosed diabetes grows at a dramatic rate throughout the United States. November 15, 2012. Available at

http://www.cdc.gov/media/releases/2012/p11_15_diagnosed_diabetes.html. Accessed on January 30, 2013.

[69] Boyle J, Thompson TJ, Gregg EW, *et al*. Projection of the year 2050 burden of diabetes in the US adult population: dynamic modeling of incidence, mortality, and prediabetes prevalence. Diabetes Care 2001;24(11):1936-1940.

[70] Centers for Disease Control and Prevention, CDC Division of Media Relations. Number of Americans with diabetes projected to double or triple by 2050. Available at http://www.cdc.gov/media/pressrel/2010/r101022.html. Accessed on January 30, 2013.

[71] Agency for Healthcare Research and Quality. Diabetes disparities among racial and ethnic minorities fact sheet. Available at http://www.ahrq.gov/research/diabdisp.htm. Accessed 23 January 2013.

[72] American Diabetes Association. American Diabetes Association releases new research estimating annual cost of diabetes at $245 billion. http://www.diabetes.org/for-media/2013/annual-costs-of-diabetes-2013.html. March 6, 2013.

[73] United Health, Center for Health Reform and Modernization. The United States of Diabetes: Challenges and opportunities in the decade ahead. Working Paper 5, November 2010. www.unitedhealthgroup.com/reform.

[74] Centers for Disease Control and Prevention. Diabetes Public Health Resource. Available at: http://www.cdc.gov/diabetes/consumer/research.htm. Accessed on November 11, 2011.

[75] American Diabetes Association. Economic costs of diabetes in the U.S. in 2007. Diabetes Care 2008;31(3):596-615.

[76] Fillenbaum GG, Hanlon JT. Racial and ethnic disparities in medication use among older adults. Am J Geriatr Pharmacother 2006;4(2):93-95.

[77] Rathore SS, Krumholz HM. Differences, disparities, and biases: Clarifying racial variations in health care use. Ann Intern Med 2004;141:635-638.

[78] Bullock KC, Edwards KL, Greene RS, *et al*. Race as a factor for intensification of diabetes medications. The Diabetes Educator 2013; published online before print 08 March 2013, doi: 10.1177/0145721713479145.

[79] Peek ME, Cargill A, Huang ES. Diabetes health disparities. Med Care Res Rev 2007;64(5 Supp.):101S-156S.

[80] Booth GL, Bishara P, Lipscombe LL, *et al*. Universal drug coverage and socioeconomic disparities in major diabetes outcomes. Diabetes Care 2012;35(11):2257-2264.

[81]Allsworth JE, Toppa R, Palin NC, *et al*. Racial and ethnic disparities in the pharmacologic management of diabetes mellitus among long-term care facility residents. Ethn Dis 2005;15:205-212.

[82] Harris MI, Eastman RC, Cowie CC, *et al*. Racial and ethnic differences in glycemic control of adults with type 2 diabetes. Diabetes Care 1999;22(3):403-408.

[83] Sequist TD, Fitzmaurice GM, Marshall R, *et al*. Physician performance and racial disparities in diabetes mellitus care. Arch Intern Med 2008;168(11):1145-1151.

[84] Twombly JG, Long Q, Zhu M, *et al*. Diabetes care in black and white veterans in the Southeastern U.S. Diabetes Care 2010;33:958-963.

[85] Bonds DE, Zaccaro DJ, Karter AJ, *et al*. Ethnic and racial differences in diabetes care: The Insulin Resistance Atherosclerosis Study. Diabetes Care 2003;26:1040–1046.

[86] McWilliams JM, Meara E, Zaslavsky AM, *et al*. Differences in control of cardiovascular disease and diabetes by race, ethnicity, and education: U.S. trends from 1999 to 2006 and effects of Medicare coverage. Ann Intern Med 2009;150(8):505–515.

[87] Trinacty CM, Adams AS, Soumerai SB, *et al*. Racial differences in long-term adherence to oral antidiabetic drug therapy; a longitudinal cohort study. BMC Health Service Research [online] 2009;9(24):1-10. Accessed November 20, 2011.

[88] Adams AS, Trinacty CM, Zhang F, *et al*. Medication adherence and racial differences in A1C control. Diabetes Care 2008;31:916-921.

[89] Shaya FT, Shin JY, Mullins CD, *et al*. Medicaid managed care: disparities in the use of thiazolidinediones compared with metformin. J Natl Med Assoc 2005;97(4):493-497.

[90] Ali MK, Bullard KM, Imperatore G, *et al*. Characteristics associated with poor glycemic control among adults with self-reported diagnosed diabetes – National Health and Nutrition Examination Survey, United States, 2007-2010. MMWR 2012;61(02):32-37.

[91] Piette JD, Heisler M, Harand A, *et al*. Beliefs about prescription medications among patients with diabetes: variation across racial groups and influences on cost-related medication underuse. J Health Care Poor Underserved 2010;21:349-361.

[92] Peek ME, Wagner J, Tang H, *et al*. Self-reported racial discrimination in health care and diabetes outcomes. Med Care 2011;49:618-625.

[93] American Diabetes Association. Standards of Medical Care in Diabetes – 2012. Diabetes Care 2012;35(Supp. 1): S11-S63.

[94] Whalen KL, Stewart RD. Pharmacologic management of hypertension in patients with diabetes. Am Fam Physician 2008;78(11):1277-1282.

[95] American Diabetes Association. Hypertension management in adults with diabetes. Diabetes Care 2004;27(Supp. 1:S65-S67.

[96] National Institutes of Health. National Heart, Lung, and Blood Institute. National High Blood Pressure Education Program, Working Group Report on Hypertension in Diabetes. Hypertension 1994;23:145-158.

[97] Cheung BMY, Li C. Diabetes and hypertension: is there a common metabolic pathway? Curr Atheroscler Rep 2012;14(2):160–166.

[98] Gornick ME. Disparities in health care: Methods for studying the effects of race, ethnicity, and SES on access, use, and quality of health care. In Guidance for the National Healthcare Disparities Report. Washington, DC: The National Academies Press, 2002.

[99] Shavers VL, Fagan P, Jones D, *et al*. The state of research on racial/ethnic discrimination in the receipt of health care. Am J Public Health 2012;102:953-966.

[100] Alegría M, Hasnain-Wynia R, Ayanian JZ. Taking the measure of health care disparities. Health Services Research 2012;3(47):1232-1254.

[101] Department of Health & Human Services. HealthCare.gov Newsroom. Improving data collection to reduce health disparities. Available at http://www.healthcare.gov/news/factsheets/2011/06/disparities06292011a.html. Accessed on February 9, 2013.

[102] Clark NM, Brenner J, Johnson P, *et al*. Reducing disparities in diabetes: the alliance model for health care improvements. Diabetes Spectrum 2011;24(4):226-230.

[103] Hebert PL, Sisk JE, Howell EA. When does a difference become a disparity? Conceptualizing racial and ethnic disparities in health. Health Affairs 2008;27(2):374-382.

[104] Lê Cook B, McGuire TG Zuvekas SH. Measuring trends in racial/ ethnic health care disparities. Med Care Res Rev 2009;66(1):23-48.

[105] Institute of Medicine. Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care. Washington, DC: National Academy Press; 2002.

[106] LeCook B, McGuire TG, Lock K, *et al*. Comparing methods of racial and ethnic disparities measurement across different settings of mental health care. Health Serv Res 2010;45(3):825-847.

[107] LeCook B, McGuire TG, Zaslavsky AM. Measuring racial/ethnic disparities in health care: methods and practical issues. Health Serv Res 2012;47(3):1232-1254.

[108] Williams DR, John DA, Oyserman D, *et al*. Research on discrimination and health: an exploratory study of unresolved conceptual and measurement issues. Am J Public Health 2012;102:975-978.

[109] Swirsky L. Alliance for Health Reform, Chapter 10 – Disparities. Updated by M. Berger on 11/16/2012. Available at http://www.allhealth.org/sourcebookcontent.asp?CHID=126. Accessed on February 9, 2013.

[110] Sims M, Diez Roux AV, Boykin S, *et al*. The socioeconomic gradient of diabetes prevalence, awareness, treatment, and control among African Americans in the Jackson Heart Study. Ann Epidemiol 2011;21(12):892-898.

[111] Smith J. Diabetes and the rise of the SES health gradient. NBER Working Paper No. 12905, issued in February 2007. Available at http://www.nber.org/papers/w12905. Accessed on February 10, 2013.

[112] Osborne CY, de Groot M, Wagner JA. Racial and ethnic disparities in diabetes complications in the northeastern United States: the role of socioeconomic status. J Nation Med Assoc 2013;105(1):51-58.

[113] Frierson GM, Howard EN, DeFina LF, *et al*. Effect of race and socioeconomic status on cardiovascular risk factor burden: the Cooper Center Longitudinal Study. Ethn Dis 2013;23(1):35–42.

[114] Mehta HB, Rajan SS, Aparasu RR, *et al*. Application of the nonlinear Blinder-Oaxaca decomposition to study racial/ethnic disparities in antiobesity medication use in the United States. Res Social Admin Pharm 2013;9:13–26.

[115] Cohen J. Design and Methods of the Medical Expenditure Panel Survey Household Component. Rockville, MD: Agency for Healthcare Research and Quality; 1997. MEPS Methodology Report No. 1. AHCPR Pub. No. 97-0026.

[116] Agency for Healthcare Research and Quality. Medical Expenditure Panel Survey. Available at www.meps.ahrq.gov/mepsweb/accessibility.jsp. Accessed February 10, 2010.

[117] Agency for Healthcare Research and Quality, Center for Financing, Access, and Cost Trends. MEPS HC-138 2010 Full Year Consolidated Data File, September 2012. Available at http://meps.ahrq.gov/mepsweb/data_stats/download_data/pufs/h138/h138doc.pdf. Accessed on November 10, 2013.

[118] Stagnitti MN, Beauregard K, Dolis A. Design, methods, and field results of the Medical Expenditure Panel Survey Medical Provider Component (MEPS-MPC) – 2006 calendar year data. Methodology Report No. 23. November 2008. Agency for Healthcare

Research and Quality, Rockville, MD. http://www.meps.ahrq.gov/mepsweb/data_files/publications/mr23/mr23.pdf.

[119] Ezzati-Rice TM, Rohde F, Greenblatt J. Sample Design of the Medical Expenditure Panel Survey Household Component, 1998–2007. Methodology Report No. 22. March 2008. Agency for Healthcare Research and Quality, Rockville, MD. http://www.meps.ahrq.gov/mepsweb/data_files/publications/mr22/mr22.pdf.

[120] MEPS-HC Sample Design and Collection Process. Agency for Healthcare Research and Quality, Rockville, Md. http://www.meps.ahrq.gov/survey_comp/hc_data_collection.jsp

[121] Agency for Healthcare Research and Quality. MEPS-HC panel design and data collection process. Available at http://www.meps.ahrq.gov/survey_comp/hc_data_collection.jsp.

[122] Machlin S, Yu W, Zodet M. Computing standard errors for MEPS estimates. January 2005. Agency for Healthcare Research and Quality, Rockville, Md. Available at http://www.meps.ahrq.gov/survey_comp/standard_errors.jsp. Accessed on March 24.

[123] Agency for Healthcare Research and Quality, Center for Financing, Access, and Cost Trends. MEPS HC-126A: 2009 Prescribed Medicines, November 2011. Rockville, MD. Available from http://meps.ahrq.gov/mepsweb/data_stats/download_data/pufs/h129/h129doc.pdf.

[124] Agency for Healthcare Research and Quality. MEPS Medical Provider Component Annual Methodology Report. Available at http://meps.ahrq.gov/data_files/publicati.ons/annual_contractor_report/mpc_ann_cntrct_methrpt.shtml.

[125] Agency for Healthcare Research and Quality. MEPS-MPC sample design and data collection process. Available at http://meps.ahrq.gov/mepsweb/survey_comp/mpc_data_collection.jsp.

[126] Agency for Healthcare Research and Quality, Center for Financing, Access, and Cost Trends. MEPS HC-126A: 2009 Prescribed Medicines, September 2011. Rockville, MD. Available at http://meps.ahrq.gov/mepsweb/data_stats/download_data/pufs/h126a/h126adoc.pdf.

[127] American Diabetes Association. Diabetes Care 2012;35(Supp. 1):S11-S63.

[128] Navarro V. Race or class, or race and class. Int J Health Serv 1989;19(2):311-314.

[129] Kawachi I, Daniels N, Robinson DE. Health disparities by race and class: why both matter. Health Affairs 2005;24(2):343-353.

[130] Cheng ER, Kindig DA. Disparities in premature mortality between high- and low-income US counties. Prev Chronic Dis 2012; 9:110120. DOI:http://dx.doi.org/10.5888/pcd9.110120.

[131] Lê Cook B. Effect of Medicaid Managed Care on racial disparities in health care access. Health Serv Res 2007;42(Part 1):124-145.

[132] McGuire TG, Alegria M, Lê Cook B, *et al*. Implementing the Institute of Medicine' definition of d disparities: an application to mental health care. Health Serv Res 2006;41(5):1979-2005.

[133] Lê Cook B, McGuire T, Miranda J. Measuring trends in mental health care disparities, 2000-2004. Psych Serv 2007;58(12):1533-1540.

[134] Lê Cook B, McGuire TG, Meara E, *et al*. Adjusting for health status in non-linear models of health care disparities. Health Serv Outcomes Res Method 2009;9:1-21.

[135] Bays HE, Chapman RH, Grandy S, SHIELD Investigators' Group. The relationship of body mass index to diabetes mellitus, hypertension and dyslipidaemia: comparison of data from two national surveys. Int J Clin Pract 2007;61(5):737-747.

[136] Khardori R, Griffing GT, Bessen HA. Type 2 Diabetes Mellitus: epidemiology. Medscape Reference: Drugs, Diseases & Procedures. Available at: http://emedicine.medscape.com/article/117853-overview#a0156. Accessed on June 22, 2013.

[137] Ronksley PE, Sanmartin C, Quan H, *et al*. Association between chronic conditions and perceived unmet health care needs. Open Medicine, North America, 6, Apr. 2012. Available at: http://www.openmedicine.ca/article/view/483/459. Accessed on August 11, 2013.

[138] Liao Y, Bang D, Cosgrove S, *et al*. Surveillance of health status in minority communities - racial and ethnic approaches to community health across the U.S. (REACH U.S.) Risk Factor Survey, United States, 2009. MMWR: Surveillance Summaries May 20, 2011/60(SS06):1-41.

[139] Piette JD, Kerr EA. The impact of comorbid chronic conditions on diabetes care. Diabetes Care 2006;29(3):725-731.

[140] American Association of Clinical Endocrinologists. Management of common comorbidities of diabetes. ACE Diabetes Resource Center. Available from: http://outpatient.aace.com/type-2-diabetes/management-of-common-comorbidities-of-diabetes. Accessed on April 14, 2013.

[141] Su D, Wen M, Markides KS. Is self-rated health comparable between non-Hispanic whites and Hispanics? Evidence from the Health and Retirement Study. J Gerontol B Psychol Sci Soc Sci 2013;68(4):622-632.

[142] Sarpong E, Miller GE. Trends in the pharmaceutical treatment of diabetes, 1997 to 2007. Research Findings #30. September 2010. Agency for Healthcare Research and Quality, Rockville, MD. http://meps.ahrq.gov/mepsweb/data_files/publications/rf30/rf30.pdf. Accessed on December 10, 2013.

[143] Soni A. Diabetes management: Tests and treatments among the adult U.S. civilian noninstitutionalized population, 2007. Statistical Brief #269, November 2009. Agency for Healthcare Research and Quality, Rockville, MD. http://www.meps.ahrq.gov/mepsweb/data_files/publications/st269/stat269.pdf. Accessed on December 24, 2013.

[144] Holmes L, Hossain J, Ward D, *et al*. Racial/ethnic variability in diabetes mellitus among United States residents is unexplained by lifestyle, sociodemographics and prognostic factors. ISRN Public Health 2012; Article ID 408079, doi:10.5402/2012/408079. Accessed on October 10, 2013.

[145] Hunt KJ, Gebregziabher M, Lynch CP, *et al*. Impact of diabetes control on mortality by race in a national cohort of veterans. Annals Epidem 2013;23(2):74-79.

[146] Bullock KC, Edwards KL, Greene RS, *et al*. Race as a factor for intensification of diabetes medications. Diab Educ 2013;39(3):335-343.

[147] Herman WH, Cohen RM. Racial and ethnic differences in the relationship between HbA1c and blood glucose: implications for the diagnosis of diabetes. J Clin Endocrin Metab 2012;97:1067-1072.

[148] Kaplan SH, Billimek J, Sorkin DH, *et al*. Reducing racial/ethnic disparities in diabetes: the Coached Care (R2D2C2) project. J Gen Intern Med 2013;28(10):1340-1349.

[149] Rathore SS, Ketcham JD, Alexander GC, *et al*. Influence of patient race on physician prescribing decisions: A randomized on-line experiment. J Gen Intern Med 2009;24(11):1183–1191.

[150] National Eye Institute, National Institutes of Health. Diabetic retinopathy. Available at http://www.nei.nih.gov/eyedata/diabetic.asp. Accessed on October 18, 2013.

[151] American Heart Association. Prevention & Treatment of Diabetes. Updated January 31, 2013. Available from: http://www.heart.org/HEARTORG/Conditions/Diabetes/PreventionTreatmentofDiabetes/Prevention-Treatment-of-Diabetes_UCM_002036_Article.jsp#. Accessed on December 10, 2013.

[152] Harris JR, Wallace RB. The Institute of Medicine's new report on living well with chronic illness. Prev Chronic Dis 2012;9:120126. Available at DOI: http://dx.doi.org/10.5888/pcd9.120126. Accessed on September 10, 2013.

[153] Kirby JB, Taliaferro G, Zuvekas SH. Explaining racial and ethnic disparities in health care. Med Care 2006;44(5 suppl):I64-72.

[154] Zaslavsky AM, Ayanian JZ. Integrating research on racial and ethnic disparities in health care over place and time. Med Care 2005;43(4):303-307.

[155] Lee J-A, Liu C-F, Sales AE. Racial and ethnic differences in diabetes care and health care use and costs. Prev Chronic Dis [serial online] 2006 July. Available from: URL:http://www.cdc.gov/pcd/issues/2006/jul/05_0196.htm. Accessed on December 9, 2011.

[156] Chesla CA, Chun KM, Kwan CML. Cultural and family challenges to managing type 2 diabetes in immigrant Chinese Americans. Diabetes Care 2009;32(10):1812–1816.

[157] Haas L, Maryniuk M, Beck J, *et al*. National standards for diabetes self-management education and support. Diabetes Care 2012;35(11):2393-2401.