


## REVIEW PAPER

# Disparities in hypertension and cardiovascular disease in blacks: The critical role of medication adherence

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Blacks are two to three times as likely as whites to die of preventable heart disease and stroke. Declines in mortality from heart disease have not eliminated racial disparities. Control and effective treatment of hypertension, a leading cause of cardiovascular disease, among blacks is less than in whites and remains a challenge. One of the driving forces behind this racial/ethnic disparity is medication nonadherence whose cause is embedded in social determinants. Eight practical approaches to addressing medication adherence with the potential to attenuate disparities were identified and include: (1) patient engagement strategies, (2) consumer-directed health care, (3) patient portals, (4) smart apps and text messages, (5) digital pillboxes, (6) pharmacist-led engagement, (7) cardiac rehabilitation, and (8) cognitive-based behavior. However, while data suggest that these strategies may improve medication adherence, the effect on ameliorating racial/ethnic disparities is not certain. This review describes the relationship between disparities and medication adherence, which likely plays a role in persistent disparities in cardiovascular morbidity and mortality.

## 1 | INTRODUCTION

Along with disparities in morbidity and mortality of cardiovascular diseases (CVDs), persistent differences in adherence to pharmacotherapy have been observed among racial/ethnic subgroups of the United States.<sup>1</sup>

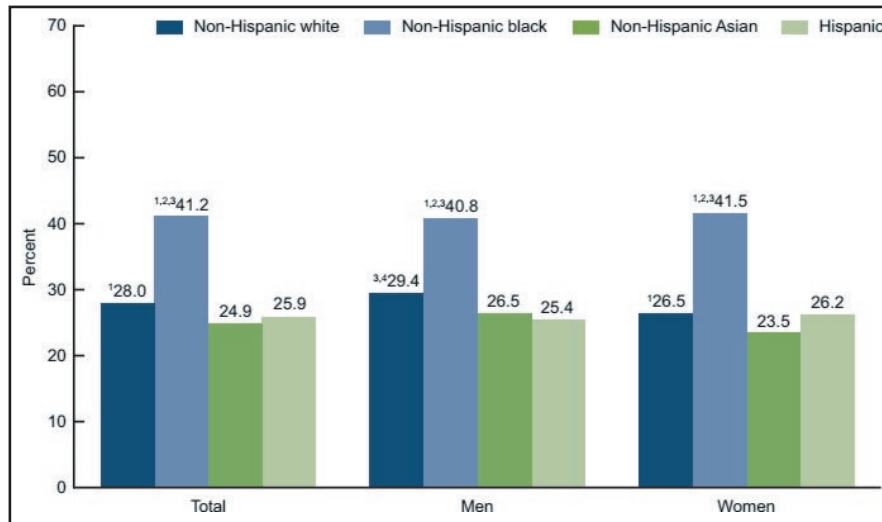
In 2011–2014, the prevalence of hypertension among black (41.2%) adults was higher than among non-Hispanic white (28.0%), non-Hispanic Asian (24.9%), and Hispanic (25.9%) adults (Figure 1). In addition, hypertension prevalence among blacks was among the highest in the world despite no definitive genetic factors with blacks having higher average blood pressures (BPs) compared with whites.<sup>2</sup> In the National Health and Nutrition Examination Survey (NHANES) 2011–2012, hypertension awareness and treatment rates were greater but control rates were lower in black patients compared with non-Hispanic whites (85.7% vs 82.7% for awareness, 77.4% vs 76.7% for treatment, and 49.5% vs 53.9% for control, respectively) (Figure 2).<sup>3</sup> According to the most recent data, the control and effective treatment of hypertension among blacks is less than in whites and remains a challenge.<sup>4</sup> A potential cause of this finding is

based on evidence from six studies showing a positive relationship between ambulatory BP (particularly at night) and reports of social injustice,<sup>5</sup> attesting to the multicomponent nature of racial healthcare disparities.

Medication nonadherence is a leading cause of inadequate hypertension management leading to CVD, stroke, and chronic kidney disease.<sup>1</sup> Approximately 50% of patients with CVD have suboptimal adherence to their prescribed medications, with deleterious effects on morbidity, mortality, and healthcare costs.<sup>6,7</sup>

When compared with white patients, blacks are disproportionately afflicted by poor adherence to cardiovascular medications, such as angiotensin-converting enzyme inhibitors,  $\beta$ -blockers, and statins,<sup>8–12</sup> even in environments with equitable access to prescription drugs.<sup>13</sup> However, despite multiple approaches to enhance adherence, there is no single intervention or strategy that has proven effective across all patients and health systems.<sup>14</sup>

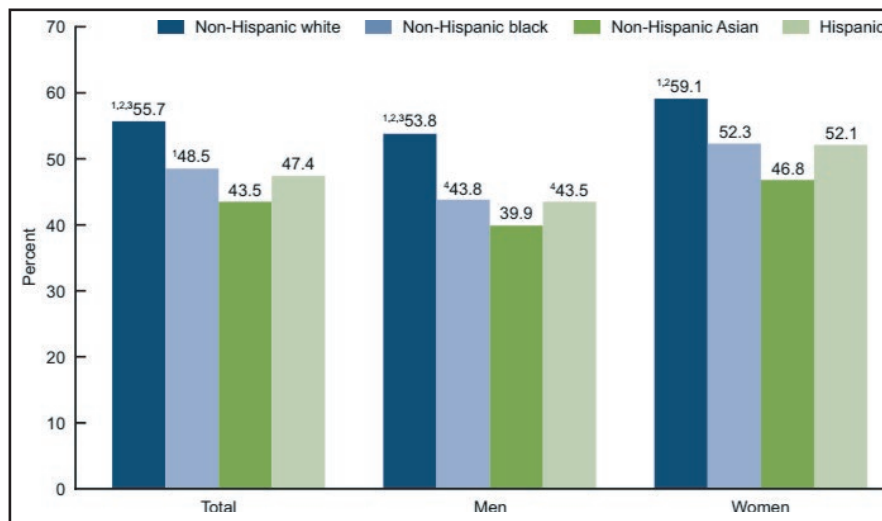
A retrospective study evaluated hypertension registries in an inner-city healthcare delivery system (N=17 176) and a health maintenance organization (N=94 297) to develop clinical prediction rules for



**FIGURE 1** Prevalence of hypertension among adults aged 18 and over, by sex and race and Hispanic origin: United States, 2011-2014.

<sup>1</sup>Significant difference from non-Hispanic Asian. <sup>2</sup>Significant difference from non-Hispanic white. <sup>3</sup>Significant difference from Hispanic.

<sup>4</sup>Significant difference from women in same race and Hispanic origin group. Note: Estimates are age-adjusted by the direct method to the 2000 U.S. census population using age groups 18-39, 40-59, and over; see reference 9. Source: Centers for Disease Control and Prevention/National Center for Health Statistics, National Health and Nutrition Examination Survey, 2011-2014. <https://www.cdc.gov/nchs/data/databriefs/db220.pdf>



**FIGURE 2** Prevalence of controlled hypertension among adults with hypertension aged 18 and over, by sex and race and Hispanic origin: United States, 2011-2014.

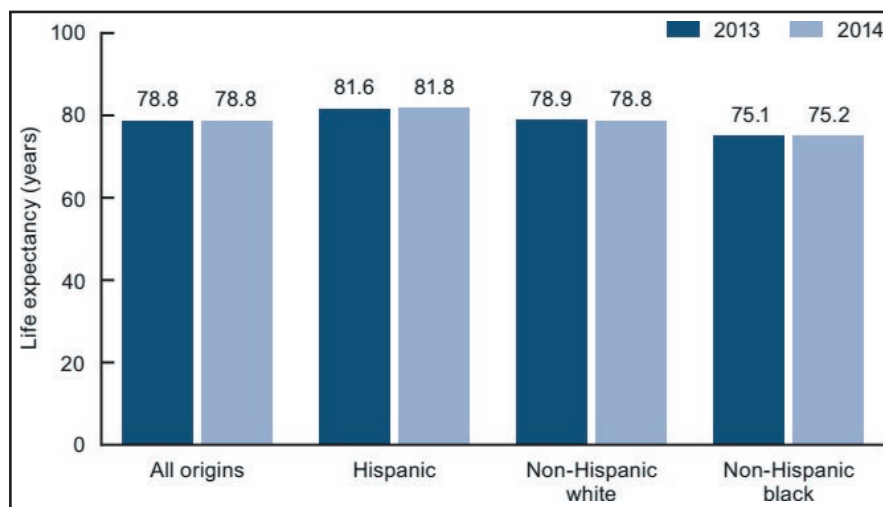
<sup>1</sup>Significant difference from non-Hispanic Asian. <sup>2</sup>Significant difference from non-Hispanic black. <sup>3</sup>Significant difference from Hispanic. <sup>4</sup>Significant difference from women in same race and Hispanic origin group.

Note: Estimates are age-adjusted by the direct method using computed weights based on the subpopulation of persons with hypertension in the 2001-2012 National Health and Nutrition Examination Survey; see reference 7. Source: Centers for Disease Control and Prevention/National Center for Health Statistics, National Health and Nutrition Examination Survey, 2011-2014. <https://www.cdc.gov/nchs/data/databriefs/db220.pdf>

adherence with antihypertensive medications.<sup>15</sup> In these populations, only 36% of the total number of patients were adherent. Adherent patients were likely to be older, white, married, and acculturated in US society; to have diabetes mellitus or cerebrovascular disease; to not abuse alcohol or controlled substances; and to be prescribed fewer than three antihypertensive medications. Although sociodemographic characteristics or clinical diagnoses were statistically associated with adherence, the combination of these characteristics was

not sufficiently accurate to allow clinicians to predict whether their patients will be adherent to treatment.

Solomon and colleagues<sup>16</sup> recently demonstrated a strong association between medication-taking consistency, medication adherence, and BP control in black patients with hypertension representing a lower socioeconomic cohort. Younger black patients were more likely to have variable medication-taking routines and thus lower adherence to treatment compared with older black patients. Notably, the findings



**FIGURE 3** Life expectancy at birth, by race and origin: US, 2013 and 2014. Note: Life expectancies are based on death rates that have been adjusted for race and Hispanic origin misclassification on death certificates (reference 1 in report). Arias E. United States life tables, 2011. National vital statistics reports; vol 64, no 11. Hyattsville, MD: National Center for Health Statistics; 2015. Source: Centers for Disease Control and Prevention/National Center for Health Statistics, National Vital Statistics System, Mortality Public domain. No permission needed. Access data table for Figure 1 at: <http://www.cdc.gov/nchs/data/databriefs/db244.pdf>

also demonstrated that most sociodemographic characteristics were not associated with adherence and better BP control, thus attesting to the multifactorial nature of BP control.

While medication nonadherence is a major patient-related factor in inadequate BP control in all populations, there are several physician or provider factors that may significantly undermine hypertension treatment, including therapeutic inertia and confusion over the many medications and combination therapies available for use.<sup>17</sup> More time should be spent strategizing with patients about adherence issues, emphasizing the importance of maintaining routines, discussing belief systems and barriers that stand between patients and effective BP control. Team-based care involving nonphysician providers along with innovative strategies appear to assist with adherence.<sup>18</sup>

Over recent decades, dramatic improvements in US CVD mortality, life expectancy, and overall health care have not occurred equally across race/ethnic groups. At least 200 000 deaths from heart disease and stroke each year are preventable, and blacks are nearly twice as likely as whites to die of preventable heart disease and stroke.<sup>19</sup> The 2013–2014 life expectancy was consistently lowest in non-Hispanic blacks at birth and at age 65 years, primarily driven by higher hypertension and CVD mortality (Figure 3). In consideration of these unacceptable gaps in morbidity and mortality, absent significant biologic explanation, it is beneficial to focus on the potential critical contribution of nonadherence, mediated by social determinants, as an underlying contributor to suboptimal BP and CVD risks control.

Although health disparities in the United States are not limited to race, racial/ethnic disparities are well documented and persistent, with evidence of earlier onset and greater severity of disease at various levels of socioeconomic status.<sup>20</sup> These differences may be noted even after controlling for health insurance, socioeconomic status, stage and

severity of disease, comorbidity, and the type of medical facility.<sup>21</sup> This review examines persistent racial disparities and the impactful role of medication adherence in support of a critical public health mission: decreasing CVD among subpopulations and high-quality monitoring of population BP levels and hypertension prevalence, diagnosis, treatment, and control pursuant to the Scientific Statement from the American Heart Association on the Social Determinants of Risk and Outcomes for Cardiovascular Disease.<sup>5,22</sup>

## 2 | METHODOLOGY

We systematically searched PubMed, ERIC, and the Cochrane Database of Systematic Reviews for English-language articles published in peer-reviewed journals between 2014 and 2016, using the search terms medication adherence and racial disparity in blacks. Our search was focused on recent literature to emphasize the current status of the disparity issues. We then cross-searched the reference lists of these studies to identify additional older studies that were used in our review if considered significant and contributory to our evaluation of the current state.

## 3 | RESULTS

Our review identified social determinants (ie, patient-provider communication and socioeconomic status) as key parameters that affect adherence and disparity (Table 1) and eight practical approaches addressing medication adherence with the potential to attenuate disparities (Table 2): (1) patient engagement, (2) consumer-directed health care, (3) patient portals, (4) smart apps and text messages, (5) digital pillboxes and pill bottles, (6) pharmacist-led engagement, (7) cardiac rehabilitation, and (8) cognitive-based behavior.

**TABLE 1** Findings on social determinants affecting medication adherence and disparity

First author (Year)	Social determinants	Key finding	Conclusion	Reference
Buckley (2016)	Patient-provider communication	Black health beliefs concerning hypertension may differ from those of healthcare providers and other ethnicities	Reconciliation of differences between patient and provider expectations for disease management may improve adherence to medical treatments among black patients with hypertension	23
Cohen (2015)	Socioeconomic status	In order to save money, almost 8% of US adults aged 18 and older did not take medication as prescribed	Belief that the recommended pharmacotherapy is needed and an understanding of the recommended treatment have been found to be lower among older adults who are economically vulnerable, compared with those with higher income	24
Mulcahy (2016)		Uninsured people who gained private coverage filled, on average, 28% more prescriptions and had 29% less out-of-pocket spending per prescription in 2014 compared with 2013	By reducing financial barriers to care, the Affordable Care Act has increased treatment rates while reducing out-of-pocket spending, particularly for people with chronic conditions	25
Rolnick (2013)		Overall, adherence rates were higher for those living in higher socioeconomic areas and for whites. Those in the lowest quartile of the living area variables (education, poverty, income) had lower drug adherence than those in other quartiles	There are variable adherence rates by condition, and, in a population with prescription coverage offering multiple avenues with which to obtain medications, the findings pointed to the need to consider additional efforts to boost adherence rates	26
Hussein (2015)		Part D introduction was associated with a 16-percentage-point decrease in the white-Hispanic disparity in achieving 80% adherence to cardiovascular medications, but with no significant net change in white-black disparities	Proactively taking the needs of vulnerable populations into account when designing policies, such as Part D, is paramount to prevent unintended disparity consequences	27
Ferdinand (2017)		Socioeconomic factors that adversely affect adherence include poverty, illiteracy, unemployment, lack of social support networks, unstable living conditions, greater distance from treatment centers, higher out-of-pocket cost of medications and care, lack of transportation, cultural beliefs reflecting mistrust in the healthcare system, and family dysfunction	Efforts to alter nonadherence on an individual or a population level must take into account community dynamics that affect the environment in which individuals make decisions about adherence	28

### 3.1 | Social determinants of disparities and nonadherence

#### 3.1.1 | Patient-provider communication

Although unscientific health beliefs are common, structured patient belief assessments may assist with identifying discordant beliefs. A systematic review of 22 studies, including 6516 participants, demonstrated that the perception by blacks that hypertension was episodic and symptomatic led to infrequent medication use.<sup>23</sup> Reconciliation of differences between patient-provider understanding as well as cultural differences, may improve adherence and acceptance of medical treatments among black patients with hypertension.<sup>23</sup>

Between 2002 and 2013, person-centered care disparities in patients who reported poor communication with healthcare providers persisted and were driven by race and financial income despite

an overall trend in improvement (Figure 4). The percentage of adults who reported substandard communication with health providers significantly decreased for whites, Hispanics, and all income groups. However, there were no statistically significant changes among blacks for the same time period.

#### 3.1.2 | Socioeconomic status

Socioeconomic status has a profound impact on CVD morbidity, mortality, and medication adherence. Among the 7.8% of US adults who did not take their medication as prescribed to save money, the poorest adults were most likely to be nonadherent.<sup>24</sup> The geographic distribution of preventable death from CVD and stroke was skewed with significantly higher death in southeastern states (Figure 5). The higher preventable mortality in these areas was driven primarily by adverse social determinants of health and

**TABLE 2** Findings on practical approaches to address adherence and disparity

Practical approaches	Author (Year)	Key finding	Conclusion	Reference
Patient engagement	Ferdinand (2017)	Patient engagement via communication with the patient in a literacy-sensitive manner is a significant parameter	Approaches for enhancing adherence are multifaceted, requiring the participation of governmental agencies, academia, and organizations devoted to optimizing health care	28
	Scott (2010)	Studies demonstrate that by engaging the patient and forming collaborative relationships, healthcare professionals can significantly influence adherence	It is crucial that programs targeted to improve adherence are customized in a manner meaningful to the specific population being addressed	29
	Barello (2015)	Active patient engagement in decision making about care, in which both physicians and patients exchange information, communicate expectations and preferences, share values, and make decisions together (eg, shared decision making) has been widely recommended by clinical guidelines	The People Health Engagement (PHE) model uses engagement phases the patients are passing through to successfully communicate with them and to promote high-quality and satisfying clinical consultations and effective treatment plans	30
	Schiff (2016)	For patients to understand and adhere to their medication regimens, they need to know the reason each medication is being prescribed. Having this knowledge has been shown to be associated with better adherence and fewer errors	Incorporating indications into prescriptions represents an opportunity for improving the safety and quality of prescribing, thereby personalizing and improving medication use	31
Consumer-directed health care	Kuntz (2014)	Multiple interventions demonstrated improvements in adherence over the follow-up period; however, since average follow-up was <1 y, the optimal length of time over which an intervention should be implemented or the sustainability of intervention effects over time was uncertain	Evidence supporting overall effectiveness of interventions was sparse, thus it is unclear whether patient-centered medication management interventions represent an improvement over more traditional medication adherence interventions	32
	Gibson (2011)	The effects of the value-based insurance design program for cardiovascular medications revealed a significant increase in medication adherence and prescription fills when measured across all enrollees	After 3 y, people enrolled in the value-based insurance program significantly improved their adherence to medication regimens and that costs for the company were revenue-neutral	33
Patient portals	Graetz (2016)	Asians and blacks were less likely than whites to access the internet through their own computer, whereas no statistically significant race/ethnic difference was found regarding access of the internet through a mobile device. (This is in keeping with the findings of a recent census survey that fewer black Americans have access to the internet at home compared with white non-Hispanics, but that use of smartphones is similar across both groups)	Although universal internet access could help mitigate some disparities in portal use, it is equally important to address gaps in use of patient portals to communicate with healthcare providers that may be related to limited health or computer literacy skills, potentially through the use of more user-friendly technology interfaces and health information that is easily understood by broad audiences	34
Smart apps and text messages	Widmer (2014)	Digital health has a beneficial effect on cardiovascular disease risk factors and outcomes	Digital health interventions were associated with improvement in risk factors for cardiovascular disease in primary studies, suggesting the potential for a positive impact of digital health interventions in a wide variety of participants and settings	35
	Thakkar (2016)	Text message interventions increased medication adherence, with an approximate doubling of the odds of patients achieving adherence to their medication regimens	Mobile telephone text messaging increased adherence to taking medications among middle-aged patients with chronic disease	36
Digital pillboxes and bottles	Inoue (2016)	The use of both the electronic (GlowCap, NantHealth) method and medication possession ratio showed that the median adherence rate for the 12 patients evaluated was 85%	The GlowCap system is a reliable way to obtain accurate adherence rates and enhance medication adherence	37

(Continued)

TABLE 2 (Continued)

Practical approaches	Author (Year)	Key finding	Conclusion	Reference
Pharmacist-led engagement	Anderegg (2016)	After 9 mo of a pharmacist-based intervention, mean systolic blood pressure was found to be 7.3 mm Hg (95% confidence interval, 2.4–12.3) lower in patients from racial minority groups who received the intervention compared with the control group ( $P=.0042$ )	A pharmacist intervention reduced racial and socioeconomic healthcare outcome disparities in mean systolic blood pressure	38
Cardiac rehabilitation	Doll (2015)	Participants in cardiac rehabilitation were more likely to be adherent to prescribed evidence-based medications. Increasing the number of sessions was associated with higher rates of adherence, even after adjustment for clinical variables	A positive association of cardiac rehabilitation and medication adherence highlights the importance of cardiac rehabilitation in secondary prevention	39
	Brady (2013)	Certain patient groups, such as women, older patients, and those with limited English-language proficiency may be less likely to receive a referral to cardiac rehabilitation, despite the greater need and demonstrated benefit	Older patients, those with limited English-language proficiency, and patients with complex comorbidities, uncontrolled risk factors, and more severe disease are at greatest risk of going unreferred by their physicians	40
Cognitive-based behavior	Lundahl (2013)	Motivational interviewing demonstrated a statistically significant and positive impact on a range of outcome measures of interest to medical providers (eg, mortality, cholesterol level, blood pressure, and body weight)	Motivational interviewing was effective across moderators such as delivery location and patient characteristics and seems successful when delivered in brief consultations	41

correlated with Centers for Disease Control and Prevention socio-environmental maps of poverty, unemployment, education, and lack of health insurance.

The Affordable Care Act has expanded US health insurance coverage, with as much as a 30% reduction in the proportion of this population that was uninsured in 2014 compared with 2013. Furthermore, uninsured people who gained private coverage filled, on average, 28% more prescriptions and had 29% less out-of-pocket spending per prescription.<sup>25</sup> Therefore, for chronic conditions, access to health insurance appeared to reduce financial barriers to care and increase treatment rates. Overall, medication adherence was higher in men, whites, older patients, and those living in areas with higher education rates and higher income.<sup>26</sup>

The Medicare Part D program offers a generous federal subsidy to individuals below 150% of the federal poverty line. Overall, the introduction of Part D was associated with a 16%-percentage-point decrease in the white-Hispanic disparity in achieving 80% adherence to cardiovascular medications, but with no significant net change in white-black disparities. Among seniors, however, average adherence actually worsened 11 percentage points ( $P<.001$ ) more among blacks relative to their white counterparts.<sup>27</sup> The likely reason for these findings is the multifactorial nature of medication adherence and its impact on racial disparity.<sup>28</sup>

## 4 | PRACTICAL APPROACHES TO ADDRESS MEDICATION ADHERENCE WITH THE POTENTIAL TO ADDRESS RACIAL DISPARITIES

### 4.1 | Patient engagement to address disparities and nonadherence

Adherence improves when providers engage patients in their health care, and patients are better educated, informed, and interactive in making healthcare decisions best suited to them.<sup>29</sup> However, patient engagement may be a more difficult goal among minorities.<sup>30</sup>

In the modern era of transparent, patient-centered medicine and shared decision making, indications-based prescribing has multiple potential benefits, including, but not limited to, improving medication safety and enhanced healthcare team communication.<sup>31</sup> Patients who have optimal knowledge about their medications demonstrate better adherence and fewer errors.<sup>32</sup> To enhance knowledge, the US Food and Drug Administration's efforts are focused on ways in which regulatory strategies, labeling, and patient information can interdigitate with healthcare delivery to improve medication adherence.<sup>28</sup>

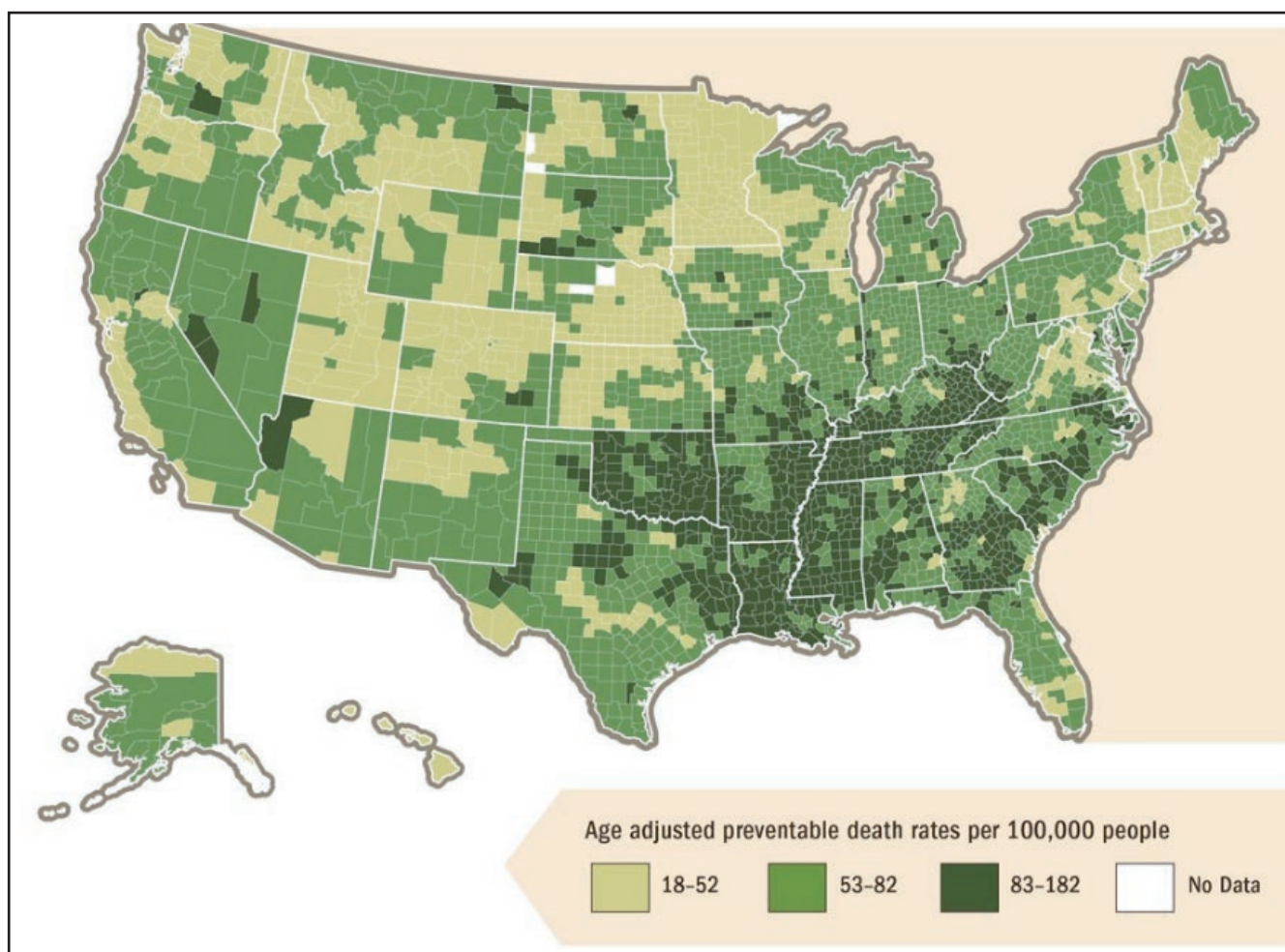
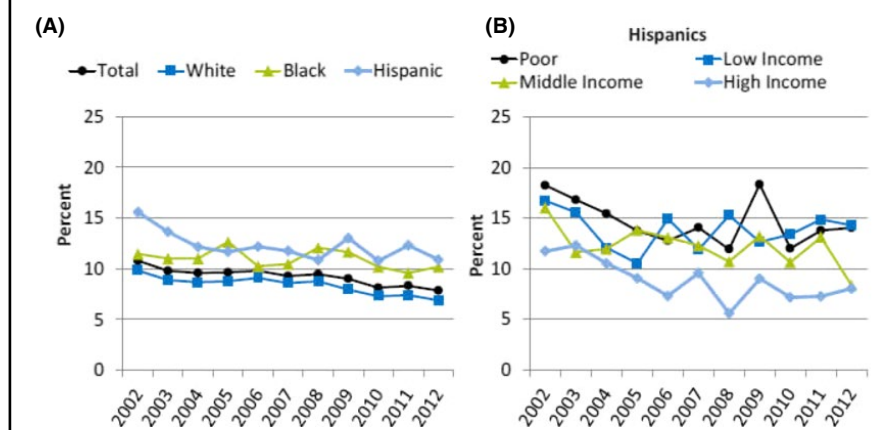
### 4.2 | Consumer-directed health care: an emerging concept

Consumer-directed health care promotes cost sharing and encourages consumers to be engaged in their care, becoming more informed



Adults who had a doctor's office or clinic visit in the last 12 months who reported poor communication with health providers, by race/ethnicity and by income among Hispanics, 2002-2012

**FIGURE 4** Disparities in person-centered care. Panel (A) depicts racial differences in patients reporting poor communications with health provider, over a period of 10 years from 2002-2012. Panel (B) depicts differences in Hispanic patients reporting poor communications with health provider, based on income over a period of 10 years from 2002-2012. Source: Agency for Healthcare Research and Quality, Medical Expenditure panel survey, 2002-2012



**FIGURE 5** National Vital Statistics System, US Census Bureau, 2008-2010. View more maps at the Interactive Atlas for Heart Disease and Stroke: <http://nccd.cdc.gov/DHDSPAtlas/>

and making smarter decisions when accessing healthcare services. Insurers or employers make available evidence-based drugs at little or no cost. In a retrospective observational study of employees from a large global pharmaceutical firm, prescription medication use rose 5% per enrollee across the entire enrolled population and increased

use was most evident for patients taking cardiovascular medication. Although not detailed by race/ethnicity, importantly, by the third year, cardiovascular medication adherence was 9.4% higher.<sup>33</sup> Based on findings from social-determinant evaluation, it is uncertain whether this emerging concept will ameliorate disparities.

### 4.3 | Patient portals and electronic health records

Increasingly, electronic health records feature patient portals that allow patients, among many other options, to request prescription refills, saving time and money.<sup>34</sup> Overall, limited access to a personal computer or means to connect with the internet for utilization of health care was twice for blacks (46%) than for whites (21%).<sup>34</sup> Contemporary data also show significant racial variability in utilization of patient portals. Patient portals and electronic records are unlikely to reduce disparities if access to computers and patient education are not integrated into this strategy.

### 4.4 | Smartphone apps and text messages

For many patients, routine text messaging may be considered to enhance adherence. In a meta-analysis of randomized controlled trials published between 2005 and 2008, eight of nine interventions for disease prevention and management showed a positive short-term effect utilizing some form of automated reminders. Clearly, text messaging and mobile health technologies represent a unique opportunity to enhance medication adherence and healthcare outcomes. A key criterion for any adherence-enhancing intervention is that it should be tailored to address the root causes of nonadherence.

Mobile technology and associated health apps have gained popularity with a growing market in recent years. In a contemporary systematic review, digital health interventions, including mobile apps were significantly associated with improved CVD outcomes.<sup>35</sup> The main challenges to increase adherence and reduce disparities with these novel tools are ease of use, costs, and adoption by blacks and persons with low socioeconomic status. Text messaging appears to improve adherence and potential outcomes in all patient populations and, in a contemporary pooled analysis, it increased medication adherence rates from 50% to 67.8%.<sup>36</sup>

### 4.5 | Digital pillboxes and pill bottles

Digital pillboxes and pill bottles have already been shown to improve medication adherence by engaging patients in innovative ways. For instance, a wireless electronic pill bottle, which reminded patients with hypertension to take their medication by emitting light and sound, increased medication adherence by 27%, over the control group.<sup>37</sup> There are no data on racial disparities.

### 4.6 | Pharmacist-led engagement

Increasingly, pharmacist-led engagement has been shown to enhance patient adherence. Physician-pharmacist collaboration improves BP including patients with low incomes, those receiving Medicaid, or those without insurance. In a recent trial involving 32 medical offices in 15 states, a clinical pharmacist was embedded within each office and made recommendations to physicians and patients in intervention offices.<sup>38</sup> BP was lower at 9 months in both the control and intervention group in all sociodemographic categories when compared

with baseline. Over half of the patients were minorities (54.7%), with the majority of those being black (71%) and Hispanic (26%). Notably, there were trends for minority patients who received the intervention to have a lower BP than nonminority patients in the control group (3.8 mm Hg; 95% confidence interval, -7.9 to 0.4 [ $P=.5846$ ]). In addition, there was a significantly greater reduction in systolic BP in the intervention group of patients making <\$25 000 than the control group of patients making <\$25 000 (7.3 mm Hg; 95% confidence interval, 2.0–12.6 [ $P=.008$ ]). Thus, pharmacist intervention reduced racial and socioeconomic disparities in the treatment of BP.

### 4.7 | Cardiac rehabilitation

Patient engagement via cardiac rehabilitation improves outcomes, including mortality, and is associated with improved medication adherence in patients post myocardial infarction.<sup>39</sup> In an analysis of patients with Medicare Part D, the number of cardiac rehabilitation sessions attended was positively associated with improved medication adherence and lower cardiovascular risk over time.<sup>39</sup> Multiple studies have documented underutilization of cardiac rehabilitation in the general population and have also identified race as a significant factor contributing to underutilization.<sup>40</sup>

### 4.8 | Cognitive-based behavior

A promising approach is the use of cognitive-based behavior strategies such as motivational interviewing.<sup>41</sup> Motivational interviewing is direct, patient-centered counseling designed to stimulate patients for change by helping them recognize and resolve the discrepancy between their behavior, personal goals, and values.

## 5 | SUMMARY

Disparities in US health care availability, utilization, and outcomes related to race/ethnicity are persistent and unacceptable and an ongoing concern tied to economic status and communication deficiencies between the healthcare team and the patient. To date, adherence interventions have had limited impact, perhaps partly because of their one-size-fits-all model. Therefore, we recommend eight different approaches to address the multidimensional scope of medical adherence. Enhancing adherence is potentially an effective and efficient means of improving US health outcomes and addressing health disparities.

These approaches include patient engagement, consumer-directed health care, patient portals, smartphone apps, digital pillboxes and pill bottles, pharmacist-led engagement, cardiac rehabilitation, and cognitive-based behavior. All of the aforementioned new and emerging strategies and technologies must also be designed to ensure cultural acceptability, accessibility, and clinical effectiveness across the diverse populations served. The current data suggest that although these strategies may improve adherence and reduce racial/ethnic and socioeconomic disparities, the overall effect on racial/ethnic healthcare disparities is unknown.



## 6 | CONCLUSIONS

Racial, ethnic, and social determinants of health disparities in health-care outcomes require special attention toward improving population-based national health status. In parallel, efforts to improve adherence must also consider cultural preferences and differences. More focused research and better means to monitor and improve adherence are essential.

### DISCLAIMER

The opinions and content of this article do not necessarily reflect guidance or policies of the US Food and Drug Administration.

### AUTHORSHIP

All authors actively contributed to the conception, writing, and editing of this article with no outside writing assistance.

### CONFLICT OF INTEREST

Dr Cryer serves as consultant for Esperion Therapeutics. Dr Ferdinand received a grant from Boehringer Ingelheim and serves as consultant for Amgen, Sanofi, Boehringer Ingelheim, Quantum Genomics, Novartis, and Eli Lilly. Drs Senatore, Clayton-Jeter, Lewin, Nasser, and Yadav have nothing to disclose.

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