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Who Must We Target Now to Minimize Future CV Events and Total Mortality? Lessons from the SUPREME-DM Cohort Study

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Abstract

Background—Examining trends in cardiovascular events (CVE) and mortality in U.S. health systems can guide the design of targeted clinical and public health strategies to reduce CVE and mortality rates.

Methods and Results—We conducted an observational cohort study from 2005–2011 among 1.25 million diabetic subjects and 1.25 million nondiabetic subjects from 11 health systems that participate in the SURveillance, PREvention and ManagEment of Diabetes Mellitus (SUPREME-DM) DataLink. Annual rates (per 1000 person-years) of myocardial infarction/acute coronary

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Disclosures

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syndrome (MI/ACS; ICD-9 410.0–410.91, 411.1–411.8), stroke (ICD-9 430–432.9, 433–434.9), heart failure (HF; ICD-9 428–428.9), and all-cause mortality were monitored by diabetes status, age, sex, race/ethnicity, and a prior CV history.

We observed significant declines in CVE and mortality rates in subjects with and without diabetes. However, there was substantial variation by age, sex, race/ethnicity, and prior CV history. Mortality declined from 44.7 to 27.1 ($p<.0001$) for those with DM and CVD, from 11.2 to 10.9 ($p=.03$) for those with DM only, and from 18.9 to 13.0 ($p<.0001$) for those with CVD only. Yet, in the approximately 85% of subjects with neither DM nor CVD, overall mortality (7.0 to 6.8; $p=.10$) and stroke rates (1.6 to 1.6; $p=.77$) did not decline and HF rates increased (0.9 to 1.15; $p=.0005$).

Conclusions—To sustain improvements in MI, stroke, HF, and mortality, health systems that have successfully focused on care improvement in high risk adults with diabetes and/or CVD must broaden their improvement strategies to target lower risk adults who have not yet developed diabetes or CVD.

Keywords

diabetes mellitus; myocardial infarction; stroke; heart failure; public health surveillance

Myocardial infarction (MI), stroke, and heart failure (HF) continue to be the leading causes of excess morbidity and mortality in the United States and among the 21 million Americans with diagnosed diabetes.^{1–3} Cardiovascular disease (CVD) rates are persistently higher in people with diabetes compared to those without diabetes and among people with prior CVD compared to people with no known CVD history.⁴ Several studies in the U.S. and other developed countries have documented overall declines in MI, stroke, HF and all-cause mortality within the overall adult population over the last 20 years, although with substantial race-ethnic and geographic variation and, in some instances, stable or even increasing CVD rates depending on diabetes status, type of CVD, and other demographic factors.^{1,5–11} Despite the overall declines in CVD rates, recent projections indicate that rates and costs of CVD will increase over the next few decades.¹² Rates of diabetes are also projected to increase, potentially undermining the observed improvements in overall CVD rates.¹³ To limit future CVD burden through targeted clinical and public health interventions, it is important to better understand trends in CV events and mortality among specific population segments where improvement may be lagging or CV rates remain high.

While vital statistics provide reasonably accurate tracking of mortality trends in those with diabetes, surveillance of trends in CVD that relies entirely on hospital-based data does not have a defined population-based denominator.^{14–16} Increased use of electronic health data (EHD), particularly electronic medical record data linked with administrative claims data, can provide a powerful system for ongoing, timely, systematic monitoring of trends in CVD and mortality in those with and without diabetes within a defined population.^{16–20} Large health care systems with EHD are particularly well-suited to longitudinal surveillance of MI, stroke, and HF and where CVD rates in subpopulations are unavailable.

In this study, we use the SURveillance, PREvention, and ManagEment of Diabetes Mellitus (SUPREME-DM) Datalink to examine MI, stroke, HF, and all-cause mortality rates from

2005 through 2011 among subjects enrolled in 11 large integrated health systems providing care to 16 million insured members in 10 states.¹⁹ To better understand opportunities for CVD intervention, we examine trends among those with and without diabetes by demographic subgroups (i.e., age, gender, race/ethnicity) and prior CVD history.

METHODS

Study Setting, Design, and Data Sources

SUPREME-DM is a consortium of 11 organizations of the HMO Research Network (HMORN): Geisinger Health System (Pennsylvania), Group Health Cooperative (Washington), HealthPartners (Minnesota), Henry Ford Health System (Michigan), Marshfield Clinic (Wisconsin), and Kaiser Permanente regions in Colorado (KPCO), Northern California (KPNC), Southern California (KPSC), Hawaii (KPHI), Southeast (Georgia, KPGA), and Northwest (Oregon and Washington, KPNW). These organizations chose to join the SUPREME-DM network in 2009. Research institutions embedded in these organizations have developed a distributed virtual data warehouse that extracts and standardizes patient information across health systems on demographics, pharmacy dispensing and claims, laboratory tests and results, and coding from outpatient and inpatient care encounters.²¹ Members of these health systems receive insurance through group plans, self-pay, Medicare, and Medicaid or other publicly-supported programs. These data were used to construct the SUPREME-DM DataLink, the largest clinically detailed private-sector diabetes population in the United States.¹⁹ Using this database, we examined trends in annual CVD and death rates in adults with and without diabetes.

Study Population

Diabetic and matched non-diabetic subjects were identified beginning January 1, 2003 and had to be enrolled within a participating health system for at least 6 months before entering the DataLink. The study period was January 1, 2005 through December 31, 2011. A subject had to be at least 20 years of age to enter the study. Thus, a subject could be enrollment eligible but not enter the study until turning 20 years of age.

Ascertainment of Diabetes and Matched Controls

We used inpatient and outpatient primary and secondary diagnosis codes, laboratory results, and pharmacy data within a 24 month time period to classify a person as having diabetes if they had: (a) one or more inpatient diabetes diagnosis based on the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes 250.x, 357.2, 366.41, or 362.01–362.07. or (b) any combination of two or more of: 1) HbA1c 6.5%; 2) fasting plasma glucose 126mg/dl; 3) random plasma glucose 200mg/dl; 4) outpatient visit diabetes diagnosis codes (same codes as for inpatient); or 5) any filled prescription for a glucose-lowering medication. When the two criteria used for identification were of the same source (e.g. two outpatient diagnoses or two elevated laboratory values), we required they occur on separate days but no more than two years apart. Patients with two dispenses of metformin or thiazolidinediones with no other indication of diabetes were not included because these agents could be treatments for pre-diabetes, polycystic ovarian syndrome, or HIV lipodystrophy. Women during pregnancy were also excluded from

diabetes identification. If two qualifying criteria were used to identify the diabetic subject, the date of the second event was used as the diabetes identification date. Similar methods accurately identify diabetes in various settings including several of our study sites.^{17,20} Our method may identify individuals with undiagnosed diabetes but it does not distinguish between Type 1 and Type 2 diabetes.

We frequency matched diabetic subjects with nondiabetic subjects by health care system, year of initial diabetes identification, sex, and within a 5-year age range. This was done annually to account for new diabetes cases originating from entering the source population and from new diabetes cases originating from the existing source population. If a subject in the control group developed diabetes, he/she was reclassified as a case.

Study Exposure Variables

Age, sex, and self-reported race/ethnicity (Asian, Black, Hispanic, and White) were based on EHD records. Subjects self-reporting Hispanic origin were categorized as Hispanic and, therefore, the other race/ethnic categories were non-Hispanic. American Indian/Alaskan Native and Native Hawaiian/Pacific Islander were also examined but the sample size was too small for stable estimates over time. Approximately 17% of the sample had unknown race/ethnicity and were excluded from the race/ethnicity analysis. While there is variability in unknown race/ethnicity by site, 76% of subjects are from sites with less than 15% unknown race/ethnicity information. Prior CVD was defined by at least two outpatient or one inpatient encounter with primary or secondary diagnosis for congestive heart failure, coronary artery disease, cerebrovascular accident, dysrhythmia, or other cardiac event (ICD-9 404.x1, 410–414, 420–421, 423–424, 426–427, 429, or 430–438) before January 1 of each calendar year of analyses. A subject could have up to 8 years of prior health information but almost all cases of prior CV history were ascertained with 18 months of data.

Study Outcome Variables

Major cardiovascular events (CVE) were ascertained using principal inpatient diagnoses codes for myocardial infarction/acute coronary syndrome (MI) ICD-9 codes 410.0–410.9 and 411.1–411.8, stroke ICD-9 codes 430–432.9 and 433–434.9 and heart failure (HF) ICD-9 codes 428–428.9. Similar methods have shown good positive predictive value.^{5,22,23} A participant could have multiple CVEs in a calendar year if such events occurred at least 7 days apart. All-cause mortality from 2005 to 2010 was determined using State death registries supplemented with internal EHR and claims data. One site used the National Death Index. Cause specific mortality was not uniformly available and thus is not included in these analyses.

Analyses

Major CVE and all-cause mortality rates per 1,000 person-years were calculated annually for the diabetic and non-diabetic subjects from each study site using total person-years as the denominator and the number of events as the numerator. For each calendar year, person-time was calculated by adding days of enrollment, stratified by diabetes status, age groups, sex, and race/ethnicity. Person-time for subjects with enrollment breaks of more than 90 days is

excluded. Person-time was truncated for subjects on the date of disenrollment, death, or conversion to diabetes. Event rates were standardized to the 2010 census age and gender population distribution to facilitate comparison with other national surveillance studies. To examine the annual absolute and relative change of major CVE and all-cause mortality rates, a Poisson regression model with logarithm link was fitted. The model included fixed effects of the covariate of interest, site, time as a continuous variable, and the 'covariate x time' interaction with number of events as dependent variable and natural log of person-year as offset. Generalized estimation equations with a compound symmetry covariance structure were used to account for the non-independence of observations by site.²⁴ Presented rate changes and reductions over time are based on the regression analyses results. Analyses were conducted using SAS version 9.2 (SAS Institute Inc., Cary, NC).

Protection of Human Subjects

This study was approved by the KPCO institutional review board (IRB), and each participating site either ceded oversight to the KPCO IRB or received approval from their local site IRB.

RESULTS

The study included almost 10 million person years of observation contributed by 1,256,537 unique diabetic subjects and 1,243,276 non-diabetic subjects, frequency matched on age and sex (Table 1; Table S1). At study entry, mean age was 59 ± 14 years. Compared to those without diabetes, those with diabetes included more Hispanics (19.1% vs 12.3%), fewer Whites (43.9% vs 53.2%), and a greater proportion with baseline CVD (16.7% vs 11.0%). Unknown race/ethnicity information declined over time as did the prevalence of prior CVD history (Table S1).

Overall Temporal Trends by Diabetes Status

Major CVE rates and all-cause mortality declined substantially from 2005 through 2011 (Figure 1; Table S2). Myocardial infarction/acute coronary syndrome (MI) rates dropped annually by 7.0% (95% CI: 5.9–8.1%) and 6.0% (95% CI: 4.6–7.3%) in people with and without diabetes representing overall relative reductions of 35% and 31%, respectively. Stroke declined annually by 3.4% (95% CI: 2.8–3.9%) and 2.2% (95% CI: 1.5–3.0%) for overall reductions of 19% and 13%, respectively. Annual heart failure (HF) hospitalization rates fell 5.2% (95% CI: 4.7–5.7%; 28% overall reduction) in people with diabetes and 2.8% (95% CI: 1.7–4.0%; 16% overall reduction) in those without diabetes. All-cause mortality declined 20% and 17% in the diabetic and non-diabetic populations. The rates of decline were significantly greater in the diabetic population for stroke ($p < 0.02$) and HF ($p < 0.001$) but similar for MI and all-cause mortality. Overall rate reductions of MI, stroke, HF, and all-cause mortality were 3.0, 2.4, 7.8, and 2.3 times greater for people with diabetes than for people without diabetes. Despite this MI, stroke, HF, and all-cause mortality remained 1.8 – 3.9 fold higher in diabetic subjects.

Temporal Trends by Diabetes Status and Prior History of Cardiovascular Disease

Regardless of diabetes status, subjects with a prior history of CVD had significant decreases in rates of MI, stroke, and HF from 2005 to 2011. Among subjects without a prior history of CVD, annual rate reductions were less than half as rapid for MI, while there was no improvement in stroke rates and even slight rate increases in HF (Figure 2, Table S3). In people with diabetes and a prior CV history, MI rates declined from 15.8 to 8.4 per 1,000 person-years, stroke declined from 9.5 to 6.7 per 1,000 person-years and HF declined from 38.7 to 18.2 per 1,000 person-years. These represent overall relative declines of 49%, 27%, and 55%, respectively. All-cause mortality rates in subjects with a prior history of CVD declined an overall 41% in people with diabetes and 28% in those without diabetes. There was little all-cause mortality improvement among subjects with no prior CV history (Figure 2; Table S3). When stratifying by age group (20–44 years, 45–64 years, 65 years and older), trends of greater improvement in subjects with a prior CVD history remained, especially for stroke, HF, and all-cause mortality (Table S4) and often with little or no improvement in subjects with no prior CVD history. Improvement trends in MI rates by prior CVD status were similar among subjects 65 years of age and older and there was variability among the younger adults likely due to reduced sample sizes. Despite improvements among subjects with a prior CV history, 2011 event rates remained 2–4 times higher compared to subjects without a prior CV history. Interestingly, 2011 rates were similar among subjects with diabetes and no prior CV history and subjects without diabetes and a prior CV history for MI (3.51 vs 3.56 per 1,000 person-years), stroke (3.24 vs 3.29 per 1,000 person-years), and HF (4.31 vs 4.83 per 1,000 person-years) (Figure 2, Table S3).

Temporal Trends by Diabetes Status and by Age and Sex

Men and women, with and without diabetes, experienced relative rate reductions of 29–38% for MI, 10–20% for stroke, 12–28% for HF, and 17–20% for all-cause mortality (Table S2). However, compared to women, men experienced slightly higher rates of MI, stroke, and HF although this attenuated from 2005 to 2011 (Table S2). Cardiovascular event rates in men and women with diabetes remained 2–4 times higher compared to those without diabetes.

As expected, rates of CVE and all-cause mortality increased with age and were persistently higher in people with diabetes, especially for HF (Table S5). The greatest absolute CVE declines were in subjects 65 years of age and older. In 20–44 year old diabetic subjects, small but significant annual rate changes were observed from 2005 to 2011 for MI (–4.8%, $p=0.0027$), stroke (–3.7%, $p=0.0037$), and HF (–4.9%, $p=0.0002$). There were no significant improvements in MI, stroke, and HF among 20–44 year old non-diabetic subjects.

Temporal Trends by Diabetes Status and by Race and Ethnicity

Among the diabetic population, MI rates were similar for Whites, Blacks, and Hispanics but lower for Asians (Figure 3; Table S6). However, all racial and ethnic groups experienced similar overall relative rates of decline in MI ranging from 31 – 37% and absolute rate decreases from 1.8 – 2.5 per 1,000 person-years. Significant MI rate reductions were also observed in the non-diabetic population ranging from 26–30% (Table S6).

Reduction in stroke rates from 2005 through 2011 was variable by race/ethnicity. Stroke was highest among Blacks with essentially no change over time for the Black diabetic population and a 9% decline in the Black non-diabetic population (Figure 3; Table S6). In subjects with and without diabetes, stroke rates fell 16% and 14%, respectively, in Whites and 26% and 10% in Hispanics. Among Asians, stroke rates fell 11% in those with diabetes but increased 9% in those without diabetes, although neither of these changes was significant (Figure 3; Table S6).

In people with diabetes, HF rates in 2011 were twice as high for Blacks (12.1–17.6 per 1,000 person-years) as Whites (6.2–8.8 per 1,000 person-years) and Hispanics (6.6–8.9 per 1,000 person-years) while Asians had the lowest rates (4.0–4.7 per 1,000 person-years). Whites, Blacks, and Hispanics with diabetes saw overall reductions of 27–29% in HF hospitalization rates, but only a 5% decline was observed in Asians (Figure 3). In the non-diabetic populations, rate reductions were 15% for Whites, 9% for Hispanics, and 7% for Asians. There was a non-significant relative rate increase of 12% for non-diabetic Blacks. All-cause mortality rates decreased overall by 12–21% for diabetic Whites, Blacks, Hispanics, and Asians. Among non-diabetics, only Hispanics experience a significant decrease in all-cause mortality (Table S6).

DISCUSSION

Summary of Results

We observed substantial and sustained declines in the rates of myocardial infarction/acute coronary syndrome (MI), stroke, heart failure (HF), and all-cause mortality among insured adults with and without diabetes receiving care at 11 integrated U.S. health care delivery systems from 2005 to 2011. Stroke and HF rates declined significantly more rapidly in people with diabetes than in people without diabetes, while rates of decline were similar for MI and all-cause mortality.

We found substantial variability in CVE rates and rate changes by gender, age, race/ethnicity, and prior CV history. While rate reductions occurred in both men and women, CVE rates remained higher in men than in women irrespective of diabetes status. We also observed CVE rate decreases across all age groups for diabetic subjects. This was not the case for non-diabetic subjects, where CVE rates remained stable among the 20–44 year olds as did stroke and HF rates among those 65 years of age and older. Racial and ethnic variation was evident with Blacks having the highest CVE and mortality rates and Asians having the lowest among those with diabetes. These disparities remained over time, despite rate reductions in MI and HF. In fact, stroke rates for diabetic Blacks and diabetic Asians did not change from 2005–2011. Although CVE rates and mortality were lower among non-diabetic subjects, similar racial and ethnic disparities persisted over time.

Of particular interest is the sharp decline in CVE rates among patients with a prior CV history. In our study, CVE rate reductions among people with a prior CV history comprise the majority of the total CVE and all-cause mortality rate decline in subjects with and without diabetes. In fact, in persons with and without diabetes but with no prior CV history, minimal rate decreases and even slight rate increases were observed for stroke, HF, and all-

cause mortality. Our findings are consistent within age strata further illuminating the role of secondary prevention in driving overall observed improvements in CVE and all-cause mortality.

Studies of Temporal Trends in Cardiovascular Disease

Surveillance of CVE within subgroups of individuals with diabetes in the U.S. has been limited.^{1,5,11,16,25} Significant declines in MI and stroke from 1990 to 2010 have been reported by diabetes status, age groups, and for Whites and Blacks.^{1,11} Our findings are similar, showing declines in overall MI, stroke, and HF rates and among older diabetic adults but they differ in that we found significant declines in stroke and HF in younger diabetic subjects and stable stroke rates among diabetic Blacks.^{1,26} We also observed significant MI rate reductions among the younger and middle-age diabetic subjects, in contrast to a recent study by Gupta and colleagues that found no decline in MI rates among the general 30–54 year old U.S. population from 2001 to 2010.⁶ We found similar declines for stroke and HF indicating that among younger diabetic patients CV event rates are improving. We also see this in the 45–64 year old non-diabetic subjects. It is possible that our insured patient population may have greater access to care or self-care behaviors leading to reductions in CV events. We found no CV event trend studies among Asians. Recently, declines in ischemic stroke rates among Mexican-Americans living in Texas were reported but did not distinguish by diabetes status.²⁷ We report for the first time significant improvements in MI, stroke, heart failure, and all-cause mortality among diabetic Hispanics and Asians. Our findings highlight the value of examining trends in specific high risk or demographic subgroups to more effectively reduce disparities in cardiovascular care.²⁸

Implications

Diabetes has been described as a coronary disease risk equivalent, but a recent meta-analysis indicates that the risk of MI is lower for patients with diabetes compared to those without diabetes but with a previous MI.⁴ We found a similar pattern in MI and also with stroke and HF initially, yet by 2011 these differences diminished to the point where event rates were similar between our diabetic subjects with no prior CV history and our non-diabetic subjects with a prior CV history. This may reflect the increased attention and care these insured patients with prior CV events received compared to patients with no prior CV history. Improved blood pressure and cholesterol medication adherence and control have been observed nationally, particularly among insured patients and patients with diabetes and CVD.^{29–32} These improvements may be in response to well-established secondary prevention and risk reduction guidelines.^{33,34} National and regional quality and accountability programs also emphasize improved risk factor control and care in diabetes and high CV risk patients. Given the continued high residual CV event rates in persons with prior CVD, especially those that also have diabetes, ongoing diligence in reducing subsequent CV events in these patients using statins, anti-hypertensive agents, aspirin, smoking cessation, and lifestyle changes remains an important focus.

However, our study also highlights that diabetic and non-diabetic patients who are not yet at the highest CV risk have not seen comparable reductions in CVE, despite improvements in blood pressure and cholesterol levels. These people represent roughly 85% of our study

population and account for the majority of CV events. Furthermore, diabetes and obesity prevalence remain high and could erode recent decreases in CV event rates.^{12,13,35} Primary prevention of diabetes and key CV risk factors will be required for long-term sustained reductions in CV event rates, including greater coordination among primary care, hospital, community, and public health efforts.^{36–39} More effective tailoring of interventions and recommendations based on age, sex, race, and ethnicity, regardless of their current CV risk, are also necessary.^{28,40,41}

Strengths and Limitations

Our study provides a novel approach to enhance existing national surveillance systems.¹⁶ An American Heart Association Strategic Impact Goal through 2020 is to reduce CVD and stroke mortality by 20% from 2010 rates. However, because of insufficient data, no nonfatal CVD goals were established.⁴² Furthermore, a number of recent large federally funded clinical trials substantially overestimated the anticipated CVE and mortality rates in diabetes and/or non-diabetes groups when planning the trials.⁴³ This overestimation reduces the power of such trials to adequately test important hypotheses. We combined several years of routinely collected EHD across 11 large, independent, integrated health care organizations representing 16 million people, used a harmonized virtual data warehouse to facilitate monitoring across sites, identified condition-specific populations (i.e. diabetes) and longitudinally followed individuals. This enables broad-based reporting of results in a systematic and timely way and has the infrastructure to integrate other health systems and more clinical, therapeutic, and patient-reported information. In the era of learning health care systems, comparative effectiveness research, and quality assessment, data systems like the SUPREME-DM DataLink provide a powerful, flexible, cost-efficient, and timely system to monitor CV event and mortality trends in large health care systems, and thus assist in the assessment of current care strategies, and the development of new strategies to meet the evolving health care needs of the overall population and particular clinically defined or demographically defined subgroups. The longitudinal integration of clinical, demographic, and patient-reported information is also likely to improve our understanding of various health-related behaviors, risk factors, and treatment preferences and enable better tailoring of care management strategies and interventions to individuals as well as groups of individuals.^{44,45}

Our study also has limitations that must be considered. First, our results are derived from insured adults at 11 U.S. health systems. However, these health systems encompass urban and rural regions of 10 states, include many Medicaid and Medicare-insured individuals, have a diverse racial and ethnic composition, and provide greater longitudinal power to examine important subpopulations than most nationally representative samples. The use of health system members provides a well-defined denominator for rate calculations and monitoring of trends over time within important patient subgroups. This approach avoids selection effects due to consent or survey non-response that affect NHANES and NHIS data. Future efforts to include other care delivery systems such as federally-qualified health centers or the Veterans Administration would broaden population representation. Second, diabetes or CVD status, CV events or deaths across sites and over time may be misclassified. However, our diabetes and CV event classification methods were similar to

previously reported and well-validated methods and the influence of undetected diabetes or unrecognized CV events is likely to attenuate our results.¹⁷ Furthermore, given the stable incidence of diabetes in this population during the study period, the interpretation of observed trends is unlikely to differ.⁴⁶ For major CV events we only included those listed as the principal discharge diagnosis from hospitalizations, a method that has had high positive predictive value in other studies.^{5,22,23} While coding of CV events may have varied across sites, using a consistent method over time and across sites limits potential bias in monitoring of changes over time. Nonetheless, our CV event rates are likely underestimates since secondary hospital diagnoses or events occurring outside the hospital are not captured. Misclassification of prior CVD history is also possible although this likely affects less than 1% of the study cohort and its effect would be slightly inflated CV event rates among subjects with no prior CVD history resulting in attenuation of our findings. Third, while recognizing potentially different etiologies and trends of CVD among Type 1 compared to Type 2 diabetes, we are currently unable to distinguish diabetes type. Finally, we had limited power to detect changes over time because we had only seven years of data. We did, however, observe clinically meaningful rate changes in major CV event and total mortality rates overall and within many subgroups. While some rate changes appear small from a clinical perspective, they are still important from a population-based perspective.⁴⁷ As more years of data are compiled we will be even better positioned to examine changes over time.

In conclusion, our findings demonstrate that from 2005 to 2011, major CV events and all-cause mortality rates declined substantially in the roughly 15% of insured adults with diabetes, a prior CV history or both. However, among the remaining insured adults without diabetes or a prior CV history, declines in CV event rates and mortality were much lower or absent. Significant age, gender, and racial-ethnic differences in CV event and mortality rates persist and attention is urgently needed to address these disparities.^{48,49} Our data strongly suggest that large U.S. health systems will be unable to sustain recent decreases in CV event and overall mortality rates unless they can implement successful targeted primary prevention strategies to reduce CV risk in patients without a prior CV event history.^{38–41,50}

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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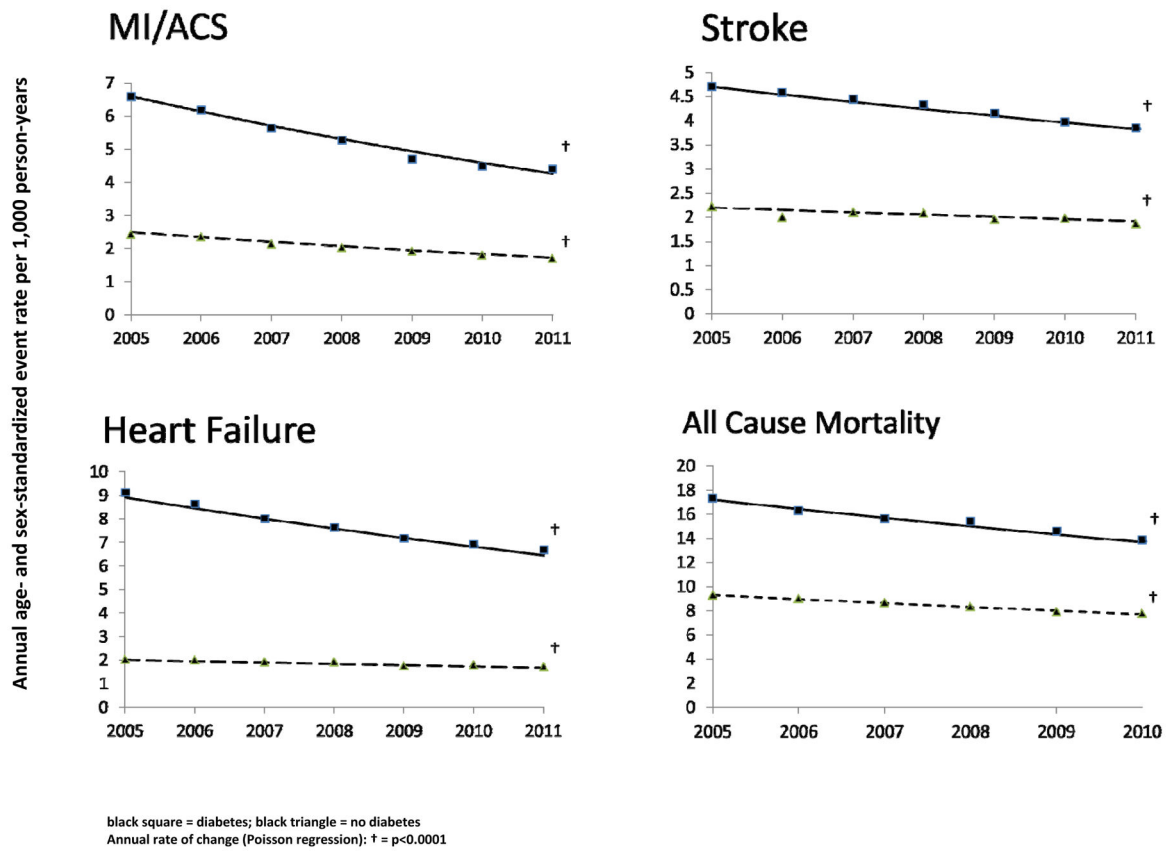


Figure 1. Rates of myocardial infarction/acute coronary syndrome, stroke, heart failure, and all-cause mortality from 2005 – 2011 by diabetes among 2.5 million insured persons across 11 health care systems

Black square = diabetes; black triangle = no diabetes

Annual rate of change (Poisson regression): † = p<0.0001

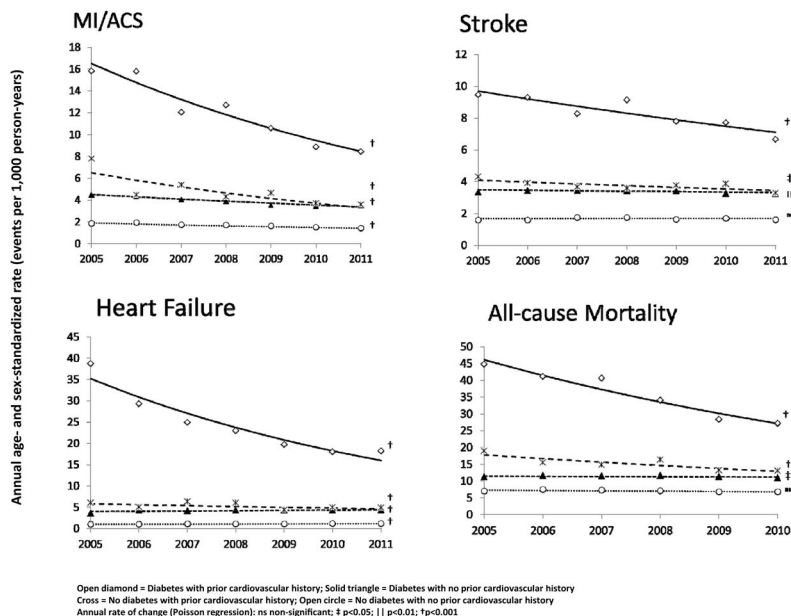


Figure 2. Rates of myocardial infarction/acute coronary syndrome, stroke, heart failure, and all-cause mortality from 2005 – 2011 among 2.5 million insured persons across 11 health care systems by diabetes status and prior cardiovascular history

Open diamond = Diabetes with prior cardiovascular history; Solid triangle = Diabetes with no prior cardiovascular history; Open circle = No diabetes with no prior cardiovascular history Annual rate of change (Poisson regression): ns non-significant; ‡ p<0.05; || p<0.01; † p<0.001

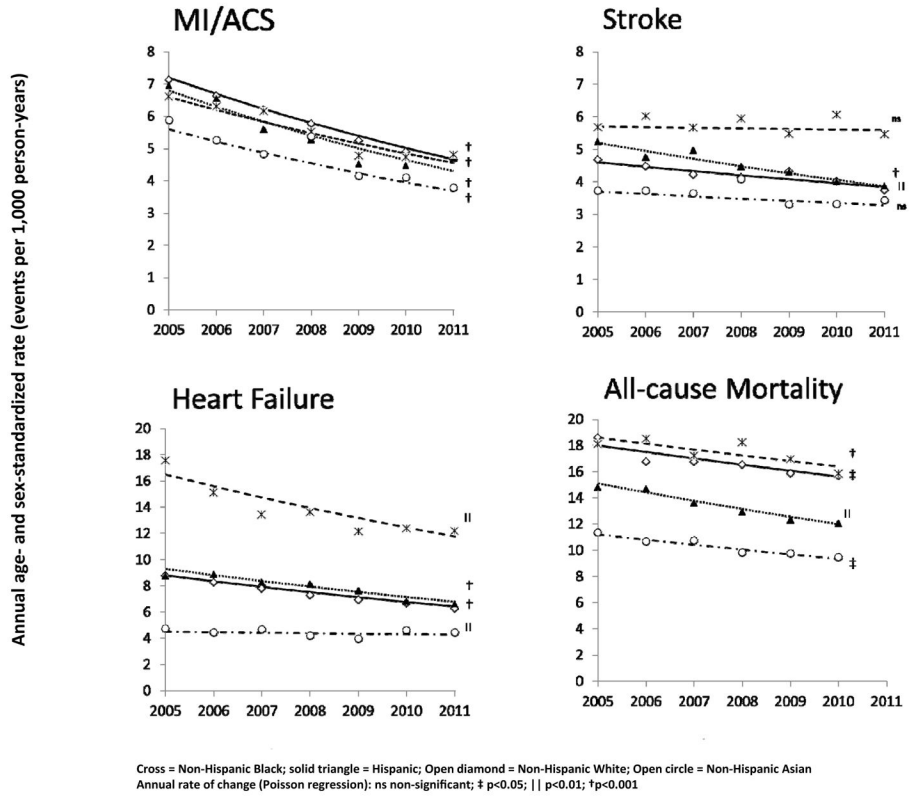


Figure 3. Racial and ethnic rates of myocardial infarction/acute coronary syndrome, stroke, heart failure, and all-cause mortality from 2005 – 2011 among 1.25 million insured persons with diabetes across 11 health care systems

Cross = Non-hispanic Black; solid triangle = Hispanic; Open diamond = Non-Hispanic White; Open circle = Non-Hispanic Asian
 Annual rate of change (Poisson regression): ns non-significant; ‡ p<0.05; || p<0.01; † p<0.001

Table 1

Demographic characteristics of study subjects at the time of study entry.

Characteristic	Diabetes		No Diabetes	
	N	%	N	%
Total Population	1,256,537	100	1,243,276	100
Age Group				
20–44 years	212,377	16.9	219,837	17.7
45–64 years	642,204	51.1	639,589	51.4
65 years	401,956	32.0	383,850	30.9
Sex				
Men	659,794	52.5	650,905	52.4
Women	596,743	47.5	592,371	47.6
Race/Ethnicity ^{a,b}				
White	551,420	43.9	661,209	53.2
Hispanic	239,702	19.1	152,737	12.3
Black	123,924	9.9	87,118	7.0
Asian	125,851	10.0	95,288	7.7
Native Hawaiian/Pacific Islander	10,363	0.8	5,016	0.4
American Indian/Alaskan Native	5,810	0.5	3,855	0.3
More than One Race	10,286	0.8	6,547	0.5
Unknown Race	189,181	15.1	231,506	18.6
Medicaid Coverage	39,416	3.1	19,269	1.5
Prior Cardiovascular History	209,953	16.7	136,675	11.0

^a All persons indicating Hispanic origin are classified as Hispanic thus the remaining race/ethnic categories are non-Hispanic.

^b Only White, Hispanic, Black, and Asian results are presented in the race/ethnicity analyses due to small sample sizes for other race/ethnic categories and difficulty in interpreting the 'Unknown' category.