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Projections of Cardiovascular Disease Prevalence and Costs: 2015–2035

Technical Report

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Executive Summary

Cardiovascular disease (CVD) is the leading cause of death in the United States and is one of the costliest chronic diseases. As the population ages, CVD costs are expected to increase substantially. To improve cardiovascular health and control health care costs, we must understand future prevalence and costs of CVD.

This study was undertaken to project the prevalence and medical costs of hypertension, coronary heart disease, congestive heart failure (CHF), stroke, atrial fibrillation, and all other CVDs from 2015 to 2035. We used a methodology that avoided double counting of costs for patients with multiple cardiovascular conditions. The projections illustrate what is likely to happen to CVD prevalence and costs if no change to current policy is made and no further action is taken to reduce the disease and economic burden of CVD. These projections provide a useful baseline against which to gauge the success of current and future CVD policy.

In 2015, 41.5% of the U.S. population (more than 100 million people) was projected to have some form of CVD. By 2035, CVD prevalence is expected to increase to 45.1% (more than 130 million people). This represents a 30% increase in the number of people with CVD over the next 20 years. Counts of people with coronary heart disease, CHF, stroke, and atrial fibrillation are expected to increase by more than 40% each between 2015 and 2035.

Between 2015 and 2035, real total direct medical costs of CVD are projected to more than double from $318 billion to $749 billion. Real indirect costs (due to lost productivity) for all CVDs are estimated to increase from $237 billion in 2015 to $368 billion in 2035 (55% increase). Total (medical and indirect) costs of CVD are expected to double from $555 billion in 2015 to $1.1 trillion in 2035. Across all conditions, relative increases in costs are expected to be the highest (more than triple) among persons aged 80 or older and Hispanics.

These findings indicate that CVD prevalence and costs are projected to increase substantially. Effective research, prevention, and treatment strategies are needed to limit the growing burden of CVD.

1. INTRODUCTION

Considering the impact of rising health care costs on the economy, it is critical to understand future cardiovascular disease (CVD) prevalence and costs in the United States. CVD is the leading cause of death in the United States and is one of the costliest chronic conditions (Alzheimer's Association, 2016; American Diabetes Association, 2013; Chronic Disease Cost Calculator, 2013; Heidenreich et al., 2011; Mozaffarian et al., 2016). U.S. medical expenditures are the highest in the world and rose from 9.5% of the Gross Domestic Product (GDP) in 1985 to 16.6% of GDP in 2014 (CBO, 2016). Between 1996 and 2005, the medical costs of CVD have grown at an average annual rate of 6% and have accounted for 15% of the increase in medical spending (Roehrig et al., 2009). This growth in costs has been accompanied by greater life expectancy, suggesting that this spending was of value (Rosen & Rosen, 2007). Despite this trend, however, there are many opportunities to further improve cardiovascular health while controlling costs (Kahn et al., 2008). To optimize these opportunities, it is imperative to understand the future of CVD prevalence and costs.

This study was undertaken to project the prevalence and medical costs of hypertension, coronary heart disease, congestive heart failure (CHF), stroke, atrial fibrillation (AFIB), and other heart diseases from 2015 to 2035. We used a methodology from previously published projections that avoids double counting disease costs across categories (Heidenreich et al., 2011). We updated the results from Heidenreich et al. (2011) as follows: (1) used the most recently available data sources, (2) generated projections of medical costs by point of service, (3) included projections of prevalence and costs of AFIB, and (4) included losses associated with household productivity due to premature mortality. The projections assume no change in policy but do reflect changing demographics over time. The projections illustrate what is likely to happen to CVD prevalence and costs if there are no changes to current policy or access to coverage and no significant medical breakthroughs occur that would significantly alter an individual's risk of developing CVD or its treatment. These projections provide a useful baseline against which to gauge the success of current and future CVD policy.

2. DATA AND METHODS

We generated projections of prevalence and costs for the following cardiovascular disease (CVD) conditions: hypertension, coronary heart disease, congestive heart failure (CHF), stroke, atrial fibrillation (AFIB), and other CVD for 2015 through 2035. In general, our methodology follows the approach used in the previously published analysis (Heidenreich et al., 2011). Cost estimates are expressed in 2015 dollars and include direct medical costs and indirect costs, which include morbidity and mortality costs.

We estimated prevalence and average cost per person for each CVD condition by age group (18–44, 45–64, 65–79, and 80+ years), race/ethnicity, and sex. The race/ethnicity groups used in this analysis are white non-Hispanic, white Hispanic, black, and other race/ethnicity. The Hispanic group includes persons of Hispanic origin who identified themselves to be of white race. We refer to this group as "Hispanics" throughout the rest of this report. The black group includes persons of Hispanic and non-Hispanic origin. The race/ethnicity definitions used in this analysis are driven by data availability.

CVD prevalence was assumed to remain constant within each of the 32 age, race/ethnicity, and sex categories. Baseline average CVD cost per person was estimated for each demographic category and allowed to grow in real terms based on the historical rate of growth of overall medical spending (direct) and real wages (indirect), which assumes that drivers of medical spending, such as rising prices and technological innovation, will continue at the same rate for the next 20 years. We generated projections of the total CVD population and costs by multiplying prevalence rates and average costs by the Census-projected population for each demographic category. Therefore, the projections reflect expected changes in population demographics but assume no change in policy that would affect prevalence and relative cost within a demographic category. Detailed descriptions of the data and methods used to generate each component of the projections are provided in the sections below.

Hypertension is a risk factor for other CVD conditions, so we generated two separate estimates of costs for hypertension. We estimated one model where we controlled for all comorbidities. Results from this model represent the costs attributable to hypertension alone. In the second model, we did not control for hypertension sequelae conditions, that is, the model did not control for coronary heart disease, CHF, stroke, AFIB, and other heart diseases. These costs for hypertension as a risk factor include the portion of the costs of complications associated with hypertension, including coronary heart disease, CHF, stroke, AFIB, and other CVD. The costs of hypertension as a risk factor should not be summed with other CVD conditions to calculate the costs of all CVD.

2.1 Projections of CVD Prevalence

Prevalence of hypertension, coronary heart disease, CHF, and stroke was estimated using data from the 2007–2014 National Health and Nutrition Examination Survey (NHANES). NHANES is a survey of a nationally representative sample administered by the National Center for Health Statistics, which is part of the Centers for Disease Control and Prevention (CDC). The survey combines an interview and a physical examination component where the interview includes demographic, socioeconomic, dietary, and health-related questions, and the examination component consists of medical, dental, and physiological measurements, as well as laboratory tests administered by highly trained medical personnel. Prevalence of hypertension was based on blood pressure measurements and the responses to interview questions about being told of having high blood pressure and taking blood pressure medications. Prevalence of coronary heart disease was based on patient self-report during an interview that asked about coronary heart disease, angina, or heart attack. Prevalence of CHF and stroke was also based on patient self-report. A list of qualifying measures and questions used to define each condition is presented in Table 2-1.

We estimated the prevalence of each condition using logit regression models controlling for survey year and demographics (age, race/ethnicity, and sex). Stepwise regressions were used to determine the significant interactions of demographics to be included in the models. We predicted prevalence of each condition in each age/race/ethnicity/sex cell for 2014 using coefficients from the logit regressions. Because NHANES does not include people in long-term care (LTC), we used National Nursing Home Survey (NNHS) data to scale NHANES prevalence estimates to account for CVD prevalence in the LTC population.

Prevalence estimates were then combined with the 2010 Census projections of population counts for 2015 through 2035 to generate projected number of people with each condition and projected prevalence for 2015 through 2035. Projected population counts for 2015 through 2035 were obtained from the 2014 Population Projections of the United States resident population by age, sex, race, and Hispanic origin generated by the U.S. Census Bureau. The 2014 projections are based on Census 2010 and were produced using a cohort-component method. The projections are based on assumptions about future births, deaths, and net international migration. We multiplied predicted prevalence of each condition in each age/race/ethnicity/sex cell by the projected population counts in the corresponding cells for 2015 through 2035 to project the number of people with each condition in each cell in each of the years. We then aggregated the number of people with the condition by age, by race/ethnicity, and by sex and calculated projected prevalence of each condition overall and by each demographic characteristic.

Table 2-1. Questions/Measures and ICD-9 Codes Used to Define CVD Conditions in NHANES and MEPS.

Condition	Qualifying Questions/ Measures from NHANES	ICD9-Codes from MEPS
Hypertension	Were you told on 2 or more different visits that you had hypertension, also called high blood pressure? Are you now taking prescribed medicine for your high blood pressure? Average SBP≥140 or average DBP≥90	401, 403
Coronary Heart Disease	Has a doctor or other health professional ever told you that you had coronary heart disease? Has a doctor or other health professional ever told you that you had angina, also called angina pectoris? Has a doctor or other health professional ever told you that you had a heart attack (also called myocardial infarction)? Rose Questionnaire	410, 411, 412, 413, 414
Congestive Heart Failure	Has a doctor or other health professional ever told you that you had congestive heart failure?	428
Stroke	Has a doctor or other health professional ever told you that you had a stroke?	430, 431, 433, 434, 436, 438
Atrial Fibrillation	N/A	427
Other heart failure, including cerebrovascular	N/A	390, 391, 393–400, 402, 404, 405, 415-426, 429, 432, 435, 437, 440–448, 450–459, 745–747

Note: CVD: cardiovascular disease; SBP: systolic blood pressure; DBP: diastolic blood pressure

Projections of AFIB prevalence were estimated using the same approach but with a different data source (because AFIB was not included in NHANES): 2009–2013 Medical Expenditure Panel Survey (MEPS). These data are described in more detail in Section 2.2.1 as they were used to estimate medical costs of CVD. The difference in prevalence estimates between NHANES and MEPS was that prevalence from NHANES was based on stated or lifetime prevalence of the condition because it was assessed using "have you ever been told…" questions. Prevalence from MEPS was based on treated prevalence as individuals were identified to have a condition if they sought medical care for that condition within the year.

2.2 Projections of CVD Costs

2.2.1 Projections of Direct (Medical) Costs of CVD

The main data source for generating projections of medical costs of CVD was the 2009 to 2013 MEPS. MEPS is a nationally representative survey of the civilian noninstitutionalized population administered by the Agency for Healthcare Research and Quality (AHRQ). MEPS provides data on participants' utilization of medical services and the corresponding medical costs. Medical conditions are identified in MEPS Medical Condition files based on self-reports of conditions leading to medical visits or treatment within the interview year. Medical conditions are classified using International Classification of Diseases, Ninth Revision, Clinical Modifications codes based on self-reported conditions that were transcribed by professional coders. CVD conditions included in this analysis were defined using International Classification of Diseases, Ninth Revision, Clinical Modifications codes with a full list of the codes presented in Table 2-1. The MEPS data measure total annual medical spending, including payments by insurers and out-of-pocket spending (co-payments, deductibles, and payments for noncovered services). The costs captured by MEPS represent payments (not charges) from the payer to the provider. MEPS spending data are obtained through a combination of self-report and validation from payers (e.g., private insurers).

Projections of the direct medical costs of CVD were estimated by point of service. The following point-of-service categories were used (MEPS expenditure files listed in parentheses): hospital (inpatient, outpatient, emergency room), physician (office-based visits), prescription (prescription), home health (home health), and other (vision, medical supplies, dental). Nursing home costs were estimated using a combination of data sources: MEPS and NNHS (see below).

For each point of service, projections of the direct medical costs of CVD were estimated using the following steps. First, we estimated per person medical costs as a function of health conditions using a two-part regression model. In the first part of the two-part model, we used a logistic regression model to predict the probability of any expenditures. For the second part of the model, we used a generalized linear model with a gamma distribution and a log link to estimate total annual medical expenditures for people having any expenditures. We used an algorithm for choosing among alternative nonlinear estimators recommended by Manning and Mullahy (2001) and found that this type of model was the most appropriate for the data. Our model controlled for CVD conditions and other potentially costly or prevalent medical conditions and sociodemographic variables. As noted above, an additional model that excluded controls for CVD conditions was estimated to quantify costs of hypertension as a risk factor.

Second, expenditures attributable to each CVD condition were calculated as the difference in predicted expenditures for a person with the specified condition and predicted expenditures for a similar person without the condition. We estimated the per person cost attributable to each CVD condition for each age/race/ethnicity/sex cell based on coefficients from the national, pooled model.

Disease-attributable expenditures are typically calculated by predicting expenditures using observed diseases and subtracting from that predicted expenditures setting the disease of interest (e.g., coronary heart disease) to zero and leaving all other covariates and diseases as they are in the data. However, in previous work, we have shown that, in nonlinear models, such as the model used here, this approach will lead to double counting of expenditures for co-occurring diseases, regardless of whether one disease causes the other (Trogdon et al., 2008). Double counting of expenditures is a particular problem in cases where more than one condition is treated during a single office visit or hospitalization. We used a technique, termed "complete classification" and described in an earlier study, to ensure that no double counting occurs (Trogdon et al., 2008). Using the parameters of the econometric model, we specifically treated each disease and combination of diseases observed in the data as a separate entity when calculating the attributable costs. For example, coronary heart disease alone and coronary heart disease with hypertension would be treated as two different diseases in the attributable expenditure calculation described above. We then divided the total expenditures attributable to the combinations of diseases back to the constituent diseases using the parameters from the model to construct shares for each constituent disease within a combination (i.e., a share of all coronary heart disease with hypertension disease costs that are attributable to coronary heart disease). The shares attribute a greater share of the joint expenditures to the disease with the larger coefficient in the main effect. The formula to construct the shares is given in Trogdon, Finkelstein, and Hoerger (2008).

Our third step in calculating projections of direct medical costs was to adjust the per person cost estimates to account for nursing home spending using data from the NNHS and National Health Accounts. We assumed that per person, non-nursing home expenditures attributable to CVD were the same for the nursing home population as for the noninstitutionalized population.

Fourth, to estimate projected costs, we first followed recommendations from AHRQ to inflate dollar values in the MEPS data to 2015. We then multiplied the per person cost of each CVD condition in each age/race/ethnicity/sex cell by the projected number of people treated for each disease in the corresponding cells for years 2015 to 2035 and summed across CVD conditions to estimate total medical costs of CVD. The projected number of people treated for each disease was calculated by using similar methodology as outlined in Section 2.1. However, instead of the NHANES data, we used 2009–2013 MEPS to predict the treated prevalence of each condition, because only those patients who receive treatment incur medical costs within a given year.

Finally, we used Congressional Budget Office (CBO) assumptions for future health care cost growth above and beyond growth due to population growth and aging (CBO, 2016). We assumed that the costs of CVD would increase at the same rate as overall medical expenditures between 2015 and 2035: an average annual rate of 2.45%.

2.2.2 Projections of Indirect Costs of CVD

Two types of indirect costs were calculated: lost productivity from (a) morbidity and (b) premature mortality.

Morbidity Costs of CVD

Morbidity costs represent the value of foregone earnings from lost productivity due to CVD. Morbidity costs include three components: work loss among currently employed individuals, home productivity loss, and work loss among individuals too sick to work (Rice et al., 1985). Per capita work loss days due to CVD by age, race/ethnicity, and sex were estimated using 2009–2013 MEPS. We estimated a negative binomial model for annual days of work missed due to illness or injury as a function of each CVD condition, other comorbid conditions, and sociodemographic variables. Per capita work days lost attributable to CVD for each age/race/ethnicity/sex cell were based on coefficients from the national, pooled model. For medical expenditures, we avoided double-counting of costs resulting from individuals with multiple conditions by employing the previously cited procedure (Trogdon et al., 2008). We generated total work loss costs by multiplying per capita work days lost due to CVD by (a) prevalence of CVD (by age, race/ethnicity, and sex) from MEPS, (b) the probability of employment given CVD (by age, race/ethnicity, and sex) from MEPS, (c) mean per capita daily earnings (by age and sex) from the 2015 Current Population Survey (CPS), and (d) Census population projections counts (by age, race/ethnicity, and sex).

Home productivity losses were estimated by valuing days spent in bed due to CVD at the replacement cost of housekeeping services (Rice et al., 1985). Per capita days in bed due to CVD by age, race/ethnicity, and sex were estimated using 2009–2012 MEPS and the same strategy as outlined above for work days lost. Days spent in bed were not assessed as part of the 2013 MEPS. We generated total home productivity loss costs by multiplying per capita bed days due to CVD by (a) prevalence of CVD (by age, race/ethnicity, and sex) from MEPS, (b) dollar value of a day of house work (by age and sex), and (c) Census population projection counts (by age, race/ethnicity, and sex) (Expectancy Data, 2014).

To estimate work loss among individuals too sick to work due to CVD, we first estimated the number of people too sick to work who would have been employed except for their CVD. For the noninstitutionalized population, we multiplied the number of people not in the labor force due to illness/disability by age from the CPS by the percentage of all work loss attributable to CVD based on the MEPS regression analysis for work loss days described above (U.S. Bureau of Labor Statistics, 2016). The assumption was that the percentage of work days missed due to CVD was the same for days missed by being out of the labor force and days missed conditional on working. For the institutionalized population, we multiplied the number of people with a primary diagnosis of CVD from the 2004 NNHS (as percentage of total population) by Census population counts and the probability of employment given CVD (by age, race/ethnicity, and sex) from MEPS. The last component accounts for individuals with CVD who might not work even if they had not been institutionalized. Finally, the sum of the number of noninstitutionalized and institutionalized people too sick to work due to CVD was multiplied by 250 work days per year and mean annual earnings from the 2015 CPS.

Mortality Costs of CVD

Mortality costs represent the value of foregone earnings and household productivity losses from premature mortality due to CVD. We estimated the present value of future earnings and household production using national estimates of annual earnings and the dollar value of household production that we used to value work loss and household production losses (described in Section 2.3.1). Future costs were discounted by the probability of surviving to each year of age at which the expected production occurs. We used 2010 U.S. life tables from the National Vital Statistics Report to calculate compounded survival rates for each age group (Arias, 2014). To ensure that losses were applied only to the populations expected to incur the losses, we multiplied the age group- and sex-specific labor costs for each state by age group- and sex-specific employment rates, and we multiplied age group- and sex-specific percentages of people living in households by household production losses by state, age, and sex (Haddix, Teutsch, & Corso, 2003). We also adjusted for expected future growth in productivity using a 1% annual growth rate and discounted the costs using a 3% annual discount rate, as recommended in Haddix, Teutsch, and Corso (2003).

We estimated death rates for each CVD condition by age, race/ethnicity, and sex using 2013 CDC Wide-ranging Online Data for Epidemiologic Research (CDC WONDER) mortality data (http://wonder.cdc.gov/mcd-icd10.htm). CDC WONDER is a public-use online database for epidemiologic research that contains information about mortality (deaths) and Census data. Assuming the death rates remain constant within each age, race/ethnicity, and sex cell, we multiplied the death rates by Census population projections to project the number of CVD deaths by age, race/ethnicity, sex, and year through 2035. Finally, we multiplied age- and sex-specific remaining lifetime earnings and household productivity losses by the projected number of deaths in the corresponding age/sex cells to get projections of total mortality costs.

The real value of indirect costs (morbidity and mortality) was assumed to grow at the CBO average annual growth rate of real earnings (1.29%) through 2035 (CBO, 2016).

3. RESULTS

3.1 Projected CVD Prevalence

Table 3-1 reports projected prevalence (in percentages) of cardiovascular disease (CVD) conditions for years 2015 through 2035, and Table 3-2 reports the projected number of people with each CVD condition for the same time period. Figures 3-1 through 3-13 show projected prevalence of CVD conditions by age, race/ethnicity, and sex.

Table 3-1. Projected Prevalence of Stated Disease by Year, 2015–2035

Year	Any CVD	Hyper-tension	CHD	CHF	Stroke	AFIB
2015	41.5%	38.8%	6.8%	2.3%	3.0%	2.1%
2016	41.7%	39.0%	6.9%	2.4%	3.1%	2.1%
2017	41.9%	39.1%	6.9%	2.4%	3.1%	2.1%
2018	42.0%	39.3%	7.0%	2.4%	3.1%	2.1%
2019	42.2%	39.4%	7.1%	2.4%	3.1%	2.2%
2020	42.4%	39.6%	7.1%	2.5%	3.2%	2.2%
2021	42.6%	39.8%	7.2%	2.5%	3.2%	2.2%
2022	42.8%	39.9%	7.3%	2.6%	3.3%	2.2%
2023	43.0%	40.1%	7.4%	2.6%	3.3%	2.2%
2024	43.2%	40.3%	7.4%	2.6%	3.3%	2.3%
2025	43.4%	40.5%	7.5%	2.7%	3.4%	2.3%
2026	43.6%	40.7%	7.6%	2.7%	3.4%	2.3%
2027	43.8%	40.9%	7.7%	2.7%	3.5%	2.3%
2028	44.0%	41.0%	7.8%	2.8%	3.5%	2.4%
2029	44.2%	41.2%	7.8%	2.8%	3.6%	2.4%
2030	44.4%	41.4%	7.9%	2.9%	3.6%	2.4%
2031	44.5%	41.5%	8.0%	2.9%	3.7%	2.4%
2032	44.6%	41.6%	8.0%	2.9%	3.7%	2.4%
2033	44.8%	41.8%	8.1%	2.9%	3.7%	2.4%
2034	44.9%	41.9%	8.1%	3.0%	3.8%	2.4%
2035	45.1%	42.1%	8.2%	3.0%	3.8%	2.5%

In 2015, over 102.7 million people (41.5%) were expected to have at least one CVD condition (Tables 3-1 and 3-2). Specifically, we estimated that in 2015 over 96.1 million of people had hypertension, 16.8 million had coronary heart disease, 5.8 million people had congestive heart failure (CHF), 7.5 million people had a stroke, and 5.2 million people had AFIB (see Table 3-2). By 2035, the number of people with CVD is expected to grow to almost 132.0 million people (45.1%), representing a 30% increase in the number of people with CVD (see Tables 3-1 and 3-2). These increases translate to an additional 27.1 million people with hypertension, 7.2 million with coronary heart disease, 3.0 million with CHF, 3.7 million with stroke, and 2.0 million with AFIB in 2035 relative to 2015 (see Table 3-2). Counts of people with coronary heart disease, CHF, stroke, and AFIB are expected to increase by more than 40% each between 2015 and 2035 (see Table 3-2).

Table 3-2. Projected Counts of People with Each Stated Disease by Year, 2015–2035

Year	Any CVD	Hypertension	CHD	CHF	Stroke	AFIB
2015	102,705,216	96,061,232	16,835,804	5,781,675	7,483,839	5,163,574
2016	104,301,244	97,534,297	17,180,364	5,913,212	7,640,646	5,259,969
2017	105,834,608	98,947,804	17,517,128	6,044,028	7,794,886	5,354,481
2018	107,349,673	100,344,016	17,858,408	6,180,135	7,954,483	5,451,242
2019	108,846,500	101,722,016	18,202,720	6,319,151	8,116,806	5,549,693
2020	110,377,983	103,130,339	18,564,863	6,466,216	8,289,457	5,653,634
2021	111,857,995	104,493,080	18,918,268	6,611,776	8,460,481	5,755,519
2022	113,399,679	105,910,900	19,296,743	6,768,282	8,645,478	5,866,312
2023	114,953,589	107,337,488	19,695,811	6,935,861	8,845,116	5,984,364
2024	116,493,685	108,757,624	20,077,372	7,095,232	9,035,181	6,095,254
2025	118,123,949	110,262,753	20,476,947	7,261,092	9,233,787	6,209,804
2026	119,677,113	111,699,038	20,853,823	7,417,899	9,420,991	6,317,717
2027	121,234,065	113,132,556	21,286,360	7,604,521	9,650,186	6,445,875
2028	122,733,646	114,518,145	21,685,917	7,776,996	9,861,631	6,561,061
2029	124,172,502	115,851,836	22,064,861	7,941,439	10,063,223	6,668,505
2030	125,584,157	117,165,992	22,429,487	8,099,358	10,258,612	6,768,884
2031	126,879,480	118,379,438	22,754,614	8,241,022	10,435,962	6,854,709
2032	128,121,500	119,547,249	23,062,740	8,375,620	10,605,876	6,934,438
2033	129,356,219	120,711,342	23,367,462	8,509,700	10,776,331	7,011,241
2034	130,622,830	121,902,740	23,683,414	8,648,751	10,952,524	7,090,298
2035	131,978,870	123,175,101	24,027,491	8,800,004	11,143,101	7,176,864

As expected, CVD prevalence increases with age (Figure 3-1). Within age groups, prevalence of CVD is expected to remain constant between 2015 and 2035. Prevalence of hypertension, CHF, and stroke is the highest among blacks (Figures 3-2 through 3-5). Prevalence of CHD and AFIB is the highest among white non-Hispanics (Figures 3-6 and 3-7). Within racial/ethnic groups, CVD prevalence is expected to grow (see Figure 3-2). For example, prevalence of hypertension among blacks is expected to increase from 46.8% in 2015 to 50.6% in 2035 (see Figure 3-3), and prevalence of AFIB among white non-Hispanics is expected to increase from 3% in 2015 to 4% in 2035 (Figure 3-7). Prevalence of total CVD is higher among males than females (Figure 3-8), however, prevalence of hypertension, CHF, stroke, and AFIB is higher among females than among males (Figures 3-9 through 3-13). Prevalence is expected to increase for all conditions among both males and females.

Figure 3-1. Stated Projected Prevalence of Any CVD by Age, 2015–2035

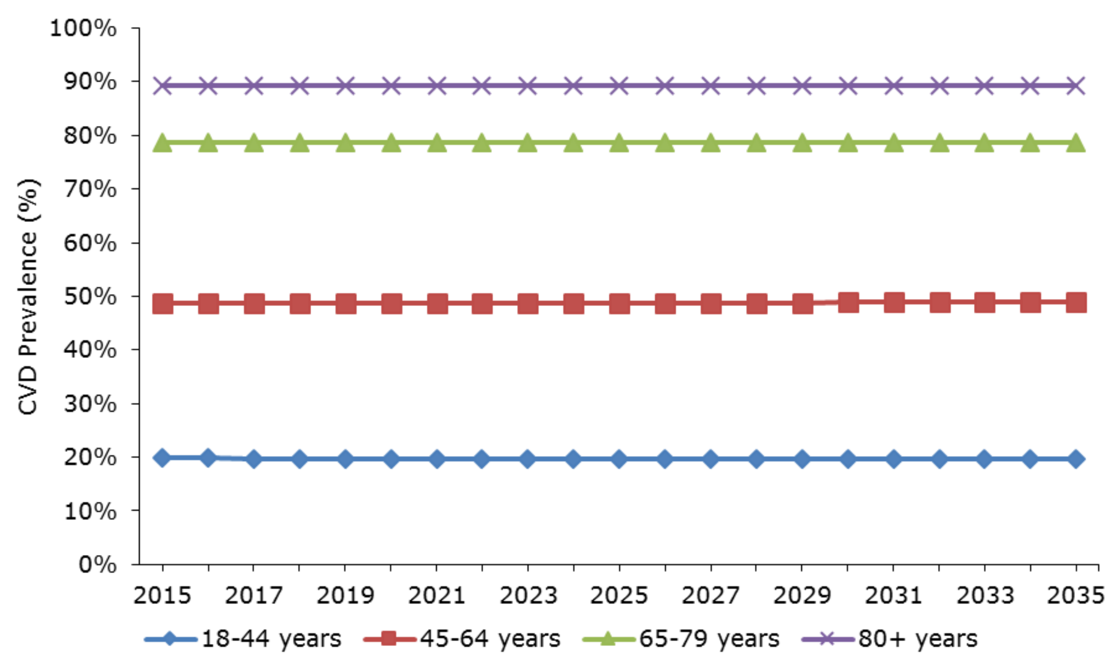


Figure 3-2. Stated Projected Prevalence of Any CVD by Race/Ethnicity, 2015–2035

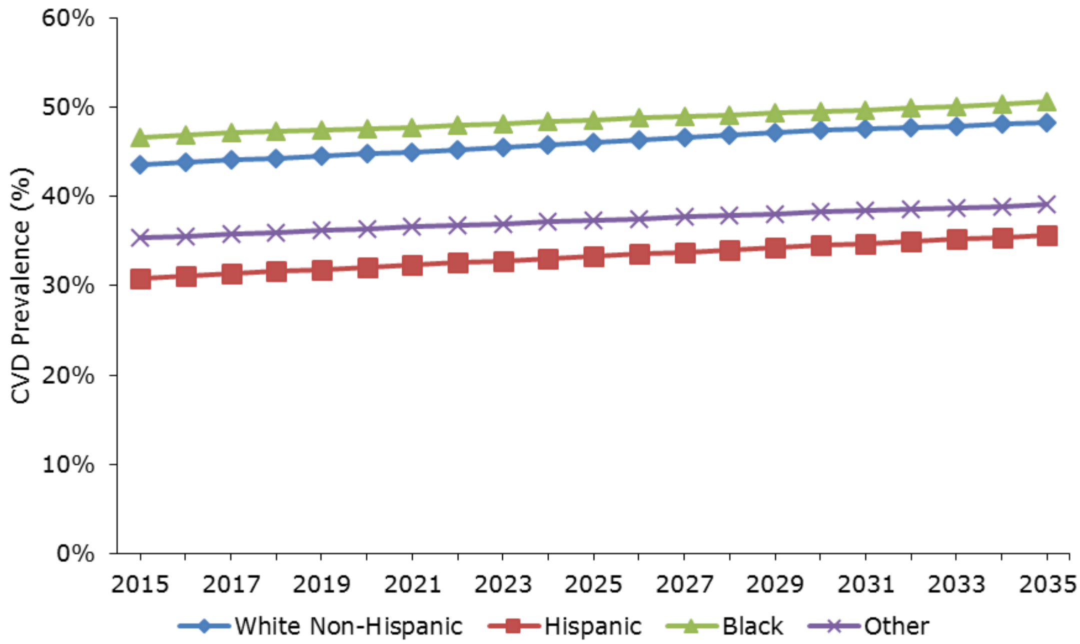


Figure 3-3. Stated Projected Prevalence of Hypertension by Race/Ethnicity, 2015–2035

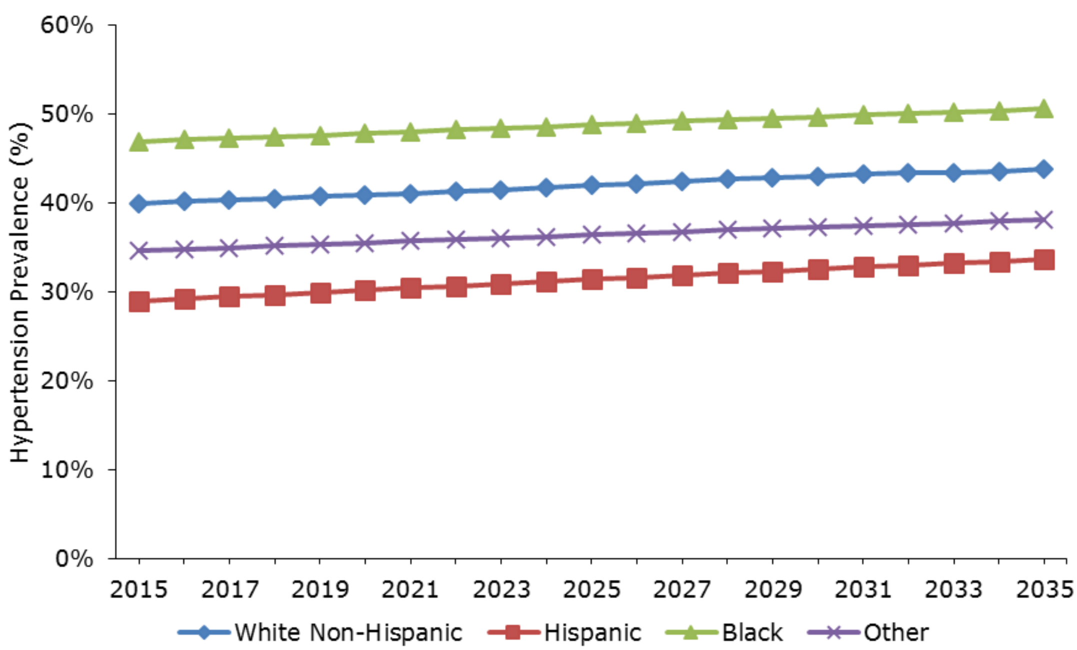


Figure 3-4. Stated Projected Prevalence of CHD by Race/Ethnicity, 2015–2035

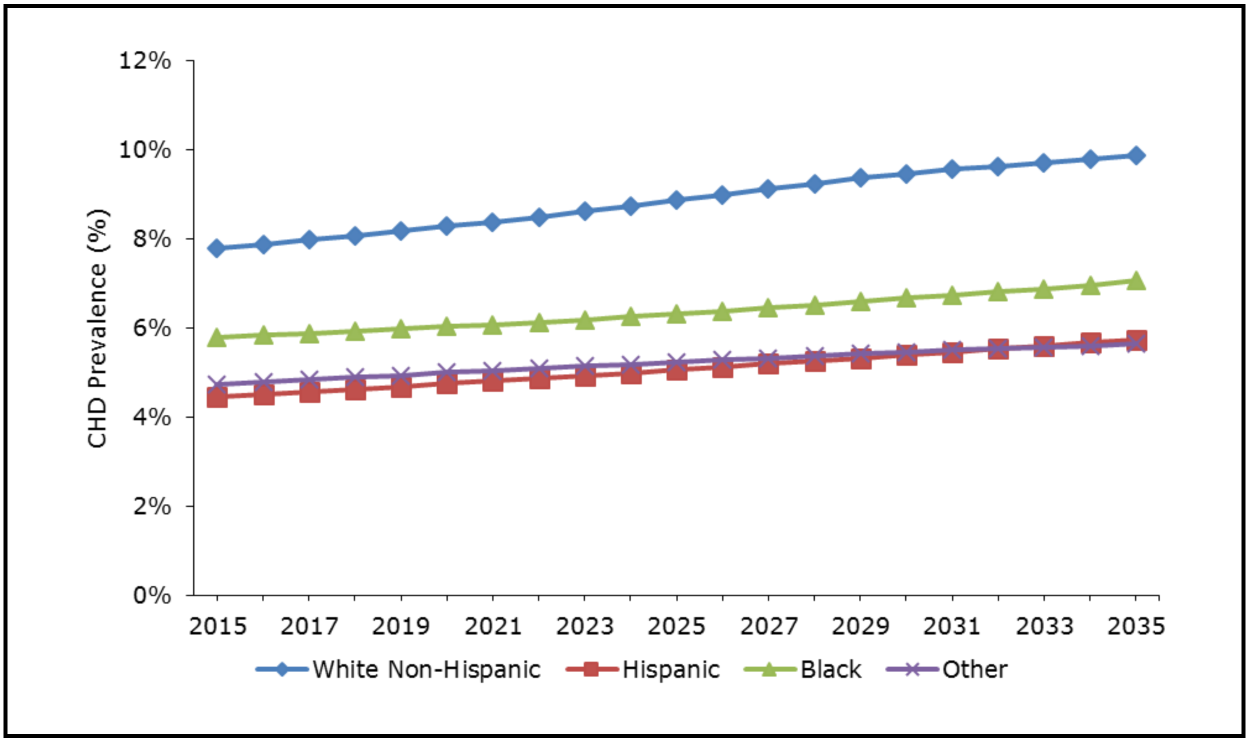


Figure 3-5. Stated Projected Prevalence of CHF by Race/Ethnicity, 2015–2035

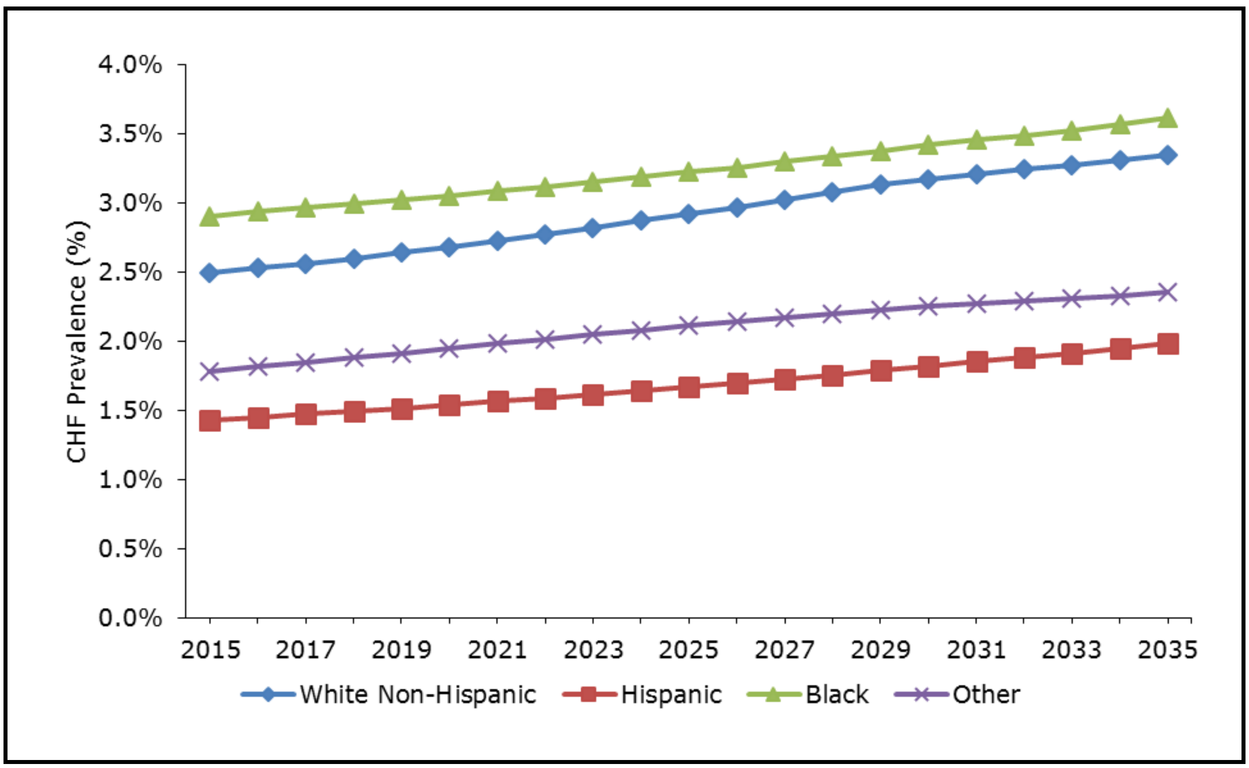


Figure 3-6. Stated Projected Prevalence of Stroke by Race/Ethnicity, 2015–2035

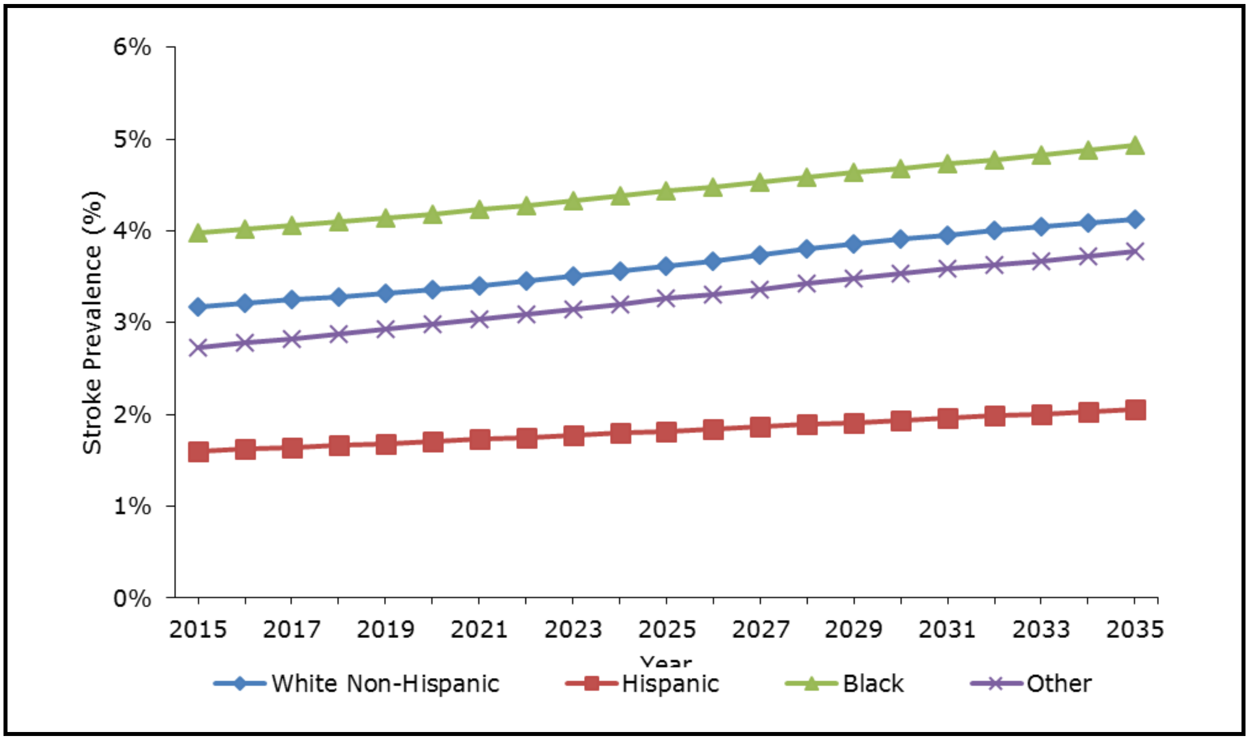


Figure 3-7. Projected Prevalence of AFIB by Race/Ethnicity, 2015–2035

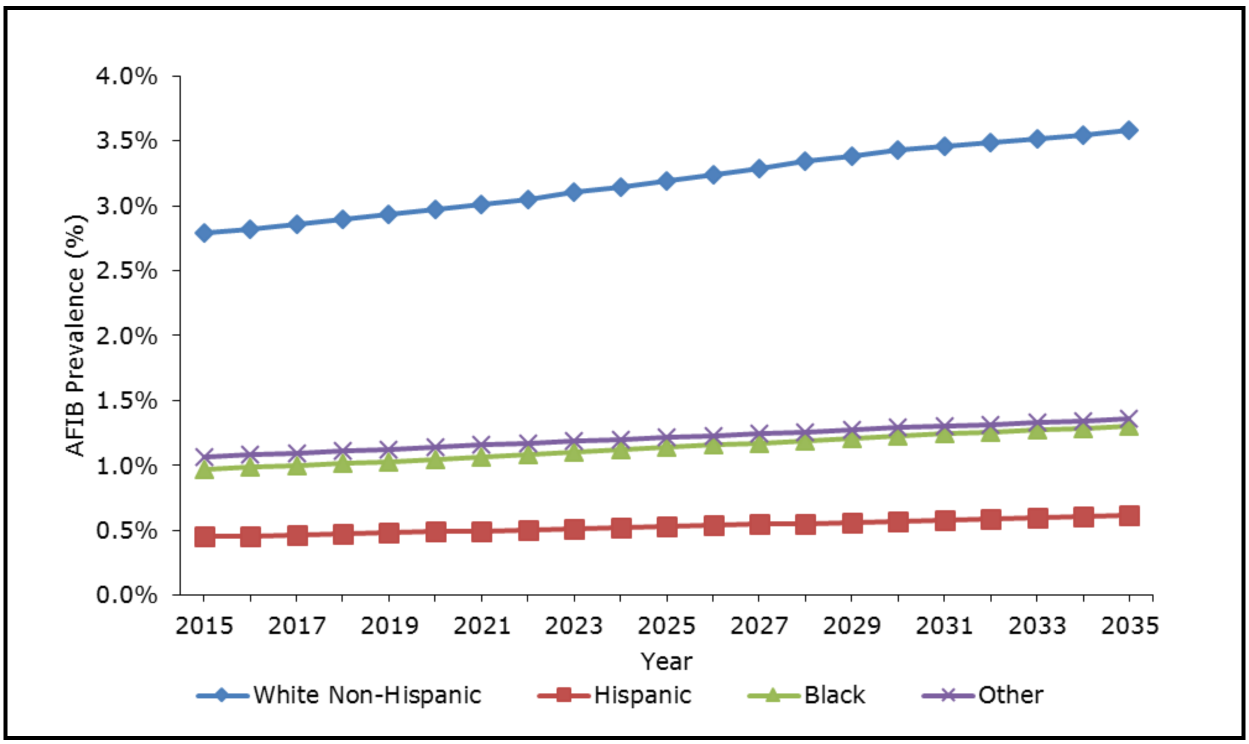


Figure 3-8. Stated Projected Prevalence of Any CVD by Sex, 2015–2035

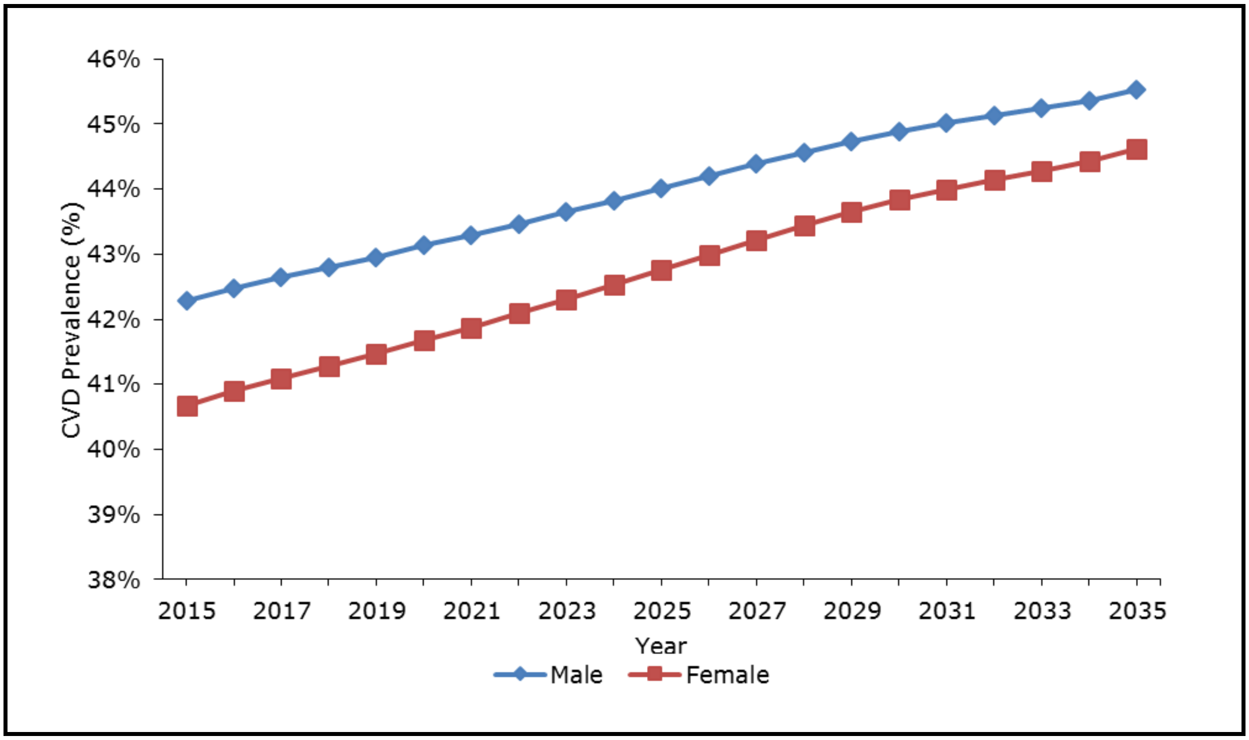


Figure 3-9. Stated Projected Prevalence of Hypertension by Sex, 2015–2035

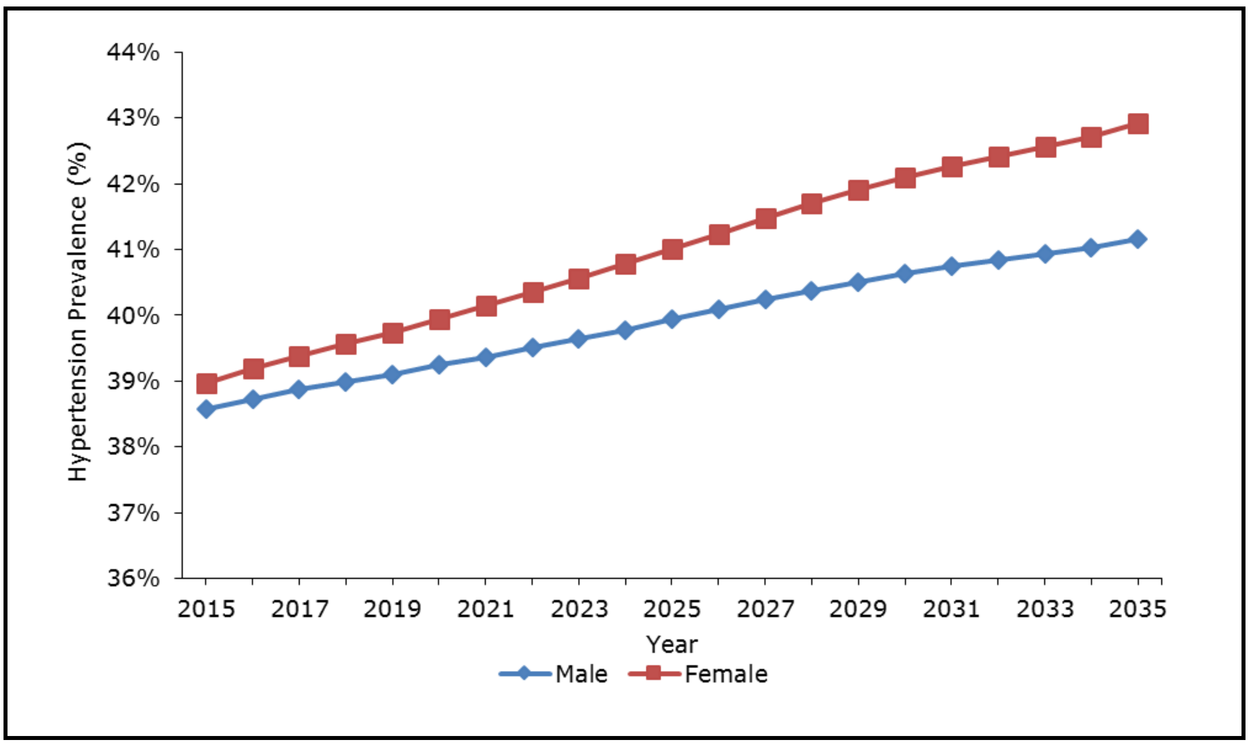


Figure 3-10. Stated Projected Prevalence of CHD by Sex, 2015–2035

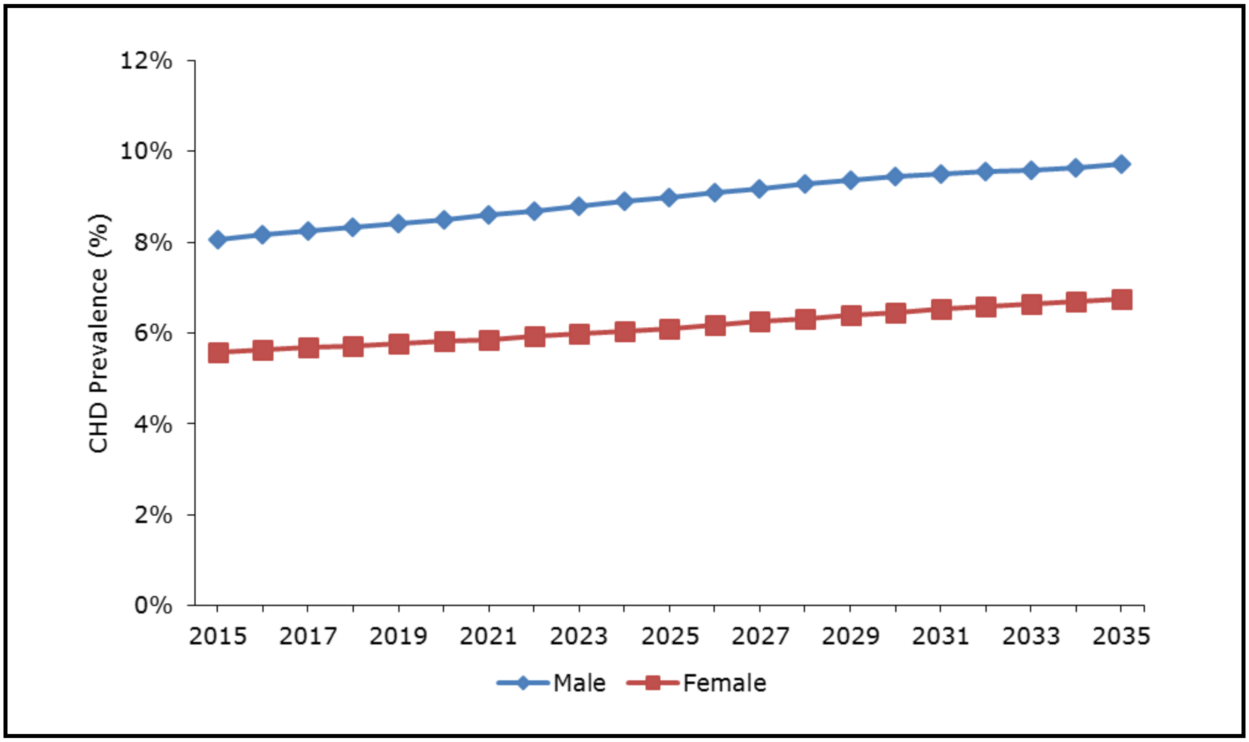


Figure 3-11. Stated Projected Prevalence of CHF by Sex, 2015–2035

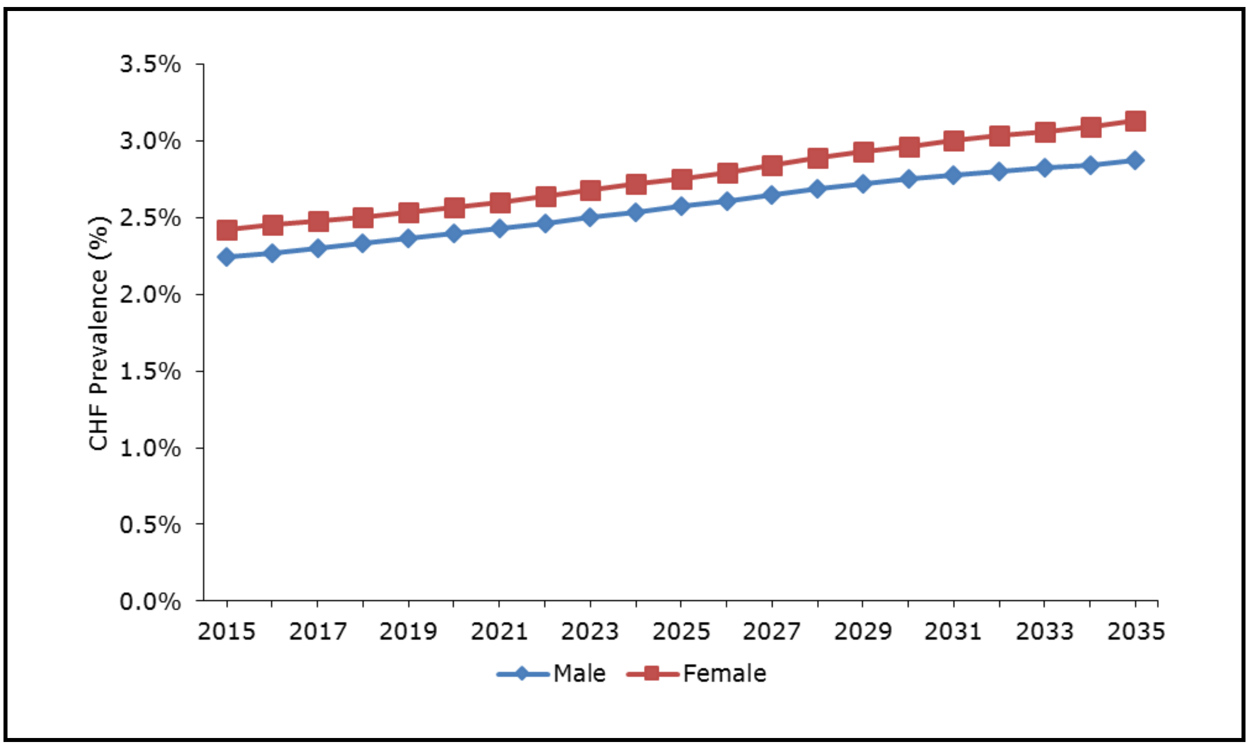


Figure 3-12. Stated Projected Prevalence of Stroke by Sex, 2015–2035

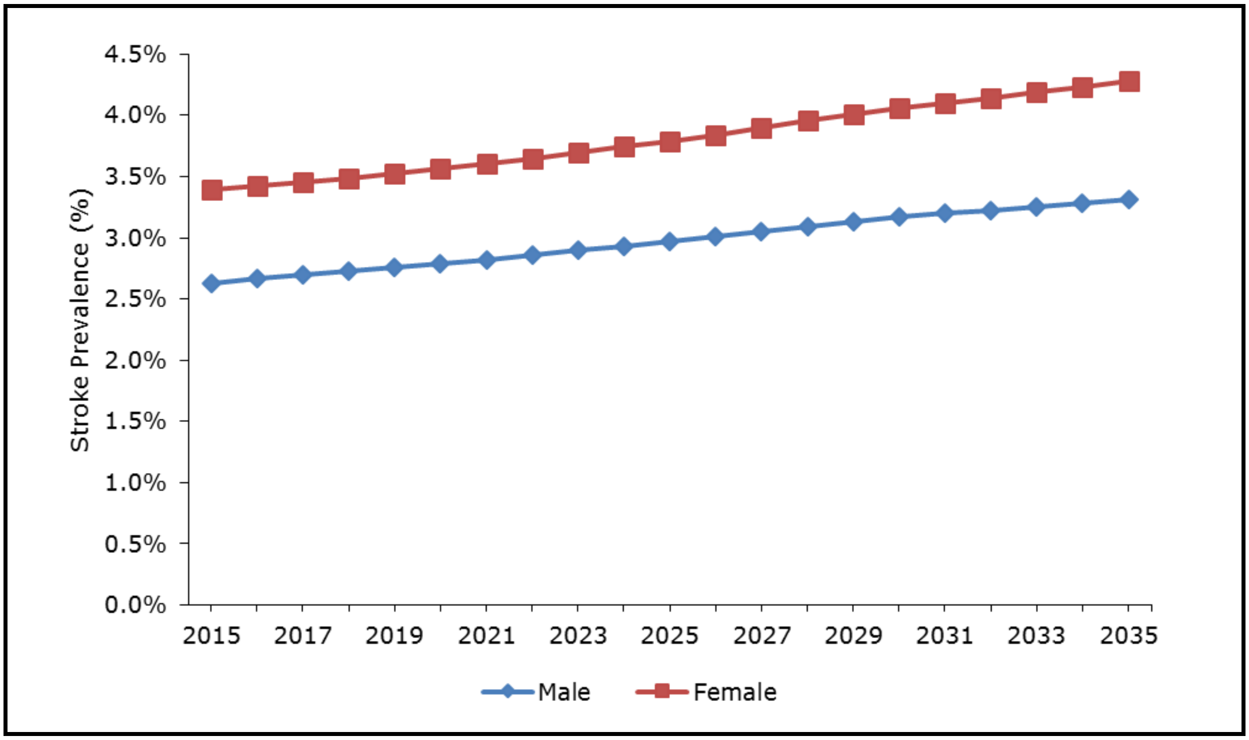
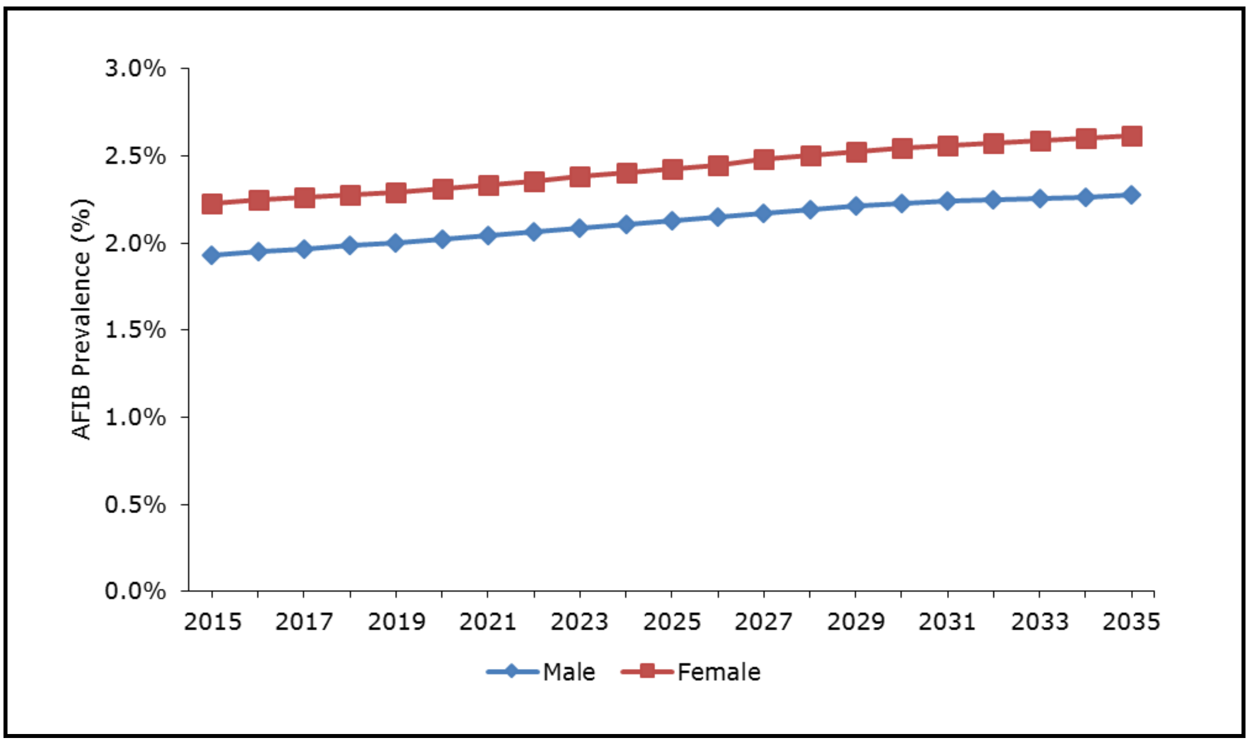


Figure 3-13. Projected Prevalence of AFIB by Sex, 2015–2035



3.2 Projected CVD Costs

Tables 3-3 through 3-5 report projected medical, indirect, and total costs of each CVD condition for 2015 and 2035 by age, race/ethnicity, and sex. Tables 3-3 to 3-5 report total projected costs of each CVD condition for 2015 through 2035. Total costs of CVD were estimated to be $555 billion in 2015 and are expected to more than double reaching $1.1 trillion in 2035 (Tables 3-3 and 3-4). In 2015, $111 billion of those costs were attributed to hypertension (increasing to $221 billion in 2035), $188 billion to coronary heart disease (increasing to $366 billion in 2035), $29 billion to CHF (increasing to $64 billion in 2035), $66 billion to stroke (increasing to $143 billion in 2035), $31 billion to AFIB (increasing to $66 billion in 2035), and $131 billion to other heart diseases (increasing to $258 billion in 2035). Total costs of hypertension as a risk factor were estimated at $157 billion in 2015, increasing to $334 billion in 2035.

In 2015, total costs of CVD were the highest among persons aged 45 to 64; however, by 2035, costs among persons aged 65 to 79 will exceed the costs incurred by persons aged 45 to 64 (Figure 3-14). For CHF, stroke, and AFIB, total costs are consistently higher among persons aged 65 to 79 than other age groups (Figures 3-15 through 3-17). Across all conditions, the highest relative (i.e., percentage) increases in total costs are expected among those aged 80 or older (costs for this age group will more than triple) followed by costs among persons aged 65 to 79 (which will more than double) (see Table 3-3). By race/ethnicity, total costs of CVD are the highest among white non-Hispanics (a result of a high number of people in this race/ethnic group) (Table 3-4 and Figure 3-18). Between 2015 and 2035, total CVD costs are expected to have the highest percentage increase among Hispanics (increase of 203%) and persons of other races (increase of 190%) (see Table 3-4). By sex, total costs of total CVD were higher among males ($325 billion) than females ($252 billion) in 2015 and increasing to $591 billion and $525 billion, respectively, in 2035 (Table 3-5 and Figure 3-19). For CHF, stroke, and AFIB, however, the costs are higher among females than among males (see Table 3-5).

In 2015, 57% of total costs represented medical costs, and 43% represented indirect costs (Figure 3-20). By 2035, this mix of total CVD costs will change, so that a higher proportion will represent medical costs (67%) and a lower proportion will represent indirect costs (33%). Coronary heart disease is the only condition for which indirect costs represent more than half of total costs in 2015 (53%). However, even for coronary heart disease, more than 50% of total costs will go to medical costs in 2035.

Table 3-3. Projected Costs of Total CVD by Age (2015$ in billions)

Condition	18–44			45–64			65–79			80+		
	$ 2015	$ 2035	% Change	$ 2015	$ 2035	% Change	$ 2015	$ 2035	% Change	$ 2015	$ 2035	% Change
Total CVD												
Medical costs	15.4	26.4	72%	94.3	152.0	61%	132.3	322.8	144%	76.1	247.5	225%
Indirect costs	33.7	47.1	40%	127.1	163.4	29%	62.1	122.0	96%	13.9	35.4	155%
Total costs	49.0	73.5	50%	221.4	315.4	42%	194.5	444.8	129%	90.1	283.0	214%
Hypertension												
Medical costs	5.3	9.4	76%	26.6	44.0	66%	25.7	64.8	152%	10.8	35.5	229%
Indirect costs	5.2	7.4	43%	23.0	30.3	32%	11.1	22.2	100%	2.8	7.3	156%
Total costs	10.5	16.8	59%	49.6	74.4	50%	36.8	87.0	136%	13.6	42.7	214%
CHD												
Medical costs	1.9	3.2	65%	22.7	36.3	60%	39.7	95.6	141%	24.7	79.4	221%
Indirect costs	9.9	13.6	37%	57.8	73.3	27%	26.4	51.8	96%	4.9	12.6	157%
Total costs	11.8	16.8	42%	80.4	109.6	36%	66.1	147.5	123%	29.6	91.9	211%
CHF												
Medical costs	0.5	0.7	62%	5.1	7.9	56%	6.5	16.2	147%	5.8	19.8	240%
Indirect costs	0.8	1.2	43%	4.9	6.2	28%	4.1	8.0	94%	1.4	3.5	151%
Total costs	1.3	1.9	50%	10.0	14.2	42%	10.7	24.2	126%	7.2	23.3	223%
Stroke												
Medical costs	0.6	1.1	66%	8.8	15.4	75%	16.5	41.5	152%	10.8	36.3	237%
Indirect costs	3.9	5.7	46%	14.8	20.0	35%	8.8	17.7	100%	2.1	5.3	152%
Total costs	4.5	6.8	49%	23.6	35.4	50%	25.3	59.2	134%	12.9	41.6	223%
AFIB												
Medical costs	0.7	1.1	65%	5.6	8.2	47%	10.5	24.3	131%	6.9	21.5	213%
Indirect costs	1.8	2.3	29%	2.6	3.1	20%	1.9	3.5	87%	0.7	1.7	156%
Total costs	2.5	3.4	38%	8.2	11.3	39%	12.4	27.8	124%	7.5	23.2	208%
Other Heart Disease												
Medical costs	6.3	10.9	72%	25.6	40.2	57%	33.5	80.4	140%	17.2	55.1	220%
Indirect costs	12.1	16.9	40%	24.0	30.4	26%	9.8	18.8	92%	2.0	5.0	152%
Total costs	18.4	27.8	51%	49.7	70.5	42%	43.2	99.2	129%	19.2	60.1	213%
Hypertension as Risk Factor												
Medical costs	7.2	12.6	75%	37.7	62.3	65%	41.5	104.7	152%	25.3	81.8	223%
Indirect costs	5.6	7.9	42%	25.1	33.0	31%	11.9	23.8	100%	3.0	7.7	156%
Total costs	12.7	20.5	61%	62.8	95.3	52%	53.3	128.5	141%	28.3	89.5	216%

3-11

Table 3-4. Projected Costs of Total CVD by Race/Ethnicity (2015$ in billions)

Condition	White Non-Hispanic			Black			Hispanic			Other		
	$ 2015	$ 2035	% Change	$ 2015	$ 2035	% Change	$ 2015	$ 2035	% Change	$ 2015	$ 2035	% Change
Total CVD												
Medical costs	241.5	514.5	113%	40.5	109.7	171%	19.7	68.9	250%	16.5	55.7	238%
Indirect costs	163.3	224.4	37%	44.9	75.9	69%	16.0	39.0	145%	12.7	28.7	126%
Total costs	404.8	738.8	83%	85.5	185.5	117%	35.6	107.9	203%	29.1	84.3	190%
Hypertension												
Medical costs	47.4	93.3	97%	10.8	26.6	146%	5.5	18.9	242%	4.7	14.9	217%
Indirect costs	26.6	37.2	40%	10.4	17.5	69%	2.9	7.2	145%	2.3	5.3	133%
Total costs	74.0	130.6	76%	21.2	44.1	108%	8.4	26.0	209%	7.0	20.2	189%
CHD												
Medical costs	71.3	158.7	123%	8.9	24.7	176%	5.0	18.6	273%	3.7	12.5	237%
Indirect costs	72.1	97.4	35%	15.3	26.1	70%	6.6	16.5	152%	4.9	11.3	129%
Total costs	143.4	256.0	79%	24.2	50.8	109%	11.6	35.2	204%	8.7	23.8	175%
CHF												
Medical costs	12.4	26.6	114%	3.5	10.7	202%	0.8	3.0	266%	1.1	4.3	289%
Indirect costs	7.8	12.0	53%	2.5	6.4	158%	0.5	1.4	181%	0.5	1.1	135%
Total costs	20.3	38.6	91%	6.0	17.1	184%	1.3	4.4	234%	1.6	5.4	243%
Stroke												
Medical costs	24.2	54.5	125%	7.4	21.2	187%	2.7	9.4	253%	2.4	9.1	278%
Indirect costs	18.5	26.6	43%	6.4	10.9	71%	2.7	6.6	143%	2.0	4.6	128%
Total costs	42.7	81.1	90%	13.8	32.2	133%	5.4	16.0	197%	4.4	13.7	210%
AFIB												
Medical costs	20.7	45.8	121%	1.4	4.1	198%	0.6	2.1	276%	0.9	3.0	238%
Indirect costs	5.8	8.2	43%	0.6	1.1	77%	0.2	0.6	146%	0.4	0.8	124%
Total costs	26.5	54.0	104%	2.0	5.2	160%	0.8	2.7	238%	1.3	3.8	206%
Other Heart Disease												
Medical costs	65.5	135.6	107%	8.5	22.3	164%	5.1	16.8	229%	3.6	11.8	226%
Indirect costs	32.4	43.0	33%	9.8	15.8	61%	3.0	6.8	125%	2.6	5.5	113%
Total costs	97.9	178.6	82%	18.2	38.1	109%	8.2	23.7	190%	6.2	17.3	179%
Hypertension as Risk Factor												
Medical costs	78.5	162.8	107%	17.5	45.0	158%	8.4	29.9	254%	7.2	23.7	230%
Indirect costs	28.9	40.2	39%	11.0	18.5	69%	3.2	7.8	145%	2.5	5.8	132%
Total costs	107.4	203.0	89%	28.4	63.5	123%	11.6	37.7	224%	9.7	29.5	205%

Table 3-5. Projected Costs of Total CVD by Sex (2015$ in billions)

Condition	Total $ 2015	Total $ 2035	Total % Change	Male $ 2015	Male $ 2035	Male % Change	Female $ 2015	Female $ 2035	Female % Change
Total CVD									
Medical costs	318.2	748.7	135%	169.6	352.7	108%	170.7	395.9	132%
Indirect costs	236.8	368.0	55%	155.2	238.5	54%	81.6	129.5	59%
Total costs	555.0	1,116.6	101%	324.8	591.2	82%	252.2	525.4	108%
Hypertension									
Medical costs	68.4	153.7	125%	33.0	73.7	124%	35.5	80.0	126%
Indirect costs	42.2	67.2	59%	27.2	43.1	59%	15.0	24.1	61%
Total costs	110.6	220.9	100%	60.2	116.8	94%	50.4	104.1	106%
CHD									
Medical costs	89.0	214.5	141%	47.9	117.0	144%	41.0	97.5	138%
Indirect costs	98.9	151.3	53%	72.8	109.8	51%	26.1	41.5	59%
Total costs	187.9	365.8	95%	120.7	226.7	88%	67.2	139.1	107%
CHF									
Medical costs	17.9	44.6	149%	6.4	15.9	150%	11.5	28.7	149%
Indirect costs	11.3	19.0	68%	6.3	10.3	63%	5.0	8.7	75%
Total costs	29.2	63.6	118%	12.7	26.2	107%	16.5	37.4	127%
Stroke									
Medical costs	36.7	94.3	157%	15.5	40.4	160%	21.1	53.9	155%
Indirect costs	29.6	48.7	64%	17.2	27.8	62%	12.5	20.8	67%
Total costs	66.3	142.9	116%	32.7	68.2	109%	33.6	74.7	122%
AFIB									
Medical costs	23.6	55.0	133%	10.0	24.2	142%	13.5	30.7	127%
Indirect costs	7.0	10.7	54%	2.1	3.8	82%	4.9	7.0	42%
Total costs	30.5	65.7	115%	12.1	28.0	132%	18.5	37.7	104%
Other Heart Disease									
Medical costs	82.7	186.6	126%	34.7	81.5	135%	48.0	105.1	119%
Indirect costs	47.8	71.1	49%	29.7	43.7	47%	18.1	27.4	51%
Total costs	130.5	257.7	97%	64.4	125.2	94%	66.1	132.4	100%
Hypertension as Risk Factor									
Medical costs	111.6	261.4	134%	51.1	117.5	130%	60.6	143.9	138%
Indirect costs	45.5	72.4	59%	28.8	45.5	58%	16.8	26.9	60%
Total costs	157.2	333.8	112%	79.8	163.0	104%	77.4	170.8	121%

Table 3-6. Projected Total Costs by Year (2015$ in billions)

Year	Total	Hyper-tension	CHD	CHF	Stroke	Other	Hypertension as Risk Factor	AFIB
2015	555.0	110.6	187.9	29.2	66.3	130.5	157.2	30.5
2016	576.0	114.9	194.7	30.3	69.0	135.3	163.5	31.8
2017	597.2	119.1	201.5	31.5	71.8	140.2	169.8	33.0
2018	618.9	123.5	208.4	32.7	74.7	145.2	176.4	34.3
2019	641.2	127.9	215.5	34.0	77.7	150.4	183.1	35.7
2020	664.7	132.6	223.0	35.4	80.8	155.7	190.3	37.2
2021	688.6	137.3	230.6	36.8	84.0	161.2	197.6	38.7
2022	713.9	142.3	238.6	38.2	87.5	167.0	205.4	40.3
2023	740.5	147.5	247.1	39.8	91.1	173.1	213.6	42.0
2024	767.6	152.8	255.7	41.4	94.8	179.3	221.9	43.7
2025	796.3	158.4	264.8	43.1	98.7	185.8	230.8	45.5
2026	825.2	164.1	273.9	44.9	102.6	192.4	239.8	47.3
2027	856.2	170.0	283.8	46.8	106.9	199.3	249.6	49.4
2028	887.2	176.0	293.6	48.8	111.1	206.3	259.4	51.4
2029	918.5	182.0	303.5	50.7	115.5	213.4	269.4	53.4
2030	950.5	188.3	313.6	52.8	119.9	220.6	279.6	55.4
2031	982.0	194.4	323.5	54.8	124.2	227.6	289.8	57.4
2032	1,013.7	200.7	333.5	56.9	128.6	234.7	300.1	59.4
2033	1,046.3	207.1	343.7	59.0	133.1	242.0	310.7	61.4
2034	1,080.4	213.8	354.4	61.2	137.9	249.6	321.9	63.5
2035	1,116.6	220.9	365.8	63.6	142.9	257.7	333.8	65.7

Figure 3-14. Projected Total (Direct + Indirect) Costs of Total CVD by Age, 2015–2035 (2015$ in billions)

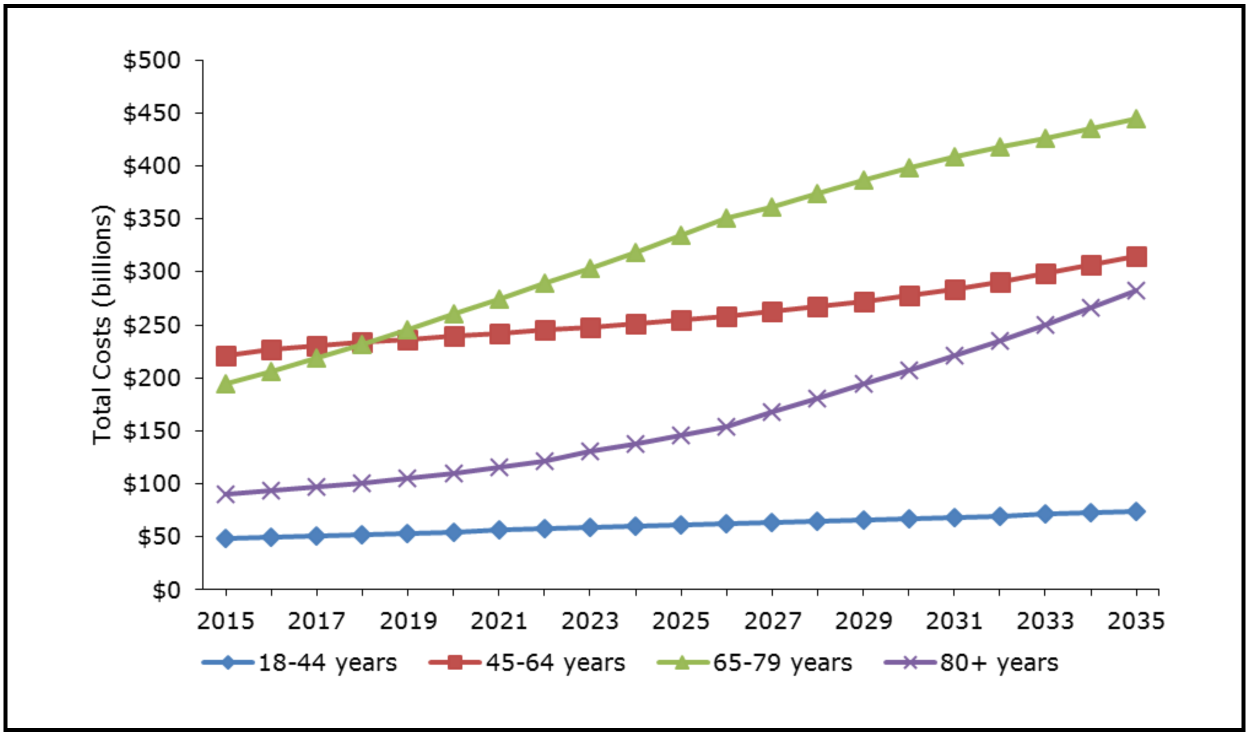


Figure 3-15. Projected Total (Direct + Indirect) Costs of CHF by Age, 2015–2035 (2015$ in billions)

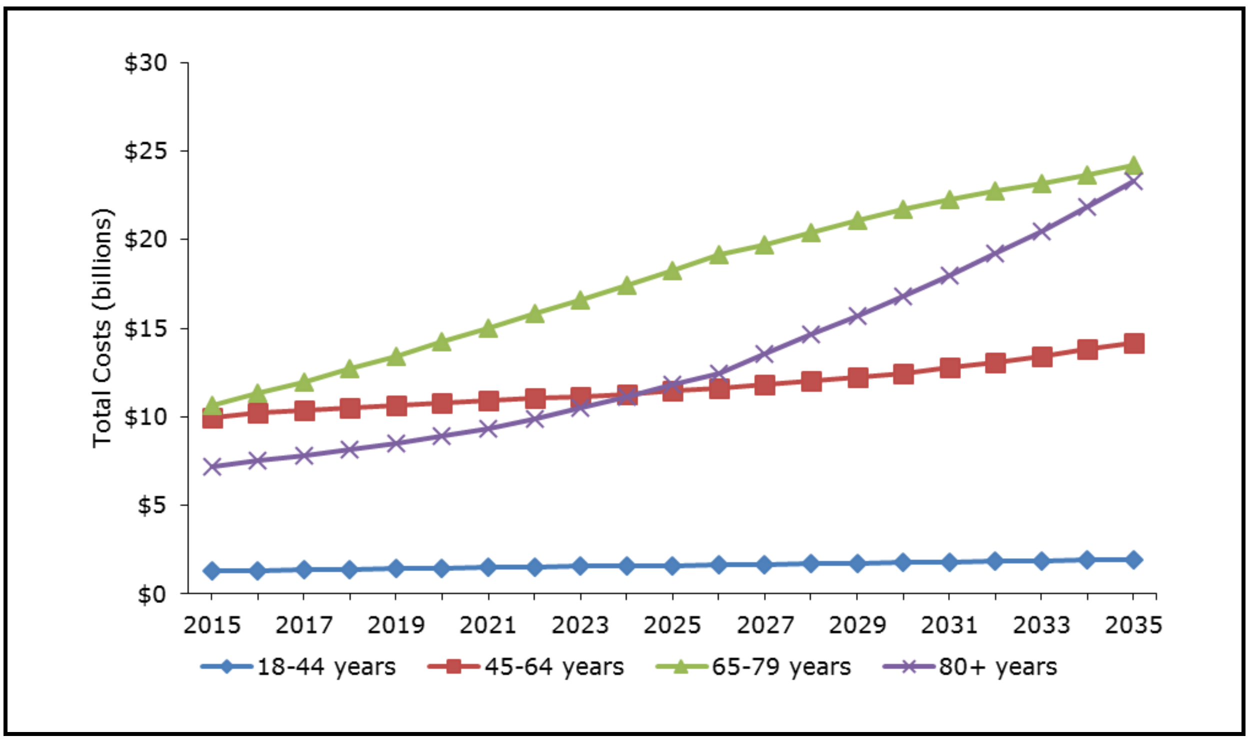


Figure 3-16. Projected Total (Direct + Indirect) Costs of Stroke by Age, 2015–2035 (2015$ in billions)

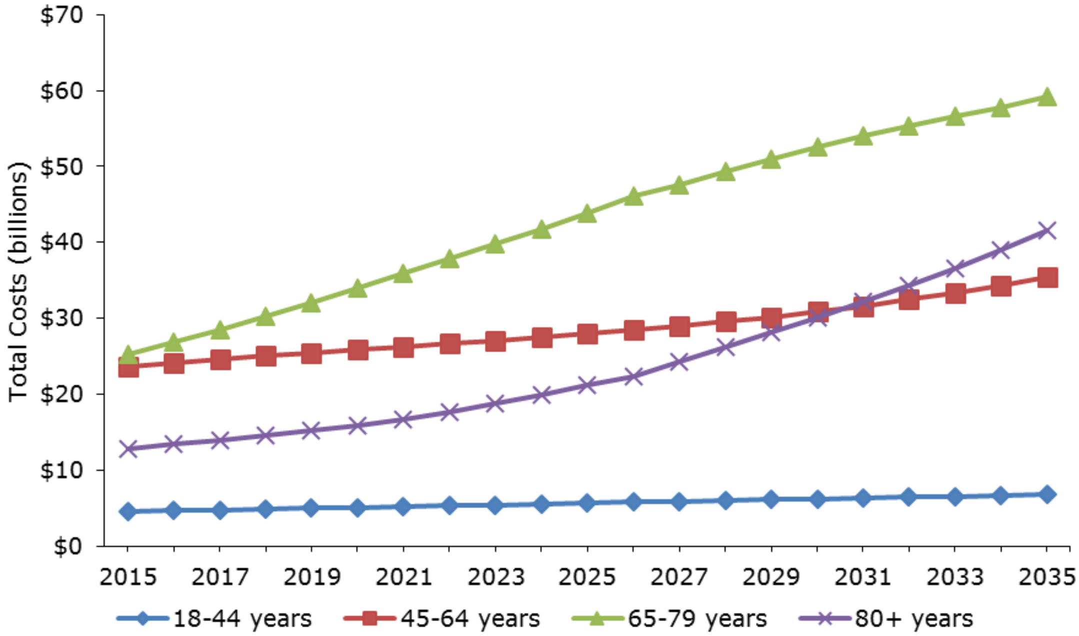


Figure 3-17. Projected Total (Direct + Indirect) Costs of AFIB by Age, 2015–2035 (2015$ in billions)

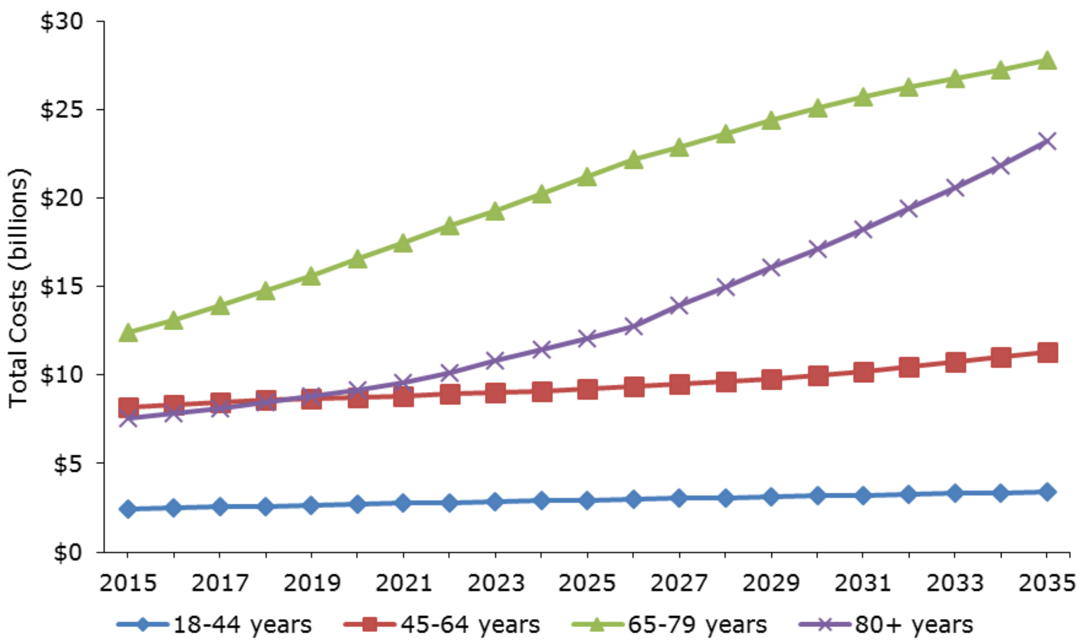


Figure 3-18. Projected Total (Direct + Indirect) Costs of Total CVD by Race/Ethnicity, 2015–2035 (2015$ in billions)

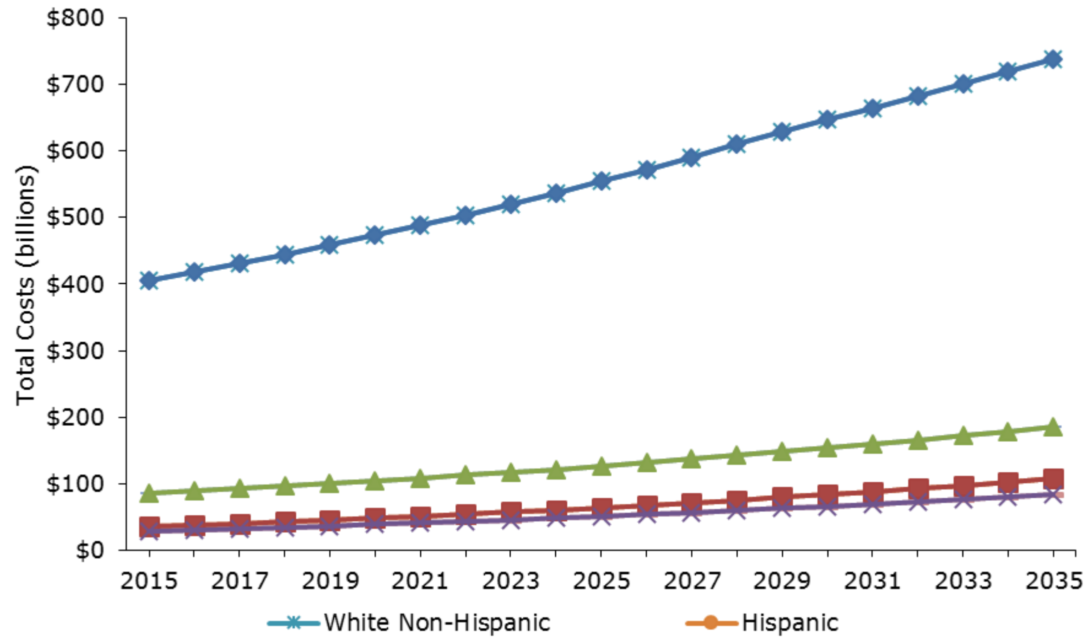


Figure 3-19. Projected Total (Direct + Indirect) Costs of Total CVD by Sex, 2015–2035 (2015$ in billions)

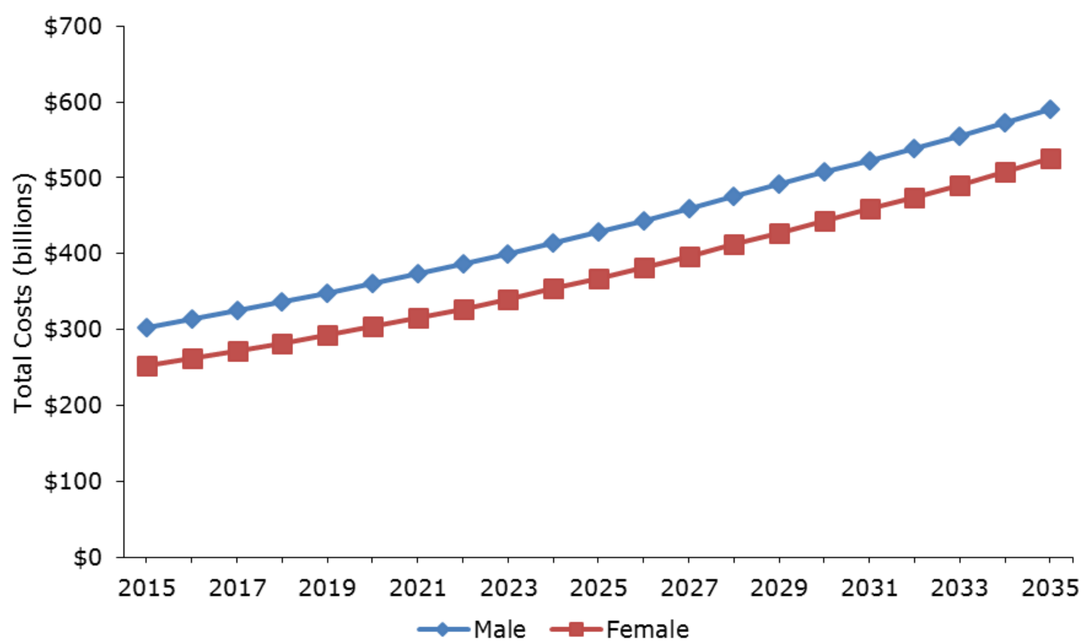
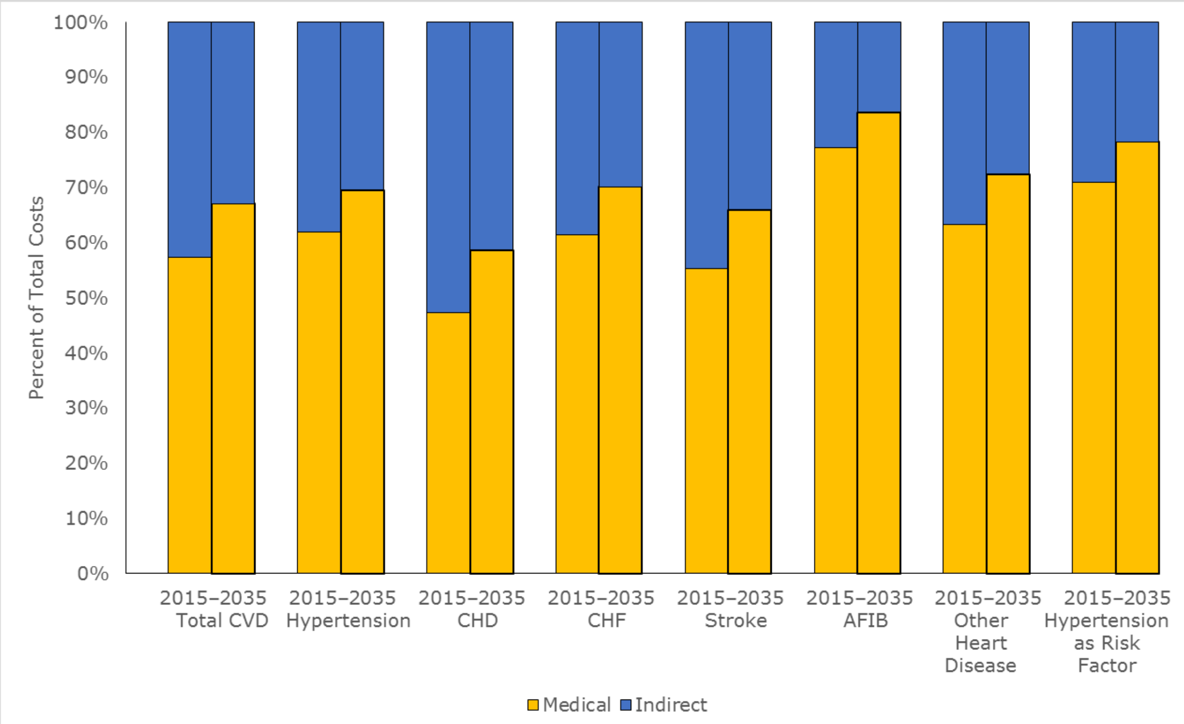


Figure 3-20. Medical and Indirect Costs, 2015 and 2035



3.2.1 Projections of Medical (Direct) Costs of CVD

Table 3-7 reports projected medical costs for each CVD condition for 2015 through 2035, and Figures 3-21 through 3-29 present projected medical costs for individual CVD conditions by age, race/ethnicity, and sex. We include separate graphs by age, race/ethnicity, and sex only for those conditions where the patterns are different from those estimated for total CVD. Medical costs of CVD are expected to increase by 135% from 2015 ($318 billion) to 2035 ($749 billion) (see Table 3-6). When costs of hypertension are expanded to include how much the presence of hypertension adds to the treatment of sequelae (i.e., costs of hypertension as a risk factor), the medical costs of hypertension are estimated at $112 billion in 2015 increasing to $261 billion in 2035. Not considering costs of hypertension as a risk factor, costs are the highest for coronary heart disease ($89 billion in 2015, increasing to $215 billion in 2035).

By age, medical costs of CVD are the lowest among persons aged 18 to 44 (because of the lower prevalence of CVD in this age group) and the highest among persons aged 65 to 79 (Figure 3-21). In 2015, medical costs of CVD are lower among persons aged 80 or older than among those aged 45 to 64. However, after 2023, costs among persons aged 80 or older begin to exceed costs among persons aged 45 to 64. This result is likely driven by the fact that the number of people aged 80 or older is increasing over time. Across all conditions, the highest relative increases in costs are expected among persons aged 80 or older (costs will more than triple) (see Table 3-3). Costs of hypertension in 2015 are the highest among persons aged 45 to 64 but in the future are quickly exceeded by costs among persons aged 65 to 79 (Figure 3-22). Costs of coronary heart disease, stroke, and AFIB are the highest among persons aged 65 to 79. Costs of CHF are the highest among persons aged 65 to 79 in 2015 through 2030 but are then exceeded by costs among persons aged 80 or older.

Table 3-7. Projected Medical Costs by Year, 2015–2035 (2015$ in billions)

Year	Total	Hyper-tension	CHD	CHF	Stroke	Other	Hypertension as Risk Factor	AFIB
2015	318.2	68.4	89.0	17.9	36.7	82.7	111.6	23.6
2016	332.9	71.5	93.2	18.7	38.5	86.3	116.7	24.6
2017	347.9	74.6	97.5	19.6	40.4	90.1	121.8	25.7
2018	363.6	77.9	102.0	20.4	42.4	94.0	127.2	26.9
2019	380.0	81.2	106.7	21.4	44.5	98.1	132.7	28.0
2020	397.4	84.7	111.8	22.4	46.8	102.4	138.7	29.3
2021	415.3	88.3	117.0	23.4	49.1	106.8	144.8	30.6
2022	434.4	92.1	122.6	24.5	51.7	111.5	151.3	32.0
2023	454.8	96.1	128.6	25.7	54.3	116.5	158.2	33.6
2024	475.5	100.2	134.6	26.9	57.1	121.5	165.3	35.1
2025	497.3	104.6	141.0	28.2	60.0	126.9	172.8	36.7
2026	519.3	109.0	147.4	29.5	62.9	132.2	180.4	38.3
2027	543.8	113.6	154.8	31.1	66.2	138.1	188.8	40.2
2028	568.3	118.3	162.0	32.6	69.5	143.9	197.3	42.0
2029	592.9	123.1	169.2	34.2	72.9	149.8	205.9	43.8
2030	618.0	128.0	176.6	35.8	76.3	155.8	214.7	45.6
2031	642.7	132.8	183.7	37.5	79.7	161.6	223.4	47.4
2032	667.7	137.7	191.0	39.1	83.1	167.5	232.3	49.2
2033	693.3	142.8	198.4	40.8	86.6	173.6	241.5	51.0
2034	720.0	148.1	206.2	42.7	90.3	179.9	251.1	52.9
2035	748.7	153.7	214.5	44.6	94.3	186.6	261.4	55.0

Figure 3-21. Projected Medical Costs of Total CVD by Age, 2015–2035 (2015$ in billions)

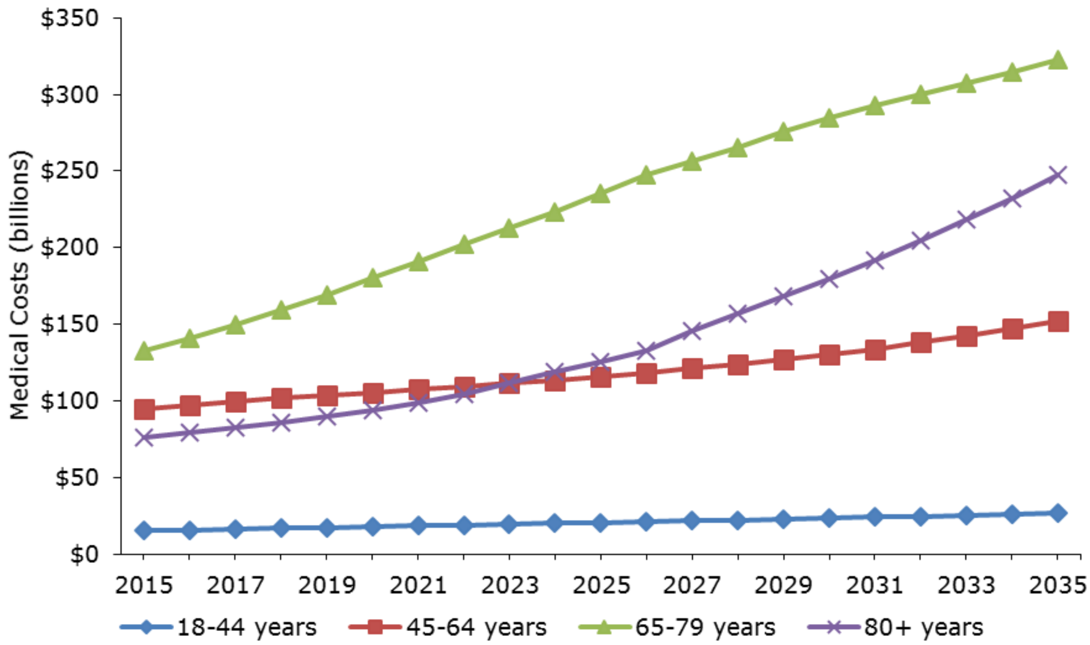


Figure 3-22. Projected Medical Costs of Hypertension by Age, 2015–2035 (2015$ in billions)

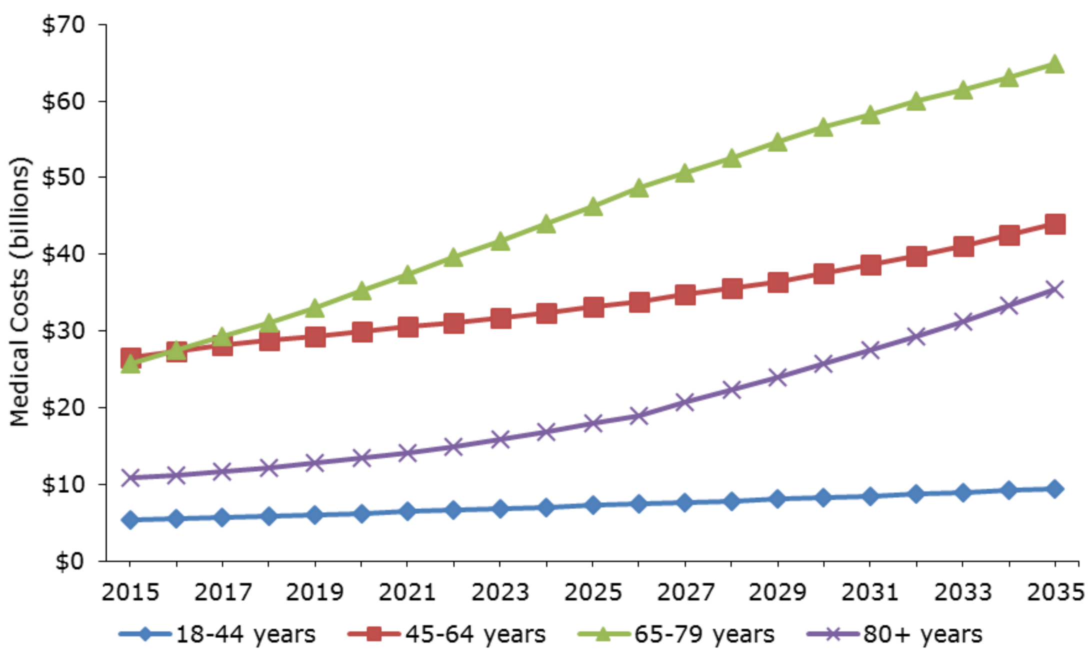


Figure 3-23. Projected Total Costs of CHD by Age, 2015–2035 (2015$ in billions)

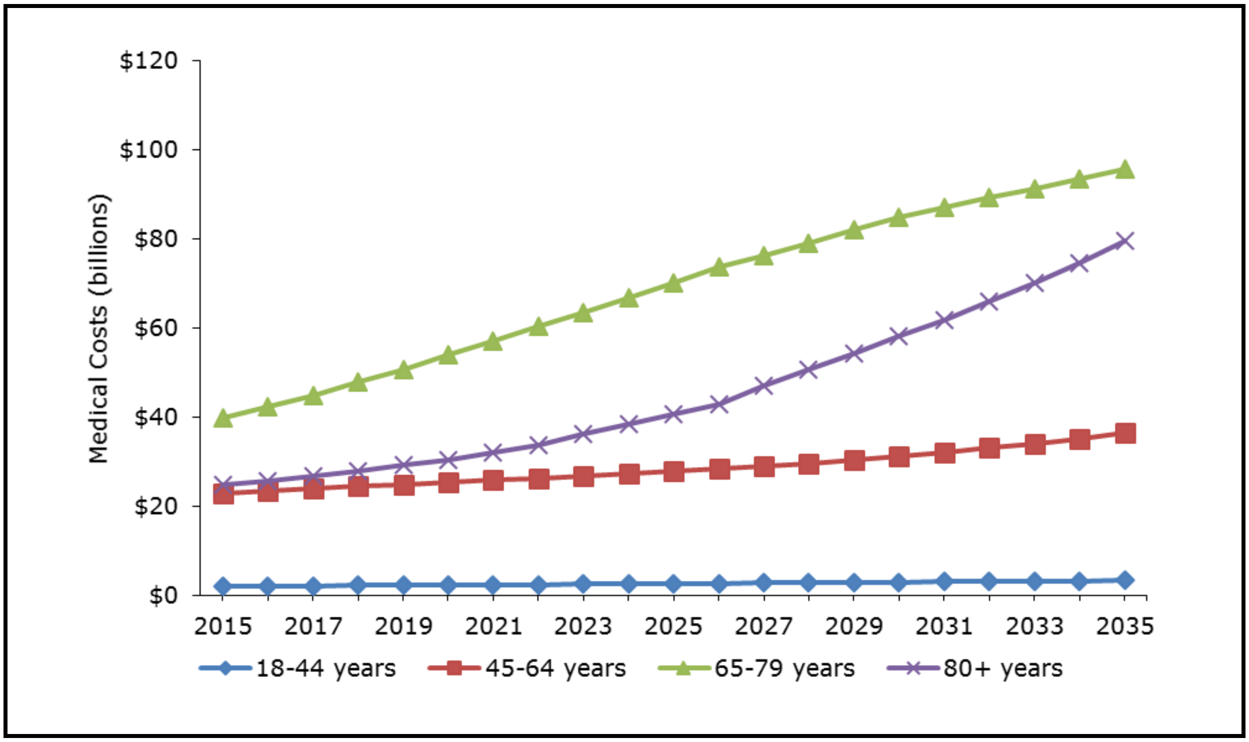


Figure 3-24. Projected Medical Costs of CHF by Age, 2015–2035 (2015$ in billions)

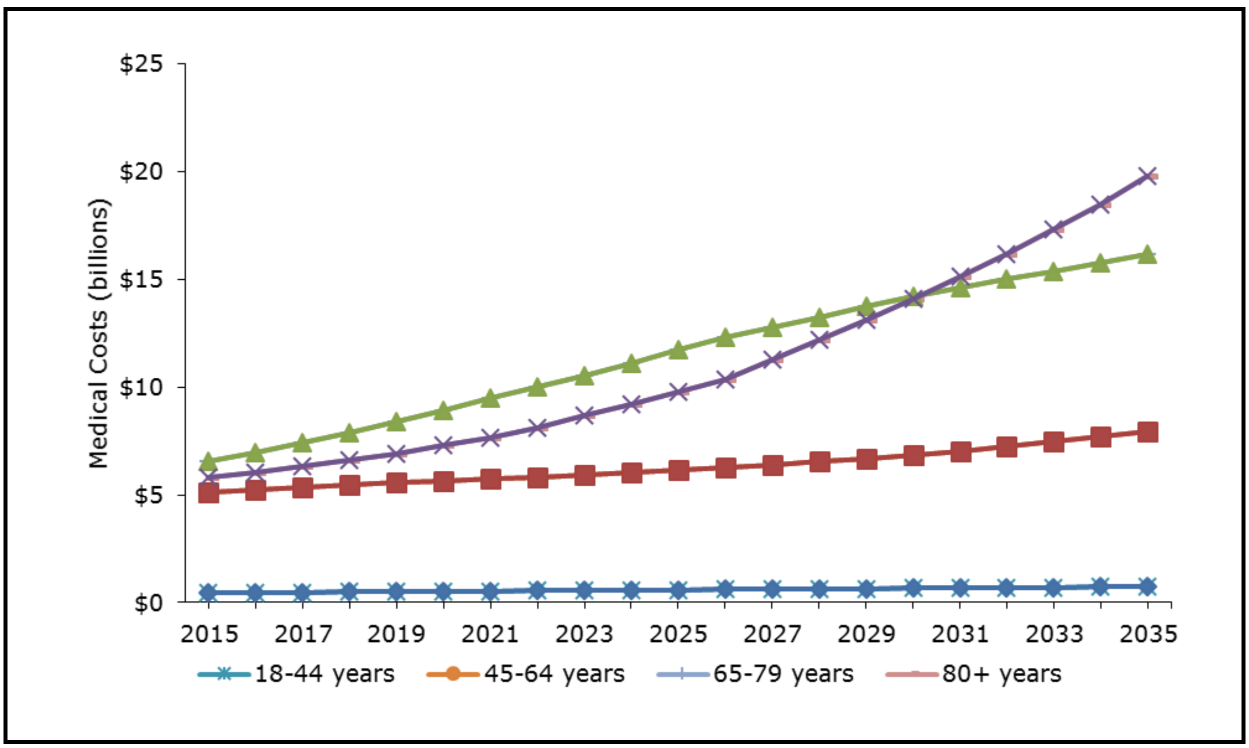


Figure 3-25. Projected Medical Costs of Stroke by Age, 2015–2035 (2015$ in billions)

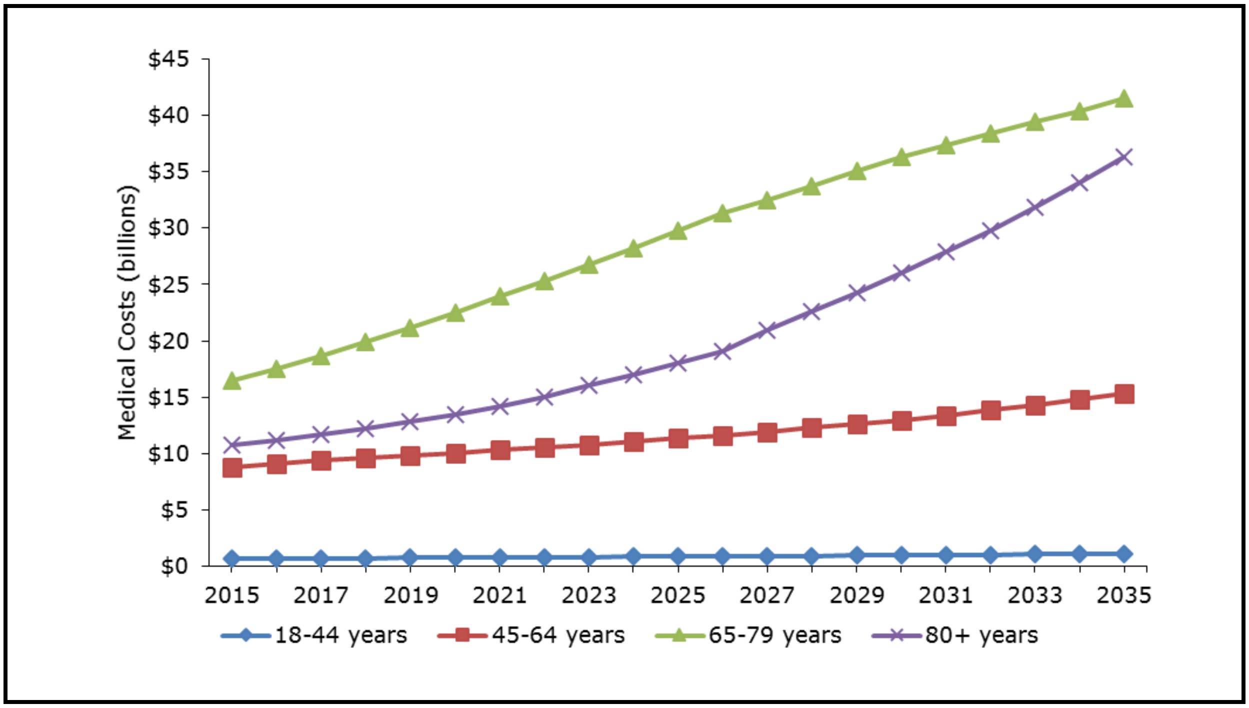


Figure 3-26. Projected Medical Costs of AFIB by Age, 2015–2035 (2015$ in billions)

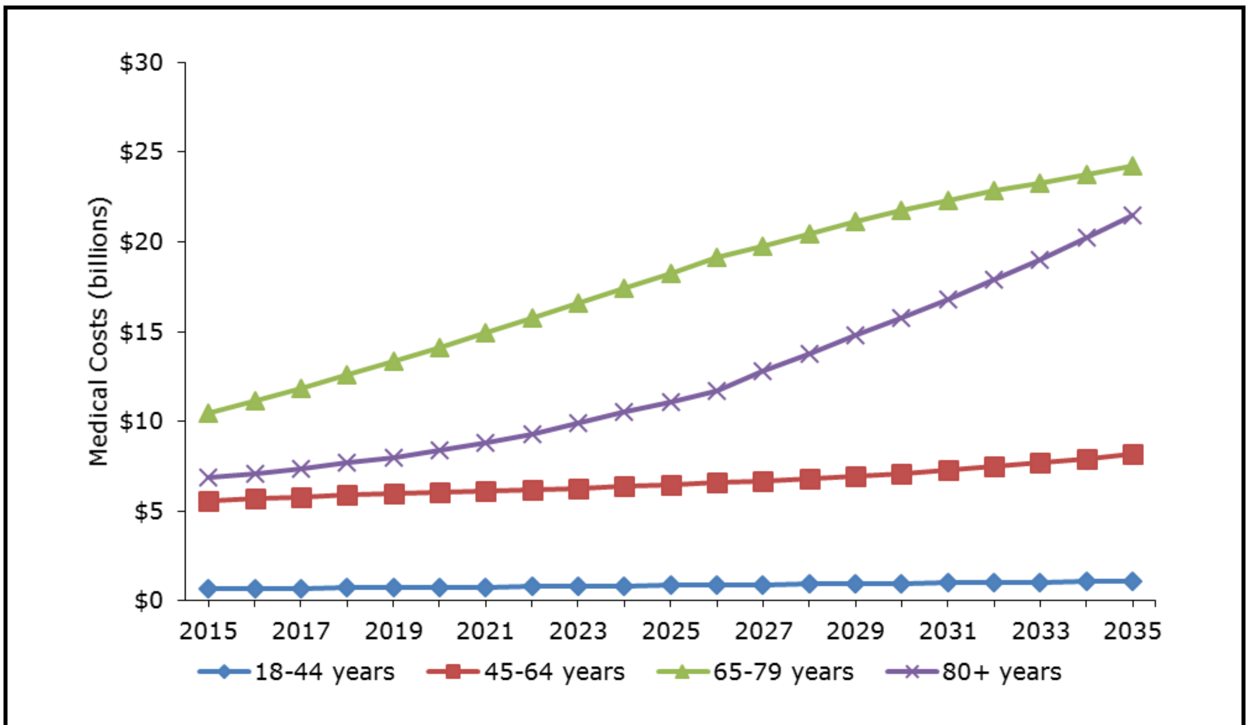


Figure 3-27. Projected Medical Costs of Total CVD by Race/Ethnicity, 2015–2035 (2015$ in billions)

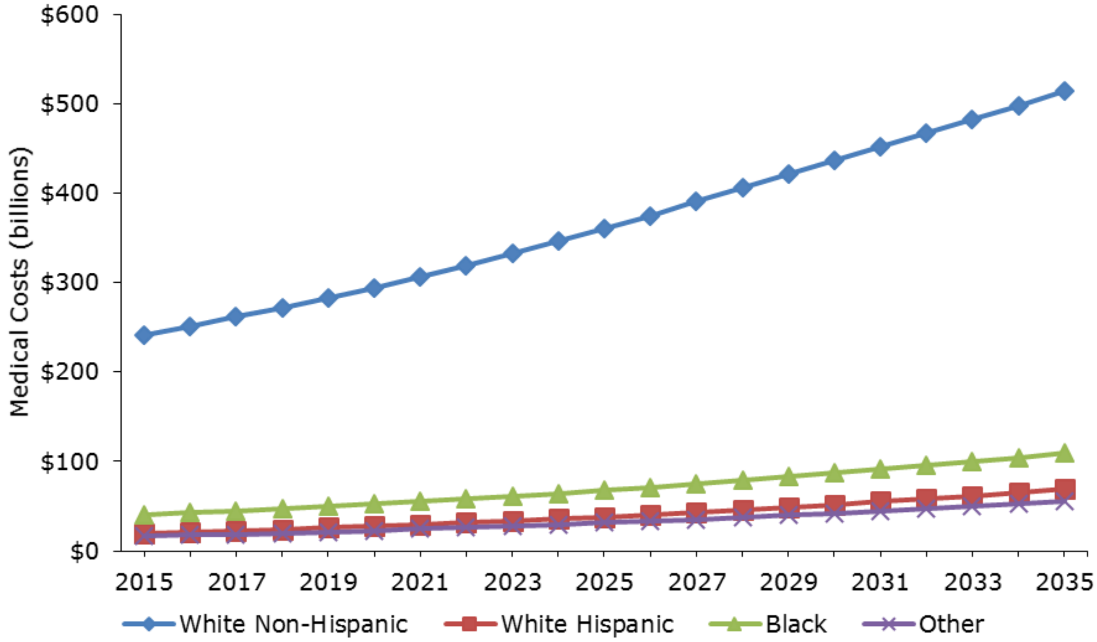


Figure 3-28. Projected Medical Costs of Total CVD by Sex, 2015–2035 (2015$ in billions)

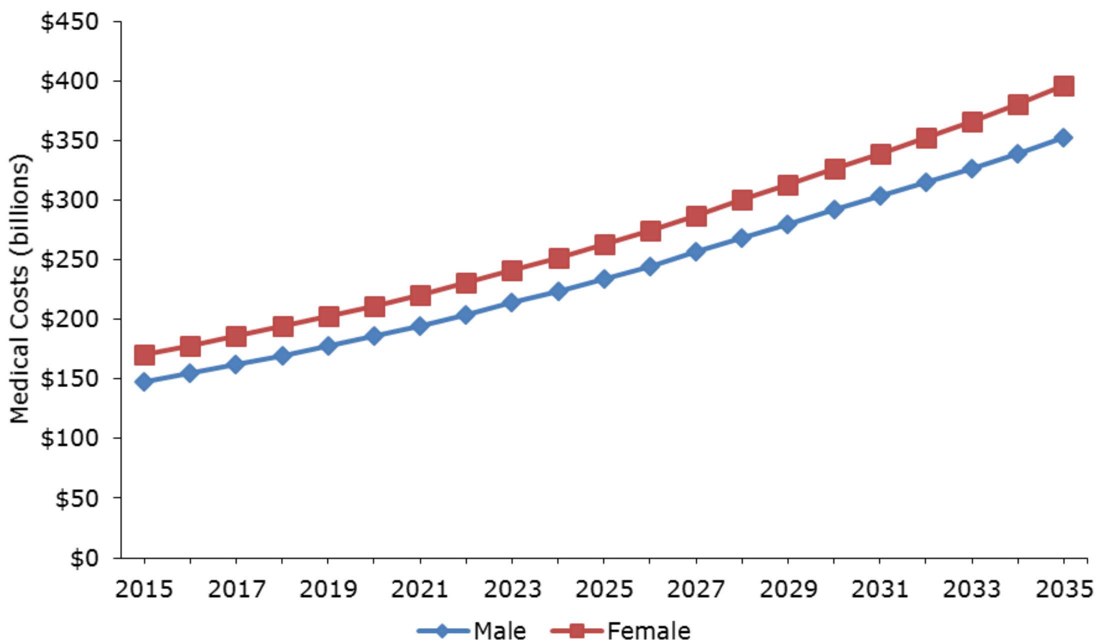
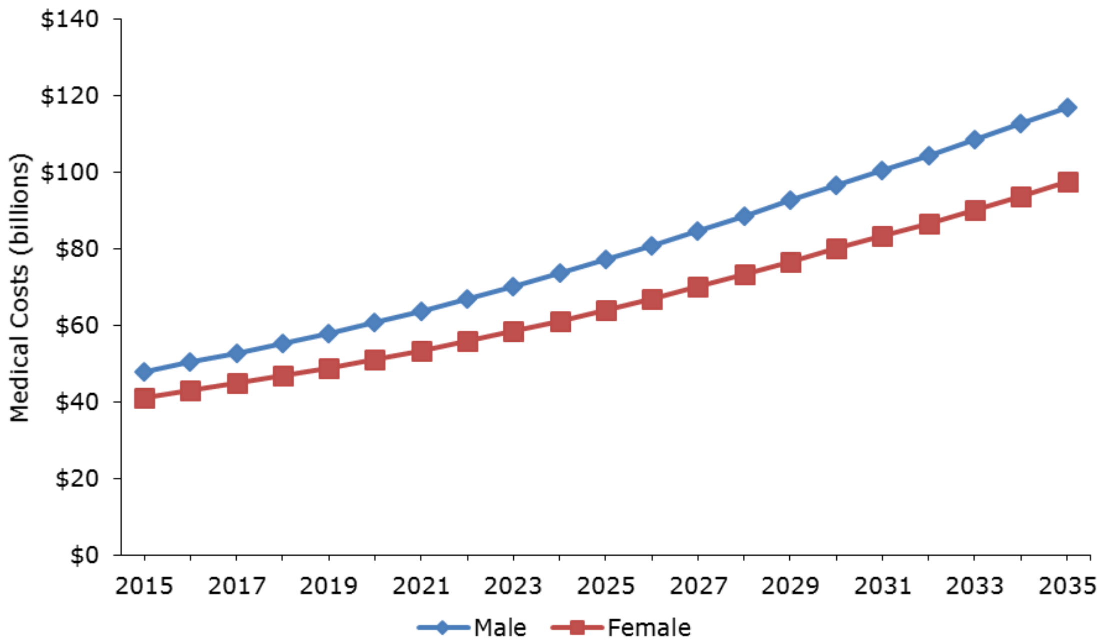


Figure 3-29. Projected Total Costs of CHD by Sex, 2015–2035 (2015$ in billions)



By race/ethnicity, the total medical costs of CVD are the highest among white non-Hispanics (see Figure 3-27). Across all conditions, between 2015 and 2035, the highest relative increases in medical costs are expected among Hispanics and persons of other races. Costs for these groups will more than triple. For blacks, medical costs of CVD are expected to increase by more than 2.5 times between 2015 and 2035 (see Table 3-4). By sex, medical costs of total CVD in 2015 are slightly higher among females than among males (see Figure 3-28), and this pattern is consistent across all conditions except coronary heart disease where the costs are higher among males than among females (Figure 3-29). Similar increases in costs are expected among both females and males through 2035 (see Table 3-5).

Table 3-8 reports percentage of total medical costs incurred by point of service for each CVD condition in 2015 and 2035. Across all conditions, hospital costs represent the largest proportion of medical costs. For hypertension, one-third of medical costs are for prescription medications. Across the conditions, coronary heart disease and stroke have the highest proportion of medical costs incurred in nursing homes (18% and 25%, respectively, in 2015). These costs are expected to increase to 23% and 28%, respectively, in 2035. For other conditions, the breakout of costs by point of service is not expected to change significantly between 2015 and 2035.

Table 3-8. Projected Medical Costs of CVD by Point of Service, 2015 and 2035 (2015$ in billions)

	Total CVD		Hypertension		CHD		CHF		Stroke		AFIB		Other Heart Disease		Hypertension as Risk Factor	
% of Total Medical Costs	**2015**	**2035**	**2015**	**2035**	**2015**	**2035**	**2015**	**2035**	**2015**	**2035**	**2015**	**2035**	**2015**	**2035**	**2015**	**2035**
Physician	15.5%	15.0%	17.5%	17.2%	12.4%	12.2%	7.4%	6.7%	3.7%	3.3%	34.3%	34.2%	18.9%	18.6%	12.1%	11.4%
Hospital	56.8%	55.5%	45.8%	45.3%	60.9%	60.2%	62.4	57.8%	46.5%	43.2%	45.1%	45.0%	68.4%	67.4%	52.2%	50.3%
Prescription	15.9%	15.3%	33.5%	33.2%	16.8%	16.3	5.5%	4.9%	8.3%	7.5%	15.6%	15.4%	6.0%	5.8%	21.0%	20.0%
Home Health	4.6%	5.5%	0.0%	0.0%	5.1%	6.1%	6.7%	7.5%	14.7%	16.0%	0.3%	0.4%	4.1%	5.1%	0.0%	0.0%
Nursing Home	5.8%	7.2%	3.2%	4.2%	1.8%	2.1%	17.9%	23.1%	24.8%	28.0%	2.1%	2.4%	2.3%	2.7%	14.7%	18.2%
Other	1.4%	1.5%	0.0%	0.0%	3.1%	3.2%	0.1%	0.1%	2.1%	2.0%	2.5%	2.5%	0.4%	0.4%	0.0%	0.0%
Total Medical Costs	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

3.2.2 Projections of Indirect Costs of CVD

As shown in Tables 3-3 and 3-9, indirect costs of CVD are expected to increase by 55% from $237 billion in 2015 to $368 billion in 2035. Indirect costs are the highest for coronary heart disease ($99 billion in 2015). Indirect costs of CVD are the highest among persons aged 45 to 64 and the lowest among persons aged 80 or older (this result is driven by the differences in the number of employed people in these age groups) (Figure 3-30). A similar pattern is observed for indirect costs of hypertension, coronary heart disease, and stroke (results not shown). For CHF and AFIB, however, the costs are highest among persons aged 45 to 64 in 2015 but are exceeded by costs among persons aged 65 to 79 by 2035 (Figures 3-31 and 3-32). Persons aged 65 or older are expected to experience the highest relative increase in indirect costs between 2015 and 2035 (costs will more than double) (see Table 3-3).

Table 3-9. Projected Indirect Costs (2015$ in billions)

Year	Total	Hyper-tension	CHD	CHF	Stroke	Other	AFIB	Hypertension as Risk Factor
2015	236.8	42.2	98.9	11.3	29.6	47.8	7.0	45.5
2016	243.2	43.4	101.5	11.6	30.5	49.0	7.1	46.8
2017	249.3	44.5	104.0	12.0	31.4	50.1	7.3	48.0
2018	255.3	45.6	106.4	12.3	32.3	51.2	7.5	49.2
2019	261.2	46.7	108.8	12.6	33.1	52.3	7.7	50.4
2020	267.3	47.9	111.2	13.0	34.0	53.4	7.8	51.6
2021	273.3	49.0	113.6	13.4	34.9	54.4	8.0	52.8
2022	279.5	50.2	116.0	13.7	35.8	55.5	8.2	54.1
2023	285.7	51.3	118.5	14.1	36.7	56.6	8.4	55.3
2024	292.1	52.6	121.0	14.5	37.7	57.7	8.6	56.7
2025	299.0	53.9	123.8	14.9	38.7	58.9	8.8	58.1
2026	305.8	55.2	126.5	15.3	39.7	60.1	9.0	59.4
2027	312.3	56.4	129.0	15.7	40.7	61.3	9.2	60.8
2028	319.0	57.7	131.7	16.2	41.6	62.4	9.4	62.2
2029	325.6	59.0	134.3	16.6	42.6	63.6	9.6	63.5
2030	332.4	60.3	137.0	17.0	43.6	64.8	9.8	65.0
2031	339.2	61.6	139.7	17.4	44.6	66.0	10.0	66.4
2032	346.1	62.9	142.5	17.7	45.5	67.2	10.1	67.8
2033	353.1	64.3	145.3	18.1	46.5	68.5	10.3	69.2
2034	360.3	65.7	148.2	18.5	47.6	69.7	10.5	70.8
2035	368.0	67.2	151.3	19.0	48.7	71.1	10.7	72.4

Figure 3-30. Projected Indirect Costs of Total CVD by Age, 2015–2035 (2015$ in billions)

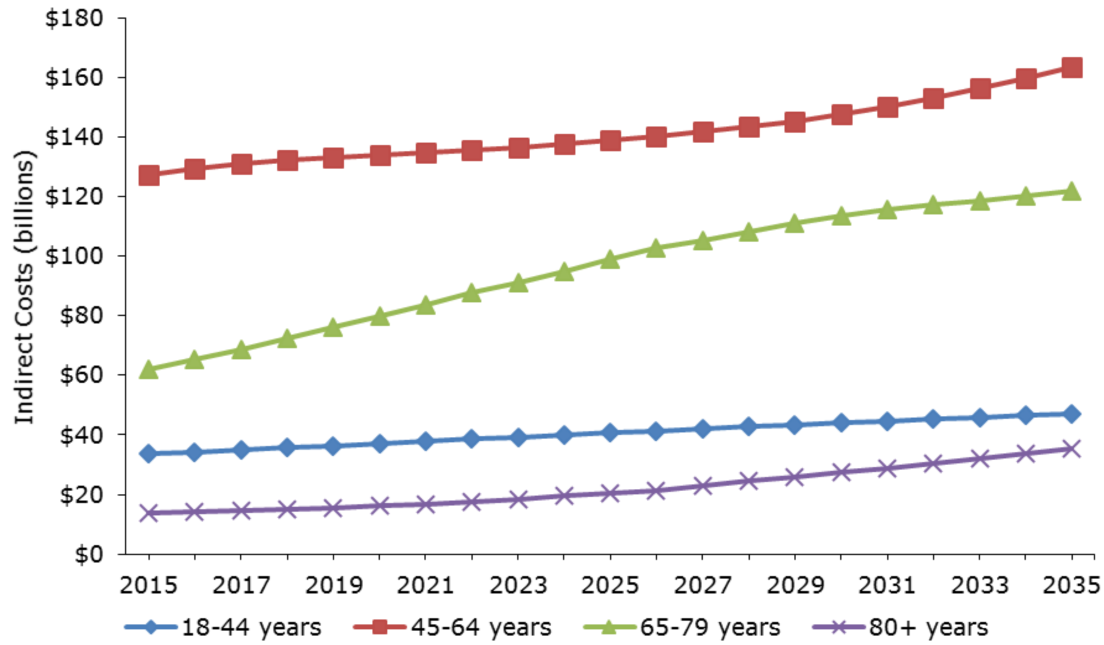


Figure 3-31. Projected Indirect Costs of CHF by Age, 2015–2035 (2015$ in billions)

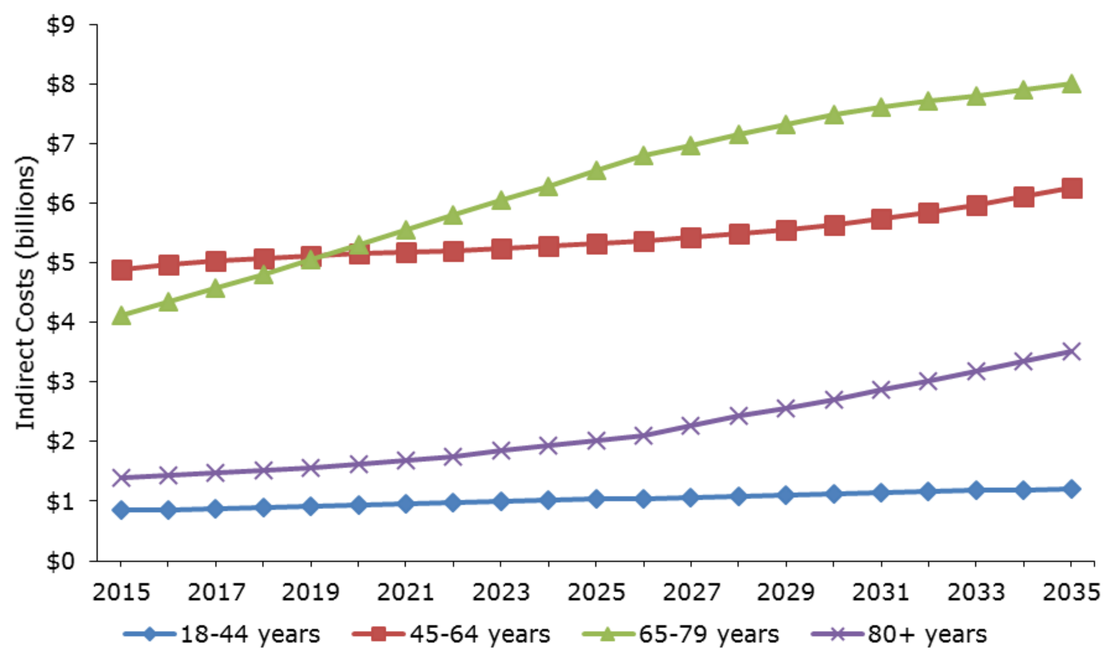
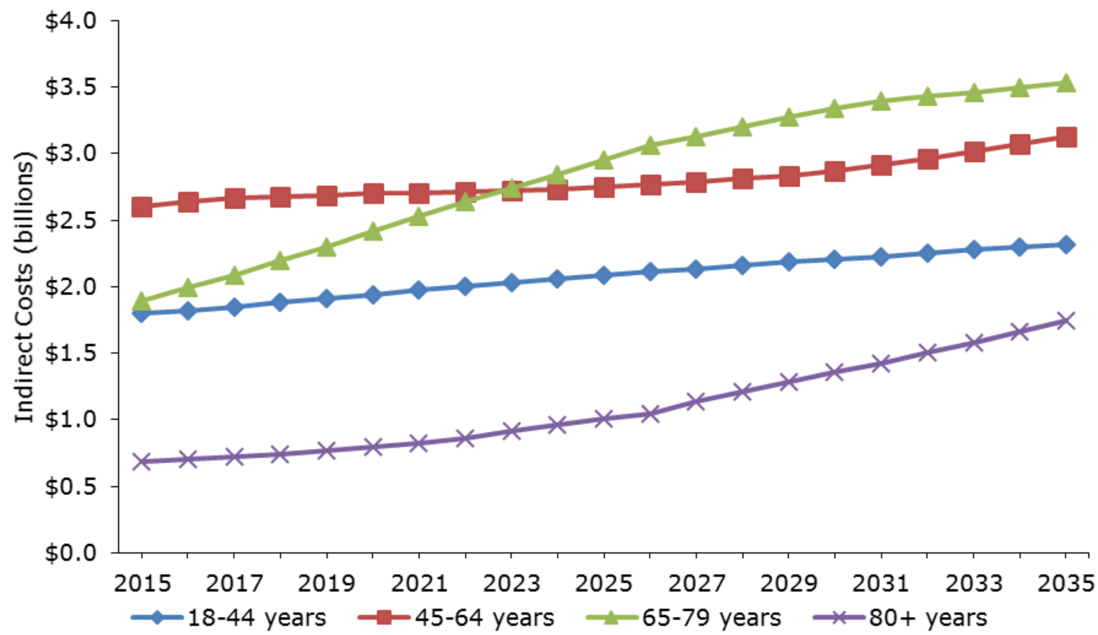


Figure 3-32. Projected Indirect Costs of AFIB by Age, 2015–2035 (2015$ in billions)



By race/ethnicity, indirect costs of CVD are the highest among white non-Hispanics (Figure 33) but Hispanics and persons of other races are expected to experience the largest relative increase in costs (more than doubling). By sex, indirect costs of total CVD are higher among males than females ($155 billion vs $82 billion in 2015) (Table 3-5 and Figure 3-34). AFIB is the only condition for which indirect costs are higher among females than males ($5 billion vs $2 billion in 2015) (Table 3-5 and Figure 3-34).

Morbidity costs represent 30% of total indirect costs and are estimated to increase by 72% from $62 billion in 2015 to $107 billion in 2035 (Table 3-10). Morbidity costs are the highest for hypertension ($23 billion in 2015). Mortality costs represent 70% of total indirect costs and are estimated to increase by 49% from $174 billion in 2015 to $261 billion in 2035 (Table 3-11). Mortality costs are the highest for coronary heart disease ($83 billion in 2015).

Figure 3-33. Projected Indirect Costs of Total CVD by Race/Ethnicity, 2015–2035 (2015$ in billions)

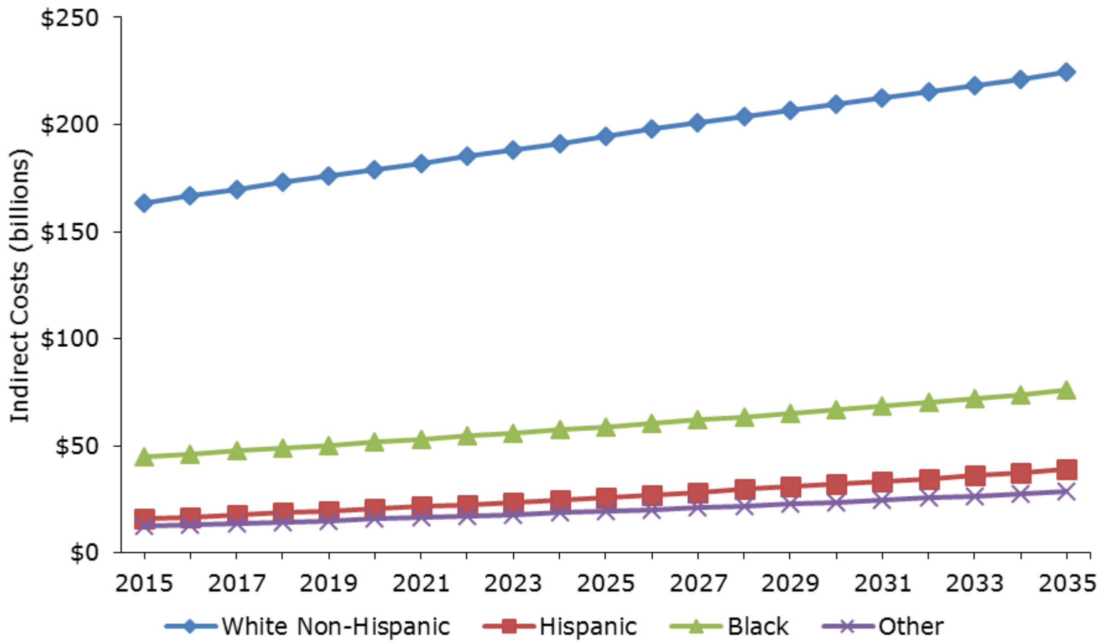


Figure 3-34. Projected Indirect Costs of Total CVD by Sex, 2015–2035 (2015$ in billions)

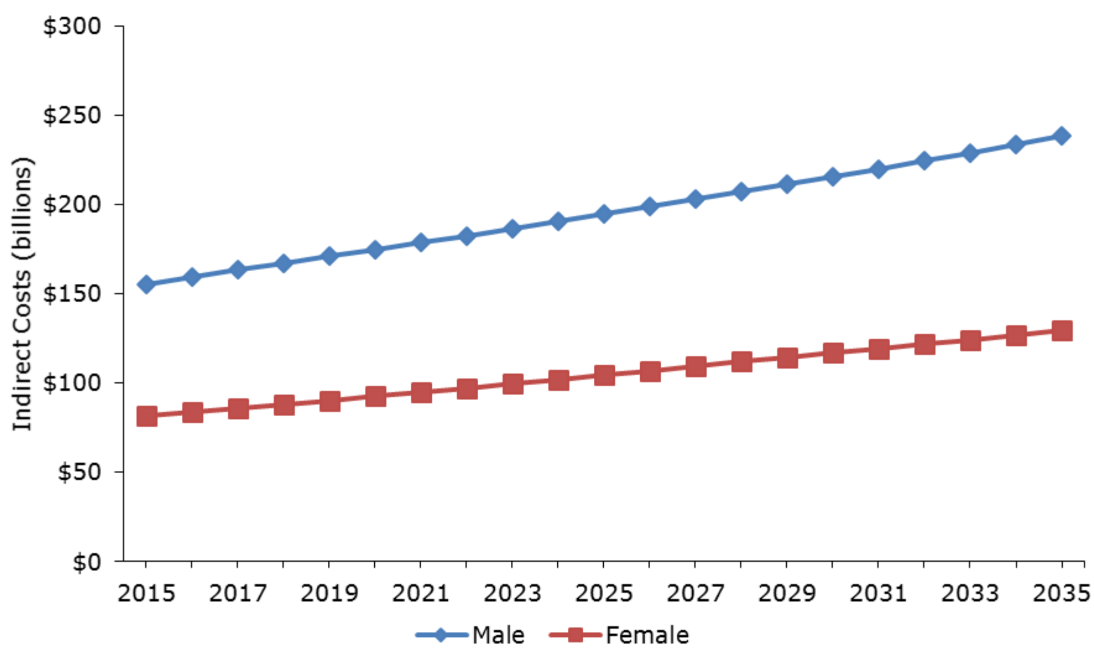


Table 3-10. Projected Morbidity Costs by Year, 2015–2035 (2015$ in billions)

Year	Total	Hyper-tension	CHD	CHF	Stroke	Other	Hypertension as Risk Factor	AFIB
2015	62.4	22.8	16.1	4.0	6.9	9.4	26.2	3.2
2016	64.4	23.5	16.7	4.2	7.1	9.6	26.9	3.3
2017	66.4	24.2	17.2	4.3	7.3	9.9	27.7	3.4
2018	68.4	24.9	17.8	4.4	7.5	10.2	28.5	3.5
2019	70.4	25.6	18.4	4.6	7.8	10.4	29.3	3.7
2020	72.5	26.3	19.0	4.7	8.0	10.7	30.1	3.8
2021	74.6	27.0	19.6	4.8	8.3	11.0	30.9	3.9
2022	76.8	27.8	20.2	5.0	8.6	11.2	31.7	4.0
2023	79.0	28.5	20.9	5.2	8.8	11.5	32.5	4.1
2024	81.3	29.3	21.6	5.3	9.1	11.8	33.4	4.2
2025	83.8	30.1	22.3	5.5	9.4	12.1	34.3	4.4
2026	86.1	31.0	22.9	5.7	9.7	12.4	35.2	4.5
2027	88.6	31.8	23.6	5.8	10.0	12.7	36.1	4.6
2028	91.0	32.6	24.3	6.0	10.3	13.0	37.0	4.8
2029	93.3	33.4	25.0	6.2	10.6	13.3	37.9	4.9
2030	95.7	34.2	25.7	6.4	10.9	13.6	38.8	5.0
2031	98.0	35.0	26.3	6.5	11.2	13.9	39.7	5.1
2032	100.2	35.8	26.9	6.7	11.4	14.2	40.6	5.2
2033	102.5	36.6	27.5	6.9	11.7	14.5	41.5	5.4
2034	104.8	37.4	28.1	7.0	12.0	14.8	42.4	5.5
2035	107.3	38.3	28.8	7.2	12.3	15.1	43.4	5.6

Table 3-11. Projected Mortality Costs by Year, 2015–2035 (2015$ in billions)

Year	Total	Hyper	CHD	CHF	Stroke	Other	Hypertension as Risk Factor	AFIB
2015	174.4	19.4	82.8	7.2	22.8	38.5	19.4	3.7
2016	178.8	19.9	84.9	7.4	23.4	39.3	19.9	3.8
2017	182.9	20.3	86.8	7.7	24.1	40.2	20.3	3.9
2018	186.9	20.7	88.6	7.9	24.7	41.0	20.7	3.9
2019	190.8	21.1	90.4	8.1	25.3	41.8	21.1	4.0
2020	194.8	21.6	92.2	8.3	26.0	42.7	21.6	4.1
2021	198.7	22.0	94.0	8.5	26.6	43.5	22.0	4.2
2022	202.7	22.4	95.8	8.7	27.3	44.3	22.4	4.2
2023	206.6	22.8	97.6	9.0	27.9	45.1	22.8	4.3
2024	210.8	23.2	99.4	9.2	28.6	45.9	23.2	4.4
2025	215.2	23.7	101.5	9.4	29.3	46.8	23.7	4.4
2026	219.7	24.2	103.5	9.7	30.0	47.7	24.2	4.5
2027	223.8	24.7	105.4	9.9	30.7	48.6	24.7	4.6
2028	228.0	25.1	107.3	10.1	31.3	49.4	25.1	4.6
2029	232.2	25.6	109.3	10.4	32.0	50.3	25.6	4.7
2030	236.7	26.1	111.3	10.6	32.7	51.2	26.1	4.8
2031	241.2	26.6	113.5	10.8	33.4	52.1	26.6	4.8
2032	245.8	27.2	115.6	11.0	34.1	53.0	27.2	4.9
2033	250.6	27.7	117.8	11.3	34.8	54.0	27.7	5.0
2034	255.5	28.3	120.1	11.5	35.6	55.0	28.3	5.0
2035	260.6	29.0	122.5	11.7	36.3	56.0	29.0	5.1

4. DISCUSSION

4.1 Prevalence and Costs of CVD in 2015

The current study demonstrates the magnitude of the health and economic burden of cardiovascular disease (CVD) in the United States. We estimated that over 100 million people had some form of CVD in 2015, and the medical and indirect costs of CVD exceeded half a trillion dollars. CVD is one of the costliest chronic conditions, as CVD-attributable annual medical costs of $318 billion surpass estimates of medical costs of diabetes ($128 billion in 2010$ reported by the Chronic Disease Cost Calculator [2013] and $176 billion in 2012$ reported by the American Diabetes Association [2013]), Alzheimer's disease ($236 billion in 2016$ reported by the Alzheimer's Association [2016]), and other chronic conditions (Chronic Disease Cost Calculator, 2013). Using data from the National Health Expenditure Data compiled by the Centers for Medicare & Medicaid Services, we estimated that medical costs of CVD constituted 10% of total national spending on health care in 2014 (Martin et al., 2016).

The results reveal significant disparities in the burden of CVD by age, race/ethnicity, and sex. As expected, CVD prevalence increases with age. In 2015, 90% of people aged 80 or older were estimated to have at least one form of CVD. Medical costs of CVD were the highest among those aged 65 to 79 years old, and indirect costs of CVD were the highest among those aged 45 to 64 (reflecting a higher employment rate among persons in this age group).

Prevalence of hypertension, CHF, and stroke is highest among blacks. For example, 47% of blacks were estimated to have hypertension in 2015 compared with 40% of white non-Hispanics. If the prevalence of hypertension, CHF, and stroke among blacks were reduced to the levels of white non-Hispanics, there would be 2 million fewer cases of hypertension, 130,000 fewer cases of CHF, and 250,000 fewer strokes in 2015. Furthermore, in 2015, total costs of these three conditions would be $6 billion lower (a reduction from $41 billion to $35 billion among blacks).

In 2015, prevalence of hypertension, CHF, stroke, and AFIB was higher among females than males. As a result, medical costs of CVD were also higher among females than males for these four conditions and for CVD in total. Indirect costs of AFIB were also higher among females than males.

The majority of medical costs attributed to CVD go to pay for hospital costs, although one-third of hypertension-attributable medical costs are for prescription medications. Nursing home care is a significant cost driver for CHF and stroke-attributable costs.

4.2 Projected Prevalence and Costs of CVD in 2035

The burden of CVD is expected to increase significantly in the next 20 years. Our results show that the number of people with CVD will increase by 30%, reaching over 130 million people in 2035 (prevalence rate of 45.1%). Total costs of CVD are expected to more than double during this period (increasing from $555 billion to $1.1 trillion). These projections assume no change in policy, access to coverage, or changes in CVD prevention or treatment over the time period but do reflect the demographics of an aging population and a relative increase in the proportion of Hispanic individuals.

Specifically, medical costs of CVD are expected to more than triple among those aged 80 or older increasing by a whopping $170 billion to almost $250 in 2035. Both medical and indirect costs of CVD among those aged 65 to 79 are also expected to more than double (in 2035, total costs of CVD in this age group will be $445 billion). Thus, the expected increases in prevalence and costs over time are due in large part to the aging of the population and longer life expectancy.

Changes in racial/ethnic composition of the country are also reflected in the projections reported here. Medical costs of CVD will more than triple and indirect costs of CVD will more than double among Hispanics and non-blacks and non-whites.

The finding presented in this report indicate that CVD prevalence and costs are projected to increase substantially over the next 20 years. Effective research, prevention, and treatment strategies are needed if we are to limit the growing burden of CVD.

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