Business problem

Data shows that Chronic Kidney Disease (CKD) is on the rise and affects 1 out 3 adults with diabetes and 1 out of 5 adults with high blood pressure (*Chronic Kidney Disease (CKD) Surveillance System*, n.d.-b). But CKD doesn't seem to have the same kind of wide-spread attention as diabetes and high blood pressure. With the progression of CKD comes worsening health problems that go beyond those of just diabetes and heart disease. The CDC claims that heart disease is the leading cause of death for people aged 45 and older (*Heart Disease | cdc.gov*, 2022). Therefore, should CKD be included as a major leading cause of death. Additionally, what are the prevalence and awareness levels of the disease? Lastly, depending upon the results and analysis of the awareness and prevalence data, attempt to answer the disparities, if any, with the results. These are the three main questions for the study.

Background

Definition: Chronic Kidney Disease is defined by (*Facts About Chronic Kidney Disease*, 2022) as a decrease in the kidney's ability to filter wastes from the body. As the kidney function levels decrease, other health problems become prominent. The degree of kidney function reduction is measured by an Estimated Glomerular Filtration Rate test (eGFR). This is a simple blood tests that shows the levels of creatinine in the blood. Creatinine is a waste product and is normally excreted through the kidneys. When the kidneys have a reduced filtration rate, the creatinine accumulates in the blood. The eGFR is a computed value based upon the amount of creatinine. eGFR is not the only factor in determining if someone has CKD, other indicators include the amount of protein in the urine or physical damage to the kidneys (American Kidney Fund, 2022).

CKD Stages: The progression of CKD is based upon ranges of eGFR. eGFR ranges from 90 or higher indicating normal kidney function to less than 15 which indicates close to failure or already experiencing kidney failure. As shown by fig. 1 CKD Stages with eGFR Ranges, there are 5 stages with Stage 5 being known as End Stage Renal Disease (ESRD). At this point, if the kidneys fail the only recourse is for a kidney transplant or dialysis.

Risk Factors: According to (*Kidney Disease*, 2022), major risk factors for CKD are diabetes and high blood pressure. Other factors include heart disease and a familial history of kidney failure. Additionally, other studies have shown that African Americans, Hispanics, and American Indians tend to have a greater propensity for CKD. The inference being these groups have higher rates of comorbidity of diabetes and high blood pressure.

Data Explanation

The study consists of an analysis of datasets listed below and from information collected from authoritative sources for Chronic Kidney Disease cited throughout the document. For the data analysis, datasets were ingested and modified to support the goals of the analysis. The original data was kept intact and merely subsets of the datasets were used for the analysis.

Datasets:

1. Center for Disease Control - Chronic Kidney Disease (CKD) Surveillance System Data sets (*Chronic Kidney Disease (CKD) Surveillance System*, n.d.-b)

    - Prevalence of CKD by U.S. State and County
    - Prevalence of CKD Stages 3-5 by Age and Race/Ethnicity
    - Prevalence of CKD Stages 3-5 by Age and Diabetes Diagnosis
    - Hypertension Among U.S. Adults
    - CKD Prevalence by Hypertension Status
    - CKD Prevalence by Diabetes Mellitus Status
    - Awareness_of_CKD_Among_US_Adults_with_CKD_3_or_4 with and without Diabetes and Hypertension
    - Awareness of CKD Among U.S. Adults with CKD Stage 3 or 4
    - Mortality Rates by eGFR Category/stage
    - Prevalence of Selected Measures Among Adults in the US 1999 - 2018

2. Center for Disease Control -Stats by the States (*NCHS Pressroom - Stats of the States*, n.d.)

    - Heart Disease Mortality by State
    - Diabetes Mortality by State
    - Kidney Disease Mortality by State

3. CDC National Health Center Statistics (*NHANES - About the National Health and Nutrition Examination Survey*, n.d.)

    - National Health and Nutrition Examination Survey
    - CDC Leading Cause of Death By Age 2020-2021 (10)

4. Comorbidity in Chronic Kidney Disease: a Large Cross-sectional Study of Prevalence in Scottish Primary Care (MacRae et al., 2020)

    - Cross-sectional analysis of a primary care dataset representing 1,274,374 adults in Scotland. Study consists of data from a group of adults aged 25 years and older. This study was a secondary analysis of general practice electronic medical record data using binary logistic regression models adjusted for age, sex, and socioeconomic status.

5. Trends in Referral Patterns to Nephrology for Patients with CKD (Ghimire et al., 2022)

- Study of adults with 1 or more visits to a nephrologist from primary care from 2006 and 2019 in Alberta, Canada.

Methods

Although this study uses datasets from several sources, the main data is the National Health and Nutrition Examination Survey (Nhanes). This program is a study to assess the health and nutritional status of adults and children in the US. The Nhanes program began in the early 1960's and continues today.

The program consists of a series of surveys that capture demographic, socioeconomic, health, and dietary measures. The CDC is responsible for this program. This dataset is the basis for the datasets from the Chronic Kidney Disease (CKD) Surveillance System and the CDC National Health Center Statistics.

Analysis

An objective of this study is to answer: if CKD is considered the 9th leading cause of death of adults in the USA, then why is there limited information disseminated about this disease? On TV, there are public service ads for heart disease, diabetes, high blood pressure, cancer, and other prominent diseases. Yet how many ads are shown for CKD? There is a single ad that talks about getting an eGFR test. If CKD is the 9th leading cause of death, then why is the public is not being made aware of the risks and the consequences of this disease? To begin the study, the analysis consists of evaluating the Leading Cause of Death Indicators, and the Death Rates By State for CKD, Diabetes, and Heart Disease as shown by figs 2-5.

Leading Cause of Death

A review of the data shows that indeed CKD is the 9th leading cause of death in adults aged 45 – 64 and the 8th leading cause of death in adults 65 and older. The Death Rates for CKD show a high of 22 percent in Mississippi to a low of 3 percent in Vermont. The Death Rates for Diabetes show a high of 33 to a low of 17. Lastly the Death Rates for Heart Disease are a high of 238 and a low of 125.

Heart disease death rates are consistent with the leading cause of death indicators for adults 65 and older. For adults 45-65, malignant neoplasms are the leading cause of death with heart disease being second. Diabetes is the 6th leading cause of death for both age groups. Considering hypertension and diabetes are two major risk factors for CKD, the death rates for CKD should be higher. But the Leading Cause of Death dataset did not include identification of comorbidities to help substantiate this hypothesis.

Prevalence and Awareness Levels

Other questions for the study are to identify the prevalence of CKD, Diabetes, and Hypertension in the US and how many people are aware of the disease. To answer these questions, graphs were created using data subsets derived from the CDC's, prevalence, awareness, and comorbidity datasets. Fig 6 shows the US States CKD prevalence rates. Fig 7. shows the CKD

prevalence rates by CKD stage. Fig 8 shows the CKD awareness by comorbidity. Fig 9. shows the CKD awareness rates by CKD. Figures 10 – 13 illustrate the prevalence rates for Diabetes, Hypertension, and Heart Disease using the Nhanes datasets. Data from a Scottish study is used for secondary analysis of comorbidity and CKD prevalence rates.

Using the Nhanes datasets, the Diabetes prevalence rate have increased by 2.5 percent from 2009 - 2020. Whereas Hypertension has increased by 3.7 percent during the same timeframe. As for CKD, using the All-Stages values, there has been an increase of 12 percent from 2009 – 2020. For Stage 4 (eGFR 15-29) there has been an increase of 12 percent from 2009 – 2020. In fact, for all stages of CKD, there has been and increase in prevalence.

Fortunately, awareness of CKD with Diabetes and Hypertension comorbidities has increased on average by 10 percent. Never-the-less, as the prevalence of CKD increases the awareness rates are still below 28 percent for Diabetes and Hypertension comorbidities. Considering these two are the greatest risk factors for CKD, and their prevalence is increasing does not bode well for minimizing and managing CKD.

Conclusion

CKD, Diabetes, and Hypertension are still increasing yet the awareness levels remain less than 30 percent. It was difficult finding substantial datasets or studies to account for the disparities between the prevalence and awareness levels. Although there are several sources for CKD information to include the CDC, National Institute of Diabetes and Digestive Diseases, and the National Kidney Foundation, these sites did not provide any data or studies referencing the reasons for the low awareness levels. In fact, the sites acknowledge the low levels and do provide educational material. In addition, this study prompts other questions to include:

- Are high risk patients being referred to nephrologists?
- Is the cost of specialized healthcare too expensive?
- Is the medical community not taking an aggressive role in CKD management?

A Canadian study identified trends of primary care referrals to nephrologists for CKD patients and found the referral rates did increase (Ghimire et al., 2022). Yet the referral rates were still considered below recommended rates.

Limitations

Some of the limitations for the study is having access to more complete data. One area is the access to data that includes both comorbidities and no comorbidities. While CKD is a disease unto its own, the leading contributing risk factors are diabetes and hypertension. The prevalence datasets did not differentiate contributing factors. Other limitations include studies that address reasons for the lack of awareness when there are several agencies that provide educational material.

Questions

Other questions for the study to expand upon are:

1. **Should CKD be higher on the list of a leading causes of death?**

The answer is yes. Consider these facts from the CDC (*By The Numbers: Diabetes in America*, 2022):

- 37.3 million people have diabetes. This equates to 11.3% of the US population
- 28.7 million people have been diagnosed with diabetes
- 8.5 million people who have diabetes have not been diagnosed. This represents 1 in 5 people who don't know they have diabetes.

Hypertension facts from Million Hearts (*Hypertension Prevalence in the U.S. | Million Hearts®*, 2021):

- As of 2017, there are an estimated 116 million people with Hypertension. This represents 47.3% of the US population.
- Over half of Americans with hypertension have untreated hypertension.
- 67.8 million have uncontrolled hypertension which is a huge 73.9%.

As stated in the opening paragraphs, 1 in 3 adults with diabetes and 1 in 5 adults with hypertension have CKD, this equates to a substantial number of people with CKD. From the data collected for this study. The Leading Cause of Death Indicators does not differentiate between those with CKD deaths and comorbidities of diabetes and hypertension. Therefore, although the statistics may show CKD as the 9th leading cause of death, death rates from CKD may be higher.

2. **Why is the awareness so low?**

Several studies have attempted to answer this very question and there is no definitive answer.

3. **Is the awareness problem with the medical community not taking a more aggressive management of CKD in their patients?**

The answer could be that the medical community is not aggressive enough with managing CKD. Other reasons could be that patients are simply ignoring the facts or do not fully understand the consequences of CKD. Another contributing factor could be that the general public is not given enough details regarding CKD. Regardless of the reason, there definitely needs to be more educational campaigns to inform the public of this disease and the consequences.

4. **What are other health concerns that come with CKD?**

According to (The Healthline Editorial Team, 2021), some of the complications from CKD may include:

- **Anemia.** With reduced kidney function, the body may not be able to properly create red blood cells.
- **Bone weakness.** Kidney damage disrupt the body's mineral such as phosphorus and calcium. This imbalance can lead to weakened bones.
- **Fluid retention.** Kidneys can't adequately filter water out of the blood. This leads to fluid retention especially in the legs and feet
- **Heart disease.** Heart disease can lead to kidney failure, or kidney failure can lead to heart disease. Heart disease is the most common cause of death in people on dialysis.
- **Hyperkalemia.** Kidney damage may lead to hyperkalemia, or elevated potassium levels.

5. Should everyone with diabetes and heart disease be checked for CKD on a continual basis?

Although people need to take the advice from their medical personnel, from my own experience, anyone diagnosed with diabetes and/or hypertension should request a kidney function test.

6. What is or are the checks for CKD?

The standard test for kidney function is known as an Estimated Glomerular Filtration Rate test (eGFR). This is a simple blood tests that shows the levels of creatinine in the blood. There are additional blood tests the doctor conducts and the combination of results presents an overall indication of the health of a kidney.

7. What are other causes of CKD?

In addition to the two major causes of CKD, other causes include (The Healthline Editorial Team, 2021b):

- a blood clot in or around the kidneys
- infection
- heavy metal poisoning
- vasculitis, an inflammation of the blood vessels
- lupus, an autoimmune disease that can cause inflammation of many body organs
- glomerulonephritis, an inflammation of the small blood vessels of the kidneys
- hemolytic uremic syndrome, which involves the breakdown of red blood cells following a bacterial infection, usually of the intestines
- multiple myeloma, a cancer of the plasma cells in your bone marrow
- scleroderma, an autoimmune condition that affects your skin

- thrombotic thrombocytopenic purpura, a disorder that causes blood clots in small vessels
- chemotherapy drugs that treat cancer and some autoimmune diseases
- dyes used in some imaging tests
- certain antibiotics

8. Are there statistics for each risk factor for CKD?

There are several sources of statistical data addressing the CKD risk factors. Samples of these sources are:

- The Chronic Renal Insufficiency Cohort (CRIC) Study (*Chronic-Kidney-Disease - Research Chronic Renal Insufficiency Cohort Study Kidney Disease*, n.d.) is an ongoing, multicenter, longitudinal study of nearly 5500 adults with CKD in the United States.
- An article describing the risk factors and other markers of CKD and the various stages of the disease. (Rossing P., 2021)
- An article (Rysz et al., 2017) discussing new techniques in the identification of biomarkers for renal disease.

9. What is the typical age for CKD diagnosis?

Although CKD can develop at any age, even in children, CKD is more prevalent in ages 60 and above. People aged 70 and above the prevalence rates is twice that of people less than 60 (*CDC Surveillance System: CKD Stages 1-4 Among U.S. Adults*, n.d.).

10. What actions can be taken to control CKD progression?

Referencing the CDC (*Prevention and Risk Management | Chronic Kidney Disease Initiative | CDC*, n.d.), below are several methods to manage CKD risks and progression of the disease.

- Control blood sugar, blood pressure, and cholesterol levels
- Eating healthy diets
- Avoid over the counter pain medications such as ibuprofen and naproxen
- Avoid certain antibiotics and blood pressure medications that are harmful to the kidneys.
- Avoid dark colored soft drinks
- Limit intake of sodium, potassium, and phosphorus containing foods.
- Limit intake of protein.
- Avoid contrast dyes used in imaging tests.

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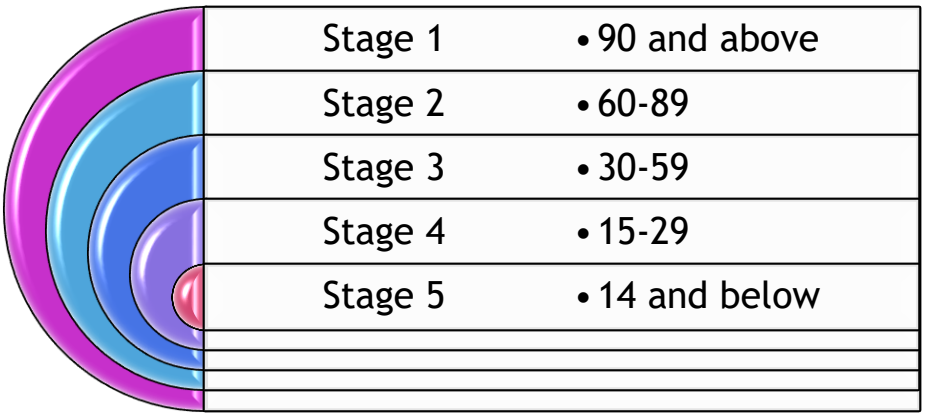

Fig. 1 CKD Stages with eGFR Ranges

Cause	Population
25-44 Years	
All causes	142,164
Unintentional injuries	48,586
Suicide	15,584
Malignant neoplasms	14,272
Diseases of heart	13,994
Homicide	8,787
Chronic liver disease and cirrhosis	4,529
Diabetes mellitus\3	3,115
Cerebrovascular diseases	2,326
Influenza and pneumonia\1	1,415
Septicemia	1,193
44-64 Years	
All causes	535,330
Malignant neoplasms	147,352
Diseases of heart	111,975
Unintentional injuries	48,251
Chronic liver disease and cirrhosis	22,483
Chronic lower respiratory diseases	22,335
Diabetes mellitus	21,856
Cerebrovascular diseases	18,084
Suicide	16,250

Nephritis, nephrotic syndrome and nephrosis	8,126
Septicemia	7,848
65 Plus	
All causes	2,117,332
Diseases of heart	531,583
Malignant neoplasms	435,462
Chronic lower respiratory diseases\1,\2	133,246
Cerebrovascular diseases	129,193
Alzheimer's disease	120,090
Diabetes mellitus\3	62,397
Unintentional injuries	60,527
Nephritis, nephrotic syndrome and nephrosis\3	42,230
Influenza and pneumonia\1	40,399
Parkinson's disease	34,435

Fig 2 - Leading Cause of Death Indicators

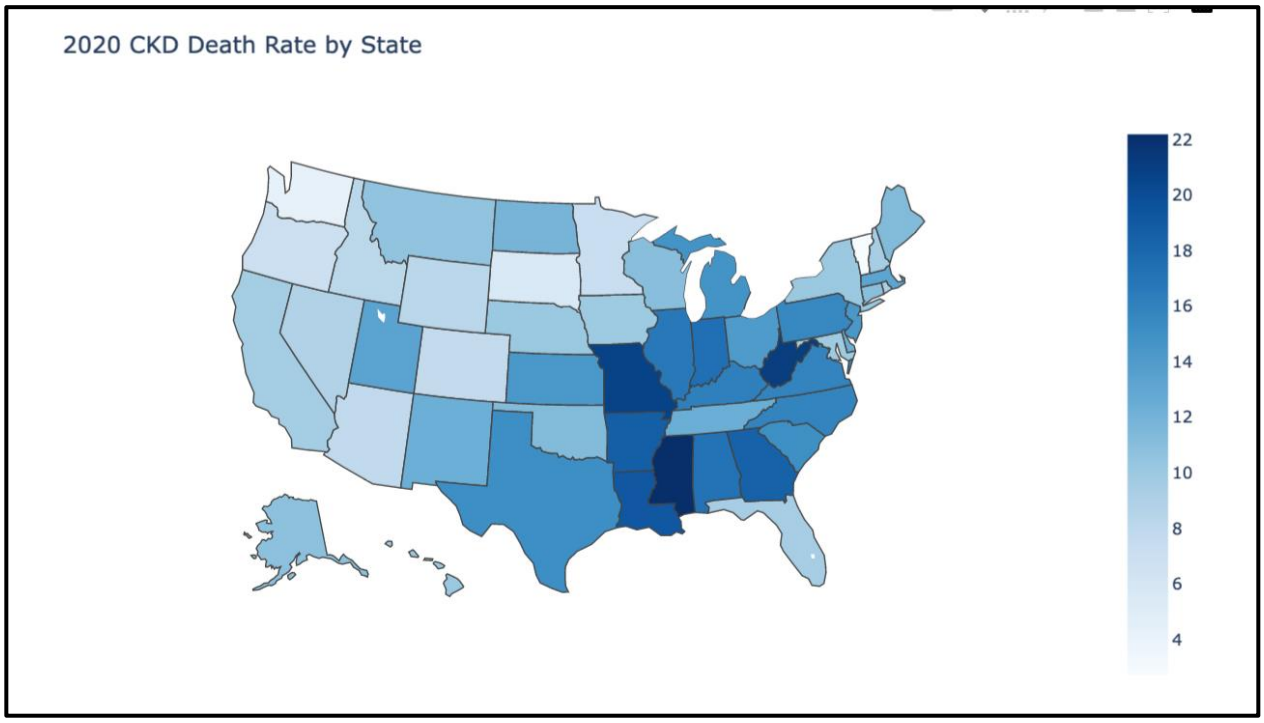

Fig 3 - 2020 CKD Death Rate By State

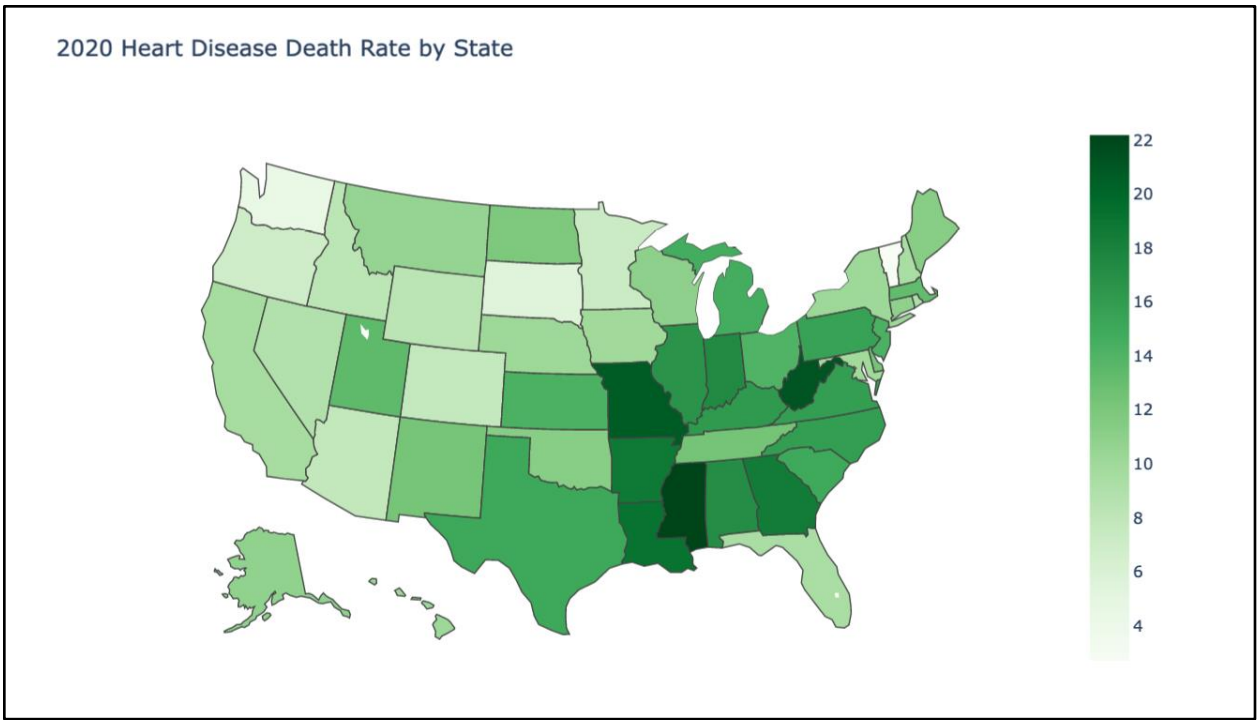

Fig 4 - 2020 Heart Disease Death Rate By State

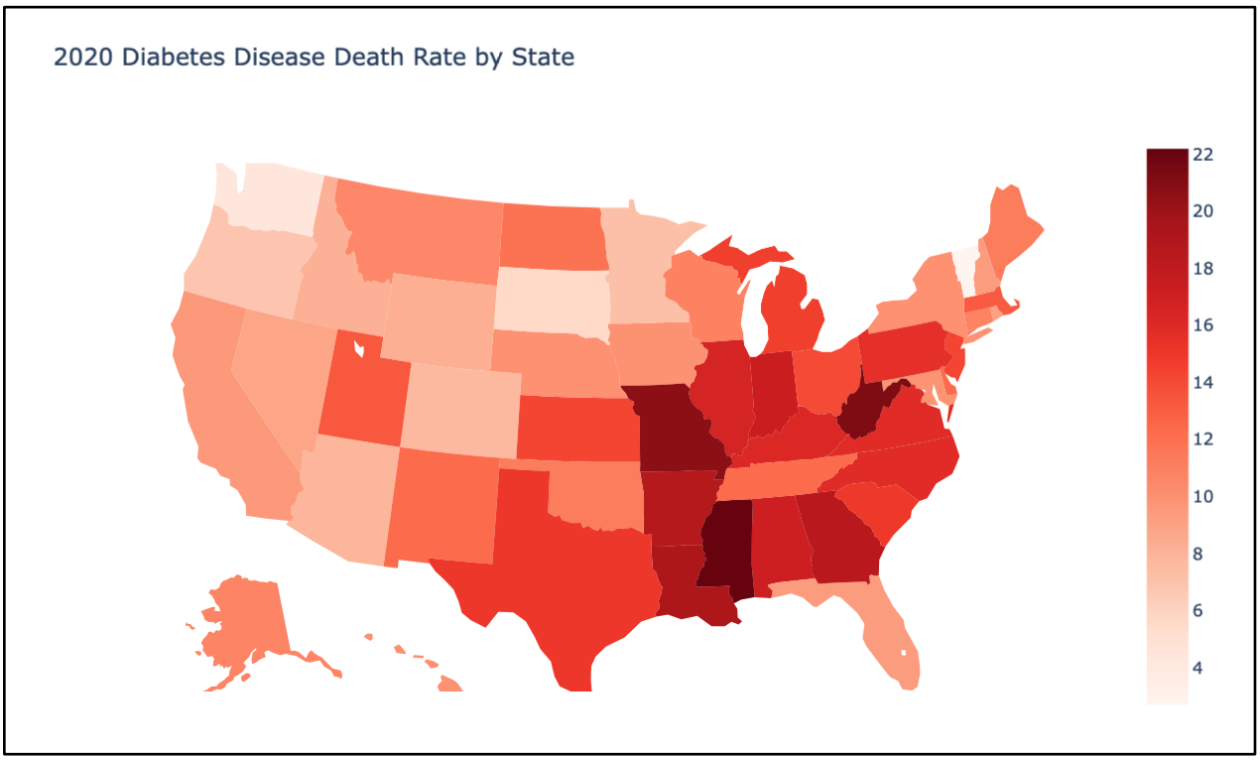

Fig 5 - 2020 Diabetes Death Rate By State

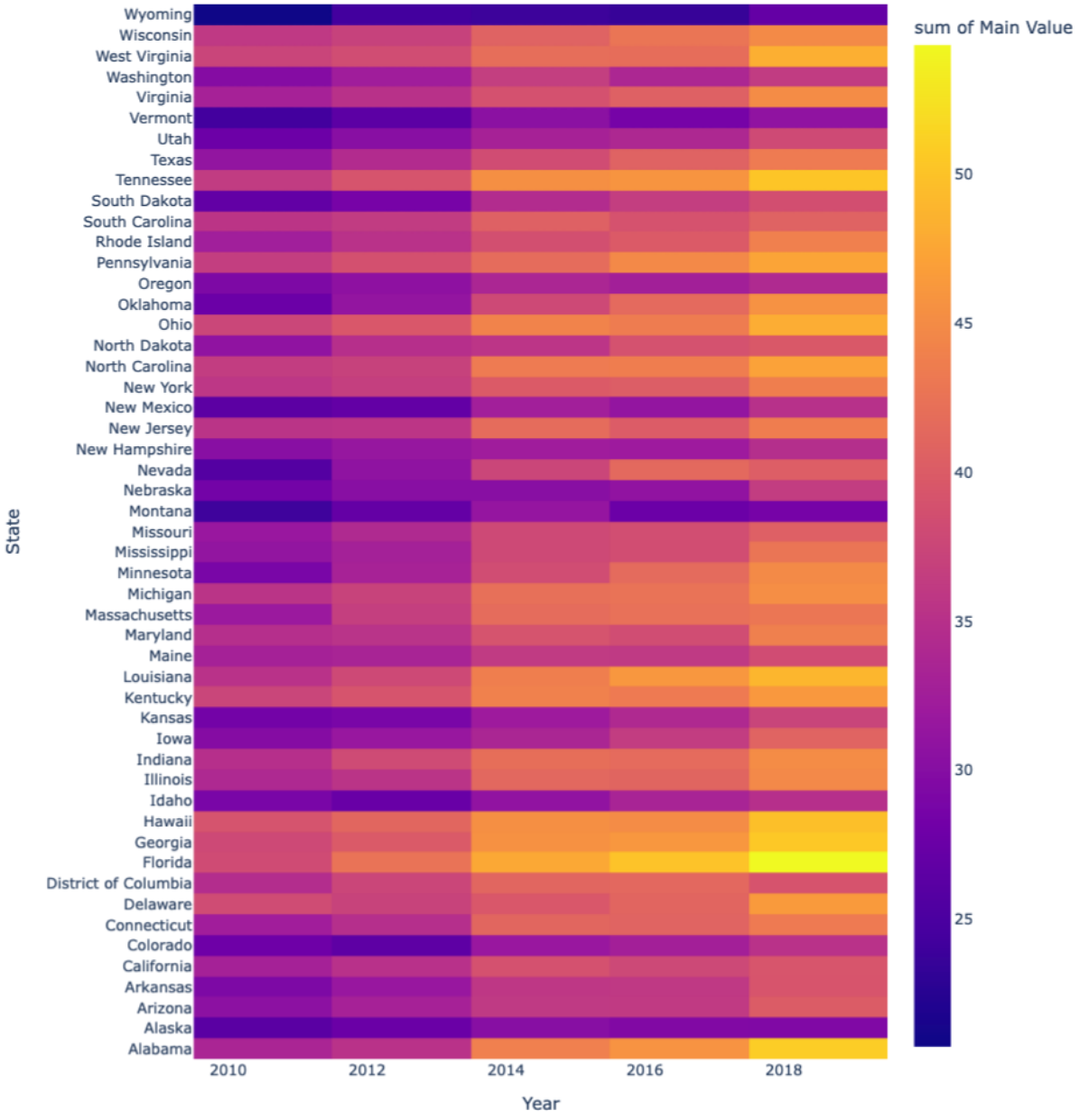

Fig 6 CKD Prevalence Rates By State 2009 – 2019

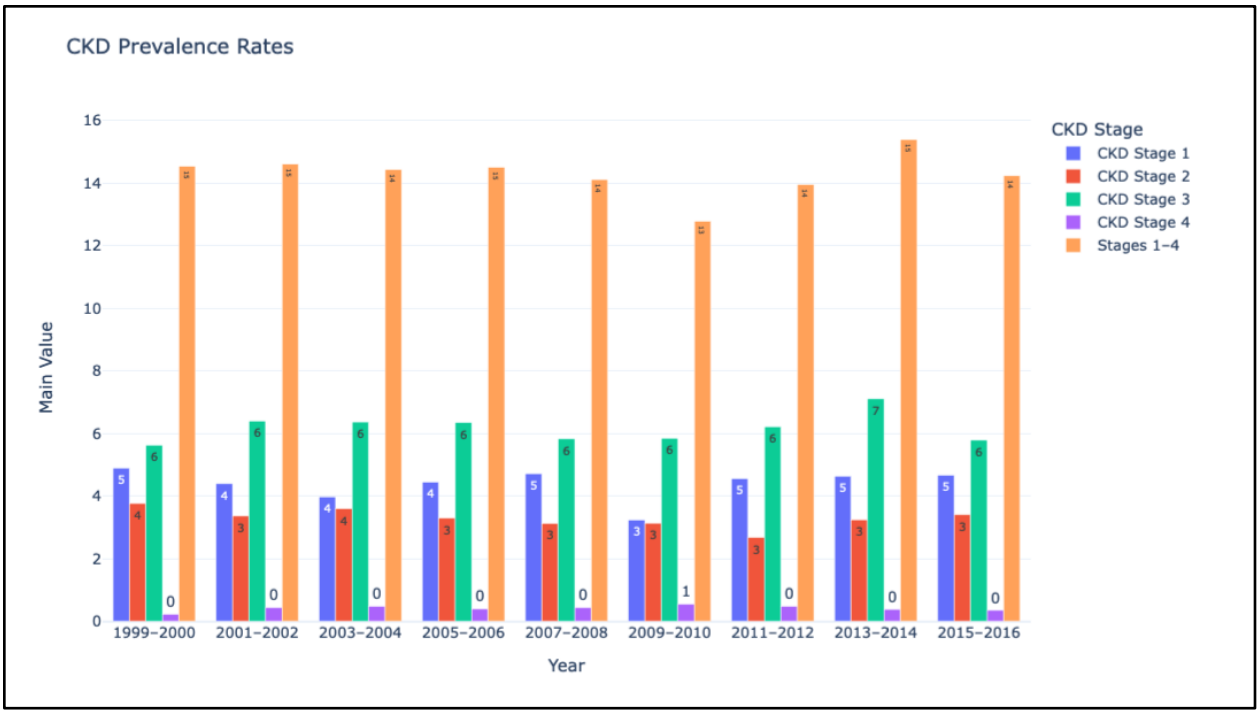

Fig 7 - CKD Prevalence Rates by CKD Stage

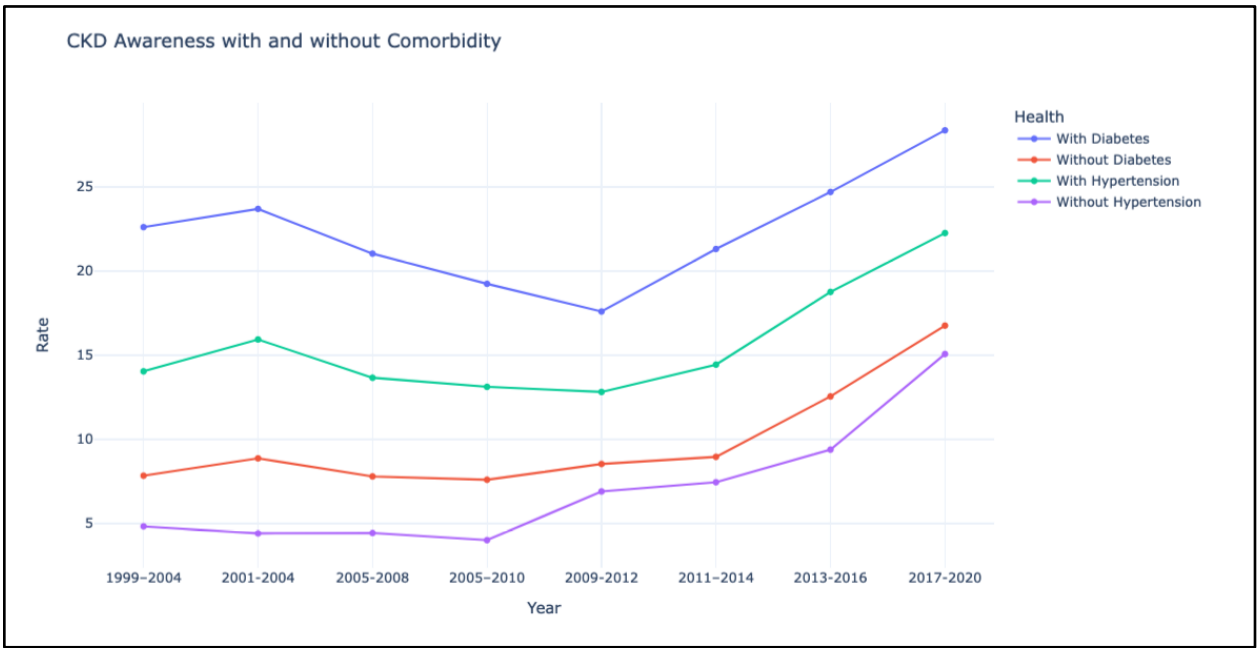

Fig 8 - CKD Awareness Rates with and without Comorbidity

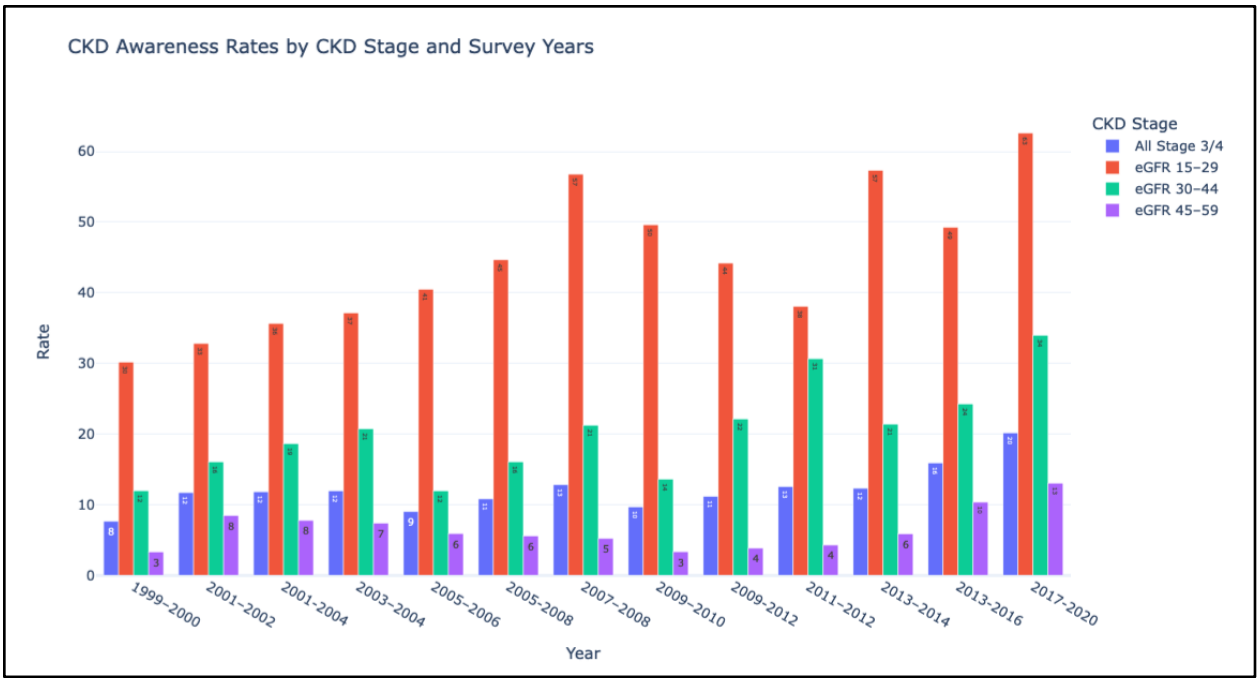

Fig 9 - CKD Awareness Rates by CKD Stage

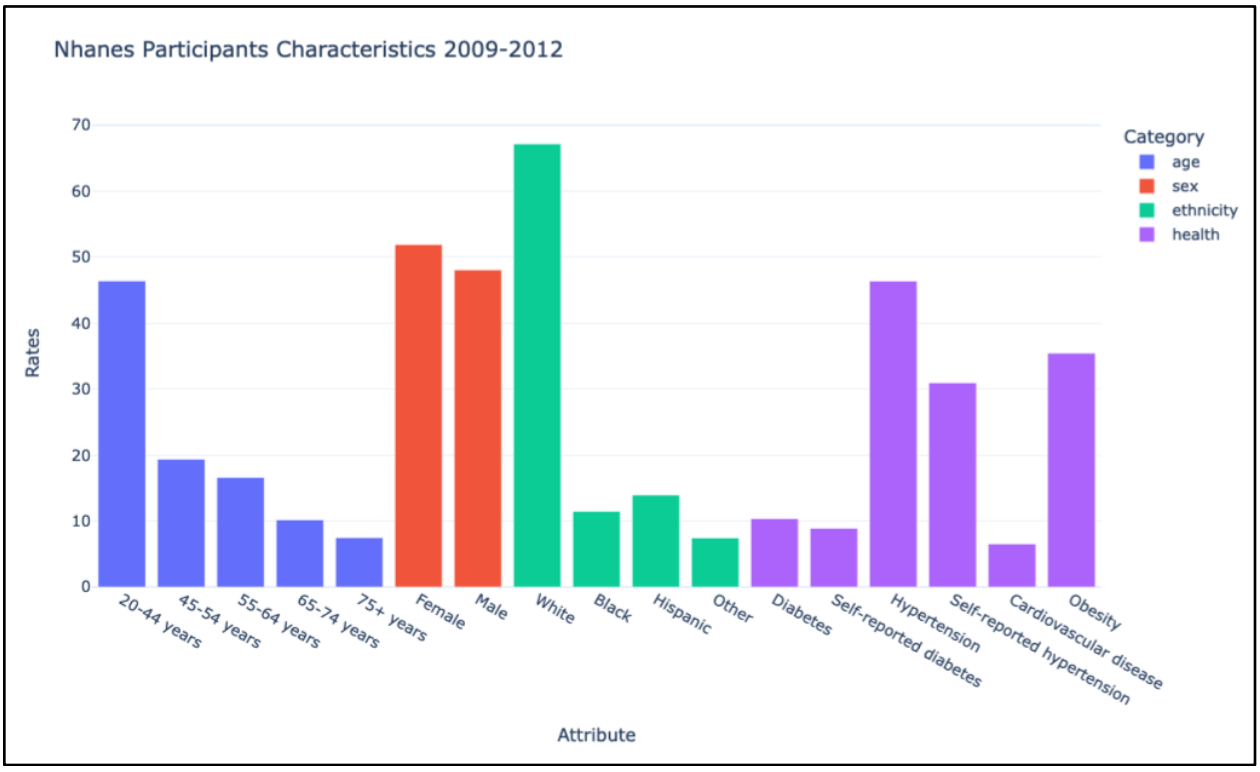

Fig 10. - Nhanes Prevalence Rates for Comorbidities 2009 - 2012

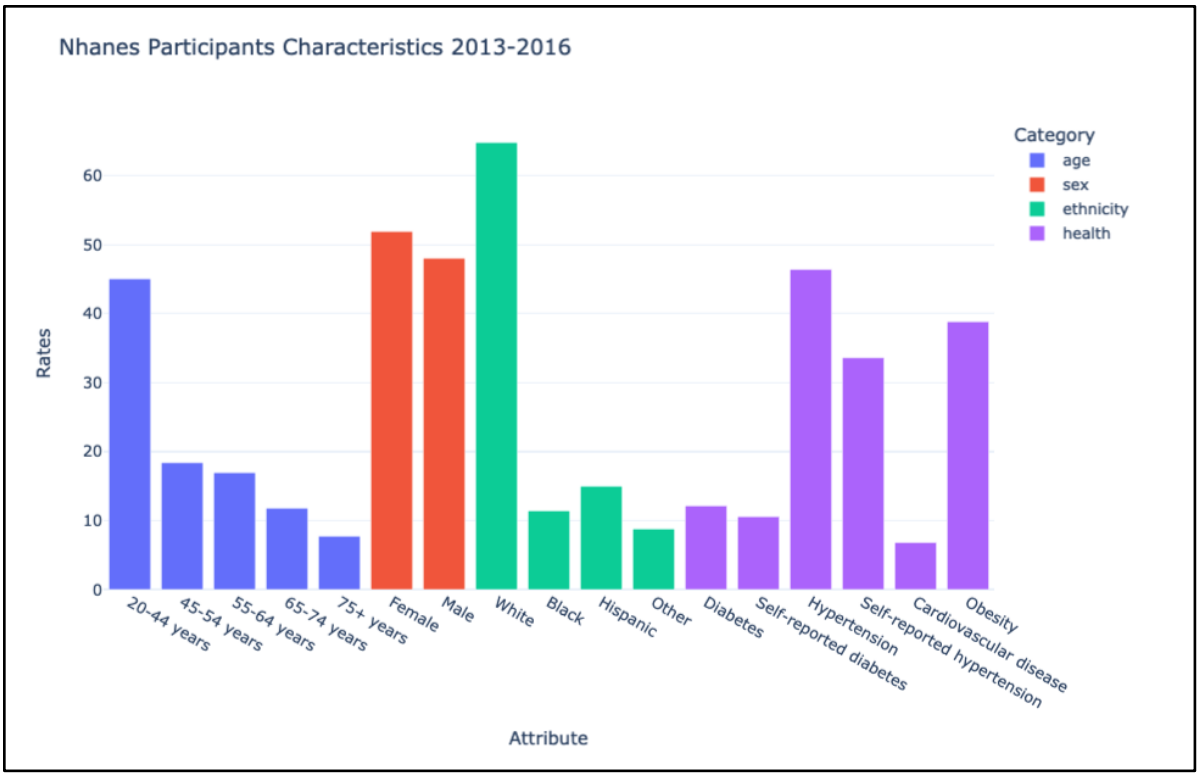

Fig 11 - Nhanes Prevalence Rates for Comorbidities 2013 – 2016

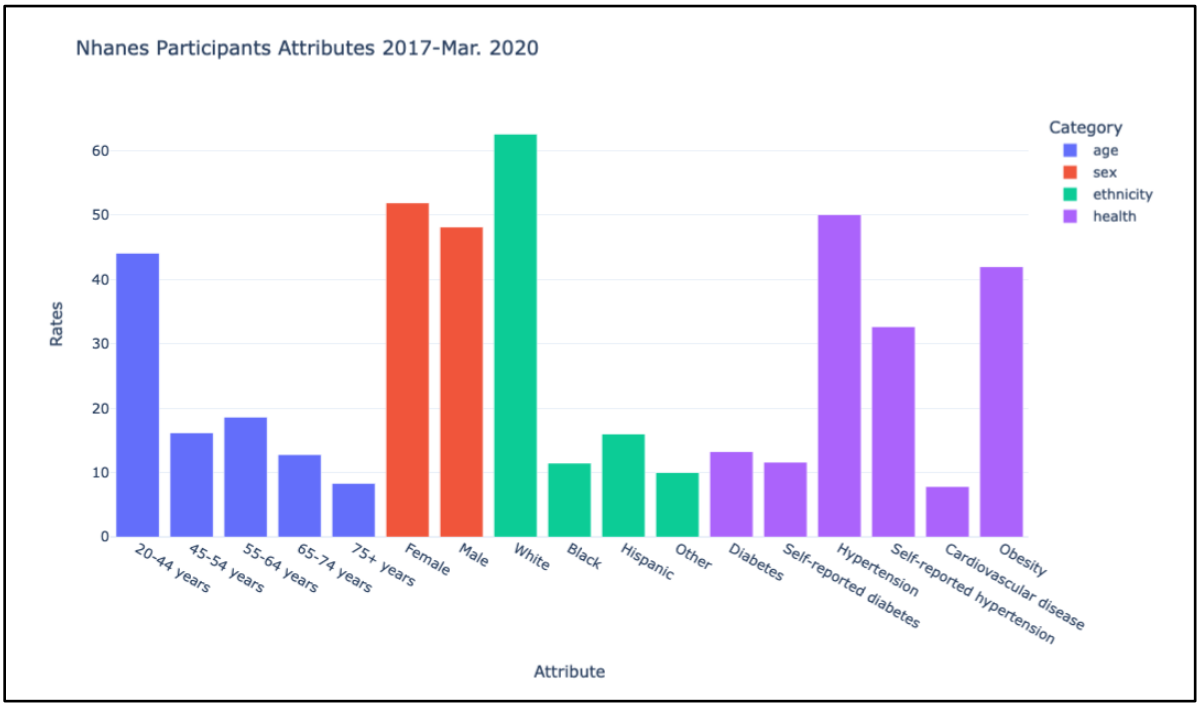

Fig 12. - Nhanes Prevalence Rates for Comorbidities 2017 - 2020

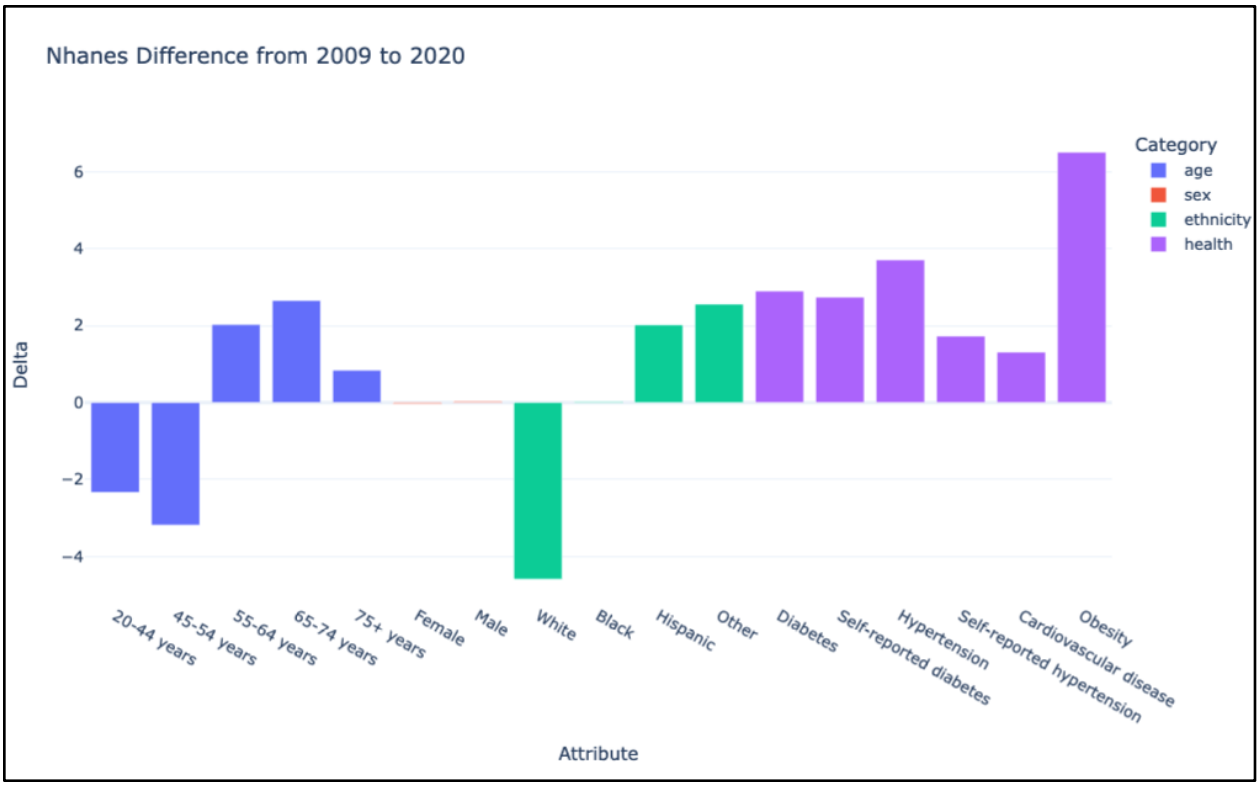

Fig13 - Prevalence Rates Deltas 2009 – 2020