**Biostatistics 521 Nutrition Lab**

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**NHANES Introduction** (adapted from <https://www.cdc.gov/nchs/nhanes/about_nhanes.htm>)

The National Health and Nutrition Examination Survey (NHANES) is a program of studies designed to assess the health and nutritional status of adults and children in the United States. The survey is unique in that it combines interviews and physical examinations. Since 1999 NHANES has been a continuously run survey with changing focus on a variety of health and nutrition measurements to meet emerging needs. The survey collects data from a nationally representative sample of about 5,000 persons each year, located in counties across the country. The NHANES interview includes demographic, socioeconomic, dietary, and health-related questions. The examination component consists of medical, dental, and physiological measurements, as well as laboratory tests administered by highly trained medical personnel. Data collected as part of NHANES is used to determine prevalence and risk factors of major diseases. Information will be used to assess nutritional status and its association with health promotion and disease prevention. NHANES findings are also the basis for national standards for such measurements as height, weight, and blood pressure. Data from this survey will be used in epidemiological studies and health sciences research, which help develop sound public health policy, direct and design health programs and services, and expand the health knowledge for the US.

**Introduction to the Problem**

The Nutrition dataset will explore the relationship between diet quality and kidney function among the NHANES cohort. Chronic Kidney Disease (CKD) is the deterioration of normal kidney function, the most severe form of which is End-Stage Renal Disease or kidney failure. In this condition, the kidneys cease to function, and the patient must undergo regular dialysis to filter contaminants from the blood. End-Stage Renal Disease decreases both lifespan and quality of life. CKD is a complex disease with genetic, demographic and lifestyle factors contributing to overall disease risk. A person’s age, race and exercise habits all factor into their risk. Diabetes and hypertension are additional major risk factors for developing renal disease. The goal of this lab is to determine if the nutritional value of the foods a person consumes also plays a role in kidney function.

Direct assessment of renal function is challenging. Instead kidney health is typically monitored indirectly using clinical lab measurements such as albumin and creatinine. Albumin is a protein made by the liver with the primary function of transporting hormones and enzymes throughout the body. A healthy kidney prevents albumin from passing from the blood into the urine. As normal kidney function declines, albumin can pass into the urine. High levels of albumin present in a urine sample can therefore be indicative of kidney disease. Creatinine is a waste product of muscle metabolism which the kidneys are responsible for removing from the body. Normally, your kidneys filter creatinine from your blood and send it out of the body in your urine. If there is a problem with your kidneys, creatinine can build up in the blood and less will be released in urine. Low creatinine levels in urine are therefore a biomarker for declining kidney function. Urine-based measurements of albumin and creatinine were collected in the laboratory portion of the NHANES survey and will be used as proxy measurements of kidney function.

The Healthy Eating Index (HEI) is a measure of diet quality used to assess how well a set of foods aligns with key recommendations of the Dietary Guidelines for Americans (DGA). The HEI takes thirteen different components of the human diet into account to create a score on the scale from 0 (least healthy) to 100 (most healthy). The HEI-2015 score (based on the 2015 DGA) has been computed for individuals in the 2015-2016 NHANES cohort and will serve as our measurement for the nutritional quality of diet. The total average HEI-2015 score for Americans was 59 out of 100, indicating that the diet of the average American did not meet dietary recommendations.

The table below illustrates the thirteen components of the HEI score and guidelines for minimum and maximum HEI scores. (See <https://epi.grants.cancer.gov/hei/developing.html#2015>)

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Max points** | **Standard for maximum score** | **Standard for minimum score of zero** |
| **Adequacy:** |  |  |  |
| **Total Fruits** | 5 | ≥0.8 cup equiv. per 1,000 kcal | No Fruits |
| **Whole Fruits** | 5 | ≥0.4 cup equiv. per 1,000 kcal | No Whole Fruits |
| **Total Vegetables** | 5 | ≥1.1 cup equiv. per 1,000 kcal | No Vegetables |
| **Greens and Beans** | 5 | ≥0.2 cup equiv. per 1,000 kcal | No Greens and Beans |
| **Whole Grains** | 10 | ≥1.5 oz equiv. per 1,000 kcal | No Whole Grains |
| **Dairy** | 10 | ≥1.3 cup equiv. per 1,000 kcal | No Dairy |
| **Total Protein Foods** | 5 | ≥2.5 oz equiv. per 1,000 kcal | No Protein Foods |
| **Seafood and Plant Proteins** | 5 | ≥0.8 oz equiv. per 1,000 kcal | No Seafood or Plant Proteins |
| **Fatty Acids** | 10 | (PUFAs + MUFAs)/SFAs ≥2.5 | (PUFAs + MUFAs)/SFAs ≤1.2 |
| **Moderation:** |  |  |  |
| **Refined Grains** | 10 | ≤1.8 oz equiv. per 1,000 kcal | ≥4.3 oz equiv. per 1,000 kcal |
| **Sodium** | 10 | ≤1.1 gram per 1,000 kcal | ≥2.0 grams per 1,000 kcal |
| **Added Sugars** | 10 | ≤6.5% of energy | ≥26% of energy |
| **Saturated Fats** | 10 | ≤8% of energy | ≥16% of energy |

In this lab, you will study the relationship between the nutritional quality of a person’s diet, measured by HEI, and kidney function, measured by albumin lab tests. Since renal function is known to be influenced by several risk factors you must also consider the effects of additional variables. For example, risk of kidney disease increases with age, and is more common in African Americans. The dataset therefore also includes the following potential risk factors: age, sex, race, socioeconomic status, hypertension, diabetes, alcohol consumption and BMI.

Sources and additional reading:

<https://www.fns.usda.gov/resource/healthy-eating-index-hei>

<https://www.urmc.rochester.edu/encyclopedia/content.aspx?contenttypeid=167&contentid=albumin_blood>

**Main Scientific Questions**

* Is diet quality associated with kidney function? That is, is the Healthy Eating Index (HEI) score associated with levels of albumin in the urine?
* Does diet quality contribute to kidney function even after adjusting for potential confounding factors such as age, sex, race, socioeconomic status, hypertension, diabetes, high alcohol consumption, and BMI?
* What confounding roles do the additional variables play (i.e. do they weaken or strengthen the relationship between HEI and albumin?)

**Variables contained in the Nutrition Dataset**

This dataset comes from the 2015-2016 NHANES cohort

|  |  |  |
| --- | --- | --- |
| **NHANES Variable Name** | **Variable Definition** | **Description** |
| SEQN | Respondent’s sequence number (ID) in NHANES study | ID Number |
| URXUMS | Albumin levels from urine (mg/L) | Outcome |
| HEI2015\_TOTAL\_SCORE | HEI Total Score | Exposure of Interest |
| RIAGENDR | Sex (Male, Female) | Potential Confounder |
| RIDAGEYR | Age (years) | Potential Confounder |
| RIDRETH3 | Race | Potential Confounder |
| DMDEDUC2 | Education level | Potential Confounder |
| BMXBMI | BMI | Potential Confounder |
| BPXSY1 | Systolic blood pressure | Potential Confounder |
| DIQ010 | Diabetes (Yes, No, Borderline) | Potential Confounder |
| WkAlcDays  (Based on the NHANES variables ALQ120Q and ALQ120U) | Number of alcoholic drinks per week | Potential Confounder |

**Levels for Categorical Variables**

**Race**

|  |
| --- |
| MexicanAmerican |
| OtherHispanic |
| White |
| Black |
| Asian |
| Other |

**Education Level**

|  |  |
| --- | --- |
| 1 | NoHighSchool |
| 2 | SomeHighSchool (no degree) |
| 3 | HighSchool |
| 4 | SomeCollege (no degree) |
| 5 | College (graduate) |