#### NHANES 2017-2018: The Comorbidity Between Osteoporosis and Diabetes Sarah Grunblatt, MS, MS, MEd, MEd, MA<sup>1</sup>

#### ABSTRACT

**Background:** Recent research shows that diabetes diagnosis may be a significant risk factor for developing diabetes. The objectives of this study is to evaluate factors associated with osteoporosis, with diabetes, and a potential comorbidity between them. **Methods:** The National Health and Nutrition Examination Survey (NHANES) 2017-2018 survey was used in this study. A total of 3,053 respondents aged 50 and over with a valid osteoporosis question response were included in this study. Among them, the analysis of outcome one contained 396 individuals who responded yes to the question "Has a doctor ever told {you/SP} that {you/s/he} had osteoporosis, sometimes called thin or brittle bones?" The second outcome contained 874 individuals who responded yes or borderline to the question "Other than during pregnancy, {have you/has SP}/{Have you/Has SP}} ever been told by a doctor or health professional that {you have/{he/she/SP} has} diabetes or sugar diabetes?"

**Results:** After adjusting for other selected factors, ages 50 to 59 years old were at reduced odds for developing both osteoporosis (OR = 0.195, 95% CI = 0.127-0.301, p = <.0001) and diabetes (OR = 0.515, 95% CI = 0.373-0.709, p = <.0001) when compared to those age 80 and above. Also, this study found that individuals told by a doctor that they have diabetes did not have significant odds of being told by a doctor they have osteoporosis (OR = 1.193, 95% CI = 0.910-1.565, p = 0.2024). Furthermore, individuals told by a doctor that they have osteoporosis did not have significant odds of being told by a doctor they have diabetes (OR = 1.157, 95% CI = 0.885-1.514, p = 0.2858). Conclusion: Age was associated with both osteoporosis and diabetes. Males had lower odds of osteoporosis but higher odds of diabetes. Mexican American, non-Hispanic asian, and other race - including multi-racial were also at increased odds for diabetes. Former drinkers were at increased odds for diabetes while occasional drinkers were protected against diabetes. Finally, the use of tobacco (yes) showed to be protective against diabetes, and there was no comorbidity between osteoporosis and diabetes in this analysis. Additional examination of these outcomes is recommended using objective "gold standard" measures such as DEXA (dual energy X-ray absorptiometry) scans and blood glucose levels from the NHANES laboratory test results.

Keywords: osteoporosis, diabetes, NHANES

#### BACKGROUND

The National Osteoporosis Foundation defines osteoporosis as "a bone disease that occurs when the body loses too much bone, makes too little bone, or both"[1]. As a result, bones become weak and may break from a fall or, in serious cases, from sneezing or minor bumps. Viewed under a microscope, healthy bone looks like a honeycomb. Osteoporosis means "porous bone," and it is a chronic disease. Osteoporotic bone has decreased hard bone mass and increased space between the dense bone matter that is filled with soft bone marrow and other soft tissues. Possible risk factors for osteoporosis include age 50 and above, female, smoking / tobacco exposure, drinking / alcohol consumption, and race (non-Hispanic white and non-Hispanic Asian).

Diabetes mellitus (diabetes) is a chronic health condition that occurs when the body creates too much sugar while trying to turn food into energy. There are 3 main types:

- Type 1 -- Immune system destroys the cells that release insulin.
- Type 2 -- Body isn't able to use insulin properly.
- Gestational -- Diabetes diagnosed during pregnancy (often temporary)

According to Health Central, type 1 diabetes is the most common chronic disease in children. Furthermore, 95% of diabetes patients have type 2. Seven million people live with undiagnosed diabetes, 30 million Americans live with diabetes, and 80 million American adults have prediabetes [2]. Possible risk factors for diabetes include age 45 and above (Type II), overweight / physical inactivity, smoking / tobacco exposure, high blood pressure, and race (African-American, Hispanic, Native American, Asian-American race, or Pacific Islander). The following image provides a potential example of the relationship between diabetes and osteoporosis [3].



#### Rationale

In 2010, osteoporosis and low bone mass were estimated to be a major public health threat for almost 54 million U.S. women and men aged 50 and older, and that number has only increased. Among the 54 million, 10.2 million adults are estimated to have osteoporosis, of which more than 80% were women [4]. Economic burden was estimated at 17 billion USD in 2005 [5]. In a study based on almost 380,000 fractures in female Medicare beneficiaries, 10% had another fracture within 1 year, 18% within 2 years, and 31% within 5 years [6]. Additionally, "although bone health is primarily associated with age, recent studies have shown that individuals with diabetes mellitus (DM) have up to 6 times higher incidence of osteoporotic fractures compared to the

general population" [7]. To reduce this alarming public health burden, additional research regarding the risk factors for and causal pathway associated with both diabetes and osteoporosis is needed.

#### VARIABLES OF INTEREST

This study focuses on both osteoporosis and diabetes as outcomes. It explores their relationship as potential predictors for each other in addition to the predictors of age (primary predictor), gender, race, alcohol consumption, and tobacco use. The chart below provides the 2017-2018 National Health and Nutrition Examination Survey (NHANES) [8] variable name, SAS label, English text, target, response type, and coded values for each of the outcomes and predictors of interest in this study.

	<b>ALL VARIABLES OF INTEREST</b>								
NHANES VARIABLE NAME	SAS LABEL	ENGLISH TEXT	TARGET	TYPE	CODED VALUES				
0\$0060	Ever told had osteoporosis/brittle bones	Has a doctor ever told {you/SP} that {you/s/he} had osteoporosis, sometimes called thin or brittle bones?	Both males and females 50 YEARS - 150 YEARS	Categorical	1: Osteoporosis 2: No Osteoporosis				
DIQO10SAS	Doctor told you have diabetes	The next questions are about specific medical conditions. {Other than during pregnancy, {have you/has SP}/{Have you/Has SP}} ever been told by a	Both males and females 1 YEARS - 150 YEARS	Categorical	1: Diabetes (Including Borderline)				
RIAGENDR	Gender	doctor or health professional that (you nave/(he/she/sr) has) diabetes or sugar diabetes? Gender of the participant	Both males and females O YEARS - 150 YEARS	Categorical	1: Male 2: Female				
RIDAGEYR	Age in years at screening	Age in years of the participant at the time of screening. Individuals 80 and over are topcoded at 80 years of age.	Both males and females O YEARS - 150 YEARS	Categorical	1: 1-9 years old 2: 10-19 years old 3: 20-29 years old 4: 30-39 years old 5: 40-49 years old 6: 50-59 years old 7: 60-69 years old 8: 70-79 years old 9: 80 years old and above				
RIDRETH3	Race/Hispanic origin w/ NH Asian	Recode of reported race and Hispanic origin information, with Non-Hispanic Asian Category	Both males and females O YEARS - 150 YEARS	Categorical	1: Mexican American 2: Other Hispanic 3: Non-Hispanic White 4: Non-Hispanic Black 5: Non-Hispanic Asian 6: Other Race - Including multiracial				
ALQ111 & ALQ121	Ever had a drink of any kind of alcohol = "No" & Past 12 mo how often have alcohol drink	The next questions are about drinking alcoholic beverages. Included are liquor (such as whiskey or gin), beer, wine, wine coolers, and any other type of alcoholic beverage. In fyour/SF3 entire life, (have you/has her/has she) had at least 1 drink of any kind of alcohol, not counting small tastes or sigs? By a drink, I mean a 12 oz. beer, a 5 oz. glass of wine, or one and a half ounces of liquor. Buring the past 12 months, about how often did (yo/SP) drink any type of alcoholic beverage? PROBE: How many days per week, per month, or per year did (you/SP) drink?	Both males and females 18 YEARS - 150 YEARS	Categorical	0: Never Drinker 1: Former Drinker 2: Occasional Drinker 3: Frequent Drinker				
SMDANY	Used any tobacco product last 5 days?	Used any tobacco product last 5 days?	Both males and females 12 YEARS - 150 YEARS	Categorical	1: Tobacco 2: No Tobacco				

#### METHODS

The NHANES, initiated in the 1960s by the Centers for Disease Control and Prevention (CDC) and National Center for Health Statistics (NCHS), is a population-based survey that assesses the health and nutritional status in the United States. The survey includes three question sets: demographic data, dietary data, and questionnaire data. A subset of the study population also completes a set of physical examinations and laboratory tests. The target population of the NHANES survey is the noninstitutionalized civilian resident population of the United States, and the sample population is the noninstitutionalized U.S. civilian population of all ages residing in all 50 states and Washington D.C.

For the 2017-2018 NHANES administration, 9,254 participants completed the interview. For the osteoporosis outcome, the eligibility criteria was respondents above age 50 (minimum target for osteoporosis variable) (n = 3,069) and those who responded yes/no to osteoporosis/brittle bone question (variable OSQ060) (n = 3,053). Because diabetes typically onests after the age of 45, these parameters also fit well with the second outcome (diabetes). Respondents were excluded if they refused to answer,

responded "don't know", or were missing (n = 16). The final analytical sample size used for both outcomes was 3,053 respondents.

#### STATISTICAL ANALYSES PERFORMED

Descriptive statistics were computed for all study variables to ensure assumptions of statistical tests to be employed were met. The sample consisted of 36.03% 60 to 69 year olds (n= 1,100), 28.65% with a diabetes or borderline diabetes diagnosis (n = 874), 12.98% with a osteoporosis diagnosis (n = 396), 50.44% female (n = 1,540), 38.39% non-Hispanic Whites (n = 1,172), 42.57% frequent drinkers (n = 1,137), and 18.51% tobacco users (n = 495). Additional details are described in detail in Tables 1 and 3 for each dependent variable analyzed in this study. All statistical analyses were generated using SAS software version 9.4 with the significance level set at a 2-sided P-value < 0.05 and a 95% Confidence Interval. Copyright<sup>®</sup> 2021 SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA [9].

As shown in the chart above, all variables were coded as categorical (2 outcomes each with 6 predictors). Therefore, logistic regression methods were utilized. The first outcome was osteoporosis with predictor variables age (primary), diabetes, gender, race, alcohol consumption, and tobacco use. The second outcome was diabetes with predictor variables age (primary), osteoporosis, gender, race, alcohol consumption, and tobacco use. The second outcome was diabetes with predictor variables age (primary), osteoporosis, gender, race, alcohol consumption, and tobacco use. Stepwise regression analysis was not necessary as the chosen predictors are known to have an association with the outcomes. Both outcomes will be studied for statistical significance utilizing the following methods: descriptive statistics (using Proc Freq in SAS), Wald chi-square bivariate analyses (using Chisq in SAS), both univariate and multivariate logistic regression modeling using Wald 95% confidence intervals and chi-square (using Proc Logistic in SAS).

#### OUTCOME #1: OSTEOPOROSIS

#### **OSTEOPOROSIS:** Study Objectives

The osteoporosis outcome in this study utilized responses to the following question from the NHANES survey: "Has a doctor ever told {you/SP} that {you/s/he} had osteoporosis, sometimes called thin or brittle bones?" The six objectives of interest regarding the osteoporosis outcome are as follows: age (primary), diabetes, gender, race, alcohol consumption, and tobacco use. Table 1 below provides the descriptive statistics according to the variables selected to measure the predictors for osteoporosis in addition to the results of a bivariate analysis utilizing Wald chi-square p-values with a significance level of set at alpha = 0.05.

Characteristic (n = 3.069***)	Total (n = 3.051)	Osteoporosis (n = 396)	Not Osteoporosis (n = 2.655)	Wald Chi-Square P-value
Аде**		. ,		<.0001*
50 to 59 Years Old. n (%)	915 (29.97)	57 (6.23)	858 (93,77)	
60 to 69 Years Old, n (%)	1.100 (36.03)	120 (10.91)	980 (89.09)	
70 to 79 Years Old, n (%)	617 (20.21)	119 (19.29)	498 (80.71)	
80+ Years Old, n (%)	421 (13.79)	100 (23.75)	321 (76.25)	
Diabetes Status	( /	. ,		0.4344
Diabetes & Borderline, n (%)	874 (28.65)	120 (13.73)	754 (86.27)	
No Diabetes, n (%)	2,177 (71.35)	276 (12.68)	1,901 (87.32)	
Gender				<.0001*
Male, n (%)	1,513 (49.56)	54 (3.57)	1,459 (96.43)	
Female, n (%)	1,540 (50.44)	342 (22.21)	1,198 (77.79)	
Race/Ethnicity				0.0010*
Mexican American, n (%)	347 (11.37)	34 (9.80)	313 (90.20)	
Other Hispanic, n (%)	290 (9.50)	40 (13.79)	250 (86.21)	
Non-Hispanic White, n (%)	1,172 (38.39)	188 (16.04)	984 (83.96)	
Non-Hispanic Black, n (%)	725 (23.75)	72 (9.93)	653 (90.07)	
Non-Hispanic Asian, n (%)	391 (12.81)	50 (12.79)	341 (87.21)	
Other Race - Including Multi-Racial, n (%)	128 (4.19)	12 (9.38)	116 (90.63)	
Alcohol Consumption				0.0005*
Never Drinker, n (%)	291 (10.89)	47 (16.15)	244 (83.85)	
Former Drinker, n (%)	787 (29.46)	114 (14.49)	673 (85.51)	
Occasional Drinker, n (%)	456 (17.07)	33 (7.24)	423 (92.76)	
Frequent Drinker, n (%)	1,137 (42.57)	153 (13.46)	984 (86.54)	
Tobacco Use				0.0225*
Tobacco, n (%)	495 (18.51)	49 (9.90)	446 (90.10)	
No Tobacco, n (%)	2,179 (81.49)	299 (13.72)	1,880 (86.28)	

#### Table 1. Descriptive Statistics & Bivariates Analysis of NHANES 2017-2018 Participants Regarding "Has a doctor ever told {you/SP} that {you/s/he} had osteoporosis, sometimes called thin or brittle bones?"

\*\*\* Responses of "refused", "don't know," and missing were excluded from analyses (n = 16).

#### **OSTEOPOROSIS:** Results

According to the variables selected as predictors with respect to the outcome of osteoporosis the following conclusions were reached: Compared to individuals 80 years old and above, people age 50 to 59 and 60 to 69 years old had lower odds (OR = 0.195, 95% CI = 0.127-0.301, p = <.0001 and OR = 0.401, 95% CI = 0.275-0.583, p = <.0001) of being told by a physician that they have osteoporosis/brittle bones after adjusting for other selected factors (primary predictor). There was no statistically significant association between diabetes status (compared to no diabetes status) and being told by a physician that they have osteoporosis/brittle bones. Compared to females, males had lower odds of being told by a physician that they have osteoporosis/brittle bones (OR = 0.110, 95% CI = 0.079-0.153, p = <.0001) after adjusting for other selected factors. Compared to non-Hispanic whites, non-Hispanic blacks were the only race that came close to having statistically significant results. This group had reduced odds (OR = 0.719, 95% CI = 0.514-1.007, p = 0.0549) of being told by a physician that they have osteoporosis/brittle bones after adjusting for other selected factors. After adjusting for other selected factors, there was no statistically significant association between amount

of alcohol consumption (compared to frequent drinking) and being told by a physician that you have osteoporosis/brittle bones. After adjusting for other selected factors, there was no statistically significant association between tobacco (yes) use (compared to no tobacco use) and being told by a physician that you have osteoporosis/brittle bones. The complete results of these univariate and multivariate logistic regression analyses for the selected predictors versus the outcome of osteoporosis status are presented in Table 2.

	Univariate Crude Odds Ratio	Univariate Wald	Multivariate Crude Odds Ratio	Multivariat Wald
Characteristic (n = 3,069***)	(95% Wald CI)	P-Value	(95% Wald CI)	P-Value
Age**				
50 to 59 Years Old	0.213 (0.150-0.303)*	<.0001*	0.195 (0.127-0.301)*	<.0001*
60 to 69 Years Old	0.393 (0.293-0.527)*	<.0001*	0.401 (0.275-0.583)*	<.0001*
70 to 79 Years Old	0.767 (0.568-1.036)	0.0838	0.871 (0.598-1.267)	0.4694
80+ Years Old	1.0		1.0	
Diabetes Status				
Diabetes & Borderline	1.096 (0.871-1.380)	0.4345	1.193 (0.910-1.565)	0.2024
No Diabetes	1.0		1.0	
Gender				
Male	0.130 (0.096-0.174)*	<.0001*	0.110 (0.079-0.153)*	<.0001*
Female	1.0		1.0	
Race/Ethnicity				
Mexican American	0.569 (0.386-0.837)*	0.0042*	0.724 (0.461-1.137)	0.1611
Other Hispanic	0.837 (0.579-1.210)	0.3453	1.086 (0.704-1.678)	0.7087
Non-Hispanic White	1.0		1.0	
Non-Hispanic Black	0.577 (0.432-0.771)*	0.0002*	0.719 (0.514-1.007)	0.0549
Non-Hispanic Asian	0.767 (0.549-1.073)	0.1218	1.041 (0.681-1.593)	0.8515
Other Race - Including Multi-Racial	0.541 (0.293-1.001)	0.0504	0.892 (0.458-1.738)	0.737
Alcohol Consumption				
Never Drinker	1.239 (0.868-1.768)	0.2379	0.763 (0.514-1.133)	0.18
Former Drinker	1.089 (0.839-1.415)	0.5211	0.919 (0.689-1.227)	0.5671
Occasional Drinker	0.502 (0.339-0.743)*	0.0006*	0.725 (0.474-1.111)	0.1397
Frequent Drinker	1.0		1.0	
Tobacco Use				
Tobacco	0.691 (0.502-0.951)*	0.0233*	1.263 (0.878-1.816)	0.2086
No Tobacco	1.0		1.0	

Univariate and multivariate logistic analyses for each predictor versus outcome was utilized to obtain the odds ratios (OR), 95% Wald confidence intervals (CI), and Wald p-values (alpha = 0.05).

#### OUTCOME #2: DIABETES (Midterm Bonus)

#### **DIABETES: Study Objectives**

The diabetes outcome in this study utilized responses to the following question from the NHANES survey: "{Other than during pregnancy, {have you/has SP}/{Have you/Has SP}} ever been told by a doctor or health professional that {you have/{he/she/SP} has} diabetes or sugar diabetes?" The six objectives of interest regarding the diabetes outcome are as follows: age (primary), osteoporosis, gender, race, alcohol consumption, and tobacco use. Table 3 below provides the descriptive statistics according to the variables selected to measure the predictors for diabetes in addition to the results of a bivariate analysis utilizing Wald chi-square p-values with a significance level of set at alpha = 0.05.

#### Table 3. Descriptive Statistics and Bivariate Analysis of NHANES 2017-2018 Participants Regarding "Other than during pregnancy, {have you/has SP}/{Have you/Has SP}} ever been told by a doctor or health professional that {you have/{he/she/SP} has} diabetes or sugar diabetes?"

		Diabetes &		Wald
Champeteristic (n = 2.000ttt)	Total	Borderline	Not Diabetes	Chi-Square
Characteristic (n = 3,069***)	(n = 3,051)	(n = 874)	(n – 2,1 <i>11</i> )	P-value
Age				<.0001^
50 to 59 Years Old, n (%)	918 (10.32)	175 (19.06)	743 (80.94)	
60 to 69 Years Old, n (%)	1,104 (12.41)	355 (32.16)	749 (67.84)	
70 to 79 Years Old, n (%)	619 (6.96)	226 (36.51)	393 (63.49)	
80+ Years Old, n (%)	426 (4.79)	127 (29.81)	299 (70.19)	
Osteoporosis Status**				0.4344
Osteoporosis, n (%)	396 (12.98)	120 (30.30)	276 (69.70)	
No Osteoporosis, n (%)	2,655 (87.02)	754 (28.40)	1,901 (71.60)	
Gender				0.0002*
Male, n (%)	1,520 (49.56)	485 (31.91)	1,035 (68.09)	
Female, n (%)	1,547 (50.44)	398 (25.73)	1,149 (74.27)	
Race/Ethnicity				0.0141*
Mexican American, n (%)	347 (11.31)	118 (34.01)	229 (65.99)	
Other Hispanic, n (%)	294 (9.59)	75 (25.51)	219 (74.49)	
Non-Hispanic White, n (%)	1,177 (38.38)	308 (26.17)	869 (73.83)	
Non-Hispanic Black, n (%)	726 (23.67)	211 (29.06)	515 (70.94)	
Non-Hispanic Asian, n (%)	395 (12.88)	127 (32.15)	268 (67.85)	
Other Race - Including Multi-Racial, n (%)	128 (4.17)	44 (34.38)	84 (65.63)	
Alcohol Consumption				<.0001*
Never Drinker, n (%)	292 (10.89)	83 (28.42)	209 (71.58)	
Former Drinker, n (%)	790 (29.47)	285 (36.08)	505 (63.92)	
Occasional Drinker, n (%)	458 (17.08)	91 (19.87)	367 (80.13)	
Frequent Drinker, n (%)	1,141 (42.56)	315 (27.61)	826 (72.39)	
Tobacco Use	. , /		, , ,	0.0258*
Tobacco, n (%)	497 (18.52)	123 (24.75)	374 (75.25)	
No Tobacco, n (%)	2,187 (81.48)	651 (29.77)	1,536 (70.23)	
*Statistically significant (p < 0.05).	. ( /	. /	. ( 7	
** NHANES Taraet: Both males and females 50 YE	ARS - 150 YEARS			
*** Responses of "refused", "don't know." and r	missing were excluded fr	rom analyses (n = 1	6).	

#### **DIABETES:** Results

According to the variables selected as predictors with respect to the outcome of diabetes the following conclusions were reached: Compared to individuals 80 years old and above, people age 50 to 59 years old had lower odds (OR = 0.515, 95% CI = 0.373-0.709, p = <.0001) of being told by a physician that they have diabetes (including borderline) after adjusting for other selected factors (primary predictor). There was no statistically significant association between osteoporosis status (compared to no osteoporosis status) and being told by a physician that they have diabetes (including borderline) after adjusting for other selected factors. Compared to females, males had increased odds of being told by a physician that they have diabetes (including borderline) (OR = 1.622, 95% CI = 1.344-1.958, p = <.0001) after adjusting for other selected factors. Compared to females, males had increased odds of being told by a physician that they have diabetes (including borderline) (OR = 1.622, 95% CI = 1.344-1.958, p = <.0001) after adjusting for other selected factors. Compared to non-Hispanic whites, four racial groups had increased odds of being told by a physician that they have diabetes (including borderline) after adjusting for other selected factors: Mexican Americans (OR = 1.516, 95% CI = 1.129-2.036, p = 0.0057), non-Hispanic blacks (OR = 1.270, 95% CI = 1.007-1.602, p = 0.0057), non-Hispanic blacks (OR = 1.270, 95% CI = 1.007-1.602, p = 0.0057), non-Hispanic blacks (OR = 1.270, 95% CI = 0.0057), non-Hispanic blacks (OR = 0.0057), non

0.0433), Non-Hispanic Asians (OR = 1.551, 95% CI = 1.154-2.084, p = 0.0036), and other races - including multi-racial (OR = 1.591, 95% CI = 1.033-2.449, p = 0.035). Compared to frequent drinkers, former drinkers had increased odds (OR = 1.380, 95% CI = 1.127-1.689, p = 0.0018) while occasional drinkers had reduced odds (OR = 0.633, 95% CI = 0.482-0.833, p = 0.0011) of being told by a physician that they have diabetes (including borderline) after adjusting for other selected factors. After adjusting for other selected factors, there was no statistically significant association between tobacco (yes) use (compared to no tobacco use) and being told by a physician that you have diabetes (including borderline). The complete results of these univariate and multivariate logistic regression analyses for the selected predictors versus the outcome of diabetes status are presented in Table 4.

Characteristic (n = 3,069)	Univariate Crude Odds Ratio (95% Wald CI)	Univariate Wald P-Value	Multivariate Crude Odds Ratio (95% Wald CI)	Multivariate Wald P-Value
Age				
50 to 59 Years Old	0.555 (0.425-0.723)*	<.0001*	0.515 (0.373-0.709)*	<.0001*
60 to 69 Years Old	1.116 (0.875-1.423)	0.3765	1.026 (0.766-1.374)	0.8644
70 to 79 Years Old	1.354 (1.039-1.764)*	0.0247*	1.256 (0.928-1.700)	0.1404
80+ Years Old	1.0		1.0	
Osteoporosis Status**				
Osteoporosis	1.096 (0.871-1.380)	0.4345	1.157 (0.885-1.514)	0.2858
No Osteoporosis	1.0		1.0	
Gender				
Male	1.353 (1.156-1.583)*	0.0002*	1.622 (1.344-1.958)*	<.0001*
Female	1.0		1.0	
Race/Ethnicity				
Mexican American	1.454 (1.124-1.881)*	0.0044*	1.516 (1.129-2.036)*	0.0057*
Other Hispanic	0.966 (0.721-1.295)	0.8181	1.021 (0.736-1.416)	0.8994
Non-Hispanic White	1.0		1.0	
Non-Hispanic Black	1.156 (0.940-1.421)	0.1685	1.270 (1.007-1.602)*	0.0433*
Non-Hispanic Asian	1.337 (1.043-1.713)*	0.0217*	1.551 (1.154-2.084)*	0.0036*
Other Race - Including Multi-Racial	1.478 (1.003-2.177)*	0.048*	1.591 (1.033-2.449)*	0.035*
Alcohol Consumption				
Never Drinker	1.041 (0.783-1.385)	0.7808	1.045 (0.772-1.415)	0.7767
Former Drinker	1.480 (1.218-1.798)*	<.0001*	1.380 (1.127-1.689)*	0.0018*
Occasional Drinker	0.650 (0.499-0.846)*	0.0014*	0.633 (0.482-0.833)*	0.0011*
Frequent Drinker	1.0		1.0	
Tobacco Use				
Tobacco	0.776 (0.621-0.970)*	0.0261*	0.833 (0.654-1.063)	0.1418
No Tobacco	1.0		1.0	

Univariate and multivariate logistic analyses for each predictor versus outcome was utilized to obtain

the odds ratios (OR), 95% Wald confidence intervals (CI), and Wald p-values (alpha = 0.05).

#### DISCUSSION AND RECOMMENDATIONS

The primary predictor of age (particularly ages 50-59) did show an overall relationship with both osteoporosis and diabetes, which was expected. Males had lower odds of osteoporosis but higher odds of diabetes. Mexican American, non-Hispanic asian, and other race - including multi-racial were also at increased odds for diabetes. Former drinkers were at increased odds for diabetes while occasional drinkers were

protected against diabetes. Surprisingly, use of tobacco (yes) showed to be protective against diabetes. Unfortunately, there was no comorbidity between osteoporosis and diabetes in this analysis. This is surprising because recent research does show that diabetes may be a significant risk factor for osteoporosis.

The lack of statistical significance between these variables may be the result of errors and limitations of this study rather than the absence of a true relationship. For example, because the osteoporosis question was only asked to individuals over 50 years old, the multivariate analysis for diabetes had to be coded to exclude ages 1-49. For consistency, the univariate analysis for diabetes was also coded this way. Some of the other results were also unexpected. This may be because many variables selected from the NHANES study were from the guestionnaire data, which could have resulted in bias and/or error. A better measure could have been to use DEXA bone density scans (for osteoporosis) and fasting glucose levels (for diabetes) from the laboratory data, for example, which are "gold standards." This would have been more objective, but it would further reduce the sample size. Additionally, crude odds ratios were used, and many confidence intervals contained 1.0. Age adjusted odds ratios would likely have provided results closer to what is typically expected for these variables. Furthermore, as with all cross-sectional studies, causation (risk ratio) cannot be determined. Finally, many other potential predictors for osteoporosis and diabetes could potentially be studied in the future. These include blood iron levels, physical activity, marital status, education, triglycerides, blood pressure, etc.

#### AUTHOR DISCLOSURE STATEMENT

S. Grunblatt reports no conflicts of interest in conducting this study and received no compensation or incentives (monetary or otherwise).

#### REFERENCES

- 1. *Learn what osteoporosis is and what it's caused by*. National Osteoporosis Foundation. [https://www.nof.org/patients/what-is-osteoporosis/]
- 2. Barros, Rodrigo. (n.d.). *Diabetes Signs, Symptoms, Types, Causes, Treatments and More.* Health Central. [https://www.healthcentral.com/condition/diabetes]
- 3. Roy B. Biomolecular basis of the role of diabetes mellitus in osteoporosis and bone fractures. World J Diabetes 2013; 4(4): 101-113
- 4. Wright, N.C., et al., *The recent prevalence of osteoporosis and low bone mass in the United States based on bone mineral density at the femoral neck or lumbar spine*. J Bone Miner Res, 2014. 29(11): p. 2520-6.
- 5. Burge, R., et al., *Incidence and economic burden of osteoporosis-related fractures in the United States, 2005-2025.* J Bone Miner Res, 2007. 22(3): p. 465-75.
- 6. Balasubramanian, A., et al., *Risk of subsequent fracture after prior fracture among older women*. Osteoporos Int, 2019. 30(1): p. 79-92.
- 7. Dumic-Cule, I., Ivanac, G., Lucijanić, T., Katičić, D., Jurin, I., Birkić, D., Rahélic, D., & Blaslov, K. (2018). Type 2 diabetes and osteoporosis: Current knowledge.
- 8. National Center for Health Statistics: *National Health and Nutrition Examination Survey*. [http://www.cdc.gov/nchs/nhanes.htm]
- 9. SAS Institute Inc 2013. SAS/ACCESS® 9.4. Cary, NC.

#### APPENDIX A: SAS CODE FOR THIS PROJECT

```
/* Sarah Grunblatt
SPRING 2021
BIOS 6102 Final Project -- SAS Code */
/* Import data sets */
LIBNAME R XPORT "C:\Users\sarah\Desktop\BIOS 2 -- Final
Project\DEMO J.XPT" ;
LIBNAME D 'C:\Users\sarah\Desktop\BIOS 2 -- Final Project\';
PROC COPY IN = R OUT = D ;
RUN ;
PROC CONTENTS DATA = D.DEMO J ;
RUN ;
LIBNAME R XPORT "C:\Users\sarah\Desktop\BIOS 2 -- Final
Project\OSQ J.XPT" ;
LIBNAME D 'C:\Users\sarah\Desktop\BIOS 2 -- Final Project\';
PROC COPY IN = R OUT = D ;
RUN ;
PROC CONTENTS DATA = D.OSQ J ;
RUN ;
LIBNAME R XPORT "C:\Users\sarah\Desktop\BIOS 2 -- Final
Project\ALQ J.XPT" ;
LIBNAME D 'C:\Users\sarah\Desktop\BIOS 2 -- Final Project\';
PROC COPY IN = R OUT = D ;
RUN ;
PROC CONTENTS DATA = D.ALQ J ;
RUN ;
LIBNAME R XPORT "C:\Users\sarah\Desktop\BIOS 2 -- Final
Project\SMQRTU J.XPT" ;
LIBNAME D 'C:\Users\sarah\Desktop\BIOS 2 -- Final Project\' ;
PROC COPY IN = R OUT = D ;
RUN ;
PROC CONTENTS DATA = D.SMQRTU J ;
RUN ;
LIBNAME R XPORT "C:\Users\sarah\Desktop\BIOS 2 -- Final
Project\DIQ J.XPT" ;
LIBNAME D 'C:\Users\sarah\Desktop\BIOS 2 -- Final Project\' ;
PROC COPY IN = R OUT = D;
RUN ;
PROC CONTENTS DATA = D.DIQ J ;
RUN ;
```

/\* Check for duplicates. \*/ **PROC SORT** DATA = D.DEMO J ; BY SEQN ; RUN ; **PROC SORT** DATA = D.OSQ J ; BY SEQN ; RUN ; **PROC SORT** DATA = D.ALQ J ; BY SEON ; RUN ; **PROC SORT** DATA = D.SMQRTU J ; BY SEQN ; RUN ; **PROC SORT** DATA = D.DIQ J ; BY SEQN ; RUN ; DATA DUPLICATE ; SET D.DEMO J ; BY SEQN ; IF NOT (FIRST.SEQN AND LAST.SEQN) THEN OUTPUT DUPLICATE ; RUN ; DATA DUPLICATE ; SET D.OSQ J ; BY SEQN ; IF NOT (FIRST.SEQN AND LAST.SEQN) THEN OUTPUT DUPLICATE ; RUN ; DATA DUPLICATE ; SET D.ALQ J ; BY SEQN ; IF NOT (FIRST.SEQN AND LAST.SEQN) THEN OUTPUT DUPLICATE ; RUN ; DATA DUPLICATE ; SET D.SMQRTU J ; BY SEQN ; IF NOT (FIRST.SEQN AND LAST.SEQN) THEN OUTPUT DUPLICATE ; RUN ;

```
DATA DUPLICATE ;
SET D.DIQ J ;
BY SEQN ;
IF NOT (FIRST.SEQN AND LAST.SEQN) THEN OUTPUT DUPLICATE ;
RUN ;
/* Horizontally combine datasets to add columns. */
DATA COMBINED NHANES 1718 ;
MERGE D.DEMO J(in=ina) D.OSQ J(in=inb) D.ALQ J(in=inc)
D.SMQRTU J(in=ind) D.DIQ J(in=ine);
BY SEQN ;
RUN ;
/* Keep the variables of interest according to how coded in
NHANES for OSTEO outcome. */
data d.select;
set COMBINED NHANES 1718 (keep= seqn OSQ060 RIAGENDR RIDAGEYR
RIDRETH3 DMDEDUC2 ALO111 ALO121 SMDANY DIO010);
where RIDAGEYR >= 50;
/* Changing age to categorical */
if RIDAGEYR= . then Age=".";
else if RIDAGEYR<10 then Age="1";</pre>
else if RIDAGEYR>=10 and RIDAGEYR<20 then Age ="2";
else if RIDAGEYR>=20 and RIDAGEYR<30 then Age ="3";
else if RIDAGEYR>=30 and RIDAGEYR<40 then Age ="4";
else if RIDAGEYR>=40 and RIDAGEYR<50 then Age ="5";
else if RIDAGEYR>=50 and RIDAGEYR<60 then Age ="6";
else if RIDAGEYR>=60 and RIDAGEYR<70 then Age ="7";
else if RIDAGEYR>=70 and RIDAGEYR<80 then Age ="8";
else Age= "9";
/* Numeric to text Osteoporosis */
if OSQ060 in (., 7, 9) then OsteoStatus=" ";
else if OSQ060=1 then OsteoStatus="Osteoporosis";
else OsteoStatus="No Osteoporosis";
/* Numeric to text Race */
if RIDRETH3= . then Race=" ";
else if RIDRETH3=1 then Race="1";
else if RIDRETH3=2 then Race="2";
else if RIDRETH3=3 then Race="3";
else if RIDRETH3=4 then Race="4";
else if RIDRETH3=6 then Race="6";
```

```
else Race= "7";
/* Changing Diabetes to categorical */
if DIQ010 in (.,7,9) then DiabetesStatus=.;
else if DIQ010 in (1,3) then DiabetesStatus=1;
else if DIQ010=2 then DiabetesStatus=2;
/* Numeric to text gender */
if RIAGENDR= . then Gender=" ";
else if RIAGENDR=1 then Gender="Male";
else if RIAGENDR=2 then Gender="Female";
/* Numeric to text Tobacco */
if SMDANY in (., 7, 9) then Tobacco=" ";
else if SMDANY=1 then Tobacco="Tobacco";
else Tobacco="No Tobacco";
/* integrate two variables
     create drinking status:
     1. never, ever
                             <varname: everdnk>
     2. never, former, occasional, frequent <varname: dnk>*/
if ALQ111 in (., 7, 9) then everdnk=.;
else if ALQ111=1 then everdnk=1;
else everdnk=0;
if ALQ121 in (., 77, 99) then curdnk=.;
else if ALQ121 in (1,2,3,4) then curdnk=1;
else if ALQ121 in (5,6,7,8,9,10) then curdnk=2;
else curdnk=0;
if everdnk=. then dnk=.;
else if everdnk=0 then dnk=0;
else do;
if curdnk=. then dnk=.;
else if curdnk=0 then dnk=1;
else if curdnk=1 then dnk=2;
else dnk=3;
end;
label
RIDAGEYR='Age in years at screening'
Age='Age, 1:[1-9), 2:[10-19), 3:[20-29), 4:[30-39), 5:[40-49),
6: [50-59), 7: [60-69), 8: [70-79), 9:>80'
RIAGENDR='Gender, 1: male, 2:female'
```

```
Gender='Gender, 1:Male, 2:Female'
RIDRETH3='Race: 1: Mexican American, 2:Other Hispanic,
3:Non-Hispanic White, 4:Non-Hispanic Black, 6: Non-Hispanic
Asian, 7: Other Race & Multi-Racial'
Race='Race: 1: Mexican American, 2:Other Hispanic,
3:Non-Hispanic White, 4:Non-Hispanic Black, 6: Non-Hispanic
Asian, 7: Other Race & Multi-Racial'
OSQ060='Ever told had osteoporosis/brittle bones: 1:yes, 2:no,
7: Refused, 9: Do not know'
OsteoStatus='Osteoporosis Status: 1:Osteoporosis, 2: No
Osteoporosis'
DIQ010SAS='Doctor told you have diabetes: 1:yes, 2:no,
3:borderline, 7: Refused, 9: Do not know'
DiabetesStatus='Diabetes Status: 1:[Diabetes, borderline), 2: No
Diabetes'
SMDANY='Used any tobacco product last 5 days?: 1:yes, 2:no, 7:
Refused, 9: Do not know'
Tobacco='Tobacco: 1:yes, 2:no, 7: Refused, 9: Do not know'
/* Integrate two variables alcohol */
ALQ111='Ever had a drink of any kind of alcohol: 1:yes, 2:no, 7:
Refused, 9: Do not know'
ALQ121='Past 12 mo how often have alchol drink, 0: Never in the
last year,
     1: Every day, 2: Nearly every day, 3: 3 to 4 times a week,
     4: 2 times a week, 5: Once a week, 6: 2 to 3 times a month,
     7: Once a month, 8: 7 to 11 times in the last year,
     9: 3 to 6 times in the last year, 10: 1 to 2 times in the
last year,
     77: Refused, 99: Do not know'
everdnk='ever drinker, 1:yes, 0:no'
curdnk='current drinker, 1:yes, 0:no'
dnk='drinking status, 0:Never Drinker, 1:Former Drinker,
2:Occasional Drinker, 3:Frequent Drinker';
run;
/* Chi Squared Des. Stat. / Biv. Analy for OSTEO*/
proc freq data = d.select;
tables Age*OsteoStatus / chisq;
```

```
run;
```

```
proc freq data = d.select;
tables Gender*OsteoStatus / chisq;
run;
proc freq data = d.select;
tables RIDRETH3*OsteoStatus / chisq;
run;
proc freq data = d.select;
tables DiabetesStatus*OsteoStatus / chisq;
run;
proc freq data = d.select;
tables Tobacco*OsteoStatus / chisq;
run;
proc freq data = d.select;
tables Dnk*OsteoStatus / chisq;
run;
/* Chi Squared Des. Stat. / Biv. Analy for DIABETES*/
proc freq data = d.select;
tables Age*DiabetesStatus / chisq;
run;
proc freq data = d.select;
tables Gender*DiabetesStatus / chisq;
run;
proc freq data = d.select;
tables RIDRETH3*DiabetesStatus / chisq;
run;
proc freq data = d.select;
tables OsteoStatus*DiabetesStatus / chisq;
run;
proc freq data = d.select;
tables Tobacco*DiabetesStatus / chisq;
```

run;

```
proc freq data = d.select;
tables Dnk*DiabetesStatus / chisq;
run;
/* REFERENCES
no diabetes -- REF = 2: no diabetes (highest frequency)
NO OSTEO -- REF = 2: no osteo
                                  (highest frequency)
female -- REF = 2: female (highest frequency)
80 + years -- REF = 9
                       (oldest age b/c outcome increases with
age)
non-hispanic white -- REF = 3
                                  (highest frequency)
frequent drinker -- REF = 3:Frequent Drinker (highest
frequency?)
no tobacco
          -- REF = 2: no
                              (highest frequency) */
/* Logistic Regression is used to predict the CATEGORICAL
dependent variable using a given set of independent variables.
*/
/* Univariate Analysis for Osteo */
    proc logistic data=d.select;
          class Age (ref='9') / param = ref;
         model OsteoStatus(event='0') = Age ; run;
    proc logistic data=d.select;
          class Gender (ref='F') / param = ref;
         model OsteoStatus(event='0') = Gender ; run;
    proc logistic data=d.select;
         class Race (ref='3') / param = ref;
         model OsteoStatus(event='0') = Race ; run;
    proc logistic data=d.select;
          class DiabetesStatus (ref='2') / param = ref;
         model OsteoStatus (event='0') = DiabetesStatus ; run;
    proc logistic data=d.select;
         class Tobacco (ref='N') / param = ref;
         model OsteoStatus(event='0') = Tobacco ; run;
    proc logistic data=d.select;
          class Dnk (ref='3') / param = ref;
         model OsteoStatus(event='0') = Dnk ; run;
/* Univariate Analysis for Diabetes */
    proc logistic data=d.select;
          class Age (ref='9') / param = ref;
```

```
model DiabetesStatus(event='1') = Age ; run;
    proc logistic data=d.select;
          class Gender (ref='F') / param = ref;
         model DiabetesStatus(event='1') = Gender ; run;
    proc logistic data=d.select;
          class Race (ref='3') / param = ref;
         model DiabetesStatus(event='1') = Race ; run;
    proc logistic data=d.select;
          class OsteoStatus (ref='N') / param = ref;
         model DiabetesStatus(event='1') = OsteoStatus ; run;
    proc logistic data=d.select;
          class Tobacco (ref='N') / param = ref;
         model DiabetesStatus(event='1') = Tobacco ; run;
    proc logistic data=d.select;
          class Dnk (ref='3') / param = ref;
         model DiabetesStatus(event='1') = Dnk ; run;
/* Miultivariate Analysis for Osteo */
    proc logistic data=d.select;
          class Age (ref='9') Gender (ref='F') Race (ref='3')
DiabetesStatus (ref='2') Tobacco (ref='N') Dnk (ref='3') / param
= ref;
         model OsteoStatus(event='0') = Age Gender Race
DiabetesStatus Tobacco Dnk ; run;
/* Miultivariate Analysis for Diabetes */
/* Cannot use youngest age as reference when using OsteoStatus
SMDANY Dnk as covariates.
         All these three variables do not have values at the
youngest age. For example, OsteoStatus only have values for age
over 50.
         Must either delete those three covariates or use Age=6
as reference. Elected to use Age=6 as reference. */
    proc logistic data=d.select;
          class Age (ref="9") Gender (ref='F') Race (ref='3')
OsteoStatus (ref='N') Tobacco (ref='N') Dnk (ref='3') / param =
ref;
         model DiabetesStatus(event='1') = Age Gender Race
OsteoStatus Tobacco Dnk ; run;
```

```
/* Save SAS output as Word file??? */
```

## NHANES 2017-2018: The Comorbidity Between Osteoporosis and Diabetes

BIOS 6102: Biostatistical Methods II Spring 2021 Sarah Grunblatt, MS, MS, MEd, MEd, MA

## **BACKGROUND: OSTEOPOROSIS**

- Osteoporosis means "porous bone," and is a chronic disease.
- The National Osteoporosis Foundation defines osteoporosis as "a bone disease that occurs when the body loses too much bone, makes too little bone, or both."
- As a result, bones become weak and may break from a fall or, in serious cases, from sneezing or minor bumps.
- Viewed under a microscope, healthy bone looks like a honeycomb.
- Possible risk factors:
  - 1. Age 50 and above
  - 2. Female
  - 3. Smoking / tobacco exposure
  - 4. Drinking / alcohol consumption
  - 5. Race (Non-Hispanic White and Asian)



## **BACKGROUND: DIABETES**

- Diabetes mellitus (diabetes) is a chronic health condition that occurs when the body creates too much sugar while trying to turn food into energy.
- There are 3 main types:
  - Type 1 -- Immune system destroys the cells that release insulin.
  - Type 2 -- Body isn't able to use insulin properly.
  - Gestational -- Diabetes diagnosed during pregnancy (often temporary)
  - According to Health Central (Barros):
    - Type 1 diabetes is the most common chronic disease in children.
    - 95% of diabetes patients have type 2.
    - 7 million people live with undiagnosed diabetes
    - 30 million Americans live with diabetes.
    - 80 million American adults have prediabetes.
- Possible risk factors:
  - 1. Age 45 and above (Type II)
  - 2. Overweight / physical inactivity
  - 3. Smoking / tobacco exposure
  - 4. High blood pressure
  - 5. Race (African-American, Hispanic, Native American, Asian-American race, or Pacific Islander)





## **RATIONALE: OSTEOPOROSIS & DIABETES**

- In 2010, osteoporosis and low bone mass were estimated to be a major public health threat for almost 54 million U.S. women and men aged 50 and older, and that number has only grown.
  - Among the 54 million, 10.2 million adults are estimated to have osteoporosis, of which more than 80% were women (Wright, 2014).
- Economic burden was estimated at **17 billion USD** in 2005 (Burge, 2007).
- In a study based on almost 380,000 fractures in female Medicare beneficiaries, 10% had another fracture within 1 year, 18% within 2 years, and 31% within 5 years (Balasubramanian, 2019).
- "Although bone health is primarily associated with age, recent studies have shown that individuals with <u>diabetes mellitus (DM)</u> have up to <u>6 times higher incidence</u> of <u>osteoporotic fractures</u> compared to the general population." (Dumic-Cule, et al., 2018) To reduce this alarming public health burden, additional research regarding the risk factors for and causal pathway associated with both diabetes and osteoporosis is needed.

NHANES VARIABLE NAME	SAS LABEL	ENGLISH TEXT	TARGET	TYPE	CODED VALUES
0\$0060	Ever told had osteoporosis/brittle bones	Has a doctor ever told {you/SP} that {you/s/he} had osteoporosis, sometimes called thin or brittle bones?	Both males and females 50 YEARS - 150 YEARS	Categorical	1: Osteoporosis 2: No Osteoporosis
DIQ010SAS	Doctor told you have diabetes	The next questions are about specific medical conditions. {Other than during pregnancy, {have you/has SP}/{Have you/Has SP} ever been told by a destor se health preferent but Yung have/(hoc/sP) has diabates or sugar diabates?	Both males and females 1 YEARS - 150 YEARS	Categorical	1: Diabetes (Including Borderli 2: No Diabetes
RIAGENDR	Gender	Gender of the participant	Both males and females O YEARS - 150 YEARS	Categorical	1: Male 2: Female
RIDAGEYR	Age in years at screening	Age in years of the participant at the time of screening, Individuals 80 and over are topcoded at 80 years of age.	Both males and females O YEARS - 150 YEARS	Categorical	1:1-9 years old 2:10-19 years old 3:20-29 years old 4:30-39 years old 5:40-49 years old 6:50-59 years old 7:60-69 years old 8:70-19 years old 9:80 years old and above
RIDRETH3	Race/Hispanic origin w/ NH Asian	Recode of reported race and Hispanic origin information, with Non-Hispanic Asian Category	Both males and females O YEARS - 150 YEARS	Categorical	1: Mexican American 2: Other Hispanic 3: Non-Hispanic White 4: Non-Hispanic Black 5: Non-Hispanic Asian 6: Other Race - Including multirac
ALQ111 & ALQ121	Ever had a drink of any kind of alcohol = "No" & Past 12 mo how often have alcohol drink	The next questions are about drinking alcoholic beverages. Included are liquer (such as whiskey or gin), beer, wine, wine coolers, and any other type of alcoholic beverage, In (your/SPs) entire life, (have you/has he/has he) had at least 1 drink of any kind of alcoholi, no counting small tastes or sips? By a drink, 1 mean a 12 oz. beer, a 5 oz. glass of wine, or one and a half ounces of liquor. Buring the past 12 months, about how often did (yo/SP) drink any type of alcoholic beverage? PROBE: How many days per week, per month, or per year did (you/SP) drink?	Both males and females 18 YEARS - 150 YEARS	Categorical	0: Never Drinker 1: Former Drinker 2: Occasional Drinker 3: Frequent Drinker
SMDANY	Used any tobacco product last 5 days?	Used any tobacco product last 5 days?	Both males and females 12 YEARS - 150 YEARS	Categorical	1: Tobacco 2: No Tobacco

## **ALL VARIABLES\* OF INTEREST**

## **METHODS**

- TARGET POPULATION: The NHANES target population is the noninstitutionalized civilian resident population of the United States.
- SAMPLE POPULATION: Noninstitutionalized U.S. civilian population of all ages residing in all 50 states and Washington D.C.
- ANALYTICAL SAMPLE SIZE: All 2017-2018 NHANES participants who completed the interview (n = 9,254)
  - Eligibility criteria for both outcomes:
    - Above age 50 (minimum target for osteoporosis variable): n = 3,069
    - Responded yes/no to osteoporosis/brittle bone question (variable OSQ060): n = 3,053
      - Because diabetes typically onests after the age of 45, these parameters also fit well with the second outcome (diabetes).
  - Exclusion criteria for both outcomes:
    - Osteoporosis response = refused, don't know, missing: n = 16
  - Final Analytical Sample Size: n = 3,053

## **STATISTICAL ANALYSES PERFORMED**

All variables are coded as **categorical** (2 outcomes each with 6 predictors). Therefore, **logistic regression** methods were utilized.

- 1. Osteoporosis with predictor variables age (primary), diabetes, gender, race, alcohol consumption, and tobacco use
- 2. Diabetes with predictor variables age (primary), osteoporosis, gender, race, alcohol consumption, and tobacco use

Stepwise regression analysis was not necessary as the chosen predictors are known to have an association with the outcomes.

#### **METHODS UTILIZED FOR BOTH OUTCOMES:**

- 1. Descriptive statistics
- 2. Bivariate analyses: Wald chi-square
- 3. Logistic regression modeling: Wald 95% confidence intervals and chi-square
  - Univariate model
  - Multivariable model

All outputs were generated using SAS software version 9.4 with the significance level set at a 2-sided P-value < 0.05 and a 95% Confidence Interval. Copyright<sup>®</sup> 2021 SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA.





# OUTCOME #1: OSTEOPOROSIS

## **OUTCOME #1: STUDY OBJECTIVES**

#### **PRIMARY PREDICTOR VARIABLE:**

1. Examine the association of **age** and being told by a physician that you have **osteoporosis/brittle bones**.

#### **SECONDARY PREDICTOR VARIABLES:**

- 2. Examine the association of **diabetes** and being told by a physician that you have **osteoporosis/brittle bones**.
- **3.** Examine the association of **gender** and being told by a physician that you have **osteoporosis/brittle bones**.
- Examine the association of race and being told by a physician that you have osteoporosis/brittle bones.
- 5. Examine the association of **alcohol consumption** and being told by a physician that you have **osteoporosis/brittle bones**.
- 6. Examine the association of **tobacco use** and being told by a physician that you have **osteoporosis/brittle bones**.

#### **OSTEOPOROSIS: DESCRIPTIVE STATISTICS & BIVARIATE ANALYSIS**

Table 1. Descriptive Statistics & Bivariates Analysis of NHANES 2017-2018 Participants Regarding "Has a doctor ever told {you/SP} that {you/s/he} had osteoporosis,

Characteristic (n = 3,069***)         (n = 3,051)         (n = 3,065)         P-value           Age*		Total	Osteoporosis	Osteoporosis	Chi-Square
Age*         <.0001*	Characteristic (n = 3,069***)	(n = 3,051)	(n = 396)	(n = 2,655)	P-value
50 to 59 Years Old, n (%)         915 (22:97)         57 (6:23)         858 (93:77)           60 to 69 Years Old, n (%)         1,100 (35:03)         120 (10:03)         980 (80:06)           70 to 79 Years Old, n (%)         617 (20:21)         119 (19:29)         498 (80:71)           60 to 69 Years Old, n (%)         617 (20:21)         119 (19:29)         498 (80:71)           60 to Years Old, n (%)         421 (13:79)         100 (23:75)         321 (76:25)           Diabetes Status         0.4344         0.30 (27:32)         0.4344           Diabetes Status         0.475 (25:65)         120 (13:73)         754 (86:27)           No Diabetes, n (%)         2,177 (71:35)         276 (12:68)         1,90 (16:73.2)           Gender               Male, n (%)         1,513 (49:56)         54 (3:57)         1,459 (96:43)           Female, n (%)         1,514 (95:64)         342 (22:21)         1,198 (77:79)           Race/Ethnicity         0.0010*         Mexican American, n (%)         347 (11:37)         34 (98:00)         313 (90:20)           Other Hispanic, n (%)         290 (95:0)         40 (13:79)         250 (86:21)         Non-Hispanic Bia/s, n (%)         72 (23:39)         188 (16:04)         94 (86:36)	Age**				<.0001*
60 to 69 Years Old, n (%)         1,100 (36.03)         120 (10.91)         980 (88.09)           70 to 79 Years Old, n (%)         617 (20.21)         119 (19.23)         498 (80.71)           80+ Years Old, n (%)         421 (13.79)         100 (23.75)         321 (76.25)           Diabetes Status	50 to 59 Years Old, n (%)	915 (29.97)	57 (6.23)	858 (93.77)	
Το to 79 Years Old, n (%)         617 (20.21)         119 (19.29)         498 (80.71)           Bot Years Old, n (%)         421 (13.79)         100 (23.75)         321 (76.25)           Diabetes Status         0.4344         Diabetes & Dorderine, n (%)         874 (28.65)         120 (13.73)         754 (86.27)           No Diabetes, n (%)         2.177 (71.35)         2.26 (13.73)         754 (86.27)         .40001 <sup>k</sup> Male, n (%)         1.513 (49.56)         54 (3.57)         1.459 (96.43)	60 to 69 Years Old, n (%)	1,100 (36.03)	120 (10.91)	980 (89.09)	
80+Years Old, n (%)         421 (13.79)         100 (23.75)         321 (76.25)           Diabetes Status         0.4344         0.4344         0.4344           Diabetes & Borderline, n (%)         874 (28.65)         120 (13.73)         754 (86.27)         0.4344           No Diabetes, n (%)         2,177 (71.35)         276 (12.68)         1,901 (87.32)         66.27)           Male, n (%)         1,513 (49.56)         54 (3.57)         1,459 (96.43)         67.79)           Race/Ethnicity         0.0010*         347 (11.37)         34 (9.80)         313 (90.20)           Other Hispanic, n (%)         347 (11.37)         250 (86.21)         0.0010*           Non-Hispanic, n (%)         1,712 (38.39)         188 (16.04)         944 (83.96)           Non-Hispanic Black, n (%)         1,712 (38.39)         188 (16.04)         944 (83.96)           Non-Hispanic Mate, n (%)         134 (12.81)         50 (12.79)         341 (87.21)           Other Hispanic Mate, n (%)         29 (12.81)         50 (12.79)         341 (87.21)           Other Race - Including Multi-Racial, n (%)         128 (4.19)         12 (9.38)         116 (90.63)           Non-Hispanic Asian, n (%)         29 (11.08)         47 (16.15)         244 (83.85)           Cornor Drinker, n (%)         29 (11	70 to 79 Years Old, n (%)	617 (20.21)	119 (19.29)	498 (80.71)	
Diabetes Status         0.4344           Diabetes Status         0.4344           No Diabetes, n (%)         2,177 (71.35)         276 (12.68)         1,901 (87.32)           Gender	80+ Years Old, n (%)	421 (13.79)	100 (23.75)	321 (76.25)	
Diabetes, & Borderline, n (%)         874 (28.65)         120 (13.73)         754 (86.27)           No Diabetes, n (%)         2,177 (71.35)         276 (12.68)         1,901 (87.32)           Gender	Diabetes Status				0.4344
$\begin{tabular}{ c c c c c c c c c c c c c c c c c c c$	Diabetes & Borderline, n (%)	874 (28.65)	120 (13.73)	754 (86.27)	
Gender         <.0001*           Male, n (%)         1,513 (49.56)         54 (3.57)         1,459 (96.43)           Female, n (%)         1,540 (50.44)         342 (22.21)         1,198 (77.79)           Race/Ethnicity         0.0010*         0.0010*           Mexican American, n (%)         347 (11.37)         34 (9.80)         313 (90.20)           Other Hispanic, n (%)         290 (9.50)         40 (13.79)         250 (86.21)           Non-Hispanic Black, n (%)         725 (23.75)         72 (9.93)         653 (90.07)           Non-Hispanic Black, n (%)         725 (23.75)         72 (9.93)         653 (90.07)           Non-Hispanic Black, n (%)         725 (12.75)         77 (9.93)         116 (90.63)           Uchold Consumption         0.0005*         0.0005*           Never Drinker, n (%)         281 (10.89)         47 (16.15)         244 (88.85)           Coccasional Drinker, n (%)         1,137 (42.57)         155 (13.46)         94 (86.54)           Occasional Drinker, n (%)         1,137 (42.57)         155 (13.46)         944 (86.54)           Tobacco, n (%)         455 (15.1)         07.24         423 (92.76)           Tequent Drinker, n (%)         1,137 (42.57)         155 (13.46)         944 (86.54)           Tobacco, n (%) <td>No Diabetes, n (%)</td> <td>2,177 (71.35)</td> <td>276 (12.68)</td> <td>1,901 (87.32)</td> <td></td>	No Diabetes, n (%)	2,177 (71.35)	276 (12.68)	1,901 (87.32)	
Male, n (%)         1,512 (49.56)         5 4(3.57)         1,459 (96.43)           Female, n (%)         1,540 (50.44)         342 (22.21)         1,198 (77.79)           Race/Ethnicity         0.0010*           Mexican American, n (%)         347 (11.37)         34 (9.80)         313 (90.20)           Other Hispanic, n (%)         347 (11.37)         24 (9.80)         313 (90.20)           Non-Hispanic White, n (%)         1,171 (23.39)         188 (16.04)         944 (83.96)           Non-Hispanic Black, n (%)         725 (23.75)         72 (99.39)         653 (90.07)           Non-Hispanic Asian, n (%)         391 (12.81)         50 (12.79)         341 (87.21)           Other Kraace - Including Multi-Racial, n (%)         128 (4.19)         12 (9.38)         116 (90.63)           Mcohol Consumption         0.0005*         0.0005*         0.0005*           Never Drinker, n (%)         291 (10.89)         477 (16.15)         244 (83.85)           Ocrassional Drinker, n (%)         1,137 (42.57)         133 (14.49)         673 (85.51)           Ocrassional Drinker, n (%)         1,137 (42.57)         133 (13.46)         984 (86.54)           Tobacco Ic         90 (9.00)         446 (90.10)         No.225*           Tobacco, n (%)         2,179 (18.49)	Gender				<.0001*
Female, n (%)         1,540 (50.44)         342 (22.21)         1,198 (77.79)           Maxcl Thinkity         0.0010*         0.0010*           Mexican American, n (%)         347 (11.37)         34 (9.80)         313 (90.20)           Other Hispanic, n (%)         290 (9.50)         40 (13.79)         250 (86.21)           Non-Hispanic Riskin, n (%)         290 (32.33)         188 (16.04)         964 (83.36)           Non-Hispanic Black, n (%)         725 (23.75)         72 (9.93)         653 (90.07)           Non-Hispanic Black, n (%)         391 (12.81)         50 (12.79)         314 (18.7.21)           Other Race - Including Multi-Racial, n (%)         128 (4.19)         12 (9.38)         116 (90.63)           Alcohol Consumption         0.0005*         0.0005*         0.0005*           Never Drinker, n (%)         291 (10.89)         471 (16.15)         224 (83.85)           Occasional Drinker, n (%)         456 (17.07)         33 (7.24)         423 (92.76)           Frequent Drinker, n (%)         1,137 (42.57)         155 (13.46)         964 (86.54)           Occasional Drinker, n (%)         4,213 (42.57)         155 (13.46)         964 (86.54)           Tobacco (%)         495 (18.51)         495 (90.10)         0.0225*           Tobacco, n (%)         <	Male, n (%)	1,513 (49.56)	54 (3.57)	1,459 (96.43)	
Bace/Ethnicity         0.0010*           Mexican American, n (%)         347 (11.37)         34 (9.80)         313 (90.20)           Other Hispanic, n (%)         290 (9.50)         40 (13.79)         250 (86.21)           Non-Hispanic Mitte, n (%)         1,172 (38.39)         188 (16.04)         944 (83.96)           Non-Hispanic Aian, n (%)         313 (12.81)         50 (12.79)         341 (87.21)           Other Rispanic Asian, n (%)         391 (12.81)         50 (12.79)         341 (87.21)           Other Rispanic Asian, n (%)         391 (12.81)         50 (12.79)         341 (87.21)           Other Rise - Including Multi-Racial, n (%)         128 (4.19)         12 (9.38)         116 (90.63)           Alcohol Consumption         0.0005*         0.0005*         0.0005*           Never Drinker, n (%)         291 (10.89)         477 (16.15)         244 (83.85)           Occasional Drinker, n (%)         456 (17.07)         33 (7.24)         423 (92.76)           Frequent Drinker, n (%)         1317 (42.57)         153 (13.46)         904 (66.54)           Tobacco Urg         495 (18.51)         904 (66.54)         0.0225*           Tobacco, n (%)         495 (18.51)         496 (90.10)         No.225*           No Tobacco, n (%)         2,179 (18.49)         <	Female, n (%)	1,540 (50.44)	342 (22.21)	1,198 (77.79)	
Mexican American, n (%)         347 (11.37)         34 (3.80)         313 (90.20)           Other Hispanic, n (%)         250 (35.0)         40 (13.77)         250 (86.21)           Non-Hispanic White, n (%)         1,172 (38.39)         188 (16.04)         944 (83.96)           Non-Hispanic White, n (%)         725 (23.75)         72 (9.33)         653 (90.07)           Non-Hispanic Black, n (%)         391 (12.81)         50 (12.79)         341 (87.21)           Other Race - Including Multi-Racial, n (%)         128 (4.19)         12 (9.38)         116 (90.63)           Alcohol Consumption         0.0005*         0.0005*         0.0005*           Never Drinker, n (%)         291 (10.89)         47 (16.15)         244 (83.85)           Occasional Drinker, n (%)         1,317 (42.57)         133 (7.24)         423 (92.76)           Frequent Drinker, n (%)         1,317 (42.57)         135 (13.46)         944 (86.54)           Tobacco, n (%)         495 (18.51)         0.0225*         0.0225*           Tobacco, n (%)         2,179 (18.49)         299 (13.72)         1,808 (68.28)	Race/Ethnicity				0.0010*
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Mexican American, n (%)	347 (11.37)	34 (9.80)	313 (90.20)	
Non-Hispanic White, n (%)         1,172 (38.39)         188 (16.04)         944 (83.96)           Non-Hispanic Black, n (%)         725 (23.75)         72 (99.39)         653 (90.07)           Non-Hispanic Asian, n (%)         391 (12.81)         50 (12.79)         341 (87.21)           Other Race - Including Multi-Racial, n (%)         128 (4.19)         12 (9.38)         116 (90.63)           Michol Consumption         0.0005*         0.0005*           Never Drinker, n (%)         291 (10.89)         47 (16.15)         244 (83.85)           Ocrassional Drinker, n (%)         787 (22.44)         114 (14.49)         673 (85.51)           Occasional Drinker, n (%)         456 (17.07)         33 (7.24)         423 (92.76)           Frequent Drinker, n (%)         1,137 (42.57)         153 (13.46)         984 (86.54)           Tobacco, n (%)         495 (18.51)         944 (69.10)         0.0225*           No Tobacco, n (%)         2,179 (81.49)         299 (13.72)         1,880 (66.28)	Other Hispanic, n (%)	290 (9.50)	40 (13.79)	250 (86.21)	
Non-Hispanic Black, n (%)         725 (23.75)         72 (9.93)         653 (90.07)           Non-Hispanic Aslan, n (%)         391 (12.81)         50 (12.79)         341 (87.21)           Other Race - Including Multi-Racial, n (%)         128 (4.19)         12 (9.38)         116 (90.63)           Other Race - Including Multi-Racial, n (%)         291 (10.89)         47 (16.15)         244 (83.85)           Former Drinker, n (%)         787 (29.46)         114 (14.49)         673 (85.51)           Occasional Drinker, n (%)         456 (17.07)         33 (7.24)         423 (92.76)           Frequent Drinker, n (%)         1,317 (42.57)         153 (13.46)         984 (86.54)           Tobacco, n (%)         495 (18.51)         49 (9.00)         40225*           No Tobacco, n (%)         2,179 (18.49)         299 (13.72)         1,880 (86.28)	Non-Hispanic White, n (%)	1,172 (38.39)	188 (16.04)	984 (83.96)	
Non-Hispanic Asian, n (%)         391 (12.81)         50 (12.79)         341 (87.21)           Other Race - Including Multi-Racial, n (%)         128 (4.19)         12 (9.38)         116 (90.63)           Alcohol Consumption         0.0005*           Never Drinker, n (%)         291 (10.89)         47 (16.15)         244 (83.85)           Former Drinker, n (%)         787 (22.46)         114 (14.49)         673 (85.51)           Occasional Drinker, n (%)         456 (17.07)         33 (7.24)         423 (92.76)           Frequent Drinker, n (%)         1,137 (42.57)         153 (13.46)         984 (86.54)           Tobacco Use         0.0225*         0.0225*         0.0225*           No Tobacco, n (%)         2,179 (81.49)         299 (13.72)         1,880 (82.8)	Non-Hispanic Black, n (%)	725 (23.75)	72 (9.93)	653 (90.07)	
Other Race - Including Multi-Racial, n (%)         128 (4.19)         12 (9.38)         116 (90.63)           Mcchol Consumption         0.0005*           Never Drinker, n (%)         291 (10.89)         47 (16.15)         244 (83.85)           Former Drinker, n (%)         787 (29.46)         114 (14.49)         673 (85.51)           Occasional Drinker, n (%)         456 (17.07)         33 (7.24)         423 (92.76)           Frequent Drinker, n (%)         1,137 (42.57)         155 (13.46)         994 (86.54)           Tobacco US         0.0225*         0.0225*           No Tobacco, n (%)         2,179 (18.149)         29 (13.72)         1,880 (62.8)	Non-Hispanic Asian, n (%)	391 (12.81)	50 (12.79)	341 (87.21)	
Alcohol Consumption         0.0005*           Never Drinker, n (%)         291 (10.89)         47 (16.15)         244 (83.85)           Former Drinker, n (%)         787 (22.46)         114 (14.49)         673 (85.51)           Occasional Drinker, n (%)         456 (17.07)         33 (7.24)         423 (92.76)           Frequent Drinker, n (%)         1,313 (42.57)         153 (13.46)         984 (86.54)           Tobacco Use         0.0225*         0.0225*           Tobacco, n (%)         2,179 (18.49)         299 (13.72)         1,808 (86.28)	Other Race - Including Multi-Racial, n (%)	128 (4.19)	12 (9.38)	116 (90.63)	
Never Drinker, n (%)         291 (10.89)         47 (16.15)         244 (83.85)           Former Drinker, n (%)         787 (22.44)         114 (14.49)         673 (85.51)           Occasional Drinker, n (%)         456 (17.07)         33 (7.24)         423 (92.76)           Frequent Drinker, n (%)         1,137 (42.57)         155 (13.46)         984 (86.54)           Tobacco IR         0.0225*         0.0225*           No Tobacco, n (%)         2,179 (81.49)         29 (13.72)         1,880 (86.28)	Alcohol Consumption				0.0005*
Former Drinker, n (%)         787 (29.46)         114 (14.49)         673 (85.51)           Occasional Drinker, n (%)         456 (17.07)         33 (7.24)         423 (92.76)           Frequent Drinker, n (%)         1,137 (42.57)         153 (13.46)         984 (86.54) <b>Tobacco Use</b> 0.0225*         0.0225*           Tobacco, n (%)         495 (18.51)         49 (9.90)         446 (90.10)           No Tobacco, n (%)         2,179 (81.49)         299 (13.72)         1,880 (86.28)	Never Drinker, n (%)	291 (10.89)	47 (16.15)	244 (83.85)	
Occasional Drinker, n (%)         456 (17.07)         33 (7.24)         423 (92.76)           Frequent Drinker, n (%)         1,137 (42.57)         153 (13.46)         984 (86.54)           Tobacco Use         0.0225*           Tobacco, n (%)         495 (18.51)         49 (9.90)         446 (90.10)           No Tobacco, n (%)         2,179 (81.49)         299 (13.72)         1,880 (86.28)	Former Drinker, n (%)	787 (29.46)	114 (14.49)	673 (85.51)	
Frequent Drinker, n (%)         1,137 (42.57)         153 (13.46)         984 (86.54) <b>Tobacco Use</b> 0.0225*           Tobacco, n (%)         495 (18.51)         49 (9.90)         446 (90.10)           No Tobacco, n (%)         2,179 (81.49)         299 (13.72)         1,880 (86.28)	Occasional Drinker, n (%)	456 (17.07)	33 (7.24)	423 (92.76)	
Tobacco Use         0.0225*           Tobacco, n (%)         495 (18.51)         49 (9.90)         446 (90.10)           No Tobacco, n (%)         2,179 (81.49)         299 (13.72)         1,880 (86.28)	Frequent Drinker, n (%)	1,137 (42.57)	153 (13.46)	984 (86.54)	
Tobacco, n (%)         495 (18.51)         49 (9.90)         446 (90.10)           No Tobacco, n (%)         2,179 (81.49)         299 (13.72)         1,880 (86.28)	Tobacco Use				0.0225*
No Tobacco, n (%) 2,179 (81.49) 299 (13.72) 1,880 (86.28)	Tobacco, n (%)	495 (18.51)	49 (9.90)	446 (90.10)	
	No Tobacco, n (%)	2,179 (81.49)	299 (13.72)	1,880 (86.28)	
	** NHANES Target: Both males and females 50	YEARS - 150 YEARS			

#### RESULTS

According to the variables selected to measure the predictors for osteoporosis utilizing Wald chi-square p-values at alpha = 0.05, the results were:

#### **1. AGE (PRIMARY PREDICTOR):**

- p = <0.0001, statistically significant</li> 2. DIABETES STATUS:
- p = 0.4344, not statistically significant **3. GENDER:**
- p = <0.0001, statistically significant</li> 4. RACE/ETHNICITY:
- p = 0.0010, statistically significant **5. ALCOHOL CONSUMPTION:**
- p = 0.0005, statistically significant 6. TOBACCO USE:
  - p = 0.0225. statistically significant

#### **OSTEOPOROSIS: UNIVARIATE & MULTIVARIATE LOGISTIC ANALYSES**

Regardin	arrate Logistic Array	with Osteo	norosis	cipants
Characteristic (n = 3,069***)	Univariate Crude Odds Ratio (95% Wald CI)	Univariate Wald P-Value	Multivariate Crude Odds Ratio (95% Wald CI)	Multivariate Wald P-Value
Age**				
50 to 59 Years Old	0.213 (0.150-0.303)*	<.0001*	0.195 (0.127-0.301)*	<.0001*
60 to 69 Years Old	0.393 (0.293-0.527)*	<.0001*	0.401 (0.275-0.583)*	<.0001*
70 to 79 Years Old	0.767 (0.568-1.036)	0.0838	0.871 (0.598-1.267)	0.4694
80+ Years Old	1.0		1.0	
Diabetes Status				
Diabetes & Borderline	1.096 (0.871-1.380)	0.4345	1.193 (0.910-1.565)	0.2024
No Diabetes	1.0		1.0	
Gender				
Male	0.130 (0.096-0.174)*	<.0001*	0.110 (0.079-0.153)*	<.0001*
Female	1.0		1.0	
Race/Ethnicity				
Mexican American	0.569 (0.386-0.837)*	0.0042*	0.724 (0.461-1.137)	0.1611
Other Hispanic	0.837 (0.579-1.210)	0.3453	1.086 (0.704-1.678)	0.7087
Non-Hispanic White	1.0		1.0	
Non-Hispanic Black	0.577 (0.432-0.771)*	0.0002*	0.719 (0.514-1.007)	0.0549
Non-Hispanic Asian	0.767 (0.549-1.073)	0.1218	1.041 (0.681-1.593)	0.8515
Other Race - Including Multi-Racial	0.541 (0.293-1.001)	0.0504	0.892 (0.458-1.738)	0.737
Alcohol Consumption				
Never Drinker	1.239 (0.868-1.768)	0.2379	0.763 (0.514-1.133)	0.18
Former Drinker	1.089 (0.839-1.415)	0.5211	0.919 (0.689-1.227)	0.5671
Occasional Drinker	0.502 (0.339-0.743)*	0.0006*	0.725 (0.474-1.111)	0.1397
Frequent Drinker	1.0		1.0	
Tobacco Use				
Tobacco	0.691 (0.502-0.951)*	0.0233*	1.263 (0.878-1.816)	0.2086
No Tobacco	1.0		1.0	
*Statistically significant.				
** NHANES Target: Both males and fen	nales 50 YEARS - 150 YEARS			
*** Responses of "refused", "don't kn	ow," and missing were exe	luded from an	alyses (n = 16).	

ariate and multivariate logistic analyses for each predictor versus outcome was utilized to obtain the odds ratios (OR), 95% Wald confidence intervals (CI), and Wald p-values (alpha = 0.05).

#### **STATISTICALLY SIGNIFICANT RESULTS**

#### 1. AGE (PRIMARY PREDICTOR): 50 to 59 Years Old (protective) • UNIVARIATE: OR = 0.213 (0.150-0.303) and p = <.0001 MULTIVARIATE: OR = 0.195 (0.127-0.301) and p = <.0001 60 to 69 Years Old (protective) UNIVARIATE: OR = 0.393 (0.293-0.527) and p = <.0001 MULTIVARIATE: OR = 0.401 (0.275-0.583) and p = <.0001 2. DIABETES STATUS: No statistically significant results 3. GENDER: Male (protective) UNIVARIATE: OR = 0.130 (0.096-0.174) and p = <.0001 MULTIVARIATE: OR = 0.110 (0.079-0.153) and p = <.0001 4. RACE/ETHNICITY: Mexican American UNIVARIATE: OR = 0.569 (0.386-0.837) and p = 0.0042 MULTIVARIATE: not statistically significant

- - Non-Hispanic Black (almost protective
  - UNIVARIATE: OR = 0.577 (0.432-0.771) and p = 0.0002
- (close) MULTIVARIATE: OR = 0.719 (0.514-1.007) and p = 0.0549 5. ALCOHOL CONSUMPTION:

#### Occasional Drinker

- UNIVARIATE: OR = 0.502 (0.339-0.743) and p = 0.0006
- MULTIVARIATE: not statistically significant
- 6. TOBACCO USE:
- Tohacco (Yes)
  - UNIVARIATE: OR = 0.691 (0.502-0.951) and p = 0.0233
  - MULTIVARIATE: not statistically significant

## **OUTCOME #1: CONCLUSIONS**

According to the variables selected as predictors with respect to the outcome of osteoporosis:

- 1. **PRIMARY PREDICTOR:** Compared to individuals 80 years old and above, people age **50 to 59** and **60 to 69** years old had lower odds (OR = 0.195, p = <.0001 and OR = 0.401, p = <.0001) of being told by a physician that they have osteoporosis/brittle bones after adjusting for other selected factors.
- 2. There was no statistically significant association between diabetes status (compared to no diabetes status) and being told by a physician that you have osteoporosis/brittle bones.
- **3.** Compared to females, **males had lower odds** of being told by a physician that they have **osteoporosis/brittle bones** (OR = 0.110, p = <.0001) after adjusting for other selected factors.
- Compared to non-Hispanic whites, non-Hispanic blacks were the only race that came *close* to having statistically significant results.
  - This group had reduced odds (OR = 0.719, 95% CI: 0.514-1.007, p = 0.0549) of being told by a physician that they have osteoporosis/brittle bones after adjusting for other selected factors.
- 5. After adjusting for other selected factors, there was no statistically significant association between amount of alcohol consumption (compared to frequent drinking) and being told by a physician that you have osteoporosis/brittle bones.
- 6. After adjusting for other selected factors, there was **no statistically significant association between tobacco** (yes) use (compared to no tobacco use) and being told by a physician that you have osteoporosis/brittle bones.

# OUTCOME #2: DIABETES

(Bonus for Midterm)

## **OUTCOME #2: STUDY OBJECTIVES**

#### **PRIMARY PREDICTOR VARIABLE:**

1. Examine the association of **age** and being told by a physician that you have **diabetes** (including borderline).

#### **SECONDARY PREDICTOR VARIABLES:**

- 2. Examine the association of **osteoporosis** and being told by a physician that you have **diabetes (including borderline).**
- 3. Examine the association of **gender** and being told by a physician that you have **diabetes (including borderline).**
- Examine the association of race and being told by a physician that you have diabetes (including borderline).
- 5. Examine the association of **alcohol consumption** and being told by a physician that you have **diabetes (including borderline)**.
- 6. Examine the association of **tobacco use** and being told by a physician that you have **diabetes (including borderline)**.

## **DIABETES:** DESCRIPTIVE STATISTICS & BIVARIATE ANALYSIS

Characteristic (n = 3,069***)           Age         Sol to 59 Years Old, n (%)           50 to 59 Years Old, n (%)         0           70 to 79 Years Old, n (%)         0           70 to 79 Years Old, n (%)         0           80+ Years Old, n (%)         0           Osteoporosis Status**         0           Osteoporosis, n (%)         2           Cender         Male, n (%)           Female, n (%)         3           Face/Ethnicity         3	Total (n = 3,051) 918 (10.32) 1,104 (12.41) 619 (6.96) 426 (4.79) 396 (12.98) 2,655 (87.02) 1,520 (49.56) 1,547 (50.44)	Diabetes & Borderline (n = 874) 175 (19.06) 355 (32.16) 226 (36.51) 127 (29.81) 120 (30.30) 754 (28.40) 485 (31.91) 209 (25.32)	Not Diabetes (n = 2,177) 743 (80.94) 749 (67.84) 393 (63.49) 299 (70.19) 276 (69.70) 1,901 (71.60) 1,035 (68.09)	Wald Chi-Square <u>P-value</u> <,0001* 0.4344 0.0002*
Characteristic (n = 3,069***)           Age         50 to 59 Years Old, n (%)         50 to 59 Years Old, n (%)         50 to 79 Years Old, n (%)         50 Years Old, n (%)	Total (n = 3,051) 918 (10.32) 1,104 (12.41) 619 (6.96) 426 (4.79) 396 (12.98) 2,655 (87.02) 1,520 (49.56) 1,547 (50.44)	Borderline (n = 874) 175 (19.06) 355 (32.16) 226 (36.51) 127 (29.81) 120 (30.30) 754 (28.40) 485 (31.91) 209 (3.57)	Not Diabetes (n = 2,177) 743 (80.94) 749 (67.84) 393 (63.49) 299 (70.19) 276 (69.70) 1,901 (71.60) 1,035 (68.09)	Chi-Square <u>P-value</u> <.0001* 0.4344 0.0002*
Characteristic (n = 3,069 ***) Age S0 to 59 Years Old, n (%) 50 to 59 Years Old, n (%) 70 to 79 Years Old, n (%) 80 Years Old, n (%) 80 Years Old, n (%) Osteoporosis Status** Osteoporosis, n (%) No Osteoporosis, n (%) No Osteoporosis, n (%) Render Male, n (%) Female, n (%) Race/Ethnicity	(n = 3,051) 918 (10.32) 1,104 (12.41) 619 (6.96) 426 (4.79) 396 (12.98) 2,655 (87.02) 1,520 (49.56) 1,547 (50.44)	(n=874) 175 (19.06) 355 (32.16) 226 (36.51) 127 (29.81) 120 (30.30) 754 (28.40) 485 (31.91) 209 (25.73)	(n = 2,177) 743 (80.94) 749 (67.84) 393 (63.49) 299 (70.19) 276 (69.70) 1,901 (71.60) 1,035 (68.09)	0.4344
Age         Solo 59 Years Old, n (%)           50 to 59 Years Old, n (%)         Solo 69 Years Old, n (%)           70 to 79 Years Old, n (%)         Solo 70 Years Old, n (%)           Solteoporosis Status**         Osteoporosis, n (%)           Osteoporosis, n (%)         Solteoporosis, n (%)           Gender         Gender           Male, n (%)         Female, n (%)           Female, n (%)         Stecitity	918 (10.32) 1,104 (12.41) 619 (6.96) 426 (4.79) 396 (12.98) 2,655 (87.02) 1,520 (49.56) 1,547 (50.44)	175 (19.06) 355 (32.16) 226 (36.51) 127 (29.81) 120 (30.30) 754 (28.40) 485 (31.91) 209 (35.73)	743 (80.94) 749 (67.84) 393 (63.49) 299 (70.19) 276 (69.70) 1,901 (71.60) 1,035 (68.09)	<.0001* 0.4344 0.0002*
50 to 59 Years Old, n (%) 60 to 69 Years Old, n (%) 70 to 79 Years Old, n (%) 80 + Years Old, n (%) 05teoporosis Status** Osteoporosis, n (%) No Osteoporosis, n (%) Cender Male, n (%) RecejEthnicity	918 (10.32) 1,104 (12.41) 619 (6.96) 426 (4.79) 396 (12.98) 2,655 (87.02) 1,520 (49.56) 1,547 (50.44)	175 (19.06) 355 (32.16) 226 (36.51) 127 (29.81) 120 (30.30) 754 (28.40) 485 (31.91) 209 (55.72)	743 (80.94) 749 (67.84) 393 (63.49) 299 (70.19) 276 (69.70) 1,901 (71.60) 1,035 (68.09)	0.4344
60 to 69 Years Old, n (%)         70 to 79 Years Old, n (%)           70 to 79 Years Old, n (%)         05           Osteoporosis Status**         05           Osteoporosis, n (%)         2           Gender         2           Male, n (%)         5           Female, n (%)         5           Race/Ethnicity         5	1,104 (12.41) 619 (6.96) 426 (4.79) 396 (12.98) 2,655 (87.02) 1,520 (49.56) 1,547 (50.44)	355 (32.16) 226 (36.51) 127 (29.81) 120 (30.30) 754 (28.40) 485 (31.91) 209 (15.72)	749 (67.84) 393 (63.49) 299 (70.19) 276 (69.70) 1,901 (71.60) 1,035 (68.09)	0.4344 0.0002*
70 to 79 Years Old, n (%)           80+ Years Old, n (%)           Osteoporosis Status**           Osteoporosis, n (%)           No Osteoporosis, n (%)           Gender           Male, n (%)           Female, n (%)           Race/Ethnicity	619 (6.96) 426 (4.79) 396 (12.98) 2,655 (87.02) 1,520 (49.56) 1,547 (50.44)	226 (36.51) 127 (29.81) 120 (30.30) 754 (28.40) 485 (31.91) 200 (25.72)	393 (63.49) 299 (70.19) 276 (69.70) 1,901 (71.60) 1,035 (68.09)	0.4344 0.0002*
80+ Years Old, n (%)           Osteoporosis Status**           Osteoporosis, n (%)           No Osteoporosis, n (%)           Gender           Male, n (%)           Female, n (%)           Race/Ethnicity	426 (4.79) 396 (12.98) 2,655 (87.02) 1,520 (49.56) 1,547 (50.44)	127 (29.81) 120 (30.30) 754 (28.40) 485 (31.91) 202 (25.73)	299 (70.19) 276 (69.70) 1,901 (71.60) 1,035 (68.09)	0.4344 0.0002*
Osteoporosis Status**           Osteoporosis, n (%)           No Osteoporosis, n (%)           Gender           Male, n (%)           Female, n (%)           Rece/Ethnicity	396 (12.98) 2,655 (87.02) 1,520 (49.56) 1,547 (50.44)	120 (30.30) 754 (28.40) 485 (31.91)	276 (69.70) 1,901 (71.60) 1,035 (68.09)	0.4344
Osteoporosis, n (%) No Osteoporosis, n (%) Gender Male, n (%) Female, n (%) Race/Ethnicity	396 (12.98) 2,655 (87.02) 1,520 (49.56) 1,547 (50.44)	120 (30.30) 754 (28.40) 485 (31.91)	276 (69.70) 1,901 (71.60) 1,035 (68.09)	0.0002*
No Osteoporosis, n (%)         2           Gender            Male, n (%)         1           Female, n (%)         2           Race/Ethnicity         2	2,655 (87.02) 1,520 (49.56) 1,547 (50.44)	754 (28.40) 485 (31.91)	1,901 (71.60)	0.0002*
Gender Male, n (%) Female, n (%) Race/Ethnicity	1,520 (49.56) 1,547 (50.44)	485 (31.91)	1,035 (68.09)	0.0002*
Male, n (%) Female, n (%) Race/Ethnicity	1,520 (49.56) 1,547 (50.44)	485 (31.91)	1,035 (68.09)	
Female, n (%) Race/Ethnicity	1,547 (50.44)	200 (25 72)		
Race/Ethnicity		398 (25.73)	1,149 (74.27)	
				0.0141*
Mexican American, n (%)	347 (11.31)	118 (34.01)	229 (65.99)	
Other Hispanic, n (%)	294 (9.59)	75 (25.51)	219 (74.49)	
Non-Hispanic White, n (%)	1,177 (38.38)	308 (26.17)	869 (73.83)	
Non-Hispanic Black, n (%)	726 (23.67)	211 (29.06)	515 (70.94)	
Non-Hispanic Asian, n (%)	395 (12.88)	127 (32.15)	268 (67.85)	
Other Race - Including Multi-Racial, n (%)	128 (4.17)	44 (34.38)	84 (65.63)	
Alcohol Consumption				<.0001*
Never Drinker, n (%)	292 (10.89)	83 (28.42)	209 (71.58)	
Former Drinker, n (%)	790 (29.47)	285 (36.08)	505 (63.92)	
Occasional Drinker, n (%)	458 (17.08)	91 (19.87)	367 (80.13)	
Frequent Drinker, n (%)	1,141 (42.56)	315 (27.61)	826 (72.39)	
Tobacco Use				0.0258*
Tobacco, n (%)	497 (18.52)	123 (24.75)	374 (75.25)	
No Tobacco, n (%)	2,187 (81.48)	651 (29.77)	1,536 (70.23)	

#### <u>RESULTS</u>

According to the variables selected to measure the predictors for **diabetes** utilizing Wald chi-square p-values at alpha = 0.05, the results were:

**1. AGE (PRIMARY PREDICTOR):** 

• p = <0.0001, statistically significant 2. OSTEOPOROSIS STATUS:

• p = 0.4344, <u>not</u> statistically significant **3. GENDER:** 

p = 0.0002, statistically significant
 4. RACE/ETHNICITY:

• p = 0.0141, statistically significant 5. ALCOHOL CONSUMPTION:

• p = <0.0001, statistically significant 6. TOBACCO USE:

p = 0.0258, statistically significant

## **DIABETES: UNIVARIATE & MULTIVARIATE LOGISTIC ANALYSES**

Table 4. Univariate & Multivariate Logistic Analyses of NHANES 2017-2018 Participants

	Univariate Crude Odds Ratio	Univariate Wald	Multivariate Crude Odds Ratio	Multivariat Wald
Characteristic (n = 3,069)	(95% Wald CI)	P-Value	(95% Wald CI)	P-Value
Age				
50 to 59 Years Old	0.555 (0.425-0.723)*	<.0001*	0.515 (0.373-0.709)*	<.0001*
60 to 69 Years Old	1.116 (0.875-1.423)	0.3765	1.026 (0.766-1.374)	0.8644
70 to 79 Years Old	1.354 (1.039-1.764)*	0.0247*	1.256 (0.928-1.700)	0.1404
80+ Years Old	1.0		1.0	
Osteoporosis Status**				
Osteoporosis	1.096 (0.871-1.380)	0.4345	1.157 (0.885-1.514)	0.2858
No Osteoporosis	1.0		1.0	
Gender				
Male	1.353 (1.156-1.583)*	0.0002*	1.622 (1.344-1.958)*	<.0001*
Female	1.0		1.0	
Race/Ethnicity				
Mexican American	1.454 (1.124-1.881)*	0.0044*	1.516 (1.129-2.036)*	0.0057*
Other Hispanic	0.966 (0.721-1.295)	0.8181	1.021 (0.736-1.416)	0.8994
Non-Hispanic White	1.0		1.0	
Non-Hispanic Black	1.156 (0.940-1.421)	0.1685	1.270 (1.007-1.602)*	0.0433*
Non-Hispanic Asian	1.337 (1.043-1.713)*	0.0217*	1.551 (1.154-2.084)*	0.0036*
Other Race - Including Multi-Racial	1.478 (1.003-2.177)*	0.048*	1.591 (1.033-2.449)*	0.035*
Alcohol Consumption				
Never Drinker	1.041 (0.783-1.385)	0.7808	1.045 (0.772-1.415)	0.7767
Former Drinker	1.480 (1.218-1.798)*	<.0001*	1.380 (1.127-1.689)*	0.0018*
Occasional Drinker	0.650 (0.499-0.846)*	0.0014*	0.633 (0.482-0.833)*	0.0011*
Frequent Drinker	1.0		1.0	
Tobacco Use				
Tobacco	0.776 (0.621-0.970)*	0.0261*	0.833 (0.654-1.063)	0.1418
No Tobacco	1.0		1.0	

ANES Target: Both males and females 50 YEARS - 150 YEARS

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range: Doorn muse sum inemnes to Texits - 190 Texits see of Trefused": "doorn't know," and missing were excluded from analyses (n = 16). Univariate and multivariate logistic analyses for each predictor versus outcome was utilized to ol the odds ratios (OR), 95% Wald confidence intervals (CI), and Wald p-values (alpha = 0.05). ne was utilized to obtain

#### STATISTICALLY SIGNIFICANT RESULTS

- **1. AGE (PRIMARY PREDICTOR):** •
  - 50 to 59 Years Old (protective)
  - UNIVARIATE: OR = 0.555 (0.425-0.723) and p = <.0001 MULTIVARIATE: OR = 0.515 (0.373-0.709) and p = <.0001 70 to 79 Years Old
  - UNIVARIATE: OR = 1.354 (1.039-1.764) and p = 0.0247 MULTIVARIATE: not statistically significant
- 2. DIABETES STATUS: No statistically significant results 3. GENDER:

#### Male (harmful)

UNIVARIATE: OR = 1.353 (1.156-1.583) and p = 0.0002

MULTIVARIATE: OR = 1.622 (1.344-1.958) and p = <.0001 4. RACE/ETHNICITY:

#### Mexican American (harmful)

- UNIVARIATE: OR = 1.454 (1.124-1.881) and p = 0.0044 MULTIVARIATE: OR = 1.516 (1.129-2.036) and p = 0.0057
- Non-Hispanic Black (harmful)
- *UNIVARIATE: <u>not</u> statistically significant* MULTIVARIATE: OR = 1.270 (1.007-1.602) and p = 0.0433
- Non-Hispanic Asian (harmful) UNIVARIATE: OR = 1.337 (1.043-1.713) and p = 0.0217 MULTIVARIATE: OR = 1.551 (1.154-2.084) and p = 0.0036
- Other Race Including Multi-Racial (harmful)
  - UNIVARIATE: OR = 1.478 (1.003-2.177) and p = 0.048
  - MULTIVARIATE: OR = 1.591 (1.033-2.449) and p = 0.035

### **DIABETES:** UNIVARIATE & MULTIVARIATE LOGISTIC ANALYSES

Characteristic (n = 3,069)	Univariate Crude Odds Ratio (95% Wald CI)	Univariate Wald P-Value	Multivariate Crude Odds Ratio (95% Wald CI)	Multivaria Wald P-Value
lge				
50 to 59 Years Old	0.555 (0.425-0.723)*	<.0001*	0.515 (0.373-0.709)*	<.0001*
60 to 69 Years Old	1.116 (0.875-1.423)	0.3765	1.026 (0.766-1.374)	0.8644
70 to 79 Years Old	1.354 (1.039-1.764)*	0.0247*	1.256 (0.928-1.700)	0.1404
80+ Years Old	1.0		1.0	
Osteoporosis Status**				
Osteoporosis	1.096 (0.871-1.380)	0.4345	1.157 (0.885-1.514)	0.2858
No Osteoporosis	1.0		1.0	
Sender				
Male	1.353 (1.156-1.583)*	0.0002*	1.622 (1.344-1.958)*	<.0001
Female	1.0		1.0	
Race/Ethnicity				
Mexican American	1.454 (1.124-1.881)*	0.0044*	1.516 (1.129-2.036)*	0.0057
Other Hispanic	0.966 (0.721-1.295)	0.8181	1.021 (0.736-1.416)	0.8994
Non-Hispanic White	1.0		1.0	
Non-Hispanic Black	1.156 (0.940-1.421)	0.1685	1.270 (1.007-1.602)*	0.0433
Non-Hispanic Asian	1.337 (1.043-1.713)*	0.0217*	1.551 (1.154-2.084)*	0.0036
Other Race - Including Multi-Racial	1.478 (1.003-2.177)*	0.048*	1.591 (1.033-2.449)*	0.035
lcohol Consumption				
Never Drinker	1.041 (0.783-1.385)	0.7808	1.045 (0.772-1.415)	0.776
Former Drinker	1.480 (1.218-1.798)*	<.0001*	1.380 (1.127-1.689)*	0.0018
Occasional Drinker	0.650 (0.499-0.846)*	0.0014*	0.633 (0.482-0.833)*	0.0011
Frequent Drinker	1.0		1.0	
obacco Use				
Tobacco	0.776 (0.621-0.970)*	0.0261*	0.833 (0.654-1.063)	0.1418
No Tobacco	1.0		1.0	
*Statistically significant.				

dds ratios (OR), 95% Wald co

#### **STATISTICALLY SIGNIFICANT RESULTS**

5. ALCOHOL CONSUMPTION:

- Former Drinker (harmful)

   UNIVARIATE: OR = 1.480 (1.218-1.798) and p = <.0001</li>

   MULTIVARIATE: OR = 1.380 (1.127-1.689) and p = 0.0018
- Occasional Drinker (protective)
  - UNIVARIATE: OR = 0.650 (0.499-0.846) and p = 0.0014 MULTIVARIATE: OR = 0.633 (0.482-0.833) and p = 0.0011

#### 6. TOBACCO USE: Tobacco (yes)

- UNIVARIATE: OR = 0.776 (0.621-0.970) and p = 0.0261
- MULTIVARIATE: <u>not</u> statistically significant

## **OUTCOME #2: CONCLUSIONS**

According to the variables selected as predictors with respect to the outcome of diabetes:

- 1. **PRIMARY PREDICTOR:** Compared to individuals 80 years old and above, people age **50 to 59 years old had lower odds** (OR = 0.515, p = <.0001) of being told by a physician that they have **diabetes (including borderline)** after adjusting for other selected factors.
- There was no statistically significant association between osteoporosis status (compared to no
  osteoporosis status) and being told by a physician that they have diabetes (including borderline) after adjusting for
  other selected factors.
- **3.** Compared to females, **males had increased odds** of being told by a physician that they have **diabetes** (including borderline) (OR = 1.622, p = <.0001) after adjusting for other selected factors.
- 4. Compared to non-Hispanic whites, four racial groups had **increased odds** of being told by a physician that they have **diabetes (including borderline)** after adjusting for other selected factors: **Mexican Americans** (OR = 1.516, p = 0.0057), **non-Hispanic blacks** (OR = 1.270, p = 0.0433), **Non-Hispanic Asians** (OR = 1.551, p = 0.0036), and **other races including multi-racial** (OR = 1.591, p = 0.035).
- 5. Compared to frequent drinkers, former drinkers had increased odds (OR = 1.380, p = 0.0018) while occasional drinkers had reduced odds (OR = 0.633, p = 0.0011) of being told by a physician that they have diabetes (including borderline) (OR = 1.622, p = <.0001) after adjusting for other selected factors.</p>
- 6. After adjusting for other selected factors, there was no statistically significant association between tobacco (yes) use (compared to no tobacco use) and being told by a physician that you have diabetes (including borderline).

## **DISCUSSION & RECOMMENDATIONS**

- The primary predictor of age did show an overall relationship with both osteoporosis and diabetes, which was expected.
- According to the variables selected for this study, neither osteoporosis nor diabetes were predictors for each other.
- Because the osteoporosis question was only asked to individuals over 50 years old, the multivariate analysis for diabetes
  had to be coded to exclude ages 1-49. For consistency, the univariate analysis for diabetes was also coded this way.
- Some results were very unexpected:
  - This may be because many variables selected from the NHANES study were from the questionnaire data, which could have resulted in bias and/or error.
  - A better measure could have been to use DEXA bone density scans (for osteoporosis) and fasting glucose levels (for diabetes) from the **laboratory data**, for example, which are "gold standards."
  - This would have been more objective, but it would further reduce the sample size.
- Crude odds ratios were used, and many confidence intervals contained 1.0. <u>Age adjusted odds ratios</u> would likely
  have provided results closer to what is typically expected for these variables.
- As with all cross-sectional studies, causation (risk ratio) cannot be determined.
- Many other potential predictors for osteoporosis and diabetes could potentially be studied in the future.
  - These include blood iron levels, physical activity, marital status, education, triglycerides, blood pressure, etc.

# EFERENCES

- Balasubramanian, A., et al., Risk of subsequent fracture after prior fracture among older women. Osteoporos • Int, 2019. 30(1): p. 79-92.
- Barros, Rodrigo. (n.d.). Diabetes Signs, Symptoms, Types, Causes, Treatments and More. Health Central. ightarrowhttps://www.healthcentral.com/condition/diabetes.
- Burge, R., et al., Incidence and economic burden of osteoporosis-related fractures in the United States, 0 2005-2025. J Bone Miner Res, 2007. 22(3): p. 465-75.
- Dumic-Cule, I., Ivanac, G., Lucijanić, T., Katičić, D., Jurin, I., Birkić, D., Rahélic, D., & Blaslov, K. (2018). Type 2  $\bullet$ diabetes and osteoporosis: Current knowledge.
- Learn what osteoporosis is and what it's caused by. National Osteoporosis Foundation.  $\bullet$ https://www.nof.org/patients/what-is-osteoporosis/.
- SAS Institute Inc 2013, SAS/ACCESS® 9.4, Carv, NC  $\circ$
- Roy B. Biomolecular basis of the role of diabetes mellitus in osteoporosis and bone fractures. World J ightarrowDiabetes 2013; 4(4): 101-113
- Wright, N.C., et al., The recent prevalence of osteoporosis and low bone mass in the United States based on 0 bone mineral density at the femoral neck or lumbar spine. J Bone Miner Res, 2014. 29(11): p. 2520-6.

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## NHANES 2017-2018: The Comorbidity Between Osteoporosis and Diabetes

BIOS 6102: Biostatistical Methods II Spring 2021 Sarah Grunblatt, MS, MS, MEd, MEd, MA