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Dietary Zinc and Vitamin D Intake and Diabetes Risk in Older U.S. Adults: NHANES 2017–2018

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Abstract

Background: *Diabetes Mellitus (DM) is a leading chronic condition worldwide, affecting an estimated 537 million individuals between the ages of 20 and 79 years, equivalent to 10.5% of the world's population. Micronutrients such as vitamin D and zinc have been suggested as potential modifiers of disease development; however, the literature often excludes older adults, resulting in limited data on their impact in this population.*

Methods: *We conducted a secondary cross-sectional analysis of the NHANES 2017–2018 dataset. Participants older than 50 years were included based on self-reported diabetes status. Logistic regression models (univariate and multivariate) were used to assess associations between micronutrient intake and diabetes, adjusting for age, BMI, gender, race, educational level, physical activity, thyroid comorbidities, smoking, and fat and sugar intake.*

Results: *Of the 9,254 survey respondents, 1,172 met inclusion criteria. In univariate analysis, zinc intake (OR 0.98, 95% CI 0.93–1.04, $p = 0.534$) and vitamin D intake (OR 1.00, 95% CI 0.99–1.00, $p = 0.831$) were not significantly associated with diabetes. In multivariate models, zinc (OR 1.02, 95% CI 0.91–1.14, $p = 0.666$) and vitamin D (OR 0.99, 95% CI 0.99–1.00, $p = 0.360$) remained nonsignificant. Significant predictors included older age (OR 1.06 per year, 95% CI 1.04–1.08, $p < 0.001$), female gender (OR 0.47 vs. males, 95% CI 0.35–0.64, $p < 0.001$), race (Mexican-American OR 1.79, 95% CI 1.06–3.02, $p = 0.029$; Non-Hispanic Black OR 1.60, 95% CI 1.10–2.34, $p = 0.014$), higher BMI (OR 1.10 per kg/m^2, 95% CI 1.08–1.13, $p < 0.001$), and lower educational attainment (college graduate OR 0.53, 95% CI 0.33–0.84, $p = 0.007$). The model demonstrated good discriminatory power (AUC = 0.73).*

Conclusion: *No significant association was found between dietary zinc or vitamin D intake and diabetes in adults aged 50 years and older. Demographic and anthropometric factors such as age, gender, race, BMI, and education were strongly linked to diabetes risk, with elevated risk observed among Mexican Americans and Non-Hispanic Blacks.*

Introduction

Diabetes Mellitus (DM) is a leading chronic condition worldwide, affecting an estimated 537 million individuals between the ages of 20 and 79 years, equivalent to 10.5% of the world's population (Hossain et al., 2024). The potential association of the intake of micronutrients, such as vitamin D and zinc, with disease development holds significant implications in clinical research (Mitri, 2011; Ahmad et al., 2024).

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Growing evidence shows that vitamin D deficiency has been linked to insulin resistance, leading to hyperglycemia and obesity, thereby increasing the risk of Type 2 Diabetes Mellitus. On the other hand, normal levels of vitamin D may reduce the risk of diabetes by lowering insulin resistance through calcium pathways regulating insulin secretion by pancreatic β-cells (Szymczak-Pajor & Śliwińska, 2019). Similarly, zinc plays an important role as a cofactor during insulin synthesis, release, and storage, while also promoting glucose transport into the cells (Ahmad et al., 2024). Other studies, however, report no association between vitamin D intake and type 2 diabetes when controlling for confounders such as obesity, lifestyle, and age (Ojo, 2019; Hu et al., 2022). Zinc has been recognized to affect pancreatic β-cells, glucose homeostasis, and insulin action, particularly in lowering fasting glucose (Ranasinghe, 2015; Wang, 2019).

Many findings in the literature excluded the older adult population (ref). Moreover, most of the available studies use serum levels of vitamin D and zinc, leaving scarce information regarding the possible impact of habitual daily vitamin D and zinc intake on diabetes in older populations. Therefore, conducting dietary studies on this specific population could provide new information demonstrating whether vitamin D and zinc intake through diet has a protective effect in the prevention of diabetes.

On the other hand, zinc can influence insulin metabolism. Deficiencies in zinc intensify insulin resistance and the development of diabetes and complications due to its role in oxidative stress and inflammation (Cai et al., 2023). However, there is less data about zinc as a risk factor due to dietary deficiency, especially in older adults who are at higher risk of zinc deficiency because of increased needs and lower absorption rates.

Furthermore, comprehensive sensitivity analyses are necessary to address key confounding variables such as body mass index (BMI), physical activity, and socioeconomic factors that can influence both nutrient absorption and diabetes risk. The limited available literature on micronutrient interactions presents an opportunity for future studies, specifically addressing the gaps in the older adult population.

Therefore, this study aims to answer the question: *"Are zinc and vitamin D associated with diabetes in older adults?"* by conducting a cross-sectional analysis. This study seeks to clarify the association between dietary zinc and vitamin D intake and the development of diabetes in adults aged 50 years and older.

Materials and Methods

A total of 9,254 individuals were interviewed as part of the NHANES 2017–2018 survey. Of these, 1,172 participants met inclusion criteria and were included in the final model. Response rates in NHANES typically range from 70% to 80%.

Exposure Description

Zinc and vitamin D intake were the primary independent variables of interest. Data on dietary zinc and vitamin D intake from both food sources and dietary supplements were obtained through 24-hour and 30-day recall questions, respectively (CDC, 2018). All nutrient intake variables were derived from the USDA Food and Nutrient Database for Dietary Studies (FNDDS), which was used to code reported food consumption into standardized units of nutrient intake.

Covariates

Based on clinical judgment and supporting literature, we adjusted for potential confounders including gender, age at screening, race/ethnicity (Mexican American, other Hispanic, non-Hispanic White, non-Hispanic Black, Asian, and other/multiracial), education level (>9th grade, 9–11th grade, high school graduate/GED or equivalent, some college or AA degree, and college graduate or above), body mass index (kg/m^2), total sugar intake (g/24h), total fat intake (g/24h), presence of thyroid problems, sedentary time, vigorous recreational physical activity, and smoking status. These variables were included due to their potential confounding effects on the association between micronutrient intake and diabetes.

Outcome Description

The outcome variable was self-reported diabetes status, assessed using the NHANES question: "Have you ever been told by a doctor or health professional that you have diabetes?" This question applied to all types of diabetes. The dataset provided numerous variables that enabled the exploration of associations between dietary micronutrient intake and self-reported diabetes status.

Inclusion and Exclusion Criteria

Participants aged 50 years or older who responded "yes" or "no" to the diabetes question were included. Exclusion criteria were: (1) reporting borderline diabetes or uncertainty about diabetes status; (2) not reporting dietary zinc or vitamin D intake; and (3) missing data on key demographic or health-related variables. After applying these criteria, 1,172 older adults were included in the analytic sample.

Statistical Analysis

Statistical analyses were conducted using STATA version 18 BE (StataCorp, 2023). Continuous variables were summarized with means, standard deviations, medians, and interquartile ranges, while categorical variables were presented as counts and percentages. Univariate logistic regression models were first used to examine the associations of zinc and vitamin D intake with diabetes status. Subsequently, multivariable logistic regression models were constructed using a stepwise approach, incorporating zinc and vitamin D intakes along with confounders selected based on biological plausibility, observed changes in coefficients, and 95% confidence intervals (CI).

Results

Study Population

Among the 9,254 respondents in NHANES 2017–2018, 3,069 were older adults (defined as > 50 years). Of these, 2,940 participants disclosed diabetes status ("yes"/"no" to "Doctor told you have diabetes?"). Participants with borderline diabetes (127), "don't know" responses (2), or refusals (0) were excluded. Supplementation data were missing for 1,558 subjects for vitamin D and 438 for zinc. The remaining 1,195 participants had complete information on age, gender, race, sedentary minutes, and 24-hour fat and sugar intake. Additional missingness included 18 for BMI, 2 for thyroid disease, and 3 for education level. Complete-case data for all variables in the final model were available for 1,172 participants, of whom 318 (27.13%) reported diabetes (Figure 1).

Of the 1,172 included participants, 480 (41.0%) had BMI ≥ 30, while 9 (0.8%) had BMI < 18.5. Most respondents were 60–69 years old (413, 35.2%); 310 (26.5%) were 50–59, 284 (24.2%) were 70–79, and 165 (14.1%) were ≥ 80. Baseline characteristics by diabetes status are listed in Table 1.

Univariate Analysis

Univariate logistic regression showed no significant association between zinc intake and diabetes (OR 0.98, 95% CI 0.93–1.04, $p = 0.534$) or between vitamin D intake and diabetes (OR 1.00, 95% CI 0.99–1.00, $p = 0.831$) (Table 2). Model readouts for each univariate specification are presented in Table 2.

Multivariable Model

In the adjusted logistic regression, dietary vitamin D and zinc intakes remained not significantly associated with diabetes (vitamin D: OR 0.99, 95% CI 0.99–1.00, $p = 0.360$; zinc: OR 1.02, 95% CI 0.91–1.14, $p = 0.666$) (Table 3). Factors associated with higher diabetes odds included older age (OR 1.06 per year, 95% CI 1.04–1.08, $p < 0.001$), male sex (female vs. male: OR 0.47, 95% CI 0.35–0.64, $p < 0.001$), race/ethnicity (Mexican-American: OR 1.79, 95% CI 1.06–3.02, $p = 0.029$; Non-Hispanic Black: OR 1.60, 95% CI 1.10–2.34, $p = 0.014$), and higher BMI (OR 1.10 per kg/m^2, 95% CI 1.08–1.13, $p < 0.001$). College graduation was associated with lower odds (OR 0.53, 95% CI 0.33–0.84, $p = 0.007$). Other covariates (total sugar, total fat, thyroid problem, smoking $\geq$100 cigarettes, sedentary minutes) are shown in Table 3.

Model Performance

Discrimination was acceptable with an area under the ROC curve (AUC) of 0.7298 (Figure 2).

Sensitivity Analysis

Because NHANES oversampled adults > 80 years, age was recoded into categories (50–59, 60–69, 70–79, $\geq$80) and the multivariable model re-estimated. Results were unchanged: no association for zinc (OR 1.03, 95% CI 0.92–1.15, $p = 0.551$) or vitamin D (OR 0.99, 95% CI 0.99–1.00, $p = 0.346$), and covariate effects remained directionally and statistically consistent (Supplementary Table S1).

Discussion

Exploring the link between dietary zinc and vitamin D intake and diabetes in older adults has important clinical implications. Adequate micronutrient intake may support insulin function and glycemic control; however, in this cross-sectional analysis of U.S. adults aged 50 years and older, we found *no significant association* between dietary vitamin D or zinc intake and prevalent diabetes after multivariable adjustment. In contrast, demographic and anthropometric factors—including older age, male sex (female vs. male with lower odds), higher BMI, race/ethnicity, and education—were strongly associated with diabetes risk. These findings underscore the continued importance of weight management and physical activity for diabetes prevention and control, and they echo documented disparities wherein Mexican Americans and Non-Hispanic Blacks experience a higher diabetes burden than Non-Hispanic Whites (Bancks et al., 2017).

Variables	Diabetes	
	NO	YES
Age (mean ± sd), years	65.5±9.2	68.3±8.8
Gender (N (%))		
Male	330 (38.6%)	169 (53.1%)
Female	524 (61.4%)	149 (46.9%)
Race (N(%))		
Mexican American	78 (9.1%)	35 (11.0%)
Other Hispanic	82 (9.6%)	24 (7.5%)
Non-Hispanic White	405 (47.2%)	128 (40.3%)
Non-Hispanic Black	160 (18.7%)	74 (23.3%)
Other race	129 (15.1%)	57 (17.9%)
Education level (N(%))		
Less than 9th grade	57 (6.7%)	31 (9.7%)
9 – 11th grade	64 (7.5%)	30 (9.4%)
High School graduate or equivalent	194 (22.7%)	73 (23.0%)
Some college or AA degree	285 (33.4%)	113 (35.5%)
College graduate or above	254 (29.7%)	71 (22.3%)
Thyroid problem (N(%))		
No	671 (78.6%)	249 (84.6%)
Yes	183 (21.4%)	69 (15.4%)
Minutes of sedentaryvigorous activity (median (25-75% IQR))	300 (180-480)	300 (180-480)
Smoked at least 100 cigarettes in life (N(%))		
No	508 (59.5%)	168 (52.8%)
Yes	346 (40.5%)	150 (47.2%)
BMI (mean ± sd), kg/m²	28.7±5.97	32.3±8.11
Total sugar (median (25-75% IQR)), g	0 (0-4.89)	0.18 (0-5.69)
Total fat (median (25-75% IQR)), g	0.11(0-2.78)	0.36 (0-4.39)
Zinc (median (25-75% IQR)), mg	0.135(0.04-0.76)	0.19(0.05-0.88)
Vitamin D (median (25-75% IQR)), mcg	25(15-50)	25(17.5-50)

BMI – body mass index; g - gram; mcg - micrograms; mg - milligrams; N – number; sd – standard deviations; % - percentage; IQR - interquartile range.

Table 1: *Baseline characteristics of the subjects according to diabetes status.*

Doctortoldyouhavediabetes	Odds ratio	Std error	Z	p-value	95%CI
Vitamin D (mcg)	0.9998775	0.0005721	-0.21	0.831	0.9987568 – 1.001
_cons	0.3718979	0.0247995	-14.83	0	0.3263341 - 0.4238232

CI - confidence interval; mcg - micrograms; mg - milligrams;Std - standard

Doctortoldyouhavediabetes	Odds ratio	Std error	Z	p-value	95%CI
Zinc (mg)	0.9828367	0.027345	-0.62	0.534	0.9306766 – 1.03792
_cons	0.3511926	0.0176361	-20.84	0	0.3182731 - 0.3875171

CI - confidence interval; mcg - micrograms; mg - milligrams;Std - standard

Table 2: *Univariate logistic regression model.*

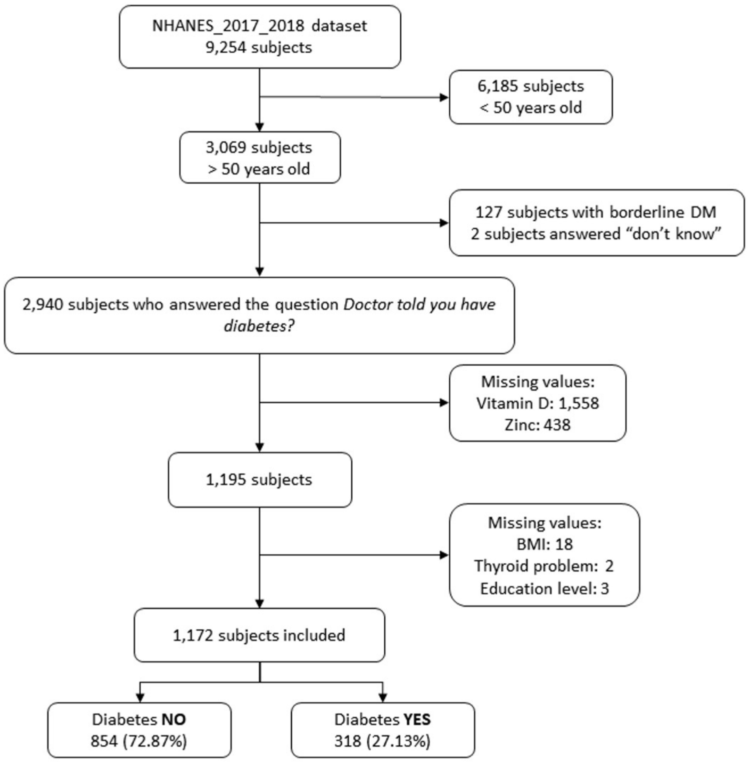

Figure 1: *Study flow chart showing sample selection and exclusions for NHANES 2017–2018.*

Interpretation in Context

The positive association of BMI with diabetes and the modest protective signal of physical activity align with prior literature emphasizing adiposity and sedentary behavior as key modifiable risks (Hu et al., 2004). Education appeared protective in our model—individuals with a college degree had substantially lower odds of diabetes (approximately half the odds compared with the low-education reference), consistent with evidence that greater educational attainment is linked to lower incident diabetes (Ma et al., 2018).

The null findings for zinc and vitamin D *dietary intake* may reflect that intake is an imperfect proxy for biological exposure in older adults. Absorption, bioavailability, supplement adherence, polypharmacy, and age-related changes in metabolism can weaken observable intake–disease associations. Prior work suggests that *serum* micronutrient measures may better capture physiologic status than dietary reports alone (Crane & Thomson, 2016). It is also plausible that any true effect of these micronutrients on diabetes risk is small relative to dominant factors such as adiposity, age, and social determinants, making detection difficult in cross-sectional analyses.

Strengths and Limitations

Strengths include the use of nationally representative NHANES data, inclusion of diverse racial/ethnic groups, and adjustment for an extensive set of demographic, lifestyle, and health-related covariates. Several limitations merit consideration. First, the cross-sectional design precludes causal inference and is susceptible to reverse causation (e.g., behavior change after diagnosis). Second, diabetes status and dietary intake rely on self-report and 24-hour/30-day recalls, which can introduce recall and misclassification bias. Third, NHANES does not distinguish between type 1 and type 2 diabetes in our analytic construct. Finally, we analyzed *intake* rather than circulating biomarkers; serum measures of zinc and vitamin D might provide a more accurate assessment of physiologic status.

Implications and Future Research

Clinically, these results reinforce prioritizing weight management and physical activity in older adults, alongside targeted efforts to reduce racial/ethnic disparities in diabetes risk (Bancks et al., 2017). Future studies should leverage longitudinal designs, incorporate biomarker-based assessments of micronutrient status and metabolism, and explore heterogeneity

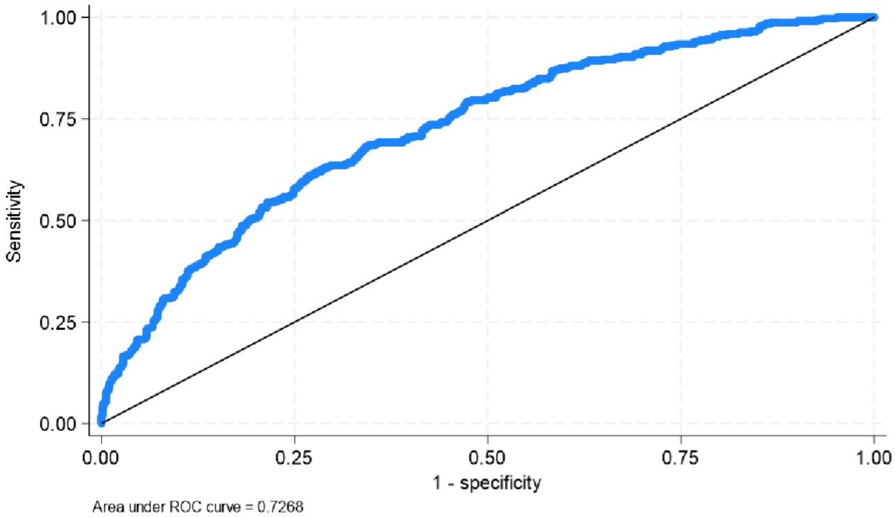

Figure 2: *Receiver operating characteristic (ROC) curve for the multivariable model.*

by genetic susceptibility, comorbidity profiles, and socioeconomic context. Randomized trials in well-defined high-risk subgroups using biomarker-guided supplementation strategies could clarify whether zinc or vitamin D confers benefit in specific clinical scenarios.

Supplementary Materials

STATA code

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Conflicts of Interest

The authors declare no conflict of interest.

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Variable	Odds ratio	Std error	Z	p-value	95% CI
Vitamin D, mcg	0.9990044	0.0010404	-0.96	0.339	.9969673 – 1.001046
Zinc, mg	1.016409	0.0560488	0.3	0.768	.912284– 1.132419
Gender – Female	0.4749172	0.0728389	-4.85	0	.3516152 – .6414579
Age at screening, years	1.057156	0.0093619	6.28	0	1.038965– 1.075665
Race					
White	1	-	-	-	-
Mexican-American	1.792453	0.477885	2.19	0.029	1.062941 – 3.022638
Other Hispanic	1.363372	0.3868352	1.09	0.275	.7818069– 2.377548
Non-Hispanic Black	1.602658	0.3087559	2.45	0.014	1.098639 – 2.337905
Other Race	3.224606	0.7282741	5.18	0	2.071255– 5.020184
Education level					
Less than 11th grade	1	-	-	-	-
High school graduate	0.7029486	0.167995	-1.47	0.14	.4400461– 1.12292
Some college or AA degree	0.8160868	0.1815764	-0.91	0.361	.5276513– 1.262193
College graduate or above	0.5276774	0.125846	-2.68	0.007	.3306474– .842116
Total sugar, g	0.9984321	0.0046191	-0.34	0.734	.9894197 – 1.007526
Total fat, g	1.009326	0.0104641	0.9	0.371	.9890235– 1.030045
BMI, kg/m²	1.102777	0.0123931	8.71	0	1.078752 – 1.127337
Minutes of sedentary activity	1.000181	0.0000807	2.24	0.025	1.000023 – 1.000339
Thyroid problem – no	0.8901762	0.1607654	-0.64	0.519	.624812 – 1.268243
Smoked at least 100 cigarettes in life – no	1.030675	0.1548966	0.2	0.841	.767711 – 1.383713
Constant	0.000653	0.0005554	-8.62	0	.0001233– .0034585

BMI - body mass index; CI - confidence interval; g - grams; mcg - micrograms; mg - milligrams; Std - standard

Table 3: *Logistic regression model 2 of the association in the development of diabetes in older adults.*

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