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Daily fruit and vegetable consumption and diabetes status in middle-aged females in the general US population

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Abstract

Objectives: Fruit and vegetable consumption may impact development of diabetes, but limited research has addressed whether daily consumption of fruits and vegetables differs by those with and without diabetes, especially within high-risk groups. Thus, the purpose of this study was to determine whether daily fruit and vegetable consumption differs by diabetes status in middle-aged females in the general US population.

Methods: This cross-sectional analysis used 2017 Behavioral Risk Factor Surveillance System data for females ages 45–64 years old in Arizona (n = 2609), Florida (n = 3768), Georgia (n = 1018), and Texas (n = 2092). Multiple logistic regression analysis by state assessed the relationship between the daily consumption of fruit (fruit, 100% fruit juice) and vegetables (green leafy or lettuce salad, potatoes, other vegetables) and diabetes status, while controlling for health status, health behaviors, demographic factors, and socioeconomic status.

Results: Across states, relatively similar proportions of participants with and without diabetes reported daily fruit consumption (with: 58%–63%; without: 61%–68%) and daily vegetable consumption (with: 58%–63%; without: 61%–68%). The results of adjusted analyses indicated that daily fruit and vegetable consumption did not differ by diabetes status across states.

Conclusion: Across states, daily fruit and vegetable consumption did not differ by diabetes status in middle-aged females. In the primary care setting, providers should educate all females ages 45–64 on the importance of eating fresh fruits and vegetables and may consider sharing information about flavonoid-rich fruit and vegetable consumption for diabetes.

Keywords

Fruit consumption, vegetable consumption, diabetes, middle-age, females

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Introduction

Worldwide there are currently up to 430 million people affected by diabetes,[1,2] and this is expected to increase.[3,4] In the United States alone, it is estimated that up to 31 million people have diabetes,[5–7] and up to one in four may not know they have it.[6] Many other chronic conditions are also related to having diabetes including depression, hypertension, and low-grade inflammation,[8] as well as kidney failure, amputations, blindness,[2,5–7] cardiovascular disease,[1,9] and stroke.[2,7] Overall in the United States, one-fifth of healthcare spending is related to diabetes and related complications,[6] and those with diabetes have a 50% higher risk of death at younger ages than those without diabetes.[1,5,6]

The onset of diabetes has been linked to many demographic and health-related factors. For example, risk factors for diabetes and related complications include age, gender, race/ethnicity, family history of diabetes, and low socioeconomic status.[1,5–7] Research also shows that those with high body mass index (BMI), sedentary lifestyles, decreased physical activity, and poor eating habits are more likely to develop diabetes.[1,6,8] However, prior research for the relationship between fruit and vegetable consumption and diabetes risk is mixed. Some studies have found that fruit and

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vegetable consumption are inversely related to risk for diabetes,[3,10,11] while others have found no relationship.[4,11]

Where prior research has focused on whether fruit and vegetable consumption is related to the risk of developing diabetes, we found no research that specifically addresses whether fruit and vegetable consumption differs between those who have been diagnosed with diabetes and those who have not. This information may be important for considering health behaviors conductive to preventing or managing diabetes, especially for middle-aged females, who is the group more likely to be diagnosed with diabetes and related complications.[1,6] Therefore, the purpose of this study was to determine whether fruit and vegetable consumption differs by diabetes status in middle-aged females in the general US population.

Methods

Design

This cross-sectional analysis used data from the 2017 Behavioral Risk Factor Surveillance System (BRFSS) by the Centers for Disease Control and Prevention (CDC).[12] BRFSS is a health-related telephone survey system established in 1984 that collects data via a random digit dialing system of more than 400,000 adult interviews annually. BRFSS collects data from all 50 states in the United States as well as the District of Columbia and three US territories, focusing on health status, prevention of diseases, and health risk behaviors. The CDC compiles all BRFSS data and makes de-identified data accessible to researchers in order to conduct secondary data analysis. As such, this study was given exempt status by the Institutional Review Board of the University of North Texas Health Science Center.

Sample

The samples for this study included middle-aged females 45–64 years old in Arizona (n = 2609), Florida (n = 3768), Georgia (n = 1018), and Texas (n = 2092) who had data for fruit and vegetable consumption and diabetes status. These states were chosen because of higher prevalence for (a) diabetes and (b) middle-aged females in comparison to other states based on the BRFSS 2016 prevalence survey data maps.[13]

Data

All variables originated from the BRFSS 2017 data set.[14,15] The outcomes were daily fruit and vegetable consumption. For fruit consumption, we used the calculated BRFSS variable that combined responses for two items ("Not including juices, how often did you eat fruit?" and "Not including fruit-flavored drinks or fruit juices with added sugar, how often did you drink 100% fruit juice such as apple or orange juice?") into "yes" or "no" for daily fruit consumption. For vegetable consumption, we used the calculated BRFSS variable that combined responses for four items ("How often did you eat a green leafy or lettuce salad, with or without other vegetables?," "How often did you eat any kind of fried potatoes, including french fries, home fries, or hash browns?," "How often did you eat any other kind of potatoes, or sweet potatoes, such as baked, boiled, mashed potatoes, or potato salad?" and "Not including lettuce salads and potatoes, how often did you eat other vegetables?") into "yes" or "no" for daily vegetable consumption. The factor of interest, diabetes status, was measured as "ever diagnosed with diabetes," versus "never diagnosed with diabetes" (which includes pre-, borderline, and gestational diabetes).

The control variables were general health status, health conditions, weight status, physical activity, alcohol use, tobacco use, age, ethnicity/race, education level, employment status, and income level. All variables and categories are shown in Table 1. Health conditions were calculated by adding the number of "yes" responses to being diagnosed with any of the following (other than diabetes): high blood pressure, high cholesterol, heart attack, coronary heart disease, stroke, skin cancer, other cancer, chronic obstructive pulmonary disease, arthritis, depression, kidney disease, or asthma, and then categorizing values as "0 health conditions," "1 health condition," or "2 or more health conditions." In BRFSS, alcohol use was measured as the average number of drink occasions per day, and we then categorized responses as "none" (no use), "light" (one or less drinks per day), "moderate" (female 1–3 drinks per day), and "excessive" (female 4 or more drinks per day).[16]

Analysis

Frequency distributions were calculated by state to describe the sample and identify any issues with distributions of variables. State data were analyzed separately in order to assess patterns of relationships between variables of interest across similar samples. If variable relations are reliable, results would be consistent in similar samples. Thus, in this study, we considered similar results in three or more of the four states to be considered reliable findings for variable relations. Multiple logistic regression analysis was conducted by state to assess the relationship separately between daily fruit consumption and diabetes status, and daily vegetable consumption and diabetes status, in middle-aged females while controlling for health status, health behaviors, demographic factors, and socioeconomic status. Four variables had 5% or more missing data. In order not to lose these participants in the final analysis, we created an additional category in each of those variables for missing data (see Table 1). We did not choose to add a "missing data" category for variables with less than 5% missing data because the category would not include enough participants to be of use in adjusted analysis. The resulting sample sizes per state for the adjusted analysis

Table 1. Participant characteristics by state and diabetes status.

Variable	Arizona (N = 2609)		Florida (N = 3768)		Georgia (N = 1018)		Texas (N = 2092)	
	Diabetes status		Diabetes status		Diabetes status		Diabetes status	
	Yes (n = 379)	No (n = 2230)	Yes (n = 619)	No (n = 3149)	Yes (n = 195)	No (n = 823)	Yes (n = 395)	No (n = 1697)
	%	%	%	%	%	%	%	%
Daily fruit	100	100	100	100	100	100	100	100
Yes	63	68	58	61	61	67	60	61
No	27	32	42	39	39	33	40	39
Daily vegetables	100	100	100	100	100	100	100	100
Yes	80	86	82	86	82	86	77	82
No	20	14	18	14	18	14	23	18
Health conditions*	100	100	100	100	100	100	100	100
0	6	25	4	20	4	25	5	23
1	11	24	13	22	17	26	13	25
2 or more	78	45	73	50	74	44	78	46
Missing data	5	6	10	7	5	5	3	6
Weight status*	100	100	100	100	100	100	100	100
Normal	13	39	14	37	10	33	11	33
Overweight	26	28	22	27	26	26	20	29
Obese	50	24	55	27	54	30	59	30
Missing data	11	9	9	9	10	11	10	8
Physical activity*	100	100	100	100	100	100	100	100
Inactive	41	24	48	33	48	31	53	32
Insufficiently active	19	17	18	16	18	21	19	20
Active	14	21	10	15	16	17	11	17
Highly active	22	33	20	31	11	27	13	25
Missing data	4	5	3	5	5	4	3	6
Alcohol use	98	96	98	97	99	96	98	97
None	699	47	74	53	70	53	76	51
Light	15	16	11	13	16	15	13	17
Moderate	9	15	8	14	8	14	6	13
Excessive	6	17	7	16	5	13	3	15
Tobacco use	100	100	99	100	100	100	100	100
Never	56	62	51	52	58	66	64	66
Former	28	23	25	25	22	19	19	18
Current	16	15	23	22	21	14	16	15
General health status	100	100	100	100	99	100	99	99
Good or better	51	83	44	76	56	81	41	81
Fair or poor	49	17	55	24	43	19	58	19
Age	100	100	100	100	100	100	100	100
45–54	34	43	36	43	33	43	33	44
55–64	66	57	64	57	67	57	66	56
Ethnicity/race	98	98	98	98	97	98	99	98
White	56	73	64	75	51	60	41	62
Hispanic	22	14	12	9	6	5	40	24
Other	20	11	22	13	41	33	18	12
Education level	99	100	100	100	100	99	100	100
Graduated college	24	44	21	32	30	46	22	43
Did not	75	56	79	67	70	53	78	57
Employment status	99	99	99	99	99	99	100	99
Employed	42	60	35	54	34	59	33	57
Retired	16	13	14	14	13	12	17	12

(Continued)

Table 1. (Continued)

Variable	Arizona (N = 2609)		Florida (N = 3768)		Georgia (N = 1018)		Texas (N = 2092)	
	Diabetes status		Diabetes status		Diabetes status		Diabetes status	
	Yes (n = 379)	No (n = 2230)	Yes (n = 619)	No (n = 3149)	Yes (n = 195)	No (n = 823)	Yes (n = 395)	No (n = 1697)
	%	%	%	%	%	%	%	%
Other	41	26	50	31	51	28	49	29
Income level*	100	100	100	100	100	100	100	100
0 to <US$25,000	39	20	45	28	42	23	42	24
US$25,000 to US$49,999	17	17	20	21	19	17	18	17
US$50,000 or more	29	49	20	37	24	43	25	48
Missing data	15	14	15	14	15	18	14	11

*"Missing data" was included as a category in these variables with more than 5% missing responses so as not to lose these participants in the final analysis.

meet (and far exceed) the rule of thumb that has been supported for multiple logistic regression, which is events per variable (EPV) of 50 and formula $n = 100 + 50i$ where i refers to number of independent variables in the model.[17] Any observations with missing data for any variables that had missing without a "missing data" category were excluded from adjusted analysis. All analyses were conducted in STATA 15 (copyright 1985-2017 Statacorp, LLC).

Results

Participant characteristics

Table 1 lists participant characteristics for middle-aged females by diabetes status. Across states, relatively similar proportions of participants with diabetes and without diabetes reported daily fruit consumption (with: 58%–63%; without: 61%–68%) and daily vegetable consumption (with: 58%–63%; without: 61%–68%). All health-related variables differed by diabetes status in each state (all p's < .05; not shown). Those with diabetes reported higher rates than those without for the following: fair or poor health (with: 43%–58%; without: 17%–24%), two or more health conditions (with: 73%–78%; without: 44%–50%), obesity (with: 50%–59%; without: 24%–30%), and physical inactivity (with: 41%–53%; without: 24%–33%). In addition, compared to those without diabetes, those with diabetes were more likely to report (all p's < .05; not shown) no alcohol use, non-white race, and lower socioeconomic status (education, employment, and income).

Adjusted statistics

As shown in Table 2, the results of multiple logistic regression analysis for middle-aged females in Arizona, Florida, Georgia, and Texas indicated that after controlling for all other variables in the model, daily fruit consumption did not differ by diabetes status in any state, and daily vegetable consumption differed by diabetes status in only one out of four states (which does not meet our criteria listed in the Methods for a "reliable" finding).

Discussion

The purpose of this study was to determine whether fruit and vegetable consumption differed by diabetes status in middle-aged females in the US general population after controlling for health status, health behaviors, demographic factors, and socioeconomic status. The results of adjusted analysis indicated that neither daily fruit nor vegetable consumption differed significantly by diabetes status across similar samples in this target population. This may be the first study that specifically assesses differences in fruit and vegetable consumption for those with and without diabetes in middle-aged females in the general population as previous studies focused on fruit and vegetable consumption as related to risk of diabetes,[3,4,10,11] differences in daily intake of sugars, carbohydrates, proteins, and fats between those with and without diabetes,[18] and the contribution of a combined metric for fruits, vegetables, and legumes on cause of death for those with diabetes.[19]

In this study, females ages 45–64 across states reported relatively moderate levels of daily fruit consumption and relatively high levels of daily vegetable consumption. However, the vegetable consumption variable included "French fries," which may not be considered a "vegetable" or healthy. This inclusion may have inflated the amount of participants considered to eat "healthy" in terms of vegetable consumption. Future research may consider asking specifically about raw fruits and vegetables. Moreover, the American Diabetes Association[20] recommends eating fewer "starchy vegetables" such as potatoes, as they raise blood glucose.

Table 2. Results of adjusted analysis across states.

Models	Arizona, N = 2427 (93%)			Florida, N = 3525 (94%)			Georgia, N = 937 (92%)			Texas, N = 1961 (94%)		
	AOR	95% CI		AOR	95% CI		AOR	95% CI		AOR	95% CI	
		Low	High		Low	High		Low	High		Low	High
Predicting daily fruit consumption (yes vs no)												
Diabetes (ever vs never)	1.07	0.82	1.38	1.16	0.95	1.42	0.95	0.66	1.38	1.28	0.98	1.67
Predicting daily vegetable consumption (yes vs no)												
Diabetes (ever vs never)	1.03	0.75	1.41	1.17	0.90	1.51	1.14	0.70	1.87	1.39	1.02	1.90

AOR: adjusted odds ratio; 95% CI: 95% confidence interval.
AORs with 95% CI that do not include 1.00 are significant; each model controlled for health conditions, weight status, physical activity, alcohol use, tobacco use, general health status, age, ethnicity/race, education level, employment status, and income level.

Thus, it may be favorable for practitioners to inform diabetic middle-aged female patients about flavonoid-rich fruit and vegetables. Flavonoids that are found in fruit (including berries, apples, pears, and cherries) and vegetables (including celery, parsley, herbs, and soy) have been shown to regulate insulin secretion, insulin signaling, and glucose uptake in insulin-sensitive tissues through signaling pathways. Thus, flavonoids may be beneficial for diabetic patients as they help insulin secretion, reduce apoptosis, decrease oxidative stress in muscle and fat, and improve hyperglycemia.[21] In addition, diabetic patients have an increased risk of developing further chronic diseases such as diabetic retinopathy, long-term vascular complications, cardiovascular disease, and cancer, so, consumption of flavonoid-rich foods may help prevent the onset of additional comorbidities.[21,22]

Conclusion

The results of this study may be generalizable to middle-aged females 45–64 years old in primary care because this was a population-based sample. This target population reported moderate levels of daily fruit consumption and high levels of daily vegetable consumption, neither of which differed by diabetes status. However, the inclusion of French fries in the vegetable variable may have inflated the proportion of vegetable consumption. Providers should screen all female patients ages 45–64 for fruit and vegetable consumption and educate on the importance of eating fruits and vegetables daily. In addition, providers may consider sharing information about the health benefits of flavonoid-rich fruit and vegetable consumption for diabetes.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

The IRB of the University of North Texas Health Science Center gave this study exempt status (IRB Number: 2018-161) because we conducted a secondary data analysis of BRFSS data, which is de-identified data made accessible online by the CDC.

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Informed consent

We conducted a secondary data analysis of BRFSS data, which is de-identified data made accessible online by the CDC.

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