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Association Between Dietary Niacin Intake and Rheumatoid Arthritis in American Women: A Study Based on National Health and Nutrition Examination Survey Database

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Objective: This study aimed to explore the association between dietary niacin intake and rheumatoid arthritis (RA) in American women through the National Health and Nutrition Examination Survey (NHANES) database.

Methods: A retrospective analysis was conducted based on NHANES 2003–2016 data. Dietary niacin intake was stratified using weighted quartiles and association of dietary niacin intake with RA was explored using weighted logistic regression models and restricted cubic splines (RCS). Subgroup analysis was conducted, adjusting for all confounding factors, and a likelihood ratio test was utilized to determine significant covariates for the interaction term. Stratified analysis was conducted on significant covariates to determine their impact on the association of dietary niacin intake with RA.

Results: Fourteen thousand five hundred and thirty-nine American women were selected according to inclusion and exclusion criteria, among whom 845 (4.4%) had RA. Compared with American women without RA, American women with RA had significantly lower dietary niacin intake (18.90 vs 21.22, $P<0.001$). Logistic regression models and RCS analysis reported a significant linear negative correlation between dietary niacin intake and prevalence of RA (Odds Ratio (OR) < 1, $P < 0.05$, P-non-linear >0.05). The interaction-term P-values showed that this association was significantly influenced by poverty income ratio (PIR), education level, Body Mass Index (BMI), and smoking (P for interaction < 0.05). Stratified analysis unveiled that this association was particularly significant in individuals aged ≥ 40 years (OR: 0.98, 95% Confidence Interval (CI): 0.97–0.99, $P < 0.05$), PIR > 3.5 (OR: 0.96, 95% CI: 0.93–0.99, $P < 0.05$), with a college education or higher (OR: 0.97, 95% CI: 0.94–0.99, $P < 0.01$), BMI ≥ 30kg/m² (OR: 0.98, 95% CI: 0.96–0.99, $P < 0.05$), non-smokers (OR: 0.97, 95% CI: 0.95–0.99, $P < 0.01$), or former smokers (OR: 0.95, 95% CI: 0.95–0.99, $P < 0.05$).

Conclusion: Increased dietary niacin intake was associated with a reduced prevalence of RA, especially in women aged ≥40, PIR > 3.5, with at least a college education, BMI ≥ 30kg/m², and currently non-smokers.

Keywords: rheumatoid arthritis, dietary niacin intake, women, NHANES

Introduction

A systemic autoimmune illness, rheumatoid arthritis (RA), can impact the heart, kidneys, lungs, digestive system, eyes, skin, and nervous system in addition to joints.[1,2] Globally, there were an estimated 17.6 million (95% UI: 15.8–20.3) RA patients in 2020, translating to an age-standardized global prevalence rate of 208.8 cases per 100,000 persons.[3] RA is more prevalent in women, affecting them more significantly than men at all ages.[3] Furthermore, the incidence rates for females and males reach their peaks at ages 70–74 and 75–79, respectively.[4] RA has an insidious onset and progresses slowly.[5,6] If not treated promptly, it may cause progressive joint damage and deformity, chronic pain, long-term disability, and premature death.[3,4,7] Unfortunately, RA is incurable, leading to increased burden on individuals and society.[8,9] However, if the disease is diagnosed

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early, many patients can achieve complete remission or significantly reduce disease activity.[10] Therefore, early identification of RA is crucial for taking preventive measures and establishing the correct treatment plan.

Dietary factors are linked to RA risk and progression.[11,12] Dietary interventions (such as the Mediterranean diet or dietary supplements) can improve RA outcomes to some extent.[13,14] According to the nutritional pattern of RA population (anti-inflammatory, antioxidant, n-3 polyunsaturated fatty acids, vitamins and minerals, weight control, etc).,[15] vitamins with antioxidant activity have attracted attention due to their potential to alleviate oxidative stress and inflammatory response in RA.[16–21] Niacin (Vitamin B3) is a dietary vitamin that contains two vitamin isomers, niacin and niacinamide. Niacin is the nutritional precursor of the bioactive molecules nicotinamide adenine dinucleotide and nicotinamide adenine dinucleotide phosphate, playing important roles in mitochondrial energy metabolism and cellular redox reactions.[22,23] An animal experiment found that niacin can reduce cell apoptosis and promote follicular development to rescue female ovarian premature aging, improving female quality of life.[24] Mirzaaghasi et al[25] found that the combination of niacin and prednisolone may have potential benefits for managing RA. However, there is currently no relevant research report in the existing literature on the association of dietary niacin intake with RA in women. Given the higher prevalence of RA in women, we believe it is necessary to investigate the association of dietary niacin intake with RA in women to improve RA management.

Based on this, we assumed that RA patients had a lower dietary intake of niacin and evaluated it using the National Health and Nutrition Examination Survey (NHANES) database. Subgroup analysis was to identify possible factors that may affect the association of dietary niacin intake with RA.

Methods

Data Source and Study Population

NHANES database is an ongoing program in the United States that uses a multi-stage stratified complex design to collect and evaluate the health and nutritional status of adults and children. Participants first receive survey interviews at home and then proceed to the Mobile Examination Center (MEC) for various clinical and laboratory examinations. NHANES was authorized by the Ethics Review Committee of the National Center for Health Statistics (NCHS) in the United States, and all participants provided informed consent. Our study only used it for secondary analysis and did not require further approval from the institutional review board.

We merged the surveys from 2003 to 2016, covering seven consecutive cycles, into one analysis sample. Seventy-one thousand fifty-eight participants were included. We excluded participants with missing medical questionnaire data or dietary niacin intake data (n = 11,016), missing covariate data (n = 31,332), and male participants (n = 14,171). Fourteen thousand five hundred and thirty-nine participants were finally selected for analysis. Detailed inclusion and exclusion processes are shown in Figure 1.

Niacin

Data collection of dietary niacin intake was based on two 24-hour dietary recall interviews in NHANES. The Mobile Examination Center (MEC) hosted the initial in-person dietary recall interview, which was followed by a phone conversation for a second interview three to 10 days later. Dietary data assessment included records of types and quantities of food and beverages (including all types of water) consumed in the past 24 hours, and estimated energy, nutrients, and other components obtained from these foods and beverages. Dietary niacin intake (mg/day) was calculated based on the average value from participants' two dietary recalls.[26,27]

Ra

The diagnosis of arthritis was obtained through self-reported questionnaires. Participants were asked that "Has a doctor or other health professional ever told you that you have arthritis?" The response options are "yes" or "no". Participants who answered "yes" were further asked that "What type of arthritis is this?" Participants who answered "RA" were confirmed to have RA.[28]

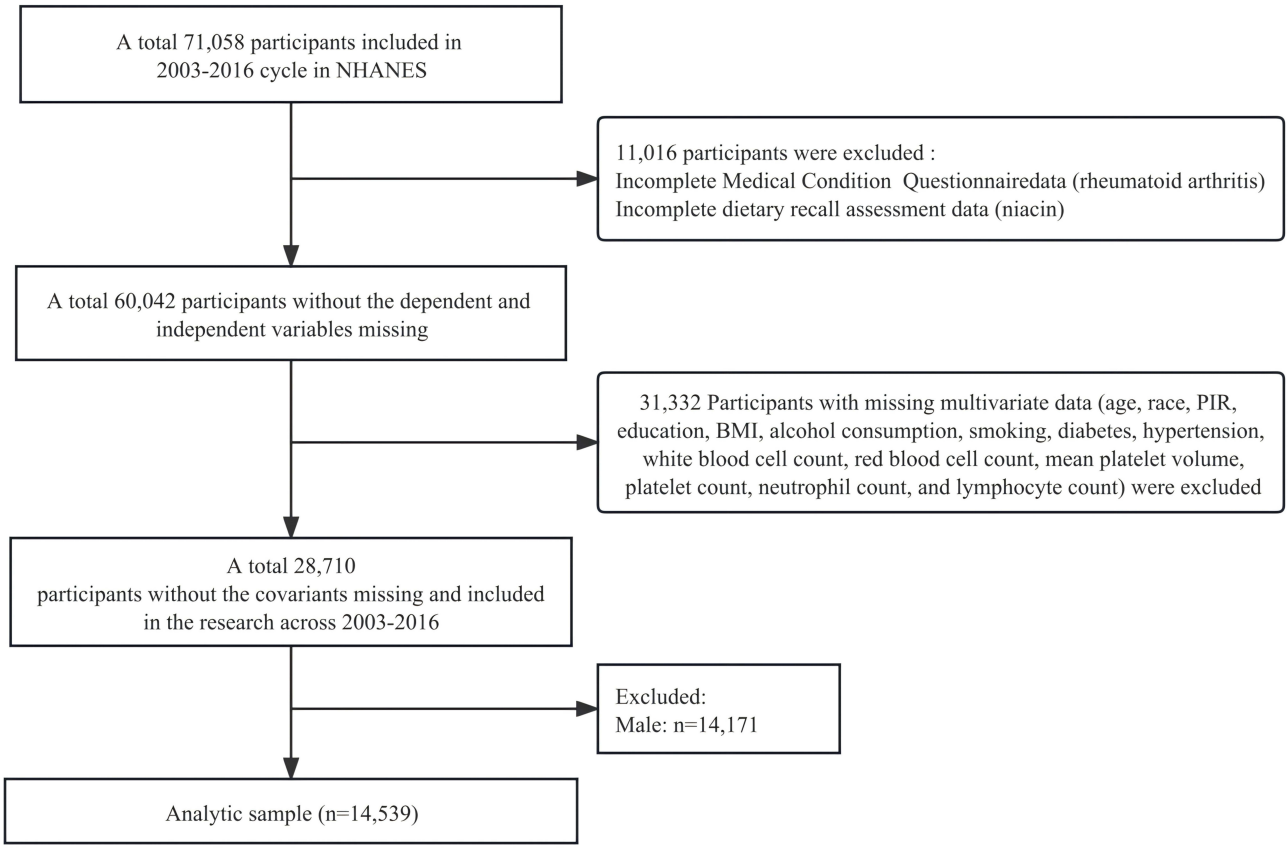

Figure 1 Flowchart of participant selection process.

Variables

Variables included age, race, poverty income ratio (PIR), education level, Body Mass Index (BMI), alcohol consumption, smoking, diabetes, hypertension, white blood cell count (WBC), red blood cell count (RBC), mean platelet volume (MPV), systemic immune inflammation index (SII), and energy intake.[29] Since RA is common in women over 40 years old,[30] the age was divided into <40 years old and ≥40 years old. Education level was divided into did not graduate from high school, graduated from high school, and college education or above.[31] PIR was classified as low income (≤1.3), middle income (1.3–3.5), and high income (>3.5).[32] According to the World Health Organization standards, participants' BMI was calculated based on weight/height^2 (kg/m^2), divided into <25, 25–30, and ≥30.[33] Alcohol drinking was categorized as yes or no.[34] Smoking status was defined based on the following questions:[35] for "Do you now smoke cigarettes", answering "Every day" or "Some days" was defined as "now smoking"; for "Smoked at least 100 cigarettes in life", answering "Yes" was defined as "former smoking"; the rest were defined as "never smoking". Hypertension[36] was defined as meeting one of the following criteria: (a) previously diagnosed with hypertension; (b) self-reported use of antihypertensive medication; (c) in the NHANES examination component, average systolic blood pressure greater than or equal to 130 mmHg or diastolic blood pressure greater than or equal to 80 mmHg.[37] Diabetes[38] was defined as meeting one of the following criteria: (a) being informed by a doctor of having diabetes; (b) taking antidiabetic medication; (c) having glycated hemoglobin >6.5%; (d) having fasting blood glucose >126 mg/dL. WBC, RBC, MPV, and SII were parameters in the complete blood cell count (CBC). Using Beckman Coulter equipment, analysis was performed using a single-beam spectrophotometer with hemoglobin measurement, along with counting, sizing, grading methods, and automated dilution and mixing devices for sample processing. The WBC difference was detected using volume scattering technology (Volume, Conductivity, and Scatter Technology, VCS). The formula for SII was platelet count × neutrophil count/lymphocyte count.[30] Relevant variables could be defined to corresponding modules through variable names (https://wwwn.cdc.gov/Nchs/Nhanes/).

Statistical Analysis

All statistical analyses were done by R (V4.2.2) software. Total population was assigned into RA group and non-RA group according to the definition of RA, and baseline tables were generated using the tableone package. Categorical variables were presented as sample size and proportion (n(%)), while continuous variables were shown as mean and standard deviation (mean(SD)) (n: unweighted sample size; n(%): weighted proportion; mean: weighted mean; SD: weighted standard deviation). Dietary niacin intake was stratified using weighted quartiles and a weighted logistic regression model of dietary niacin intake and RA was constructed using the survey package, adjusting for various confounding factors. In the weighted logistic regression model after adjusting for all confounding factors, restricted cubic splines (RCS) were utilized to explore the association of dietary niacin intake with RA. Stratified analysis was performed on categorical variables, and likelihood ratio test was conducted on interaction terms of stratified logistic regression models adjusted for all confounding factors. $P<0.05$ indicates a significant difference. In the weighted logistic regression model, subgroup analysis was done for confounding factors with interaction term $P<0.05$.

Results

Baseline Characteristics

This study included 14,539 female participants, and clinical and biochemical characteristics of the participants are presented in Table 1. The overall population consisted of 63.4% individuals aged 40 years and above, 10.9% participants had diabetes, 45.4% were hypertensive, and the average dietary niacin intake was 21.12 mg/d. The dietary niacin intake was significantly lower in RA population than in non-RA population (18.90 mg/d vs 21.22 mg/d, $P<0.001$). Age, race, PIR, education level, BMI, smoking, drinking, diabetes, hypertension, and RBC showed significant statistical differences between groups ($P<0.05$).

Table 1 Characteristics of NHANES Participants from 2003 to 2016

Characteristics	Total	Non-Rheumatoid Arthritis	Rheumatoid Arthritis	P value
Overall	14539	13,694 (95.6)	845 (4.4)	
Age				<0.001
<40	5183 (36.6)	5103 (37.8)	80 (10.8)	
≥40	9356 (63.4)	8591 (62.2)	765 (89.2)	
Race				<0.001
Mexican American	2356 (7.8)	2231 (7.9)	125 (6.0)	
Other Hispanic	1290 (4.8)	1204 (4.7)	86 (5.7)	
Non-Hispanic White	6777 (69.8)	6428 (70.1)	349 (65.0)	
Non-Hispanic Black	2972 (11.4)	2722 (11.0)	250 (18.4)	
Other race	1144 (6.3)	1109 (6.3)	35 (4.9)	
PIR				<0.001
≤1.3	4800 (23.4)	4415 (22.9)	385 (35.5)	
1.3–3.5	5455 (36.2)	5154 (36.1)	301 (39.0)	
>3.5	4284 (40.4)	4125 (41.1)	159 (25.5)	
Education				<0.001
Did not graduate from high school	3508 (16.5)	3216 (16.1)	292 (26.0)	
Graduated from high school	3372 (22.7)	3171 (22.6)	201 (26.3)	
College education or above	7659 (60.8)	7307 (61.4)	352 (47.7)	
BMI (kg/m^2)				<0.001
<25	4454 (35.0)	4282 (35.4)	172 (25.8)	
25–30	4157 (28.0)	3930 (28.1)	227 (25.8)	
≥30	5928 (37.0)	5482 (36.5)	446 (48.4)	

(*Continued*)

Table 1 (Continued).

Characteristics	Total	Non-Rheumatoid Arthritis	Rheumatoid Arthritis	P value
Smoking				<0.001
Never smoking	9109 (59.7)	8660 (60.3)	449 (46.5)	
Former smoking	2861 (21.0)	2663 (20.9)	198 (23.3)	
Now Smoking	2569 (19.3)	2371 (18.8)	198 (30.2)	
Alcohol drinking				0.002
No	5802 (32.2)	5412 (31.8)	390 (39.8)	
Yes	8737 (67.8)	8282 (68.2)	455 (60.2)	
Diabetes				<0.001
No	12416 (89.1)	11,818 (89.7)	598 (76.0)	
Yes	2123 (10.9)	1876 (10.3)	247 (24.0)	
Hypertension				<0.001
No	7403 (54.6)	7167 (55.6)	236 (32.9)	
Yes	7136 (45.4)	6527 (44.4)	609 (67.1)	
White blood cell (10^3/μL)	7.39 (2.30)	7.39 (2.30)	7.49 (2.37)	0.431
Red blood cell (10^6/μL)	4.45 (0.40)	4.45 (0.39)	4.40 (0.42)	0.011
MPV (fL)	8.17 (0.94)	8.17 (0.94)	8.17 (0.96)	0.869
SII	580.20 (339.20)	578.22 (333.70)	622.90 (439.60)	0.060
Energy (Kcal)	1789.65 (625.47)	1796.47 (625.75)	1642.81 (601.22)	<0.001
Dietary niacin intake (mg/d)	21.12 (9.32)	21.22 (9.35)	18.90 (8.29)	<0.001

Correlation Between Dietary Niacin Intake and RA

There was a significant negative correlation between dietary niacin intake and prevalence of RA (Odds Ratio (OR)<1, P<0.05) (Table 2). Further stratification of dietary niacin intake into quartiles was performed, with lower dietary niacin intake Q1 (≤14.95) as the reference, to construct a weighted logistic regression model. Compared with Q1, there was a trend of reducing RA prevalence with elevating dietary niacin intake (Q2 (14.95–19.65), Q3 (19.65–25.63), Q4 (>25.63)), with a significant P value for trend (P for trend <0.05).

Overall, after adjusting for all confounding factors, a significant overall trend was seen between dietary niacin intake and RA (P-overall < 0.05), and there was a linear relationship between them in the RCS analysis (P-non-linear = 0.3147 > 0.05) (Figure 2).

Table 2 Associations Between Dietary Niacin Intake and Odds Ratios (95% Confidence Intervals) for Rheumatoid Arthritis, NHANES 2003–2016

	OR (95% CI)		
Participants	**Crude**	**Model I**	**Model II**
All participants	0.97 (0.95–0.98)***	0.98 (0.97–0.99)*	0.98 (0.97–0.99)*
Dietary niacin intake (mg/day)			
Q1 (≤14.95)	Ref.	Ref.	Ref.
Q2 (14.95–19.65)	0.82 (0.64–1.05)	0.95 (0.73–1.23)	0.94 (0.72–1.22)
Q3 (19.65–25.63)	0.65 (0.47–0.89)	0.78 (0.56–1.10)	0.78 (0.56–1.09)
Q4 (>25.63)	0.46 (0.34–0.63)	0.63 (0.44–0.88)	0.63 (0.45–0.89)
P for trend	<0.001	0.036	0.047

Note: Crude: Unadjusted; Model I: Adjusted for age, race, PIR, education level, BMI, alcohol consumption, smoking; Model II: Adjusted for age, race, PIR, education level, BMI, alcohol consumption, smoking, diabetes, hypertension, white blood cell count, red blood cell count, mean platelet volume, systemic immune-inflammatory index.*P-value<0.05, ***P-value< 0.001.

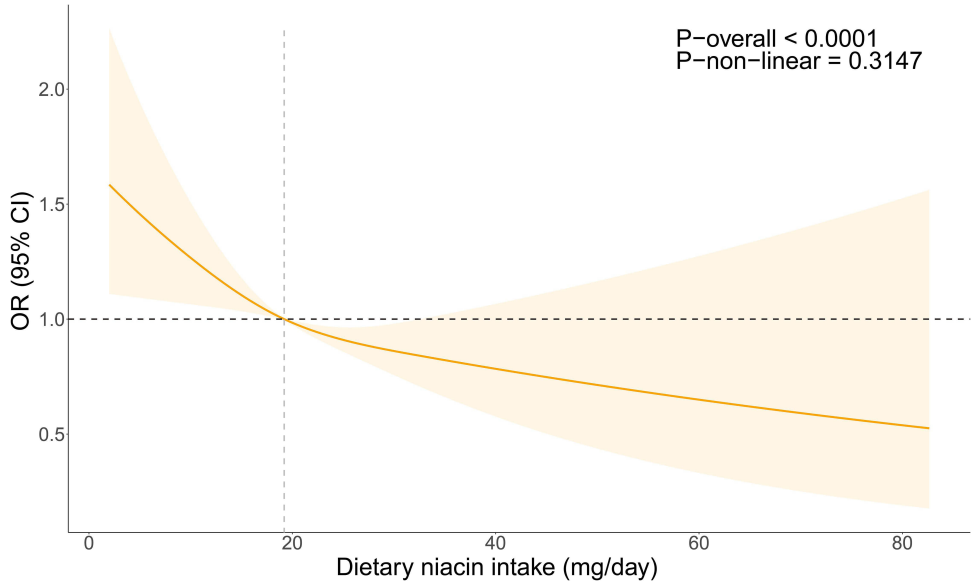

Figure 2 OR of dietary niacin intake concerning RA adjusted for covariates in NHANES 2003–2016 The RCS line is adjusted for various factors including age, race, PIR, education, BMI, alcohol consumption, smoking, diabetes, hypertension, white blood cell count, red blood cell count, mean platelet volume, and systemic immune-inflammatory index. The OR is visualized by the Orange line, and the shaded region signifies the 95% CI.
Abbreviations: OR, Odds Ratio; CI, Confidence Interval.

Subgroup Analysis

Interaction test unveiled that association between dietary niacin intake and RA prevalence was influenced by PIR (*P* for interaction = 0.008), education level (*P* for interaction = 0.002), BMI (*P* for interaction = 0.027), and smoking (*P* for interaction = 0.001) (Table 3).

Subgroup analysis was conducted (Table 4). It was found that in individuals aged ≥40 years (Crude: OR: 0.97, 95% Confidence Interval (CI): 0.96–0.99, *P*<0.01; Model I, Model II: OR: 0.98, 95% CI: 0.97–0.99, *P*<0.05), PIR>3.5

Table 3 Association Between Dietary Niacin Intake and Rheumatoid Arthritis in Categorical Variables

Participants	OR	95% CI	P-value	P for interaction
Age				0.855
<40	0.98	0.94–1.02	0.300	
≥40	0.97	0.96–0.99	0.001	
Race				0.225
Mexican American	0.96	0.93–0.99	0.007	
Other Hispanic	0.96	0.92–0.99	0.009	
Non-Hispanic White	0.97	0.95–0.99	<0.001	
Non-Hispanic Black	0.97	0.96–0.99	0.008	
Other race	1.00	0.96–1.03	0.800	
PIR				0.008
≤1.3	0.98	0.97–0.99	0.042	
1.3–3.5	0.97	0.95–0.99	0.017	
>3.5	0.95	0.92–0.99	0.007	
Education				0.002
Did not graduate from high school	0.98	0.96–1.00	0.088	
Graduated from high school	0.99	0.97–1.02	0.500	
College education or above	0.95	0.93–0.97	<0.001	

(*Continued*)

Table 3 (Continued).

Participants	OR	95% CI	P-value	P for interaction
BMI (kg/m^2)				0.027
<25	0.96	0.93–0.98	0.002	
25–30	0.98	0.96–1.01	0.200	
≥30	0.97	0.95–0.99	<0.001	
Smoking				0.001
Never smoking	0.96	0.94–0.98	<0.001	
Former smoking	0.96	0.94–0.98	<0.001	
Now Smoking	0.99	0.97–1.01	0.400	
Alcohol drinking				0.614
No	0.97	0.95–0.99	0.002	
Yes	0.97	0.95–0.99	0.002	
Diabetes				0.247
No	0.97	0.96–0.99	<0.001	
Yes	0.96	0.93–0.99	0.004	
Hypertension				0.874
No	0.97	0.94–0.99	0.011	
Yes	0.97	0.96–0.99	0.004	

Note: Interaction term p-values adjusted for age, race, PIR, education level, BMI, alcohol consumption, smoking, diabetes, hypertension, white blood cell count, red blood cell count, mean platelet volume, systemic immune-inflammatory index.

Table 4 Association Between Dietary Niacin Intake and Rheumatoid Arthritis by Age, PIR, Education Level, BMI, Smoking (95% Confidence Interval), NHANES, 2003–2016

	OR (95% CI)		
Participants	**Crude**	**Model I**	**Model II**
Age			
<40	0.98 (0.94–1.02)	0.98 (0.94–1.02)	0.98 (0.94–1.02)
≥40	0.97 (0.96–0.99)**	0.98 (0.97–0.99)*	0.98 (0.97–0.99)*
PIR			
≤1.3	0.98 (0.97–0.99)*	1.00 (0.98–1.01)	1.00 (0.98–1.01)
1.3–3.5	0.97 (0.95–0.99)*	0.98 (0.96–1.01)	0.98 (0.96–1.01)
>3.5	0.95 (0.92–0.99)**	0.96 (0.93–0.99)*	0.96 (0.93–0.99)*
Education			
Did not graduate from high school	0.98 (0.96–1.00)	0.99 (0.97–1.01)	0.99 (0.97–1.01)
Graduated from high school	0.99 (0.97–1.02)	1.00 (0.98–1.03)	1.00 (0.98–1.03)
College education or above	0.95 (0.93–0.97)***	0.97 (0.94–0.99)**	0.97 (0.94–0.99)**
BMI (kg/m^2)			
<25	0.96 (0.93–0.98)**	0.97 (0.94–1.00)	0.97 (0.94–1.00)
25–30	0.98 (0.96–1.01)	1.00 (0.97–1.02)	1.00 (0.97–1.03)
≥30	0.97 (0.95–0.99)***	0.98 (0.96–0.99)*	0.98 (0.96–0.99)*
Smoking			
Never smoking	0.96 (0.94–0.98)***	0.97 (0.95–0.99)**	0.97 (0.95–0.99)**
Former smoking	0.96 (0.94–0.98)***	0.97 (0.95–0.99)*	0.98 (0.95–0.99)*
Now Smoking	0.99 (0.97–1.01)	1.00 (0.98–1.03)	1.00 (0.98–1.03)

Note: Crude: Unadjusted; Model I: Adjusted for age, race, PIR, education level, BMI, alcohol consumption, smoking; Model II: Adjusted for age, race, PIR, education level, BMI, alcohol consumption, smoking, diabetes, hypertension, white blood cell count, red blood cell count, mean platelet volume, systemic immune-inflammatory index.*P-value<0.05, **P-value<0.01, ***P-value< 0.001.

(Crude: OR: 0.95, 95% CI: 0.92–0.99, $P<0.01$; Model I, Model II: OR: 0.96, 95% CI: 0.93–0.99, $P<0.05$), and college or above (Crude: OR: 0.95, 95% CI: 0.93–0.97, $P<0.001$; Model I, Model II: OR: 0.97, 95% CI: 0.94–0.99, $P<0.01$), BMI≥30kg/m² (Crude: OR: 0.97, 95% CI: 0.95–0.99, $P<0.001$; Model I, Model II: OR: 0.98, 95% CI: 0.96–0.99, $P<0.05$) and never smoked (Crude: OR: 0.96, 95% CI: 0.94–0.98, $P<0.001$; Model I, Model II: OR: 0.97, 95% CI: 0.95–0.99, $P<0.01$) or former smokers (Crude: OR: 0.96, 95% CI: 0.94–0.98, $P<0.001$; Model I: OR: 0.97, 95% CI: 0.95–0.99, $P<0.05$; Model II: OR: 0.98, 95% CI: 0.95–0.99, $P<0.05$), there was a significant negative correlation between dietary niacin intake and RA prevalence.

Discussion

To our knowledge, this is the first study to investigate the correlation between dietary niacin intake and RA in American women using the NHANES database. Our research results showed that compared to non-RA individuals, RA patients had a lower dietary niacin intake (18.90 mg/d vs 21.22 mg/d, $P<0.05$). Additionally, there was a negative correlation between dietary niacin intake and prevalence of RA, especially in individuals aged ≥40 years, with PIR > 3.5, with a college degree or higher, with a BMI ≥ 30kg/m², and in those who had never smoked or previously smoked.

A rat experiment showed that the combination of niacin and prednisolone can activate immune regulation in rats, promote a decrease in certain hematological and RA parameters (such as neutrophil iron absorption, myeloperoxidase, nitric oxide, C-reactive protein, etc)., and may be a useful method for treating RA.[25] However, there have been no studies reporting the impact of dietary niacin on RA patients. Niacin plays a role in the most common RA extra-articular manifestations, such as interstitial lung disease.[39] Jia et al[40] showed that niacin can alleviate pulmonary arterial hypertension through hematopoietic prostaglandin D synthase (H-PGDS) in macrophages. Lohani et al revealed that niacin deficiency leads to genetic instability in normal fetal lung fibroblasts and increases genetic instability caused by nitrosamine ketone, a carcinogen in cigarette smoke.[41] Thus, niacin is critical in RA occurrence and development. Therefore, analyzing the impact of dietary niacin on RA through the NHANES database has certain clinical translational value.

Currently, the recommended dietary intake of niacin for adult women is 14 mg/d, with a tolerable upper intake level of 35 mg/d.[42,43] Our research unraveled that when dietary intake of niacin was >14.95 mg/d, the prevalence of RA was significantly reduced. Following dietary guidelines has a positive impact on lowering RA risk. Nonetheless, characteristics of the Western diet include a high intake of red meat, saturated fat, trans fat, and refined carbohydrates, mainly increasing RA risk through inflammation, obesity induction, and insulin resistance.[44,45] Foods rich in niacin include fish, meat, milk, liver, peanuts, and legumes.[22] The Mediterranean diet may be rich in niacin as it contains varying fruits, vegetables, nuts, seafood, fish, whole grains, legumes, olive oil, and moderate amounts of wine.[22,46] Based on this, American women can make dietary adjustments related to niacin to maintain a healthier lifestyle, which may be helpful in preventing RA.

According to reports, NAD levels decrease with age,[47,48] meanwhile, the incidence of RA is also increasing,[4] and RA patients are more prone to complications such as cardiovascular diseases.[49] Sufficient dietary niacin intake can prevent dyslipidemia and cardiovascular diseases.[50–52] Therefore, intake of niacin should also be increased with age. In addition, smoking and obesity (BMI≥30kg/m²) are recognized environmental factors for RA.[53,54] Reduced dietary niacin intake is associated with an elevated risk of obesity.[55] Niacin deficiency also increases the genetic instability risk caused by smoking[41] and is vital in triggering specific RA subtypes.[56,57] Additionally, higher levels of education and income often represent healthier dietary patterns.[58,59] However, statistics show that only 0.1% of Americans maintain a healthy diet.[60] Therefore, in the population of American women studied, there may also be insufficient dietary niacin intake due to excessive reliance on processed foods, fast food, etc. In conclusion, attention should be paid to supplementation of dietary niacin intake in these populations, which may be beneficial for the prevention of RA.

Pathogenesis of RA is complex, mainly manifested as bone destruction, synovitis, immune cell dysfunction, and inflammatory reactions.[10,61] Immune system of RA patients is typified by systemic inflammation and generation of autoantibody, causing activation and release of immune cells, resulting in joint damage and functional impairment.[62–66] Niacin is crucial for physiological functions of varying immune cells, including macrophage-specific loss of hematopoietic prostaglandin D synthase, homeostasis of circulating monocyte subsets, and neutrophil migration in inflammation,[40,67,68] and it also has anti-inflammatory effects.[69,70] Therefore, niacin may have an impact on the regulation of the immune system to some extent, thereby alleviating RA symptoms. In addition, RA patients often suffer from pain, inflammation, and neurologic-related

issues.[71–73] Niacin is a key mediator for neuronal development and survival in the central nervous system, and it helps alleviate pain and symptoms related to the nervous system.[42,74] Although niacin is not a therapeutic drug for RA, this evidence suggests its potential benefits in RA. Therefore, much research is needed to clarify the exact effects and safety of niacin in RA.

This work demonstrated a negative association between dietary niacin and prevalence of RA, based on a nationally representative survey of American women. It does, however, have certain deficiencies. Firstly, our data does not include the intake of dietary niacin supplements, so it cannot accurately reflect the total amount of dietary niacin in individuals. Furthermore, dietary habits and nutritional needs undergo dynamic changes throughout the lifespan, which cannot be assessed by cross-sectional studies. In addition, our study results are based on a survey of American women, and research is needed to determine if they can be generalized to other populations. Finally, this study is a cross-sectional study and cannot make causal inferences.

Data Sharing Statement

The data and materials in the current study are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

The study was approved by the Ethical Committee of Affiliated Jinhua Hospital, Zhejiang University School of Medicine. Informed consent was waived by the committee.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare no conflicts of interest.

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