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Applied nutritional investigation

Dietary patterns and nutrient intake of individuals with rheumatoid arthritis and osteoarthritis in the United States

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ABSTRACT

Objective: The aim of this study was to investigate the differences in adherence to the Mediterranean diet, assessed by the alternative Mediterranean Diet (aMED) score, and diet quality, assessed by Healthy Eating Index 2015 to 2020 (HEI-2015), between presence and type of arthritis (rheumatoid arthritis and osteoarthritis). Additionally, the study investigated the association between aMED scores and HEI-2015 scores and the presence of arthritis.
Methods: Cross-sectional data from four cycles (2007–2014) of the National Health and Nutrition Examination Survey were used and weighted to produce a nationally representative sample. Arthritis information was extracted from the Medical Conditions file and recoded into relevant variables. Food group and nutrient data from the 24-h recall was transformed to provide aMED and HEI-2015 scores.
Results: Individuals with arthritis had significantly worse adherence to the Mediterranean diet and diet quality. aMED scores were 3.43 ± 0.04 for individuals with arthritis and 3.54 ± 0.03 for individuals without arthritis ($P = 0.014$). HEI-2015 scores were also lower in individuals with arthritis (51.41 ± 0.37) than in those without (53.50 ± 0.28; $P < 0.001$). There were no significant differences in aMED or HEI-2015 scores between individuals with rheumatoid arthritis and those with osteoarthritis. There were also no associations between aMED scores or HEI-2015 scores and the presence of arthritis.
Conclusions: Individuals diagnosed with arthritis can take steps to improve their diet quality as a possible route to reduce arthritis symptoms and maintain a healthy body weight. Further research on dietary patterns and their potential to treat and manage arthritis is warranted.

Introduction

Arthritis, a musculoskeletal condition, results in joint pain, swelling, functional impairment, disability, and loss of quality of life [1,2]. Around 22.7% of U.S. adults report having medically diagnosed arthritis, with rheumatoid arthritis (RA) and osteoarthritis (OA) being the two most common types [1]. Inflammation has been found to play a key role in the development and severity of arthritis [2,3]. Potent eicosanoids, such as prostaglandin E2 and leukotriene B4, and proinflammatory cytokines, such as tumor necrosis factor, interleukin (IL)-1 B, IL-6, and IL-8, are elevated in individuals with arthritis [2,3]. Lifelong treatment of symptoms is necessary and pharmacologic treatments may lead to negative side effects such as osteoporosis, diabetes, myocardial infarction, weight gain, gastric ulcers and bleeding, hepatic toxicity, renal and bone marrow damage, alveolitis, and pneumonia [4–7].

Recent research has indicated that diet can improve inflammation and arthritis symptoms, without negative side effects [8–11]. Specifically, the Mediterranean diet, known for reducing the risk for cardiovascular mortality, cancer incidence, and neurodegenerative diseases, is being studied for its effects on inflammation [12,13]. The Mediterranean diet emphasizes eating a variety of fruit, vegetables, legumes, nuts, healthy fats (primarily olive oil), and fish; consuming alcohol in moderation; and limiting red meat consumption [8]. The diet contains high sources of antioxidants and anti-inflammatory compounds such as resveratrol, found in red wine, and hydroxytyrosol, found in olive oil [14]. Randomized

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controlled trials have demonstrated that individuals with arthritis who follow the Mediterranean diet demonstrated significant decreases in pain scores, early morning stiffness, disease activity, physical function, and global assessment, a measure of overall functional status [8,9]. There is a greater applicability for clinicians and patients to focus on dietary patterns instead of specific nutrients to make positive dietary changes to manage their condition. Recommending whole dietary patterns or food groups aid in patient understanding and focuses on actual food intake rather than supplementation. The purpose of the present study was to assess the differences in adherence to the Mediterranean diet, assessed by the alternative Mediterranean Diet (aMED) score, and diet quality, assessed by the Healthy Eating Index (HEI) 2015 to 2020, between presence and type of arthritis (RA and OA). The study also investigated the association between aMED scores and HEI-2015 scores and the presence of arthritis.

Methods

Sample population

Dietary intake, medical conditions, and body measurement data from the National Health and Nutrition Examination Survey (NHANES) were used in this study. Public-use data files were obtained from National Center for Health Statistics (NCHS), a section of the Centers for Disease Control and Prevention. A multistage, stratified sampling method was used to select NHANES participants and the survey oversamples older adults, blacks, Asians, and Mexican Americans to produce accurate health measurements for these minority groups. The present study aggregated data from four 2-year NHANES cycles from 2007 to 2008, 2009 to 2010, 2011 to 2012, and 2013 to 2014. The present study was exempt from Institutional Review Board approval because it did not require any identifiable data and NCHS Research Ethics Review Board reviewed and approved all NHANES data collection protocols.

Participants

Inclusion criteria included individuals with complete, valid, and reliable demographic information data, arthritis data, body measurement data, and dietary recall data. Individuals with incomplete relevant data, pregnant women, individuals <30 y of age, and those with a diet recall of <500 kcal/d were excluded from the analysis (n = 395).

Personal and demographic data

NHANES demographic data was collected during in-home interviews conducted by trained professionals [15]. The demographic information used in the present study included age, sex, race/ethnicity, marital status, and poverty income ratio. Race/ethnicity included white ("non-Hispanic white"), black ("non-Hispanic black"), Hispanic ("Mexican American" and "other Hispanic"), and other ("non-Hispanic Asian," "other race- including multi-racial"). Marital status included single ("never married"), single and previously married ("widowed," "divorced," and "separated"), and together ("married" and "living with partner"). Weight and height were measured to calculate body mass index (BMI). Weight was measured using a digital floor scale with automated data capture and height was measured with a wall-mounted stadiometer with automated data capture. BMI was calculated by dividing weight in kilograms by height in meters squared (kg/m^2).

Arthritis data

Presence of arthritis was determined from the self-reported data conducted during the Mobile Exam Center visit. Presence of arthritis was determined using the question "Has the doctor ever said you had arthritis?" Data included responses "yes" and "no" and excluded responses "refused," "don't know," and all missing data. If an individual responded "psoriatic arthritis" to the question "which type of arthritis was it?", they were removed from the "yes" category and put into the "no" category due to a small sample size. Therefore, the "yes" category only included OA and RA and the "no" category was all individuals without these two common forms of arthritis. Type of arthritis was determined using the question "Which type of arthritis was it?" Data included responses "osteoarthritis or degenerative arthritis" and "rheumatoid arthritis" and excluded responses "psoriatic arthritis," "other arthritis," "other," "refused," "don't know," and all missing data.

Dietary data

Dietary intake data was collected from the NHANES 24-h recall. The recall was conducted by a trained interviewer and used a computer-assisted dietary interview and automated multiple pass method [15]. Measuring utensils were also used to accurately estimate portion sizes. Food and beverage intake for the previous 24 h were collected and the information was uploaded into the U.S. Department of Agriculture's (USDA) Food and Nutrient Database for Dietary Studies and the Food Patterns Equivalence Database to determine nutrient composition and food patterns, respectively [16,17].

Adherence to the Mediterranean diet was measured using the aMED score [18,19]. Scores ranged from 0 to 9 with a higher score indicating greater adherence. Weighted samples were used to determine a nationally representative median intake for each category. A value of 1 point was given for intake greater than the population-based median intake (servings/d) for vegetables, legumes, fruits and fruit juices, nuts, whole grains, fish, and the ratio of monounsaturated fatty acids (MUFAs) to saturated fatty acids (SFAs) [18,19]. Individuals received 1-point for consuming less than the population-based median intake of red/processed meats and consuming 5 to 25 g/d of alcohol [18,19]. The raw measurements from the 24-h recall were transformed to provide a correct aMED score. The score included the variables legumes, nuts, whole grains, intact fruit and fruit juices, fish high and low in ω-3 fatty acids, vegetables excluding potatoes, beef/veal/pork/lamb/game/cured/luncheon meat, and the ratio of total MUFAs to SFAs.

Diet quality was assessed using the HEI-2015 [20]. The HEI-2015 is based on the 2015 Dietary Guidelines for Americans created by the USDA [20]. The HEI-2015 scores 13 components for a total of 100 points and a higher score indicates better diet quality. HEI scores >80 indicate "good" diet quality and scores <50 indicate "poor" diet quality [21]. The components are scored based on energy density of 1000 kcals and Table 1 shows specific scoring standards for each component [20].

Analysis

SPSSversion 24 (IBM, Armonk, NY, USA) was used for statistical analysis and $P < 0.05$ indicated statistically significant findings. Data were analyzed using complex samples to produce nationally representative estimates with statistically appropriate standard errors. Descriptive statistics were used to examine the characteristics of the study population. Independent *t* tests were used to assess differences in aMED scores, HEI-2015 scores, and nutrient intake between individuals with and without arthritis. Independent *t* tests were also conducted to assess the differences among aMED scores, HEI-2015 scores, and nutrient intake between the two common types of arthritis, OA and RA. Total aMED and HEI-2015 scores were divided into tertiles and a logistic regression was used to assess the association between dietary pattern scores and the presence of arthritis. The lowest tertile of the dietary pattern score and individuals without arthritis were used as reference points. All analyses were controlled for sex, race/ethnicity, marital status, and poverty income ratio.

Results

The sample included 17,224 individuals. Of these, 48.1% (n = 8461) were men and 51.9% (n = 8763) were women. Table 2 shows the personal and demographic characteristics of the sample. There were 15,770 individuals included in the analyses for the presence of arthritis and 2871 included in the analyses for the type of arthritis. Women reported significantly higher rates of arthritis than men (women: n = 3257 [60.4%], men: n = 2240 [39.6%]; $P < 0.001$). Individuals diagnosed with arthritis were significantly older at screening than those not diagnosed with arthritis (with: 60.4 ± 0.2 y, without: 49.3 ± 0.2 y; $P < 0.001$). Additionally, individuals with arthritis had significantly higher BMIs than those without arthritis (with: 30.98 ± 0.20 kg/m^2, without: 28.54 ± 0.13 kg/m^2; $P < 0.001$). Regarding the type of arthritis, individuals with OA were older at screening than those with RA (OA: 61.9 ± 0.3 y, RA: 58.6 ± 0.5 y; $P < 0.001$) and older at the average age of initial diagnosis (OA: 49.4 ± 0.5 y, RA: 44.6 ± 0.6 y; $P < 0.001$). There were no significant differences in BMI between individuals with RA (30.8 ± 0.37 kg/m^2) and OA (30.9 ± 0.28 kg/m^2; $P = 0.81$).

aMED Results

Figure 1 shows the differences in total aMED scores and HEI 2015 to 2020 scores for the presence and type of arthritis. Individuals with arthritis (3.43 ± 0.04) had significantly lower aMED scores than those without arthritis (3.54 ± 0.03; $P = 0.016$). Overall, total aMED scores were poor (total average 3.46 ± 0.27) and only three participants received a score of 9, the highest possible aMED score.

Table 1
Healthy Eating Index 2015 to 2020 scoring standards*

	Component	Points	Maximum points	Minimum score of zero
Adequacy				
	Total fruit†	5	≥0.8 cup equivalents	No fruit
	Whole fruits‡	5	≥0.4 cup equivalents	No whole fruit
	Total vegetables§	5	≥1.1 cup equivalents	No vegetables
	Greens and beans§	5	≥0.2 cup equivalents	No dark green vegetables or legumes
	Whole grains	10	≥1.5 oz equivalents	No whole grains
	Dairy	10	≥1.3 cup equivalents	No dairy
	Total protein foods§	5	≥2.5 oz equivalents	No protein foods
	Seafood and plant protein§,‖	5	≥0.8 cup equivalents	No seafood or plants
	Fatty acids¶	10	(MUFA + PUFA) / SFAs ≥2.5	(MUFA + PUFA) / SFAs ≤1.2
Moderation				
	Refined grains	10	≤1.8 oz equivalents	≥4.3 oz equivalents
	Sodium	10	≤1.1 g	≥2 g
	Added sugars	10	≤6.5% of energy	≥26% of energy
	Saturated fats	10	≤8% of energy	≥16% of energy

MUFA, monounsaturated fatty acid; PUFA, polyunsaturated fatty acid; SFA, saturated fatty acid
*Scores are based per 1000 kcals and scored proportionately.
†Includes 100% fruit juice.
‡Includes all forms except juice.
§Includes legumes, beans, and peas.
‖Includes seafood, nuts, seeds, soy products (other than beverages), and legumes.
¶Ratio of PUFAs and MUFAs to SFAs.

Table 2
Personal and demographic characteristics of sample (N = 17,224)*

Category	Total	Participants with arthritis†	Participants without arthritis	RA	OA
Age, y (mean ± SE)	54.4 ± 14.9	**60.4 ± 12.8**‡	**49.3 ± 14.2**‡	60.8 ± 12.5	63.9 ± 12.7
Age at diagnosis, y (mean ± SE)		48.18 ± 0.3	–	**44.6 ± 0.6**‡	**49.5 ± 0.5**‡
Sex (%)					
Male	8461 (48.1)	**2240 (39.6%)**‡	6221 (51.7)	408 (38.1)	749 (36.4)
Female	8763 (51.9)	**3257 (60.4)**‡	5506 (48.3)	626 (61.9)	1307 (63.6)
Race/Ethnicity (%)					
White	7995 (70.3)	2992 (76.6)	5003 (67.5)	432 (66.4)	1357 (84.2)
Black	3596 (10.9)	1215 (10.7)	2381 (10.9)	327 (18)	316 (6.7)
Hispanic	4145 (12.5)	1044 (8.3)	3101 (14.4)	233 (12)	289 (5.2)
Other	1488 (6.3)	246 (4.4)	1242 (7.2)	42 (3.6)	94 (3.9)
Marital status (%)					
Married, living together	10,821 (67.1)	3087 (62.9)	7734 (69)	537 (60.5)	1197 (63.9)
Divorced, widowed, separated	4531 (22.5)	1970 (30)	2561 (19.2)	403 (32)	717 (29.1)
Single, never married	1864 (10.4)	436 (7.1)	1428 (11.8)	93 (7.5)	141 (7)
Income					
<100% federal poverty rate (%)	776 (12.4)	291 (14.4)	485 (11.4)	83 (22.6)	71 (11.7)
100%–185% federal poverty rate	997 (17.6)	387 (21)	610 (16)	94 (24.7)	109 (17.5)
>185% federal poverty rate	2353 (70.1)	739 (64.6)	1614 (72.5)	116 (52.8)	253 (70.7)
Body mass index, kg/m^2 (mean ± SE)	30.1 ± 0.17	**30.98 ± 0.20**‡	**28.54 ± 0.13**‡	30.8 ± 0.37	30.9 ± 0.28
Total	17,224	5497	11 727	1034	2056

OA, osteoarthritis; RA, rheumatoid arthritis
*Data presented as total number of individuals in the sample and population-based percentages.
†Includes RA and OA.
‡$P < 0.05$ indicates statistical significance.

Regarding the type of arthritis, there were no significant differences in aMED scores (RA: 3.47 ± 0.12, OA: 3.63 ± 0.10; $P = 0.193$). Figure 2 shows the aMED score by each component. Individuals with arthritis had lower aMED scores than those without arthritis due to statistically significant fewer individuals receiving points for consuming vegetables (with arthritis: 48.8%, without arthritis: 52.7%; $P = 0.002$), and legumes (with arthritis: 16.7%, without arthritis: 21.3%; $P < 0.001$) greater than the population-based median intake. There were no significant differences in fruit/fruit juices ($P = 0.11$), nuts ($P = 0.20$), whole grains ($P = 0.07$), processed and red meats ($P = 0.41$), fish ($P = 0.79$), ratio of MUFAs to SFAs ($P = 0.43$), and alcohol ($P = 0.25$) intakes between individuals with and without arthritis.

Regarding the type of arthritis, there were no significant differences in aMED scores (RA: 3.47 ± 0.12, OA: 3.63 ± 0.10; $P = 0.193$) and no significant differences in any of the subgroups of aMED scores.

HEI-2015 Results

Individuals with arthritis also had lower total HEI-2015 scores, indicating worse dietary quality (with arthritis: 51.42 ± 0.37, without arthritis: 53.48 ± 0.28; $P < 0.001$; Fig. 1). Individuals without arthritis had significantly higher scores in total fruit, whole fruit, total vegetables, greens and beans, whole grains, seafood and plant protein, added sugars, SFAs, and empty calories (Table 3). Mean HEI-2015 scores for individuals with and without arthritis were slightly >50 points, falling into the "fair" diet quality category [21]. There were no differences between types of arthritis and total HEI-2015 scores (RA: 52.34 ± 0.98, OA: 53.06 ± 0.71; $P = 0.488$; Fig. 1). Seafood and plant protein was the only subgroup that had a significant difference (RA: 2.40 ± 0.13, OA: 2.69 ± 0.14; $P = 0.043$; Table 3).

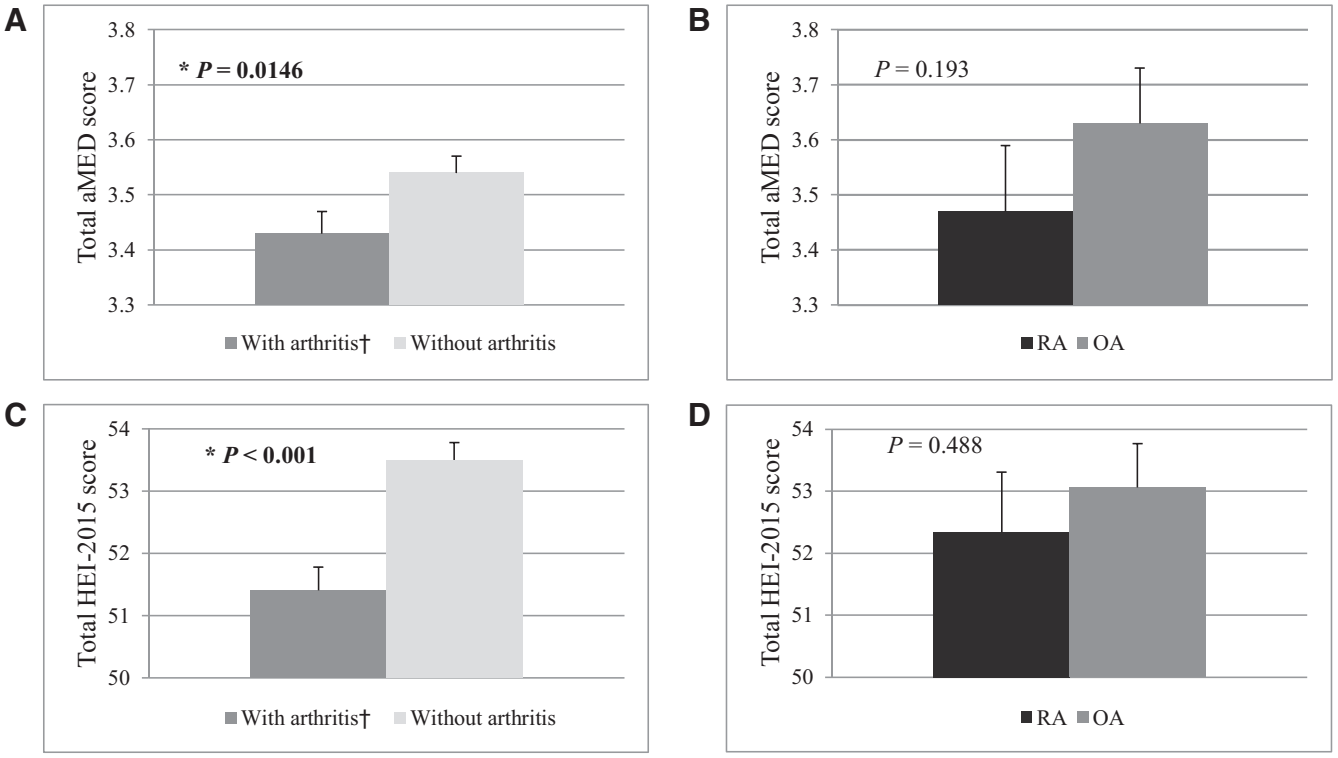

Fig. 1. Differences in total aMED scores and HEI 2015–2020 for the presence and types of arthritis. (Data from 24-h diet recall from the National Health and Nutrition Examination Survey 2007–2014.) (**A**) Differences in aMED scores between individuals with and without arthritis. (**B**) Differences in aMED scores between individuals with RA and OA. (**C**) Differences in HEI-2015 scores between individuals with and without arthritis. (**D**) Differences in aMED scores between individuals with RA and OA. *$P < 0.05$ indicates statistical significance. †"With arthritis" includes OA, RA, and psoriatic arthritis. aMED, alternate Mediterranean Diet; HEI, Healthy Eating Index; OA, osteoarthritis; RA, rheumatoid arthritis.

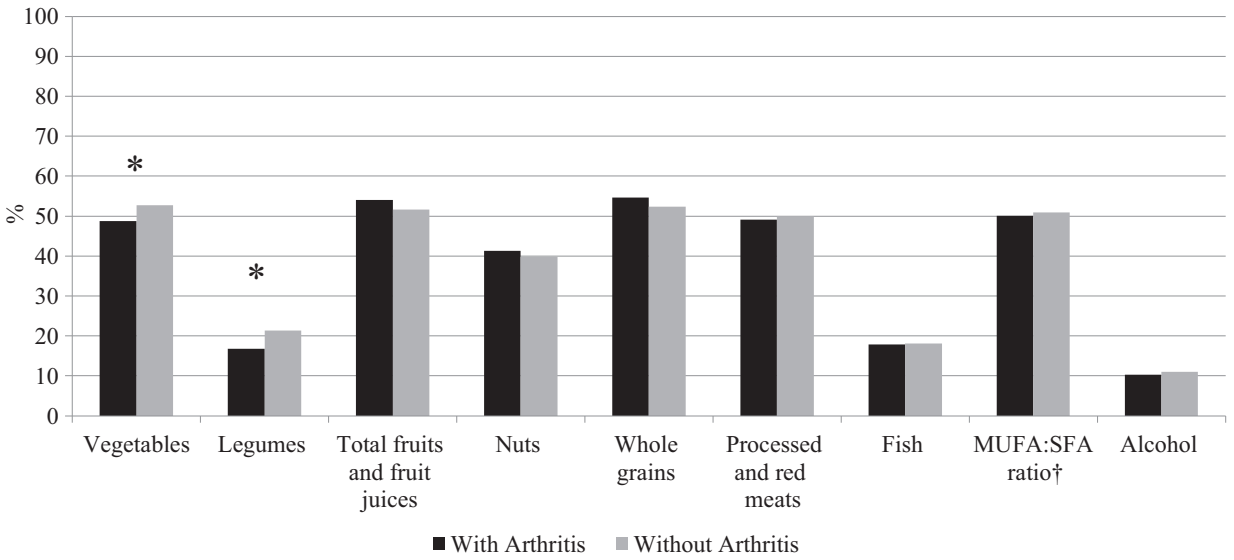

Fig. 2. Proportion of individuals with (includes OA, RA, and psoriatic arthritis) and without arthritis who received 1 point for each alternate Mediterranean Diet score subcategory. (Data from 24-hour diet recall from the National Health and Nutrition Examination Survey 2007-2014.) *$P < 0.05$ indicates statistical significance. †MUFA:SFA ratio = total monounsaturated fat intake to total saturated fat intake ratio. MUFA, monounsaturated fatty acid; OA, osteoarthritis; RA, rheumatoid arthritis; SFA, saturated fatty acid.

Nutrient results

Overall, individuals with arthritis consumed more calories and macronutrients than those without arthritis and had lower intakes of vitamins, minerals, and dietary fiber (Table 4). Individuals with arthritis consumed significantly more total sugar, total fat, total SFAs, and total MUFAs, while also consuming significantly less dietary fiber, and β-carotene. There were no significant differences between individuals with RA and OA in any macronutrient, vitamin, or mineral intake (Table 4).

Table 3
Differences in mean (SE) HEI 2015 scores for individuals with and without arthritis* by HEI-2015 subgroups

Healthy Eating Index score†	With arthritis Mean (SE)	Without arthritis Mean (SE)	*P*-value	RA Mean (SE)	OA Mean (SE)	*P*-value
Adequacy‡						
Total fruit (0–5)	2.25 (0.05)	2.39 (0.04)	**0.039**§	2.35 (0.15)	2.45 (0.11)	0.476
Whole fruit (0–5)	2.17 (0.05)	2.32 (0.04)	**0.019**§	2.21 (0.14)	2.40 (0.12)	0.160
Total vegetables (0–5)	3.06 (0.05)	3.22 (0.03)	**0.001**§	3.00 (0.11)	3.12 (0.09)	0.243
Greens and beans (0–5)	1.61 (0.05)	1.81 (0.05)	<**0.001**§	1.45 (0.13)	1.54 (0.10)	0.490
Whole grains (0–10)	2.48 (0.10)	2.78 (0.06)	**0.003**§	3.00 (0.23)	2.81 (0.17)	0.398
Dairy (0–10)	4.45 (0.08)	4.62 (0.06)	0.121	4.92 (0.18)	4.76 (0.22)	0.511
Total protein poods (0–5)	4.31 (0.03)	4.35 (0.02)	0.259	4.29 (0.07)	4.32 (0.06)	0.808
Seafood and plant proteins (0–5)	2.48 (0.05)	2.63 (0.05)	**0.002**§	2.40 (0.13)	2.69 (0.14)	**0.043**§
Fatty acids (0–10)	5.37 (0.09)	5.52 (0.06)	0.076	5.31 (0.27)	5.37 (0.22)	0.816
Moderation‖						
Refined grains (0–10)	5.94 (0.09)	6.12 (0.06)	0.090	5.99 (0.21)	5.90 (0.16)	0.632
Sodium (0–10)	4.15 (0.09)	4.18 (0.06)	0.687	4.19 (0.22)	4.29 (0.14)	0.588
Added sugars (0–10)	6.68 (0.10)	6.92 (0.07)	**0.013**§	6.79 (0.23)	6.90 (0.20)	0.597
Saturated fat (0–10)	6.43 (0.09)	6.61 (0.07)	**0.028**§	6.44 (0.25)	6.50 (0.18)	0.832
Empty calories (0–20)	13.11 (0.12)	13.54 (0.11)	<**0.001**§	13.24 (0.36)	13.4 (0.27)	0.686
Total HEI 2015 score (0–100)	51.42 (0.37)	53.48 (0.28)	<**0.001**§	52.34 (0.98)	53.06 (0.71)	0.488

HEI, Healthy Eating Index; OA, osteoarthritis; RA, rheumatoid arthritis
Analysis controlled for sex, race/ethnicity (white, black, Hispanic, or other), marital status (married/living as a couple, widowed/divorced/ separated, or single/never married), and poverty income ratio
*Includes RA and OA.
†Scores range from 0 to 100 and higher scores indicate better diet quality.
‡Higher scores indicate higher consumption.
§$P < 0.05$ indicates statistical significance.
‖High scores indicate lower consumption.

Table 4
Differences in mean (SE) macronutrient and antioxidant intake for individuals with and without arthritis*

	With arthritis Mean (SE)	Without arthritis Mean (SE)	*P*-value	RA mean (SE)	OA mean (SE)	*P*-value
Energy (kcal)	2113 (23.00)	2076 (18.00)	0.108	2037 (48.00)	2042 (43.00)	0.920
Protein (g)	83.13 (1.05)	82.18 (0.76)	0.358	78.34 (2.23)	79.93 (2.23)	0.434
Carbohydrate (g)	256.79 (2.76)	252.73 (2.00)	0.145	252 (6.00)	253 (5.00)	0.839
Total sugars (g)	111.96 (1.80)	107.78 (1.32)	**0.015**†	111 (5.00)	110 (4.00)	0.806
Dietary fiber (g)	17.14 (0.28)	17.98 (0.24)	**0.003**†	17.48 (0.64)	17.85 (0.71)	0.580
Total fat (g)	79.25 (1.12)	76.70 (0.83)	**0.027**†	77.46 (2.5)	76.48 (1.87)	0.714
Total SFAs (g)	25.32 (0.42)	24.28 (0.31)	**0.017**†	24.78 (0.93)	24.39 (0.73)	0.682
Total MUFAs (g)	28.55 (0.41)	27.66 (0.29)	**0.033**†	28.15 (1.00)	27.69 (0.68)	0.660
Total PUFAs (g)	18.30 (0.33)	17.95 (0.23)	0.239	17.55 (0.65)	17.59 (0.54)	0.953
Vitamin A, RAE (μg)	614.20 (16.82)	648.88 (15.32)	0.120	620 (28.00)	618 (31.00)	0.956
Vitamin C (mg)	86.51 (2.21)	91.55 (1.89)	**0.044**†	86.65 (4.92)	86.33 (4.20)	0.958
Vitamin E as α-tocopherol (mg)	8.30 (0.17)	8.41 (0.12)	0.414	8.42 (0.41)	8.43 (0.34)	0.980
β-carotene (μg)	2353 (106)	2648 (104)	**0.006**†	2184 (209)	2294 (210)	0.682
Lycopene (μg)	4814 (228)	4894 (190)	0.751	4895 (696)	5073 (489)	0.743
Selenium (μg)	116.85 (1.50)	114.87 (1.88)	0.160	110 (4.00)	114 (3.00)	0.205
Zinc (mg)	11.33 (0.17)	11.26 (0.13)	0.697	11.13 (0.31)	11.12 (0.34)	0.961

MUFA, monounsaturated fatty acid; OA, osteoarthritis; PUFA, polyunsaturated fatty acid; RA, rheumatoid arthritis; RAE, retinol activity equivalent; SFA, saturated fatty acid
Analysis controlled for sex, race/ ethnicity (white, black, Hispanic, or other), marital status (married/living as a couple, widowed/divorced/ separated, or single/never married), and poverty income ratio
*Includes RA and OA.
†$P < 0.05$ indicates statistical significance.

Association between dietary patterns and presence of arthritis

There were no associations between aMED scores or HEI-2015 scores and reporting having arthritis between the lowest, middle, and highest tertiles of scores (Table 5). Individuals in the highest tertile of aMED scores had a similar association of having arthritis compared with the lowest and middle tertile scores (middle tertile: odds ratio [OR], 0.96; 95% confidence interval [CI], 0.85–1.09; highest tertile: OR, 0.90; 95% CI, 0.82–1.00). Similar results were found within HEI-2015 scores. Individuals in the highest tertile did not have a significant difference in the association for having arthritis compared with the low and middle tertile groups (middle tertile: OR, 0.98; 95% CI, 0.89–1.08; highest tertile: OR, 0.97; 95% CI: 0.86–1.08).

Discussion

This study found significant differences in dietary patterns between individuals with and without arthritis. Individuals with arthritis had worse dietary quality and poorer adherence to the Mediterranean diet than those without the condition. The results of the present study were similar to previously published studies. A cross-sectional study comparing individuals with RA and healthy controls found that healthy participants had higher HEI-2005 scores than individuals with RA (RA: 54.8 ± 9.5; healthy controls: 58.6 ± 9; $P = 0.004$) [22]. A similar cross-sectional study found that individuals with RA had a mean HEI-2010 score of 58.7 ± 15.9 and only 7.1% of participants' scores were "good," 58.3% were "fair," and 34.5% were "poor" [21]. These previous

Table 5
Associations between aMED and HEI-2015 and the presence of arthritis*

	Lowest tertile	Middle tertile†	Highest tertile
aMED Low: <3 Middle: 3 High: ≥4	1.00	0.96 (0.85–1.09)	0.90 (0.82–1.00)
HEI-2015 Low: ≤45.5901 Middle: 45.5901–58.1043 High: >58.1043	1.00	0.98 (0.89–1.08)	0.97 (0.86–1.08)

aMED, alternate Mediterranean Diet; HEI, Healthy Eating Index; OA, osteoarthritis; RA, rheumatoid arthritis
Analysis controlled for sex, race/ ethnicity (white, black, Hispanic, or other), marital status (married/living as a couple, widowed/divorced/separated, or single/never married), and poverty income ratio
*Includes RA and OA.
†Results presented as OR (95% CI).

studies also found that only 35.7% of individuals with arthritis received the maximum HEI score for vegetables and individuals with arthritis consumed significantly less fiber than those without arthritis [21,22]. These results were similar to the findings in the present study and indicate that individuals with arthritis have poor diet quality.

Individuals with arthritis not only had worse diet quality and adherence to the Mediterranean diet, but they also had significantly higher BMIs than individuals without arthritis. Other research has reported individuals with RA had a mean BMI of 29.6 ± 8.8 kg/m^2, which was similar to the present study [21]. Excess body weight can exasperate arthritis symptoms such as pain and joint stiffness [23,24]. Additionally, overweight and obesity are risk factors for OA and weight loss has been reported to improve knee pain and function in individuals with OA [23–25]. Related to RA, severe obesity has been associated with more rapid progression of disability [26]. Individuals with arthritis can take steps to improve their diet quality as a method to maintain a healthy weight and possibly reduce arthritis symptoms.

There were multiple possible explanations for individuals with arthritis having poorer diet quality. Studies have indicated that the functional disabilities of arthritis may affect ability to prepare meals or self-feed [21]. A previous study by Grimstvedt et al. found that Health Assessment Questionnaire scores, a measure of functional status, were inversely correlated with diet quality scores in individuals with RA, and higher functional impairments resulted in worse diet quality [22]. This impairment may cause individuals with arthritis to purchase more convenience foods, which tend to have a lower nutrient content.

Individuals with arthritis were also significantly older at screening than those without the condition. Typically, older adults in the United States tend to have better diet quality than middle-aged adults in part due to becoming more conscious of nutrition as a way to manage or prevent chronic diseases [27]. Also, a greater number of older adults participate in food-assistance programs such as the Supplemental Nutrition Assistance Program or home-delivered meals, which may improve their diet quality. However, in older adults, many sociodemographic and health characteristics have been associated with overall diet quality, such as smoking status, income level, and dental health [28]. A previous study found that 85% of individuals with RA were nonsmokers compared with 96% of healthy participants [22]. If similar patterns occurred in the present study, smoking status may have contributed to the observed differences in diet quality. Also, research has indicated that diet quality improves as income level increases [27]. In the present study, 72.5% of individuals without arthritis were >185% of the federal poverty rate, whereas only 64.6% of individuals with arthritis were >185% of the federal poverty rate. These variables may explain the differences in diet quality because individuals with arthritis may not be able to afford fresh and healthier foods. Additionally, edentulous persons have poorer diet quality than individuals with all their teeth [24]. A NHANES study found that individuals with RA are more likely to be edentulous and have periodontitis than those without arthritis [29]. Smoking status, income level, and dental health may explain some of the differences in diet quality between individuals with and without arthritis.

Regarding the type of arthritis, there were no significant differences in dietary patterns and macronutrient intake between individuals reporting RA and OA. To our knowledge, this was the first study to compare diet quality between types of arthritis. However, a 2017 study assessed nutrition beliefs in individuals with RA and OA with a health screening questionnaire and found that 62% of individuals with RA and 50% of individuals with OA believed they have an appropriate diet [30]. The previous study did not assess actual dietary patterns, but this present study found that individuals with arthritis do not have optimal diet quality. In combination, these results may indicate a difference in perception of diet and actual diet quality scores for individuals with arthritis. Also, in the previous study, 32% of individuals with RA and 17% of individuals with OA reported changing their dietary habits after diagnosis ($P = 0.049$), but only 5% and 4%, respectively, reported seeing a registered dietitian [30]. Of the individuals who changed their diets, the most common changes were decreased consumption of sweets, abstaining from meat, and abstaining from diary [30]. It may be beneficial to target those individuals with poor diet quality or individuals desiring to improve their diet quality and refer them to a registered dietitian for nutritional counseling. Registered dietitians are experts in facilitating behavior change and knowledgeable about the Mediterranean diet and maintaining a healthy weight.

There were no significant associations between adherence to the Mediterranean diet or diet quality and the presence of arthritis. The present study did not assess the effects of diet quality on the risk for arthritis or severity of arthritis symptoms. A potential reason no association was found in this study may be due to use of “presence of arthritis” as the comparative variable. Assessing diet quality scores and severity arthritis symptoms (i.e., morning stiffness, pain, etc.) may be more advantageous to assess if the Mediterranean diet and better diet quality improve arthritis conditions. Further research should be conducted to understand differences in dietary intake and presence and type of arthritis as found in this study.

This study’s finding that individuals with arthritis have worse diet quality than those without arthritis can be useful in a practical setting. Clinicians can encourage patients with arthritis to improve their diets by eating more vegetables, plant-based protein, and whole grains. They can also recommend following a dietary pattern similar to the Mediterranean diet as a way to not only improve their diet quality but the management of their disease. Previous studies have found that the Mediterranean diet can improve pain, early morning stiffness, disease activity, and physical function in individuals with RA [8,9,31]. Related to OA, higher adherence to the Mediterranean diet is positively associated with better quality of life [32,33]. Additionally, the Mediterranean diet can reduce serum cartilage oligomeric matrix protein, a marker of cartilage degradation, by 8% and interleukin-1a by 47% in patients

with OA [34]. This evidence suggests that the Mediterranean diet has been beneficial as an intervention to reduce symptoms in RA and OA. Clinicians should recommend this dietary pattern to patients with arthritis as a possible intervention to reduce inflammatory symptoms.

Although individuals without arthritis had better adherence to the Mediterranean diet and diet quality, overall scores for this group were still poor. Individuals without arthritis were younger (~50 y of age) and may also benefit from improving diet quality at this age to help maintain a healthy body weight. Poor diet quality can lead to weight gain and overweight or obesity, both of which are risk factors for OA [23,24].

Strengths and limitations

The present study was unique in its use of NHANES data, which is cross-sectional and weighted to produce nationally representative data of the U.S. population. Research indicates that the Mediterranean diet can affect the severity of arthritis symptoms and to our knowledge, this was the first study to examine current adherence to the diet in individuals with arthritis. The study was also unique in assessing dietary differences between types of arthritis. Using both aMED and HEI-2015 scores was another strength of the study. Although aMED and total HEI-2015 scores cannot be compared directly due to inherent differences in calculating the scores, the results of the present study demonstrate similarities between the diet indices scores. Low intakes of specific aMED components in one group were also low in the similar HEI-2015 component, indicating similarities of measurements for the two assessments.

A limitation to the present study was the reliance on self-reported data for medical information, such as the presence and type of arthritis, and dietary information. There may have been individuals with undiagnosed arthritis in the "no" category. An additional limitation to the study was the use of BMI as indication for weight status. BMI solely measured the ratio of weight to height and did not take body composition into consideration. The method of collecting dietary information in the present study was done by a 24-h recall, which is not reflective of day-to-day variations in diet. However, to limit recall bias, the 24-h recall was completed using an automated multiple pass method to decrease gaps in memory and over- or underestimation. Measuring utensils were also used to accurately estimate portion sizes during data collection. Another limitation to the present study was the lack of information on smoking, physical activity, and oral health, which have been found to affect the functional ability of individuals with RA or OA [29,32,35].

Conclusion

This study investigated the differences in diet quality between the presence and type of arthritis. Individuals with arthritis tend to have worse diet quality, as measured by aMED and HEI-2015 scores, and higher BMIs than their counterparts without arthritis. There were no significant differences between individuals with OA and RA in aMED scores, HEI-2015 scores, and macronutrient intake. There were also no associations between diet quality scores and the presence of arthritis. Individuals diagnosed with arthritis can take steps to improve their diet quality as a possible method to maintain a healthy body weight and manage arthritis symptoms. Further research should be conducted on adherence to the Mediterranean diet or higher diet quality and the potential to prevent and manage arthritis.

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