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# Lower Healthy Eating Index-2005 dietary quality scores in older women with rheumatoid arthritis *v.* healthy controls

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## Abstract

*Objective:* To assess the dietary quality of older women with and without rheumatoid arthritis (RA) using the Healthy Eating Index-2005 (HEI-2005) to identify potential strategies to improve the nutritional status.
*Design:* Cross-sectional. Diet was assessed using 7 d food records and analysed for nutrient composition (Food Processor v. 7·11). Diet quality was determined using the HEI-2005, a measure of compliance with 2005 US Dietary Guidelines. Individuals with RA completed a self-reported evaluation of arthritis (pain scale and disability index). Independent two-tailed *t* tests or Mann–Whitney tests compared the differences between groups and correlations were computed between HEI-2005 and measures of disease reactivity.
*Setting:* Arizona, USA.
*Subjects:* Older (≥ 55 years) women (*n* 108) with RA (*n* 52) and healthy controls (HC; *n* 56).
*Results:* There were no differences between groups in age, weight, or BMI ($kg/m^2$). HC participants had higher mean HEI-2005 scores for whole fruit (cups; $P = 0·02$), total fruit (cups; $P = 0·05$), whole grains (oz; $P = 0·004$), oil (g; $P = 0·05$) and total HEI score ($P = 0·04$) than the RA group. In the RA group, these same HEI components were inversely correlated with disability index ($r = -0·20$, $P = 0·04$). Participants with RA reported lower mean intakes of carbohydrate (g; $P = 0·02$), fibre (g; $P = 0·01$) and vitamin C (mg; $P = 0·04$).
*Conclusions:* This is the first study examining the dietary quality in older women with and without RA using the HEI-2005. Living with RA was associated with significantly lower dietary quality. Since even small changes in dietary quality can translate into better nutritional status, future interventions should focus on increasing dietary quality in this high-risk group.

**Keywords**
Healthy Eating Index-2005
Dietary quality
Rheumatoid arthritis
Women

Arthritis is the most common cause of disability in the United States, affecting one in five adults and nearly 300 000 children[1]. As the population ages, the prevalence is expected to increase from forty-six million (during 2003–2005) to approximately sixty-seven million US adults[1]. Several joint and musculoskeletal conditions are considered as forms of arthritis, including rheumatoid arthritis (RA)[2]. RA is an autoimmune disorder characterised by chronic joint synovium inflammation[3]. It can be difficult to separate RA from other forms of arthritis, as there is not a single definitive symptom specific to RA alone[3]. The 1987 revised criteria, set forth by the American College of Rheumatology, is the most common diagnostic tool. To be diagnosed with RA, one must meet at least four of the following seven criteria: (i) morning joint stiffness lasting at least an hour before improvement; (ii) arthritis of three or more joint areas for at least 6 weeks; (iii) arthritis of hand joints for at least 6 weeks; (iv) symmetrical arthritis; (v) presence of rheumatoid nodules; (vi) presence of serum rheumatoid factor; and (vii) radiographical changes as determined by X-ray[4].

According to these criteria, the prevalence of RA in adults is approximately 1 %[5,6]. Another research study estimated a 1·4 % prevalence rate for women and 0·7 % rate for men in the United States[3]. RA is twice as common in women as men and often begins in middle and late adulthood[3,6]. The average age for RA peak incidence is 55–64 years in women and 65–75 years in men[3]. Risks associated with RA include joint destruction, deformity, loss of physical function, increased mortality

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rates and lower quality of life, largely attributed to pain and fatigue[3,6,7].

Nutrient intake and diet appear to be important components of RA disease activity[8]. Research suggests that individuals with RA may have poorer dietary habits and inadequate nutrient intake compared with those without RA[2,9–11]. Several explanations for these differences include limited ability to shop and/or prepare food due to the pain and loss of physical function characteristic of RA, side effects of medication, and finally, the pathology of the disease itself that may cause reduced appetite/desire to eat[12–14].

Commonly used methods of nutritional assessment include standardised anthropometric techniques (e.g. height, weight, skinfold assessment), serum blood measurements and specific nutrient evaluation through self-reported food intake[15,16]. Many of these assessment tools may not be appropriate or reliable for use within the RA population. For example, Elkan *et al.* [17] report that BMI (kg/m$^2$) was an inappropriate diagnostic measure of malnutrition in the RA population. In this sample, 52 % (*n* 26) of women and 30 % (*n* 3) of men were considered malnourished as determined by the fat-free mass index; however, only 12 % of women and none of the men had a BMI less than 18·5 kg/m$^2$. Thus, better diagnostic instruments to evaluate nutritional status in this population are needed. Serum or blood measurements may be misinterpreted in an RA population due to the negative effect of inflammation on serum albumin, thyroxine-binding pre-albumin and retinol-binding globulin[18]. Furthermore, such measurements may not be representative of long-term intake for several nutrients. Finally, traditional methods of nutrition assessment, such as food frequency or food records, focus largely on energy and nutrient intakes, rather than dietary quality and food patterns. Nutrients are found in a variety of foods in various amounts; thus, it can be difficult for the average layperson to determine the type or amount of these foods to consume for optimal benefits. In addition, focusing on single nutrients does not take into account the complexity of the human diet[19].

A public health approach to nutrition involves a shift in focus from a single nutrient to dietary quality. Researchers have examined several methods of determining dietary quality. Common approaches include the Diet Quality Index (DQI), the DQI-Revised (DQI-R), the Healthy Diet Indicator (HDI), the Healthy Eating Index (HEI) and the HEI-2005[20]. The original DQI was developed to assess eight food groups, but was found to be only marginally associated with nutrient adequacy[20]. The DQI was revised in 1994 (DQI-R) to more accurately reflect changes in nutrition policy[21]. Although the DQI-R is significantly correlated with several plasma biomarkers, it is not associated with markers of inflammation[20]. The HDI is based on the dietary guidelines for the prevention of chronic disease set forth by the WHO in 1990[22]. Scoring involves a dichotomous (yes/no) response for meeting recommended ranges of nine categories including saturated fats, polyunsaturated fats, protein, complex carbohydrates, fibre, fruits and vegetables, pulses, nuts and seeds, monosaccharides and disaccharides and cholesterol[22]. The HEI is based on the 1992 Food Guide Pyramid and is composed of ten components allowing for scores of 0–10 for each. This approach allows for the assignment of different food groups to mixed dishes. For example, lasagna would have points allotted to grain (for the pasta), vegetable (tomato and tomato sauce) and milk (cheese)[23]. A newer version of the HEI has been created, the HEI-2005. This system of assessment reflects the 2005 version of the Dietary Guidelines for Americans/MyPyramid Food Guidance System and is based on energy density rather than quantity[24–26]. The HEI-2005 scoring system comprises twelve component scores representing the following intake groups: total fruit, whole fruit (excluding juice consumption), total vegetables, dark green and orange vegetables and legumes, total grains, whole grains, milk, meat and beans, oils, saturated fat, sodium and energy from solid fat, alcohol and added sugar per 4184 kJ (see Table 2). Ways in which the HEI-2005 differs from the original HEI include assessment based on a density basis and the inclusion of the whole fruit, dark green and orange vegetables and legumes, whole grains, oils and kilojoules from solid fat, alcohol and added sugar categories[27]. The HEI-2005 is a unique and relevant approach to dietary quality assessment. Research has found significant inverse associations between the HEI (original and HEI-2005) and several markers of health including plasma blood markers (antioxidant concentrations, C-reactive protein), overweight, obesity and metabolic syndrome[19,28–30]. It is clear that HEI is a relevant marker of dietary health; however, less is known about HEI in women with RA.

The present study examines dietary quality in older women with and without RA using the HEI-2005 scoring system. It was predicted that women with RA would have lower component and total HEI scores than similar healthy women. By identifying potential differences, we hope to highlight the need for dietary intervention in a high-risk group and simple dietary strategies that women with RA can use to improve their dietary quality.

## Experimental methods

### *Study design*

A cross-sectional design was utilised to compare the dietary quality of older women with RA (*n* 52) and healthy controls (HC; *n* 56) of similar age and BMI.

### *Participants*

Women (≥ 55 years old) were recruited from the local community through arthritis support groups, arthritis clinics, women's groups and senior centres. Eligibility criteria consisted of a clinical diagnosis of RA for at least

**Table 1** Participant characteristics stratified by group (*n* 108)

| Variable | Rheumatoid arthritis (*n* 52) | | | | Healthy controls (*n* 56) | | | | *P* value |
|---|---|---|---|---|---|---|---|---|---|
| | *n* | % | Mean | SD | *n* | % | Mean | SD | |
| Age, years | | | 65·0 | 6·0 | | | 66·0 | 6·0 | 0·34 |
| Race | | | | | | | | | |
| Caucasian | 44 | 85 | – | | 54 | 96 | – | | |
| Non-Caucasian | 8 | 15 | – | | 2 | 4 | – | | |
| Currently taking hormone replacement therapy | 36 | 69 | – | | 29 | 52 | – | | |
| Non-smoker | 43 | 17 | – | | 53 | 5 | – | | |
| Height (cm) | | | 160·0 | 7·0 | | | 163·0 | 6·0 | 0·02* |
| Weight (kg) | | | 65·0 | 15·0 | | | 68·0 | 14·0 | 0·33 |
| BMI (kg/m$^2$) | | | 25·7 | 5·7 | | | 25·5 | 4·8 | 0·86 |
| Duration of disease (years) | | | 23·0 | 14·0 | | | – | | |
| Current use of methotrexate | 22 | 42 | – | | – | | – | | |
| Current use of prednisone | 19 | 37 | – | | – | | – | | |
| C-reactive protein (CRP) (mg/dl)† | | | 1·5 | 1·7 | | | 0·4 | 0·8 | 0·01** |
| HAQ (0–3)‡ | | | 1·5 | 0·8 | | | 0·3 | 0·6 | 0·01** |
| Pain scale§ | | | 45·0 | 29·0 | | | – | | |

†Where ≤ 1 is low risk, 1·1–2 is moderate risk and >2 is high risk[35].
‡Stanford Health Assessment Questionnaire (HAQ) index is a measure of functional status (scored 0–3, with 3 being unable to perform) in eight categories of function (dressing/grooming, arising, eating, walking, hygiene, reach, grip and errands/chores).
§Measure of overall pain using a visual analogue scale of 0–100, with 100 representing maximum pain.
*Significant at the 0·05 level.
**Significant at the 0·01 level.

5 years for the RA group or never diagnosed with RA for the HC group. Exclusion criteria included diagnosis of any serious health problems including renal, hepatic or CVD. Potential participants were interviewed over the telephone to determine eligibility. The Arizona State University Institutional Review Board approved the present study and the research was conducted according to these guidelines.

### *Data collection*

Participants completed the questionnaires to evaluate the current health, health and medical history and a self-reported evaluation of arthritis, including pain scale and a disability index derived from the Stanford Health Assessment Questionnaire (HAQ)[31,32]. Information regarding medication use was obtained from the interviews with participants. Anthropometric measurements were obtained using a balance beam scale for weight and height (HealthOMeter; Sunbeam Products, Boca Raton, FL, USA). BMI (kg/m$^2$) was then computed from these measurements. The 7 d weighed food records were completed by participants and analysed using the Food Processor Nutrition and Fitness Software version 7·11 (ESHA Research, Salem, OR, USA). Before completion, participants received instruction on how to complete the food records from a registered dietitian. After completion, records were reviewed and clarified by a registered dietitian to ensure accuracy. Reported daily intake of nutrients was determined, including energy, fat, saturated fat, protein, carbohydrate, fibre, sugar, vitamin C and calcium. Fasting blood samples were drawn from each participant and samples were centrifuged within 30 min at 3000**g** for 10 min at 4°C. The blood was separated and samples were stored at −45°C.

### *Dietary quality*

Dietary quality was measured using HEI-2005. HEI-2005 establishes a score, ranging from 0 to 100, based on twelve dietary criteria, with lower scores indicating poor dietary quality. The 2005 scoring system is based on nutrient density rather than energy intake[27]. The first nine of the twelve dietary components making up the HEI-2005 – total fruit (cups), whole fruit (excluding juice consumption; cups), total vegetables (cups), dark green and orange vegetables and legumes (cups), total grains (oz), whole grains (oz), milk (cups), meat and beans (oz), oils (g) – are expressed per 4184 kJ. Increased consumption of foods fitting within these categories contributes to a higher HEI total score[33]. For example, to obtain the maximal five points for the total vegetables component, one must consume ≥ 1·1 cups of total vegetables per 4184 kJ. If one consumes 7531 kJ in 1 d, and only one cup of vegetables, he or she would score 2·5 points towards his or her total HEI score. If this same person consumed 11 715 kJ and only one cup of vegetables, vegetable component points would equal 1·6 points. The last three of the twelve components (saturated fat (% energy), sodium (g), and kilojoules from solid fat, alcohol and added sugar (% energy)) are based on the percentage of total energy intake. Lower intake of these components contributes to a higher HEI-2005 total score.

Each day of every participant's 7 d weighed food records was scored following the Development and Evaluation of the HEI-2005 Technical Report[27]. An average of the 7 d was used to determine each participant's final HEI-2005 component and total score. Atypical food items, such as mixed dishes, were divided into categories using the American Diabetes Association's Exchange Lists for Diabetes and then scored[34]. HEI

**Table 2** Participant Healthy Eating Index (HEI-2005) scores stratified by group (*n* 101)

| | | Rheumatoid arthritis (*n* 48) | | Healthy controls (*n* 53) | | |
|---|---|---|---|---|---|---|
| Variable | Score range | Mean | SD | Mean | SD | *P* value |
| Whole fruit (cups)† | 0–5 | 3·1 | 1·6 | 3·7 | 1·3 | 0·02* |
| Total fruit (cups)† | 0–5 | 3·4 | 1·3 | 4·0 | 1·1 | 0·05* |
| Total vegetables (cups)† | 0–5 | 3·1 | 1·5 | 3·5 | 1·0 | 0·30 |
| Dark green, orange vegetables and legumes (cups)† | 0–5 | 1·4 | 1·3 | 1·5 | 1·0 | 0·37 |
| Total grain (oz)† | 0–5 | 4·3 | 0·6 | 4·4 | 0·5 | 0·37 |
| Whole grain (oz)† | 0–5 | 0·9 | 1·2 | 1·6 | 1·3 | 0·004** |
| Milk (cups)† | 0–10 | 4·0 | 2·9 | 4·5 | 2·8 | 0·30 |
| Meat and beans (oz)‡ | 0–10 | 6·8 | 2·6 | 7·4 | 2·1 | 0·19 |
| Oil (g)† | 0–10 | 1·1 | 1·3 | 1·7 | 1·8 | 0·05* |
| Saturated fat (% energy)† | 0–10 | 5·9 | 2·8 | 6·2 | 2·5 | 0·69 |
| Sodium (g)‡ | 0–10 | 4·7 | 2·1 | 4·5 | 1·6 | 0·47 |
| Added sugar, Fat and alcohol† (% energy) | 0–20 | 17·0 | 3·6 | 17·2 | 2·8 | 0·85 |
| Total score‡,§ | 0–100 | 54·8 | 9·5 | 58·6 | 9·0 | 0·04* |

†Determined using Mann–Whitney non-parametric test.
‡Determined using independent *t* tests.
§Where ≤ 50 is poor; 51–80 is needs improvement; >80 is good[33].
*Significant at the 0·05 level.
**Significant at the 0·01 level.

coding was standardised by two investigators and weekly meetings assured that scoring was done consistently and correctly.

### *Measures of disease activity*

Fasting C-reactive protein (CRP) concentration, an inflammation marker, was measured for all participants. After a 12 h fast, blood was collected using a 23 g × 1″ needle into a red-top serum separation tube. After 15 min, the tube was spun for 15 min at 25°C in a centrifuge. Samples were then sent to an outside laboratory, Sonora Quest, for serum CRP concentration analysis. The Stanford HAQ was used as a measure of functional status for all participants[31,32]. This questionnaire consists of twenty questions in eight categories of function (dressing/grooming, arising, eating, walking, hygiene, reach, grip and errands/chores). Each question was scored from 0 to 3, with 0 indicating no difficulty in completing the task, 1 indicating some difficulty, 2 indicating much difficulty and 3 indicating inability to complete the task. If a participant was dependent on the use of a physical aid or device to help them complete the task in a given category, the minimum possible score for that category was raised to two. The highest score from each category were averaged to give the disability index (ranged from 0 to 3). In addition, those in the RA group provided a measure of pain, assessed using a visual analogue pain, reporting a number between 0 and 100 mm, with 100 representing maximum pain.

### *Statistical analysis*

Power calculations determined from pilot data collected in our laboratory found that a sample size of thirty-two women per group would be sufficient to detect a difference with a power of 0·80 and an $\alpha$ of 0·05. Descriptive statistics were computed for the characteristics of the study participants (mean and SD). The Kolmogrov–Smirnov statistic and histograms were used to test the normality of variables. These tests revealed the following variables to be non-normally distributed: carbohydrate (g), vitamin C (mg), whole fruit HEI (cups), total fruit HEI (cups), total vegetables, dark green, orange vegetables & legumes HEI (cups), total grain HEI (oz), whole grain HEI (oz), milk HEI (cups), oil HEI (g), saturated fat HEI (% energy) and added sugar, fat and alcohol HEI (% energy). Independent, two-tailed *t* tests were utilised to test for differences between the RA and HC groups on variables deemed to be normally distributed. Mann–Whitney tests were utilised for non-normally distributed variables. Equality of variance was checked using Levene's test. Pearson correlations were computed between measures of disease reactivity (CRP and HAQ) and HEI-2005 scores for all participants. All analyses were performed using the Statistical Package for the Social Sciences statistical software package version 15·0 (SPSS Inc., Chicago, IL, USA), and results were considered significant if *P*-value was ≤ 0·05.

## Results

Characteristics of participants (*n* 108) are reported in Table 1. There were no significant differences between the RA and HC groups in age, weight or BMI. Of the HC participants, 96 % reported being non-smokers, whereas only 85 % of RA participants were non-smokers. Less than half of the RA participants reported the use of methotrexate (*n* 22; 42 %) or prednisone (*n* 19; 37 %) to treat the disease. On average, duration of disease was approximately 23 years. Using the 0–3 scale of the HAQ, measure of disability was approximately 1·5, whereas pain on average was self-reported as 41 on a 1–100 visual analogue pain scale.

Analyses revealed significant differences between the RA and HC groups in the total HEI score (RA = 54·8 (SD 9·5);

**Table 3** Dietary characteristics stratified by group determined by the 7 d weighed food records (*n* 108)

| Variable | Rheumatoid arthritis (*n* 49) | | Healthy controls (*n* 53) | | *P* value |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | |
| Energy intake (kcal)† | 1446 | 389 | 1580 | 334 | 0·07 |
| Fat (g)† | 47 | 20 | 51 | 18 | 0·43 |
| Fat (% energy)† | 28 | 10 | 29 | 7 | 0·63 |
| Saturated fat (g)† | 16 | 9 | 18 | 11 | 0·28 |
| Saturated fat (% energy)† | 9 | 4 | 10 | 3 | 0·63 |
| Protein (g)† | 60 | 16 | 65 | 16 | 0·09 |
| Protein (% energy)† | 17 | 4 | 17 | 3 | 0·59 |
| Carbohydrate (g)† | 196 | 59 | 216 | 46 | 0·02* |
| Carbohydrate (% energy)† | 54 | 8 | 55 | 9 | 0·56 |
| Fibre (g)† | 15 | 6 | 18 | 6 | 0·01** |
| Sugar (g)† | 84 | 44 | 95 | 29 | 0·14 |
| Vitamin C (mg)‡ | 95 | 54 | 129 | 63 | 0·004** |
| Calcium (mg)† | 686 | 361 | 712 | 237 | 0·67 |

†Determined using independent sample *t* tests. 1 kcal = 4·184 kJ.
‡Determined using Mann–Whitney non-parametric test.
*Significant at the 0·05 level.
**Significant at the 0·01 level.

HC = 58·6 (SD 9·0); $P = 0·04$) and several of the twelve dietary components making up the HEI-2005 (Table 2). Participants in the HC group reported higher HEI-2005 component scores for whole fruit (cups: RA = 3·1 (SD 1·6); HC = 3·7 (SD 1·3); $P = 0·02$), total fruit (cups: RA = 3·4 (SD 1·3); HC = 4·0 (SD 1·1); $P = 0·05$), whole grains (oz: RA = 0·9 (SD 1·2); HC = 1·6 (SD 1·0); $P = 0·004$) and oil (g: RA = 1·1 (SD 1·3); HC = 1·7 (SD 1·8); $P = 0·05$).

There was a significant inverse correlation between the HAQ and total HEI ($r = -0·20$, $P = 0·04$); thus, as HAQ increased, quality of diet decreased. CRP was not significantly correlated with HEI-2005 scores ($r = 0·06$, $P = 0·56$).

Selected dietary characteristics are shown in Table 3. Mean energy intake, fat (g and % energy), saturated fat (g and % energy) and protein (g and % energy) did not differ significantly between the RA and HC groups; however, those in the HC group reported higher mean intake of each. Participants with RA reported significantly lower intakes of carbohydrate (g: RA = 196 (SD 59); HC = 216 (SD 46); $P = 0·02$), fibre (g: RA = 15 (SD 6); HC = 18 (SD 6); $P = 0·01$) and vitamin C (mg: RA = 95 (SD 54; HC = 129 (SD 63); $P = 0·04$).

## Discussion

This is the first study to examine the dietary quality in older women with and without RA using the HEI-2005. Our results indicate that participants with RA had significantly lower component scores and total quality HEI score than HC, without significant differences in a 7 d average energy, fat, saturated fat and protein intake. Analyses revealed that participants in the HC group had significantly higher dietary quality scores in whole fruit (cups; $P = 0·02$), total fruit (cups; $P = 0·05$), whole grains (oz; $P = 0·004$), oil (g; $P = 0·05$) and total HEI score ($P = 0·04$). Recent emphasis have been placed on dietary quality and food patterns[19,36]. Low dietary diversity and variety have been associated with increased risk of all-cause mortality and chronic disease[28,29,37]. From a public health perspective, people are advised to eat a variety of nutritious foods, not specific nutrients. The present study found that when comparing the dietary intakes of these two groups, significant differences were found in dietary quality components, whereas traditional single-nutrient analysis found fewer significant differences.

The HEI-2005 scoring for total fruit consumption requires ≥0·8 cups of fruit per 4184 kJ for a maximal score, whereas whole fruit consumption requires ≥0·4 cups of fruit per 4184 kJ[26]. HC participants reported more servings per 4184 kJ for both whole fruit and total fruit (includes fruit juice) than the RA participants. Fruit is an important source of vitamins, minerals, fibre and antioxidants[24,38]. Whole fruits are particularly essential elements of diet, as opposed to fruit juices that may have lesser amounts of these. In our sample, participants with RA also reported consuming significantly lesser fibre (g; $P = 0·01$) and vitamin C (mg; $P = 0·04$) than HC. Research suggests that high fruit consumption is associated with lower odds of impaired lower-extremity function and instrumental activities of daily living in older white women[39]. The mechanisms behind the protective effects of consuming fruit remain unclear, but it is hypothesised that increased intake of antioxidants plays a role[40]. Antioxidants may help prevent free radical damage that contributes to inflammation associated with RA. Additional research has found an inverse association between increased fruit consumption with metabolic syndrome, CVD and decreased levels of CRP[41]. This offers another benefit of fruit consumption for individuals with RA, as they are at increased risk of cardiovascular morbidity and

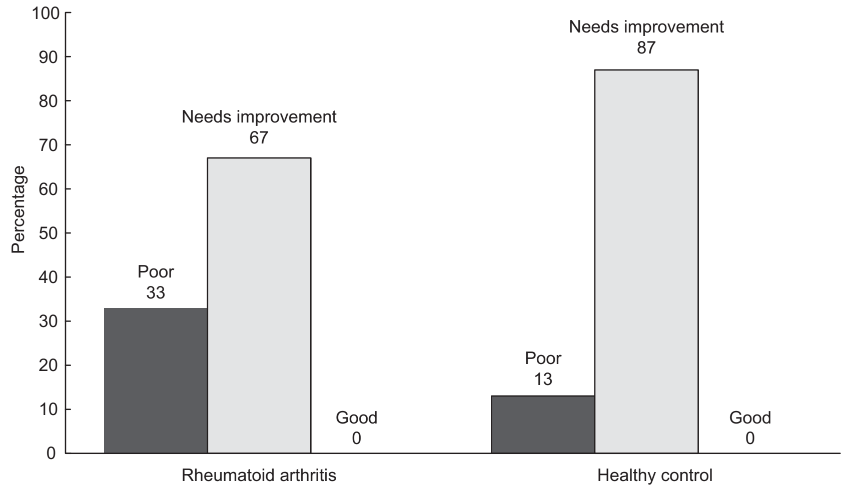


**Fig. 1** Percentage of rheumatoid arthritis and healthy control groups by Healthy Eating Index (HEI-2005) score category

mortality[3,6,7]. Overall, more research is needed to examine the effects of fruit intake specific to RA.

To be included in the HEI-2005 whole grain category, the food item must contain the entire grain kernel[26]. Examples include oatmeal, bulgur, buckwheat and brown rice. A maximal score in this category requires consumption of 1·5 oz/4184 kJ. RA participants reported significantly lower whole grain intake (0·9 (SD 1·2) oz/4184 kJ) than HC participants (1·6 (SD 1·3) oz/4184 kJ), while total grain intake was similar. The most recent US Dietary Guidelines place greater emphasis on whole grain intake as opposed to refined grains[24]. Whole grains are a good source of fibre, vitamins and minerals, such as magnesium and antioxidants. In the present study, participants with RA reported significantly lower intakes of carbohydrate (g; $P = 0·02$) and fibre (g; $P = 0·01$) than the HC participants. An earlier study by Kremer and Bigaouette found that female participants with RA consumed significantly less carbohydrate and fibre than recommended[9]. Another study using the original HEI found that CRP was inversely associated with the grain component HEI score[30]. CRP is a non-specific inflammatory marker that has been associated with RA and also with microvascular dysfunction[42]. In the present sample, we did not find a significant association between CRP and grain HEI.

Oils are also an important part of the diet due to the provision of essential fatty acids and vitamin E. In the HEI-2005, the oil category consists of non-hydrogenated oils and oils from nuts, seeds and fish[24]. To score the maximal 10 points in this HEI category, one must consume ≥ 12 g of oil per 4184 kJ[26]. In the present study, participants with RA (1·1 (SD 1·3) g/4184 kJ) had a significantly lower intake of oil than HC participants (1·7 (SD 1·8) g/4184 kJ, although both were very low. Similarly, Kremer and Bigaouette found that women with RA consumed significantly less PUFA[9]. Research suggests that the consumption of non-hydrogenated oils, such as *n*-3 fatty acids, is particularly important for RA patients[43]. Kjeldsen–Kragh *et al.*[43] found that 7–10 g of PUFA and/or *n*-3 fatty acids may have anti-inflammatory effects similar to the effects of naproxsen.

Research suggests that dietary variety increases the likelihood of nutrient adequacy among adults[44]. The mean HEI score for each group (RA group 54·8 (SD 9·5); HC group 58·6 (SD 9·0)) falls into the 'needs improvement' category of 51–80[33]. However, the HC group was significantly higher than the RA women in this category (see Fig. 1). This four-point total HEI score difference likely exists due to differences previously mentioned in fruit and whole grain components of the HEI scores. From a public health perspective, to make a significant increase in HEI score, one could adjust several aspects of dietary intake. A study by Hornick *et al.*[45] found that incremental dietary changes in the typical dietary intake of women, 31–50 years of age, increased HEI-2005 scores up to 50 points[45]. Examples of food group changes included increasing fruits from 0·8 to 2·5 cups/d, increasing vegetable servings from 1·6 to 2·5 cups/d, increasing fat-free and low-fat milk servings from 1·4 to 3 cups/d and replacing margarine and butter with vegetable oils. It is thought that approximately 10 % of the population meets the HEI 'good' category qualified as an HEI score of ≥ 80[33]. In the present sample, no one scored in the 'good' range. To amplify the health benefits of one's diet, an HEI score of 80 should be one's minimal goal[33,46].

Low dietary diversity and HEI scores have been linked to increased risk of overweight, obesity, CVD, metabolic syndrome, cancer and all-cause mortality[28,29,37,47]. An inverse association between HEI scores has been identified with overweight and obesity even after controlling for several confounders including age, sex, physical activity and socio-economic status[28]. A study examining the relationship between dietary diversity and mortality found that even after adjustment for education, race, smoking and fibre intake, relative risk of mortality significantly increases with the consumption of two or fewer foods groups[37]. Increasing one's diet variety, and thereby increasing the HEI-2005 score, is beneficial.

The results of the present study add to the growing body of literature regarding the nutritional needs of the RA population and use of the HEI-2005. In particular, the use of the HEI-2005 for dietary quality evaluation is a strength of the present study. This index measures how compliant one is with national dietary guidelines. Recently, the State of the USA and Institute of Medicine recommended tracking the dietary habits of the adult population using HEI-2005[46]. Another strength of the study is the use of 7 d weighed food records. Earlier HEI studies have utilised 24 h recall and 3 d food records[19,28]. The additional 4 d of dietary intake provides further indication that our records are closely aligned with each individual's usual intake. In addition, the use of weighed food records is a more objective measure than self-report dietary intake alone.

Although we took precautions to increase food record objectivity through weighing, this method may be limited in terms of methods of preparation. However, food records are considered one of the best methods at present to measure and track food intake[48]. The number of days needed to determine the nutrient intake more accurately may differ substantially from one nutrient to another.

This is the first study to examine dietary quality in older women with and without RA using the HEI-2005. The results of the present study indicate that RA is associated with decreased component and total HEI-2005 scores. Older women with RA comprise a high-risk group for nutritional deficiencies. Future nutritional interventions should focus on increasing dietary quality in this high-risk group of older women with RA.

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