Title of the article: Assessing the Diet Quality of Individuals with Rheumatic Conditions: A Cross-Sectional Study

Abstract

Arthritis along with other rheumatic conditions is a significant cause of chronic pain and disability, affecting around 3.5 million Australians. However, little is known regarding the overall diet quality of those living with arthritis. This study aimed to assess the dietary quality of Australians living in the Australian Capital Territory region with rheumatic conditions. This cross-sectional study analysed dietary intake data of individuals living with rheumatic conditions using a validated food frequency questionnaire. Dietary quality was assessed using the Healthy Eating Index-2015 (HEI-2015) to examine associations between diet composition, age, income and arthritis impact using the short form of the Arthritis Impact Measurement Scales 2 (AIMS2-SF). Participants, predominantly female (82.6%), were grouped by age: 18-50 years (n=32), 50-64 years (n=31), and 65+ years (n=23). Significant correlations were observed between age and HEI-2015 (r_s=0.337, p=0.002) and income and AIMS2-SF (r_s=-0.353, p<0.001). The mean HEI-2015 score for the 18-49 years group was *Fair* (72.1±12.3), lower than both the 50-64 years group score of *Good* (81.5±9.72) (p=0.004), and the 65+ years group score of *Good* (81.8±12.1) (p=0.007). Dietary fibre, seafood and plant protein, fatty acids, and refined grains were identified as dietary components of concern for the 18-49 years group, and total fruit and added sugar were components of concern for people in the worst tertile for the AIMS2-SF. People aged between 18-49 years were consuming a lower quality diet compare to people aged 50 years and over. Further research is needed to understand why this association is occurring in this high socioeconomic region of Australia (a high-income country).

Introduction

Arthritis, a term used to describe a variety of rheumatic conditions affecting the musculoskeletal system, is a major cause of chronic pain and disability within Australia.[1] Between 2014-2015, approximately 15.3% of the Australian population were living with any form of arthritis, equating to 3.5 million Australians.[1] The majority of cases reported were osteoarthritis (58.9%), rheumatoid arthritis (11.5%), and around 35% were unspecified.[1] Arthritis presents as a large economic burden in Australia with an estimated $23.9 billion per year in medical care and indirect costs.[2]

Diet is strongly associated with health outcomes and may modulate quality of life and health status of people living with arthritis.[3] Moreover, there is a belief by some individuals living with arthritis that diet is influential in modulating their arthritis symptoms.[4] Much of the current literature assessing the diet of people with arthritis focuses on the influence of specific nutrients [5] or food groups and their relationship with arthritis symptoms [6,7], with limited evidence of the effect of overall dietary quality.[8] In 2017, a study by Berube et al. indicated that the dietary quality of people living with rheumatoid arthritis was relatively poor and that this may be associated with functional disability.[8] Assessing dietary quality allows for greater insight into the relationship between dietary intake and nutrition-related health outcomes.[9] Based on healthy choices within core food groups, diet quality itself is a measurement of food patterns and compliance with dietary guidelines. Within the literature, the relationship between diet quality and beneficial health is well documented [10,11]; and risk factors such as obesity and hypertension decrease as diet quality increases, indicating a possible inverse association.[12] Likewise, higher-quality diets are associated with reduced risk of all-cause mortality, cardiovascular disease (CVD), cancer, and type 2 diabetes.[13,14]

Considering that a 1.5-2-fold increased risk of developing CVD occurs in individuals with rheumatoid arthritis, and living with osteoarthritis is also associated with similar increased risk of CVD development, the relevance of assessing diet quality as a potential modifiable risk factor in the arthritic populations is apparent. [15,16]. Moreover, sustained improvements in diet quality may reduce the risk of CVD in the short and long term.[17] There are several major indices available for evaluating dietary quality, including the Healthy Eating Index (HEI), Healthy Diet Indicator (HDI), Healthy Food Index (HFI), and the Diet Quality Index (DQI).[9] Of the indices above, the HEI, updated in 2015, represents an appropriate tool to measure the diet quality of people living with arthritis in western, high-income countries. Moreover, this diet quality assessment index is comprehensive and compares dietary intake to intake recommendations and subsequently identifies areas where the increasing and decreasing of dietary components is needed.[18] Therefore, considering the prevalence and gravity of arthritis within Australia, and the beneficial relationship that diet quality may have, this study aimed to assess the dietary quality of Australians living with all types of arthritis using the HEI-2015.

Methods

Study design

The present study is a cross-sectional analysis of baseline data collected as part of a ten-week randomised waiting list design study involving the daily monitoring of heart rate and heart rate variability using the smartphone application "HRV4 Training". Participants were grouped into either the intervention or waiting list group on a 1:1 basis, with the waiting group required to wait four weeks before commencing use of the application. This project was approved by the Human Research Ethics Committee of the University of Canberra (HREC – 17-77) and was carried out in accordance with the Declaration of Helsinki (1989) of the World Medical Association. Participants were informed of the study aims and procedures and provided written informed consent for study participation prior to enrolment.

Participants and eligibility criteria

Recruitment was conducted through internal newsletter and website of Arthritis Australian Capital Territory (ACT), local media, online media and using snowballing. Recruiting through snowballing was encouraged by the investigators and included participants sharing the study advertisement, and "word of mouth" advertising by current participants. In each case, contact was initiated by the potential participant. The inclusion criteria was individuals aged 18 years and over , having a diagnosis of any rheumatic condition and living in the greater ACT region including Queanbeyan (New South Wales) and rural areas which typically access Arthritis ACT services and support programs. Cognitive screening using the Mini-Mental State Examination (MMSE) [19] was performed to ascertain suitability for participation, and individuals scoring 25 and above out of 30 were included. All participants were required to have access to a smartphone for the installation and daily use of the HRV4 Training application. Therefore, participants were excluded if they scored 24 or under on the MMSE, were not diagnosed with arthritis, were living outside the recruitment area, or did not possess a mobile phone. In addition, participants were excluded if they were already participating in another research study which incorporated a lifestyle intervention.

Measurements

A group of trained health scientists (nutritionists, dietitians, occupational therapists, exercise physiologists) collected demographic, socioeconomic, and health-related information using standard validated questionnaires and clinical procedures. Participants also disclosed information relating to whether they thought that their income over the past three years was sufficient to cover their needs. Anthropometric measurements, including participant height, weight, and skinfold measurements were also taken and Body Mass Index (BMI) was calculated according to the World Health Organisation standards.[20] The short form of the Arthritis Impact Measurement Scales 2 (AIMS2-SF) questionnaire was also used to evaluate health-related quality of life outcomes in individuals with arthritis as a tool which has been validated in individuals with arthritis and has been used other rheumatic conditions..[21,22]

Food Frequency Questionnaire

All participants completed an estimation of daily nutrient intake during an interviewer-administrated validated food frequency questionnaire (FFQ).[23,24] The use of FFQ allowed for consideration of episodic consumption of food items consumed only a few times a year on special occasions such as a religious event, seasonal variations, and the overall variability of day-to-day diets.[25] The FFQ required participants to recall from a list of food items the type and quantity of food consumed over the past year. The food analysis software FoodWorks8™ (Xyris Software, QLD, Australia) was used to provide estimates of the daily nutritional value of foods and the energy intakes reported in participants FFQ using nutrient information listed in Australian Food Composition Database (Ausfoods 2017). Furthermore, to ensure that food items selected from the database represented the food items asked within the FFQ, the list of food items were discussed between a qualified dietitian, food scientist and nutritionist until consensus was reached.

Healthy Eating Index

The overall diet quality of participants was assessed following the HEI-2015 guidelines and scoring standards.[18] In total there are 13 food clusters in the HEI-2015: total fruit, whole fruit, total vegetables, greens and beans, whole grains, dairy, total protein foods, seafood and plant proteins, refined grains, added sugar, fatty acids, sodium, and saturated fats. Of these 13 components, 10 (total fruit, whole fruit, total vegetables, greens and beans, dairy, total protein, seafood and plant proteins, refined grains, and sodium) were scored based on their nutrient density per 4184 kilojoules (KJ). The fatty acids component was scored based on intake of total monounsaturated and polyunsaturated fatty acids divided by the amount of saturated fatty acids. Whereas both added sugar and saturated fat were scored on their contribution to the total percentage of energy. The total HEI-2015 score is based on a scale from 0 to 100 and represented as the sum of all component scores with higher values representing diet quality. An HEI score of less than 51 is considered as *poor* quality diet; between 51 and 80 reflecting *fair* dietary quality; and scores greater than 81 representing *good* dietary quality.

Statistical analysis

Normality of data was assessed using the Kolmogorov-Smirnov test of normality. Normally distributed continuous variables are presented as mean ± standard deviation, while non-normally distributed continuous variables being presented as median (1^{st}, 3^{rd} quartile). Tertiles were used to classify non-linear continuous variables when needed. Categorical variables are presented as frequencies and relative frequencies. Associations between categorical variables were tested with the Fisher's exact test. Mean differences among the classes of a categorical variable were tested with ANOVA, when normality was met, or with Kruskal-Wallis test otherwise. All dietary analyses which reached significance were adjusted for multiple comparisons using Bonferroni correction. Spearman's coefficient of correlation (r_s) was used to evaluate relationships between variables. All analyses were performed in IBM SPSS version 25 (Armonk, NY: IBM Corp). Statistical significance was predefined at α=0.05.

Results

Participants

The sample consisted of 86 participants who met the inclusion criteria, with most participants being female (n=71). Participant sociodemographic data are presented in Table 1. Participants were living with osteoarthritis (n=39), rheumatoid arthritis (n=20), psoriatic arthritis (n=8), ankylosing spondylitis (n=8), inflammatory arthritis (n=5), fibromyalgia (n=2), bursitis (n=1), Stihl's disease (n=1), and unsure/other (n=2). With respect to duration of arthritis, 26 participants were living with arthritis for 5 years or less, 20 for between 6-10 years, 24 for between 11-20 years, and 16 for 21 years or longer. Participants were categorised into tertiles by age (18-50 years (n=32), 50-64 years (n=31), and 65+ years (n=23)) and the AIMS2-SF (T1 (n=31), T2 (n=26), and T3 (n=29). When categorising by age, there was no difference between reported income (p=0.280); however, when categorised by AIMS2-SF, participants tended to have a lower income in the highest AIMS2-SF tertile (p=0.013). There was no difference in BMI between groups (both p's>0.05).

Outcomes

A significant positive correlation was observed between age and HEI-2015 (r_s=0.337, p=0.002), while a negative association was observed between income and AIMS2-SF score (r_s=-0.353, p<0.001). All correlation analyses performed are presented in Table 2. The average daily energy and macronutrient intakes are displayed by age and AIMS2-SF tertiles in Table 3. In each analysis (age and AIMS2-SF), there were no differences across tertiles for energy, protein, total fat, saturated fat, trans fat, carbohydrate, and alcohol (all p's>0.05). However, when analysis was stratified by age groups, there was a lower dietary fibre intake (p=0.022) in the 18-40 years group (31.1±11.3g) compared to the 65+ years group (41.5±16.2g).

The average HEI-2015 scores categorised by age group are presented in Table 4. A between-groups effect was observed for the overall HEI-2015 score with age (p=0.001). Overall, the 18-49 years group scored *Fair* (72.1 ± 12.3), the 50-64 years group scored *Good* (81.5 ± 9.72), and the 65+ years group scored *Good* (81.8 ± 12.1). The 18-49 years group scored worse than the 50-64 years group (p=0.004) and the 65+ years group (p=0.007). Between age groups, there were no observed differences between the HEI-2015 adequacy components: total fruit, whole fruit, total vegetables, greens and beans, whole grain, dairy, and total protein (all p's>0.05). Significant between-group differences were observed for seafood and plant proteins (p=0.002), and fatty acids (p=0.042). Specifically, for seafood and plant proteins, lower scores were observed for the 18-49 years group (5.00 (3.67, 5.00) compared to the 50-64 years groups (5.00 (5.00, 5.00)) (p=0.042) and 65+y groups (5.00 (5.00, 5.00)) (p=0.012). Fatty acids intake scores were lower for the 18-49 years group (2.35 (0.06, 6.13)) compared to the 65+ years group (6.33 (2.44, 10.0)) (p=0.042). There were also no significant differences observed between the HEI-2015 moderation components: added sugar, sodium, and saturated fat (all p's>0.05). However, saturated fat scores were low across all ages. A between-group effect was observed for the refined grain component (p=0.001). Lower scores were observed for the 18-49 years group (10.0 (5.94, 10.0) compared to the 50-64 years groups (p=0.009) and 65+y groups (p=0.018) who both received high scores (10.0 (10.0, 10.0)).

The average HEI-2015 scores categorised by AIMS2-SF are presented in Table 5. There was no difference in the overall HEI-2015 score between groups (p=0.208). There were no differences observed between the AIMS2-SF tertiles HEI-2015 components scores for whole fruit, total vegetables, greens and beans, whole grain, dairy, total protein, seafood and plant proteins and fatty acids (all p's>0.05). However, a between-groups effect was observed for total fruit (p=0.045), with a lower score observed with the AIMS2-SF T3 (5.00 (3.64, 5.00) compared to the AIMS2-SF T2 group (5.00 (5.00, 5.00)) (p=0.039). There were also no observed significant differences between the HEI-2015 moderation component scores: refined grains, sodium, and saturated fat (all p's>0.05). However, saturated fat scores were low across all tertiles. Differences were observed between groups for added sugar (p=0.016). The AIMS2-SF T1 group (10.0 (10.0, 10.0)) scored higher than the AIMS2-SF T3 group (10.0 (8.93, 10.0)) (p=0.012).

Discussion

This study assessed the dietary quality of individuals living with rheumatic conditions in the ACT region of Australia. In this population sample living in a high socioeconomic region, diet quality appears to be lower for individuals 18-49 years of age compared to people over 50 years of age. This appeared to be driven by lower consumption of dietary fibre, seafood, monounsaturated and polyunsaturated fatty acids, and foods from plant protein sources along with higher consumption of refined grain products. In this study, we did not observe a difference in diet quality in participants with higher AIMS2-SF scores. However, higher AIMS2-SF was associated with less desirable consumption of total fruit and added sugars, which may be related to lower-income. The identification of these dietary patterns represents areas of improvement and the need for individualised dietary advice to improve diet quality of individuals living with rheumatic conditions.[11]

The relatively *poor* score in refined grain intake by the 18-49 years age group is of particular interest. Refined grain intake is associated with higher total mortality rates [26], and the preference of whole grain consumption is recommended due to their health-protective properties [27] and association with successful ageing.[28] Evidence surrounding wholegrain intake in arthritis in lacking; however, compared with refined grains, whole grains have been associated with improved body composition and potential to reduce inflammation.[29] The present study found no significant difference between the mean wholegrain component scores of the different age groups. However, the average scores could be considered suboptimal overall, suggesting that general improvements in this component are needed within the sample population.

The HEI-2015 scores for seafood and plant protein were overall adequate; however, scores for the 18-49 years age group were lower than both other groups. This is of particular importance to individuals living with arthritis due to their anti-inflammatory potential and association with reduced risk of CVD in individuals living with rheumatoid arthritis.[30,31] Additionally, supplementation of omega-3 fatty acids may also hold benefits to manage symptoms of arthritis [13], although this should be carefully considered as required therapeutic doses need to be adequately monitored in larger population samples.[5] Thus, adequate increases in seafood consumption are potentially an area in which adaptations could be made to improve the overall diet quality of the younger proportion of the arthritis population. It was also observed that each of the three age groups scored low with respect to the fatty acids profile component of the HEI-2015 in the 18-49 years group compared to both other groups. Specifically, increasing mono- and poly-unsaturated fatty acid consumption from foods such as olive, nuts, and fatty fish may reduce rates of CVD and assist with pain reduction and/or functional improvements.[10,13,14,32] While saturated fat scores were relatively poor across our sample, its effects are suggested to be dependent on the overall dietary quality [26] and may be confounded by the content of saturated fat in processed and/or packaged foods.

Sugar consumption, particularly added sugar, is a considerable health concern, and has been independently associated with development of obesity, metabolic disease [33] and type 2 diabetes [34,35]. In the present study, those with the highest AIMS2-SF scores scored lower in the added sugar component compared to the group with the lowest AIMS2-SF score. This is supported by the survey results from a rheumatoid arthritis registry [4], where intake of sweetened beverages and desserts were reported to increase the negative symptoms in individuals living with rheumatoid arthritis. As sugar consumption has been shown to have a pro-inflammatory effect [36] and taking into consideration that in all forms of arthritis inflammation is an underlining mechanism for onset of negative symptoms [37], sugar reduction strategies should be considered as priorities in the management of arthritis.

Typically, the food components discussed are considered immunomodulatory and are intrinsic in diets that are linked with positive CVD and health outcomes, including the adoption of a Mediterranean style dietary pattern.[38] The Mediterranean diet is characterised by the relatively high consumption of olive oil, legumes, whole grains, vegetables, and fruits, and moderate consumption of fish, dairy, wine and low to moderate consumption of red meat products. In conjunction with providing potential protective effects against diseases associated with low-grade inflammation [12], the adherence to the Mediterranean diet may prove useful in improving the dietary quality of the sampled population, especially the individuals in the younger age category. Previous studies have suggested lower adherence to a Mediterranean style diet is present in people with arthritis [38], and although we did not assess the adherence to the Mediterranean diet, lower scores have been observed with the HEI-2015 in people with arthritis in the United States compared to those without.[39]

The findings also imply that people with arthritis over 50 years of age had *good* HEI-2015 diet quality scores overall. This finding is further supported in a study by Kant (2004) [40], who reported that age, income, and education level are main contributors associated with healthier dietary patterns. In addition, the people over 50 years in our study scored higher on perception of income in relation to meeting their overall needs, which could represent older people in this sample also having greater health awareness. This is further supported by Thieli et al. (2004) [41], who postulated that higher diet quality with increasing age can also be due to change in health consciousness. However, the causal relationship between age and diet quality is unknown, and further research in this area may help with the development of age-tailored arthritis health interventions. The youngest participants in this study perceived their income as *low* (28.1%) or *moderate* (31.3%) in meeting their needs. Conversely, around half of the 50-64 years group and the 65+ years group perceived their income as being *good* or *excellent* (58.1% & 47.8%, respectively). Thus, the relationship between perceived income adequacy and dietary quality is unclear in this population, and the results are further confounded by the ACT region being a relatively high socioeconomic area compared to the rest of Australia. However, despite these findings, past studies assessing socioeconomic status (SES) [42] have indicated that income is also a considerable factor contributing to overall dietary quality. Therefore, further investigation into the influence of SES on dietary quality is required before any causal relationship between income and dietary quality can be confirmed. Therefore, future research in this area must also consider use of different economic measures that can reflect the overall quality of life in conjunction with participants own income when attempting to understand the relationship between income and diet quality. Such evaluative measures should include equalised final household income, and determiners of wealth status.

Although we utilised a comprehensive approach to analyse the dietary intake of individuals living with arthritis (all forms), the dietary measurements were performed cross sectionally only on a single occasion and may be prone to the measurement errors and underreporting.[43] However, this methodological approach is commonly used and observed results are also comparable to other studies of similar design and trained professionals were used to collect the adequate dietary intake. It is also important to note that this study includes participants living with different forms of arthritis that can affect individuals differently representing a limitation to the present analyses. Nevertheless, the relative consistency in the dietary patterns in this population sample indicates potential for more concrete investigations of the dietary intake in individuals living with all forms of arthritis. Moreover, as many non-government organisations, such as Arthritis ACT, where the majority of participants were recruited, provide support for people with all forms of arthritis and have limited capacity to provide condition-specific dietary advice. Therefore, our results represent a step towards improved nutrition in the arthritis community as a whole, which may develop towards more specific, individualised advice in the future.

Conclusion

In conclusion, the present study assessed the overall dietary quality of individuals living with rheumatic conditions in the ACT and identified that individuals between 18-49 years of age were consuming a lower quality diet. Key dietary areas that require improvements and development of dietary strategies include increased consumption of seafood and protein-containing foods and reductions in refined grain and added sugar. Healthy dietary patterns such as the Mediterranean diet may prove useful in improving the dietary quality of the studied sample population and consequently improve arthritis-related symptoms and the reduction of associated CVD risk. A more comprehensive assessment of the relationship between dietary quality and income within this population is required before any conclusions around causal relationships can be drawn.

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Table 1 . Sociodemographic information of adults living with arthritis (n=86).

Age-groups	18-50y (n=32)	50-64y (n=31)	65+y (n=23)	*p* value
BMI (kg/m^2)	29.2 ± 6.72	30.4 ± 10.2	29.0 ± 5.0	0.846
Female sex *n* (%)	22 (68.8)	29 (93.5)	20 (87.0)	0.029
Reported Income				0.280
Low, n (%)	9 (28.1)	5 (16.1)	5 (21.7)	
Moderate, n (%)	10 (31.3)	8 (25.8)	7 (30.4)	
Good, n (%)	8 (25.0)	14 (45.2)	11 (47.8)	
Very good, n (%)	5 (15.6)	4 (12.9)	0 (0.00)	
AIMS2-SF	4.46 ± 1.06	4.57 ± 0.88	4.31 ± 0.85	0.609
Tertiles (AIMS2-SF)	T1 (n=31)	T2 (n=26)	T3 (n=29)	
Age (years)[a]	50.0 (44.0, 65.0)	62.0 (55.0, 69.3)	52.0 (38.0, 59.5)	0.044
BMI (kg/m^2)[a]	27.8 ± 4.94	30.4 ± 6.17	30.8 ± 10.8	0.283
Female sex *n* (%)	22 (71.0)	23 (88.5)	26 (89.7)	0.106
Reported Income				0.013
Low, n (%)	1 (3.23)	6 (23.1)	12 (41.4)	
Moderate, n (%)	10 (32.3)	9 (34.6)	6 (20.7)	
Good, n (%)	15 (48.4)	8 (30.7)	10 (34.5)	
Very good, n (%)	5 (16.1)	3 (11.5)	1 (3.45)	

BMI = Body Mass Index. Data expressed as mean ± standard deviation or mean (1st, 3rd interquartile range)

Table 2. Spearman's coefficient of correlation (r_s) for the relation of key variables associated with arthritis and diet (n=86)

	Age	BMI	Income	AIMS2-SF	HEI-2015 (Total)
Age	1				
BMI	0.023	1			
Income	0.061	-0.157	1		
AIMS2-SF	-0.075	0.099	-0.353[b]	1	
HEI-2015 (Total)	0.337[a]	-0.199	0.198	-0.140	1

[a] : p=0.002, [b] : p=0.001

Table 3. Daily dietary macronutrient, fibre, and total energy intake in adults with arthritis (n=86)

Age-groups	18-49y (n=32)	50-64y (n=31)	65+y (n=23)	*p* value
Energy (kJ)	8351 (7054, 11319)	9313 (7382, 11995)	9958 (7721, 10911)	0.696
Protein (g)	95.1 (79.6, 119)	111 (86.7, 134)	95.3 (79.8, 127)	0.287
Total fat (g)	87.7 (66.9, 130)	99.8 (71.0, 120)	91.9 (74.3, 120)	0.206
Saturated fat (g)	33.4 ± 12.6	31.2 ± 11.5	30.0 ± 9.50	0.519
Trans fat (g)	1.37 ± 0.622	1.32 ± 0.664	1.16 ± 0.404	0.411
Carbohydrates (g)	198 (151, 253)	211 (163, 246)	211 (163, 257)	0.249
Dietary fibre (g)	31.1 ± 11.3[a]	39.4 ± 14.0	41.5 ± 16.2[a]	0.013
Alcohol (g)	1.41 (0.08, 6.52)	1.86 (0.21, 5.95)	2.05 (0.04, 7.29)	0.882
Tertiles (AIMS2-SF)	T1 (n=31)	T2 (n=26)	T3 (n=29)	
Energy (kJ)	9430 (7129, 11914)	9117 (7635, 10709)	9220 (6974, 11369)	0.862
Protein (g)	108 (80.2, 139)	102 (82.2, 123)	93.1 (79.9, 121)	0.164
Total fat (g)	96.4 (72.6, 137)	94.1 (70.8, 108)	91.7 (69.7, 131)	0.927
Saturated fat (g)	31.6 ± 11.7	30.1 ± 8.23	33.2 ± 13.5	0.611
Trans Fat (g)	1.35 ± 0.559	1.25 ± 0.528	1.28 ± 0.678	0.783
Carbohydrates (g)	213 (173, 239)	185 (161, 235)	220 (150, 279)	0.608
Dietary fibre (g)	36.1 ± 12.1	38.8 ± 16.5	36.0 ± 14.7	0.727
Alcohol (g)	2.27 (0.07, 5.95)	1.37 (0.21, 7.29)	1.82 (0.05, 5.71)	0.690

Data expressed as mean ± standard deviation or median (1^{st},3^{rd}). [a] p = 0.022.

Table 4. Healthy Eating Index-2015: components, criterion, and scores based on age-groups.

Dietary Component (Score Range)	Standard for maximum score	Standard for minimum score	18-49y	50-64y	65+y	*p* value
n			*n*=32	*n*=31	n=23	
Adequacy (higher score indicates higher consumption)						
Total fruit (0-5)	≥0.8 cup eq. per 4184kJ	No whole fruit or juice	5.00 (3.59, 5.00)	5.00 (4.35, 5.00)	5.00 (5.00, 5.00)	0.160
Whole fruit (0-5)	≥0.4 cup eq. per 4184kJ	No whole fruit	5.00 (5.00, 5.00)	5.00 (5.00, 5.00)	5.00 (5.00, 5.00)	0.343
Total vegetables (0-5)	≥1.1 cup eq. per 4184kJ	No vegetables	5.00 (4.13, 5.00)	5.00 (5.00, 5.00)	5.00 (5.00, 5.00)	0.333
Greens and beans (0-5)	≥0.2 cup eq. per 4184kJ	No dark green vegetables or beans	5.00 (2.96, 5.00)	4.83 (3.12, 5.00)	5.00 (3.99, 5.00)	0.660
Whole grain (0-10)	≥1.5 oz eq. per 4184kJ	No whole grains	5.86 (3.09, 10.0)	8.22 (4.00, 10.0)	7.85 (3.84, 10.00)	0.409
Dairy (0-10)	≥1.3 cup eq. per 4184kJ	No dairy	6.98 (2.53, 8.73)	7.17 (5.19, 10.0)	7.03 (4.45, 9.14)	0.233
Total protein (0-5)	≥2.5 oz eq. per 4184kJ	No protein foods	5.00 (5.00, 5.00)	5.00 (5.00, 5.00)	5.00 (5.00, 5.00)	0.600
Seafood and plant proteins (0-5)	≥0.8 oz eq. per 4184kJ	No seafood or plant proteins	5.00 (3.67, 5.00)[ab]	5.00 (5.00, 5.00)[a]	5.00 (5.00, 5.00)[b]	0.002
Fatty acids (0-10)	(MUFAs+PUFAs)/SFAs = ≥2.5	(MUFAs+PUFAs)/SFAs = ≤1.2	2.35 (0.06, 6.13)[c]	4.92 (1.14, 9.35)	6.33 (2.44, 10.0)[c]	0.042
Moderation (higher score indicates lower consumption)						
Refined grains (0-10)	≤1.8 oz eq. per 4184kJ	≥4.3 oz eq. per 4184kJ	10.0 (5.94, 10.0)[de]	10.0 (10.0, 10.0)[d]	10.0 (10.0, 10.0)[e]	0.001
Added sugar (0-10)	≤6.5% of energy	≥26% of energy	10.0 (9.85, 10.0)	10.0 (9.56, 10.0)	10.0 (9.73, 10.0)	0.885
Sodium (0-10)	≤1.1 oz eq. per 4184kJ	≥2.0 oz eq. per 4184kJ	10.0 (10.0, 10.0)	10.0 (10.0, 10.0)	10.0 (10.0, 10.0)	0.954
Saturated fat (0-10)	≤8% of energy	≥16% of energy	1.99 (0.23, 6.32)	4.79 (0.43, 8.61)	4.68 (2.77, 7.66)	0.069
Total Score			72.1 ± 12.3[fg]	81.5 ± 9.72[f]	81.8 ± 12.1[g]	0.001

HEI: Healthy Eating Index; PUFAs: Polyunsaturated Fatty Acids; MUFA: Monounsaturated Fatty Acids; SFAs: Saturated Fatty Acids. Total healthy eating score (> 80 = good, 51-80 = fair, < 51= poor). [a] p = 0.042, [b] p = 0.012, [c] p = 0.042, [d] p = 0.009, [e] p = 0.018, [f] p = 0.004, [g] p = 0.007.

Table 5. Healthy Eating Index-2015: components, criterion, and scores based on AIMS2-SF Tertiles.

Dietary Component (Score Range)	Standard for maximum score	Standard for minimum score	T1	T2	T3	*p* value
n			*n*=31	*n*=26	*n*=29	
Adequacy (high score indicates higher consumption)						
Total fruit (0-5)	≥0.8 cup eq. per 4184kJ	No whole fruit or juice	5.00 (4.03, 5.00)	5.00 (5.00, 5.00)[a]	5.00 (3.64, 5.00)[a]	0.045
Whole fruit (0-5)	≥0.4 cup eq. per 4184kJ	No whole fruit	5.00 (5.00, 5.00)	5.00 (5.00, 5.00)	5.00 (5.00, 5.00)	0.400
Total vegetables (0-5)	≥1.1 cup eq. per 4184kJ	No vegetables	5.00 (4.94, 5.00)	5.00 (4.76, 5.00)	5.00 (4.71, 5.00)	0.945
Greens and beans (0-5)	≥0.2 cup eq. per 4184kJ	No dark green vegetables or	5.00 (3.27, 5.00)	4.96 (3.71, 5.00)	5.00 (2.40, 5.00)	0.828
Whole grain (0-10)	≥1.5 oz eq. per 4184kJ	No whole grains	7.92 (3.84, 10.0)	8.30 (3.23, 10.0)	5.36 (2.66, 9.99)	0.342
Dairy (0-10)	≥1.3 cup eq. per 4184kJ	No dairy	6.70 (2.98, 9.41)	7.09 (5.73, 9.04)	7.09 (3.90, 9.36)	0.799
Total protein (0-5)	≥2.5 oz eq. per 4184kJ	No protein foods	5.00 (5.00, 5.00)	5.00 (5.00, 5.00)	5.00 (5.00, 5.00)	0.738
Seafood and plant proteins (0-	≥0.8 oz eq. per 4184kJ	No seafood or plant proteins	5.00 (5.00, 5.00)	5.00 (5.00, 5.00)	5.00 (5.00, 5.00)	0.762
Fatty acids (0-10)	(MUFAs+PUFAs)/SFAs = ≥2.5	(MUFAs+PUFAs)/SFAs = ≤1.2	4.82 (1.42, 9.32)	3.94 (1.35, 9.09)	4.12 (0.77, 9.12)	0.934
Moderation (higher score indicates lower consumption)						
Refined grains (0-10)	≤1.8 oz eq. per 4184kJ	≥4.3 oz eq. per 4184kJ	10.0 (8.65, 10.0)	10.0 (10.0, 10.0)	10.0 (8.43, 10.0)	0.222
Added sugar (0-10)	≤6.5% of energy	≥26% of energy	10.0 (10.0, 10.0)[b]	10.0 (9.53, 10.0)	10.0 (8.93, 10.0)[b]	0.016
Sodium (0-10)	≤1.1 oz eq. per 4184kJ	≥2.0 oz eq. per 4184kJ	10.0 (10.0, 10.0)	10.0 (10.0, 10.0)	10.0 (10.0, 10.0)	0.762
Saturated fat (0-10)	≤8% of energy	≥16% of energy	3.55 (1.79, 7.93)	4.24 (1.06, 7.44)	2.92 (0.86, 7.44)	0.686
Total score			79.0 ± 12.0	80.5 ± 11.3	74.9 ± 12.8	0.208

HEI: Healthy Eating Index; SD: Standard Deviation; PUFAs: Polyunsaturated Fatty Acids; MUFA: Monounsaturated Fatty Acids; SFAs: Saturated Fatty Acids. Total healthy eating score (> 80 = good, 51-80 = fair, < 51= poor). [a] p = 0.039, [b] p = 0.012.