Measures of Diet Quality across Calendar and Winter Holiday Seasons among Midlife Women: A 1-Year Longitudinal Study Using the Automated Self-Administered 24-Hour Recall

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ABSTRACT

Background Systematic seasonal bias may confound efforts to estimate usual dietary intake and diet quality. Little is known about dietary quality over the winter holiday season.

Objectives The aims of this study were to test for differences in intakes of energy, percentage of energy from macronutrients, fruits and vegetables, and diet quality measured using the Healthy Eating Index 2010 (HEI-2010) by calendar and winter holiday seasons.

Design Longitudinal cohort design.

Participants/setting Data were derived from the Life in All Seasons study. Two cohorts of women aged 40 to 60 years (N = 52) from the greater Grand Forks, ND, area were followed for 1 year each between July 2012 and July 2014. Each woman completed an online diet recall using the Automated Self-Administered 24-Hour Recall every 10 days during the year, with a 92% response rate.

Statistical analyses Effects of calendar and winter holiday seasons on intakes of energy, percent energy from macronutrients, HEI-2010 total and component scores, and grams per day of individual fruits and vegetables were tested using mixed linear models.

Results The mean total HEI-2010 score was 60.1±1.4. There were seasonal differences in some HEI-2010 component scores, but not in total scores. More lettuce or mixed lettuce salad was consumed during summer than during winter (P = 0.034), and more fresh tomatoes were consumed during summer and fall compared with winter (P = 0.001). More corn, berries, peaches and nectarines, and melons (P < 0.001) were consumed during summer. There was no seasonal difference in reported intakes of energy (P = 0.793). The total HEI-2010 score for dietary intake observed over the winter holiday season was lower than the rest of the year (P < 0.001). Reported energy intake was not different (P = 0.228).

Conclusions In this population, diet quality is significantly lower during the winter holiday period, but mostly consistent by season. Multiple recalls in any season can give a reasonable representation of usual overall diet quality throughout the year.

These market changes may have had profound effects on seasonality of the US diet, particularly for F/V. However, prices of various forms of produce still vary seasonally. Although total amounts of produce consumed may not vary, individual F/V consumed may fluctuate by season.

In addition, late fall and winter include holidays that are traditionally celebrated with an abundance of food. Several studies demonstrate positive energy balance and weight or fat mass gain during this period. Limited research suggests that energy intake is highest around the winter holiday season, but none have reported food intake during the holiday season compared with the rest of the year.

If seasonality (either full-year or during winter holidays) affects dietary intakes, particularly for F/V that are under-consumed in the United States, this information could potentially be used in the planning of interventions to increase intake of F/V. Awareness of variation in intakes by season also has implications for assessing, designing, and analyzing studies seeking to measure usual intakes.

To our knowledge, there have been no studies in the past 30 years that have frequently monitored dietary intakes of US individuals over a full year. The objectives of this study were to assess the variability in intakes of energy, percentage of energy from macronutrients (percent energy), and diet quality by season and winter holiday period among a small sample of women (aged 40 to 60 years) with self-reported dietary data collected over a 1-year period. The hypothesis was that intakes, especially for F/V, varied by season; specifically, that more F/V would be consumed during summer and fall than during winter and spring. A second hypothesis was that diet quality would decline over the winter holiday season compared with the rest of the year.

MATERIALS AND METHODS

Study Design and Setting

Data were derived from the Life in All Seasons study, a closed cohort design conducted with two cohorts of women. Each cohort was followed for 1 year between July 2012 and July 2013. The primary objective of the study was to determine whether body composition varied over seasons and a secondary objective was to determine the roles of diet and physical activity in body composition. In the present analysis, results are presented from the dietary intake component of the study.

Participants

Based on previous studies at the Grand Forks Human Nutrition Research Center assuming $\alpha=0.05$ and a within-subject variance of 1.4%, power analysis determined that 45 women were needed to provide 80% power to detect a mean difference of 1.0 percentage point of body fat from season to season. Fifty-four individuals were recruited in two cohorts, one during July 2012 and the other during July 2013, by advertisements posted at the University of North Dakota and the surrounding area of Greater Grand Forks, ND. Inclusion criteria included being a woman aged 40 to 60 years, a body mass index (BMI) between 18 and 35, no more than $\pm10$-lb weight change for 6 months before the study, ambulatory, and having access to high-speed Internet. Exclusion criteria included health conditions that would limit participation in physical activity, medications that would influence appetite or weight change and intentions to change diet or physical activity for the purpose of weight loss during the study. All participants received a stipend for their participation in the study. The study protocol was approved by the University of North Dakota and all participants provided written informed consent. The study was registered at ClinicalTrials.gov (NCT01674296).

Study Variables

The meteorologic definition was used to categorize seasons: summer (June, July, and August), fall (September, October, and November), winter (December, January, and February), and spring (March, April, and May). The winter holiday period was defined as November 20 to January 2 to include Thanksgiving, Christmas, and New Year holidays. Dietary outcomes of interest in this study were energy, percent energy from macronutrients, diet quality as assessed by the Healthy Eating Index-2010 (HEI-2010) and amounts (grams per day) of F/V consumed by season.

Diet Assessment

Dietary intake data were collected and analyzed using the Automated Self-Administered 24-Hour Recall (ASA24) recall, 2011 version, developed by the National Cancer Institute. Briefly, the ASA24 is an automated, multiple-pass, self-administered, online 24-hour dietary recall method. Respondents are guided through the recall process using a series of prompted steps. First is the Meal-Based Quick List, where respondents are asked to list all foods and beverages consumed at each meal occasion during the previous 24-hour period. The next step is the Meal Gap Review, where respondents are asked whether they consumed anything during any 3-hour period when no foods were reported. Afterward, respondents are prompted to provide details about the foods and beverages reported. Next, a pop-up window appears with questions about the consumption of commonly forgotten foods and beverages, such as drinking water. Next, respondents review all foods and drinks reported, with the opportunity to edit or add. A final pop-up window then provides a final option to add foods or beverages. ASA24 has been validated in a small controlled feeding study and compared with intakes collected using the interviewer-administered US Department of Agriculture Automated Multiple-Pass Method. At the first visit, participants received instruction about completing recalls from a registered dietitian nutritionist and performed a practice recall. Every 10 days, participants received an e-mail directing them to log on to a secure website and complete an ASA24 recall for food consumed from midnight to midnight of the preceding day. The data collection days ensured proportional representation of week days and weekends. No feedback was provided. Because dietary intake fluctuates day to day, no recalls were excluded based on reported energy intake.

HEI-2010

The HEI-2010 is a measure of overall diet quality that was developed jointly by the National Cancer Institute and the US Department of Agriculture to assess how well sets of foods, such as an individual’s dietary intake, comply with federal guidelines.
dietary guidance. It is composed of 12 key food group and nutrient components of which nine are components that Americans are encouraged to increase: Total Fruit, Whole Fruit, Total Vegetables, Greens and Beans, Whole Grains, Dairy, Total Protein Foods, Seafood and Plant Proteins, and Poly- and Monounsaturated Fatty Acids, and three components that individuals are encouraged to reduce: Refined Grains, Sodium, and Empty Calories (ie, percent energy from solid fats, added sugars, and alcohol). The Mono- and Polyunsaturated Fatty Acid component is expressed as the ratio of unsaturated to saturated fatty acids. All other components are calculated as amounts in MyPyramid equivalents per 1,000 kcal. Therefore, HEI-2010 and its component scores are independent of quantity and can be used to estimate the diet quality of any set of foods at different levels of the food environment. The minimum score for a single component is 0. The maximum score ranges between 5 and 20, depending on the component. For the components for which Americans are encouraged to increase intake, a higher score indicates more of that component is consumed. For the three components that Americans are encouraged to limit, a higher score reflects lower consumption. Scores of the 12 components are summed to create a total HEI-2010 score, with 100 being the optimal score. The HEI-2010 has been validated and details can be found elsewhere.21,26

Statistical Analysis
SAS code provided by the National Cancer Institute for the purpose of calculating HEI-2010 scores when using multiple days of ASA24 recall data was used for these analyses.27

Data are reported as mean±standard error. To assess differences in baseline characteristics between cohorts 1 and 2, t tests and χ² statistics were used. All recalls were averaged within a season for each woman. Because all recalls were averaged, no adjustments were made for missing recalls. Effects of season on intakes of energy, percent energy from macronutrients, HEI-2010 total and component scores, and amounts of individual F/V were tested using mixed linear models, in which season was the fixed effect and subject was a random effect. If the overall model was significant, Tukey’s contrasts were used to do pairwise comparisons between all seasons. Effects of the winter holiday season were also tested using mixed linear models, with winter holiday season as the fixed effect and subject as the random effect. All analyses were conducted using SAS version 9.428 and a P value of 0.05 was considered significant.

RESULTS
Participant Characteristics
Seventy-three women attended informational meetings and 61 signed consents. Seven women subsequently declined due to concerns about time commitments for study visits. Fifty-four women began the study and two dropped out due to time constraints in complying with study requirements. Data presented here are from 52 participants (96%) who completed the year-long study. Group 1 (n=27) was studied between July 2012 and July 2013, and group 2 (n=25) was studied between July 2013 and July 2014. Participating women were mostly non-Hispanic white (96%) with a mean age of 49.4±0.8 years and a mean BMI of 26.5±0.6. Thirty-three percent were overweight and 23% were obese. There were no differences between groups by age (P=0.238), BMI (P=0.412), or weight status (P=0.123). Participants completed a total of 1,866 diet recalls (range=33 to 37 per individual) and 92% completed the requested 36 recalls. One participant completed 37 recalls, two participants missed two recalls, and one person missed three recalls. Because dietary intakes vary within a person by day, there were no exclusions and all

Figure 1. Mean daily energy and percent energy from macronutrients reported by midlife women (N=52) living in the northern plains by season, as assessed by the Automated Self-Administered 24-Hour Recall.23 Seasonal effects were tested using a mixed linear model. 6Significantly different from fall at P=0.022.
Energy and Macronutrient Intake
Seasonal macronutrient intake and food group intakes were evaluated. Energy intake did not differ by season ($P=0.793$) (Figure 1). The percent energy from carbohydrate was higher during fall vs summer ($P=0.022$), whereas percent energy from fat ($P=0.538$) and protein ($P=0.453$) did not vary across seasons. The percent energy from alcohol also did not vary ($P=0.206$). Amount of alcohol consumed was highest during summer months ($P=0.042$) (Figure 2). Annually, only 5 out of 52 women did not drink alcohol at all, whereas 30 out of 52 consumed an average of one or fewer drinks and 17 out of 52 consumed more than one drink per day.

HEI-2010 Scores
Total and HEI-2010 component scores are shown by season in Table 1. The annual total HEI-2010 score was $60.1\pm1.4$ out of 100 possible points and there were no significant differences between pairs of seasons. The component score for Total Fruit was highest during summer ($P=0.002$), whereas Fatty Acids was lowest during winter and highest during the spring ($P=0.012$), and Refined Grains ($P=0.007$) and Sodium ($P=0.004$) were both highest during summer and lowest during fall. Overall, Whole Fruit, Total Vegetables, Total Protein Foods, and Seafood and Plant Proteins component scores were the closest to being optimal (more than 75% of the maximum score). Relative to other components, the lowest mean component scores (below 50% of the maximum) were for Whole Grains, Fatty Acids, and Sodium. The Empty Calories, Refined Grains, Dairy, and Total Fruit component scores were more than 60% of the maximum.

Vegetables and Fruits
Total Vegetables (cup equivalents per day) did not vary by season ($P=0.503$), but, as observed in the HEI-2010 scores, Total Fruit did, with summer being higher than fall ($P=0.020$; data not shown). However, the types of F/V consumed (grams per day) varied by season (Table 2). Study participants consumed more lettuce or mixed lettuce salad during the summer than during the winter ($P=0.034$), and more fresh tomatoes during the summer and fall compared with winter ($P=0.001$). The most corn was eaten during summer ($P<0.001$). More berries, peaches, nectarines, and melons ($P<0.001$) were consumed during the summer months and more citrus fruits were eaten during winter and spring than during summer and fall ($P<0.001$).

Winter Holiday Season
Dietary quality over the winter holiday season was compared with the rest of the year. Participants completed 222 diet recalls (range=4 to 5 each) during the winter holiday season. There was no difference in energy intake between recalls collected during the winter holiday season compared with the rest of the year ($1,979\pm72$ vs $1,922\pm56$ kcal, respectively; $P=0.228$). There was also no difference in the percent energy from fat ($P=0.241$) or carbohydrate ($P=0.729$). However, the percent energy from protein was lower during the winter holiday season than the rest of the year (15.6% vs 16.3%, respectively; $P=0.036$). There was no difference in the percent energy from alcohol ($P=0.404$) or the grams of alcohol consumed ($P=0.557$). Forty-eight percent of women (25 out of 52) reported not consuming any alcohol during the winter holiday season.
the winter holiday season. Among those women who did consume alcohol during the winter holidays, the amount reported was higher than the rest of the year (20.3 g vs 15.3 g; $P=0.006$) (Figure 2). The total HEI-2010 score for dietary intake observed during the winter holiday season was 53.2±1.8 compared with 60.8±1.4 during the rest of the year ($P<0.001$) and 59.9±1.7 during the nonholiday winter season ($P<0.001$). HEI-2010 component scores during the winter holiday season were lower than the rest of the year for Total Fruit, Whole Fruit, Total Vegetables, Greens and Beans, Dairy, Seafood and Plant Proteins, Fatty Acids, and Empty Calories ($P<0.05$). There was no difference in Whole Grains ($P=0.994$), Total Protein Foods ($P=0.132$), Refined Grains ($P=0.271$), or Sodium ($P=0.214$) (Figure 3).

**DISCUSSION**

This study describes dietary intake patterns of midlife women over a period of 1 year. As hypothesized, HEI-2010 scores were significantly lower during the winter holidays compared with the rest of the year. Contrary to expectations, the results suggest little seasonal difference in reported intakes of energy and percent energy from macronutrients or in total HEI-2010 score in this group of women. Only the HEI-2010 score for the Total Fruits component was consistent with the hypothesis. There were differences in individual types of F/V consumed within the broad categories of F/V. There was no difference in the percent energy from alcohol by season, but amount (grams) of alcohol consumed was highest during summer. Diet quality was markedly lower during the winter holiday season than the rest of the winter season.

In the United States, the period between Thanksgiving and New Year’s Day is widely associated with a plethora of highly palatable foods. Observed energy intake was not different during the winter holiday season, but diet quality varied considerably from the rest of the year. HEI-2010 scores were significantly lower during the winter holidays for eight out of the 12 food and nutrient components, including Empty Calories, which consists of solid fats, added sugars, and alcoholic beverages. This suggests that, at least in this group of women, individuals consumed more energy-dense and fewer nutrient-rich foods.

The lack of annual seasonality in energy intake found in this study echoes results of a 6-month study that examined the number of days needed to estimate usual energy and absolute nutrient intakes. Stote and colleagues\(^6\) conducted face-to-face 24-hour recalls every 10 days during winter, spring, and summer months from February to July and found no effect of season on intraindividual variation in energy and nutrient intake. Also similar to the present findings, a recent study of men and women living in the Washington, DC, area reported no seasonal variation in energy or nutrient intake.\(^8\) In the present study, the percent energy from carbohydrate intake was higher during fall than summer. de Castro\(^3\) found that total carbohydrate intake was highest in the fall, but other studies have not reported this observation. Few studies have reported food group intakes. Subar and colleagues\(^2\) examined the possibility of seasonal bias in reported food group consumption making use of data collected via food frequency questionnaire that queried intake over the past year.\(^5\) They found evidence of seasonality bias in reporting of frequency of intake of some F/V. Ziegler and

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**Table 1. Mean Healthy Eating Index 2010 component and total scores reported by midlife women (N=52) living in the northern plains by season and by full year of ASA24\(^a\)**

<table>
<thead>
<tr>
<th>Component</th>
<th>Maximum score</th>
<th>Summer</th>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
<th>Full Year</th>
<th>$P$ value(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Fruit</td>
<td>5</td>
<td>3.6±0.2(^y)</td>
<td>3.0±0.2(^z)</td>
<td>3.0±0.2(^z)</td>
<td>3.1±0.2(^z)</td>
<td>3.3±0.2</td>
<td>0.002</td>
</tr>
<tr>
<td>Whole Fruit</td>
<td>5</td>
<td>4.2±0.2</td>
<td>3.7±0.2</td>
<td>3.8±0.2</td>
<td>3.9±0.2</td>
<td>4.0±0.2</td>
<td>0.122</td>
</tr>
<tr>
<td>Total Vegetables</td>
<td>5</td>
<td>3.8±0.1</td>
<td>4.0±0.1</td>
<td>3.7±0.1</td>
<td>3.9±0.1</td>
<td>3.9±0.1</td>
<td>0.139</td>
</tr>
<tr>
<td>Greens and Beans</td>
<td>5</td>
<td>2.6±0.2</td>
<td>2.4±0.2</td>
<td>2.3±0.2</td>
<td>2.9±0.2</td>
<td>2.7±0.2</td>
<td>0.122</td>
</tr>
<tr>
<td>Whole Grains</td>
<td>10</td>
<td>3.4±0.3</td>
<td>4.0±0.3</td>
<td>4.1±0.3</td>
<td>3.5±0.3</td>
<td>3.8±0.3</td>
<td>0.050(^c)</td>
</tr>
<tr>
<td>Dairy</td>
<td>10</td>
<td>7.2±0.3</td>
<td>7.2±0.3</td>
<td>7.4±0.3</td>
<td>7.0±0.3</td>
<td>7.3±0.3</td>
<td>0.560</td>
</tr>
<tr>
<td>Total Protein Foods</td>
<td>5</td>
<td>4.6±0.1</td>
<td>4.5±0.1</td>
<td>4.5±0.1</td>
<td>4.5±0.1</td>
<td>4.6±0.1</td>
<td>0.790</td>
</tr>
<tr>
<td>Seafood and Plant Proteins</td>
<td>5</td>
<td>3.7±0.2</td>
<td>3.5±0.2</td>
<td>3.5±0.2</td>
<td>3.8±0.2</td>
<td>3.9±0.2</td>
<td>0.517</td>
</tr>
<tr>
<td>Fatty Acids</td>
<td>10</td>
<td>4.0±0.3(^yz)</td>
<td>4.1±0.3(^yz)</td>
<td>3.5±0.3(^z)</td>
<td>4.5±0.3(^y)</td>
<td>3.9±0.3</td>
<td>0.012</td>
</tr>
<tr>
<td>Refined Grains</td>
<td>10</td>
<td>7.6±0.3(^y)</td>
<td>6.4±0.4(^z)</td>
<td>6.9±0.3(^yz)</td>
<td>7.0±0.3(^yz)</td>
<td>7.0±0.3</td>
<td>0.007</td>
</tr>
<tr>
<td>Sodium</td>
<td>10</td>
<td>3.6±0.3(^y)</td>
<td>2.6±0.3(^z)</td>
<td>2.9±0.3(^yz)</td>
<td>3.3±0.3(^z)</td>
<td>3.0±0.3</td>
<td>0.004</td>
</tr>
<tr>
<td>Empty Calories</td>
<td>20</td>
<td>12.5±0.5</td>
<td>12.9±0.5</td>
<td>12.8±0.5</td>
<td>12.8±0.5</td>
<td>12.7±0.4</td>
<td>0.848</td>
</tr>
<tr>
<td>Total score</td>
<td>100</td>
<td>60.7±1.5</td>
<td>58.2±1.6</td>
<td>58.2±1.6</td>
<td>60.3±1.5</td>
<td>60.1±1.4</td>
<td>0.066</td>
</tr>
</tbody>
</table>

\(^a\)ASA24=Automated Self-Administered 24-Hour Recall.23

\(^b\)Seasonal effects were tested using a mixed linear model.

\(^c\)Overall model was significant but no pairwise comparisons differed.

\(^\)Values within seasons with the same superscript letters (y, z) are not significantly different ($P>0.05$) by Tukey contrasts.
RESEARCH

Table 2. Consumption of selected vegetables and fruits (grams per day) by midlife women (N=52) living in the northern plains by season, as assessed by ASA24

<table>
<thead>
<tr>
<th>Vegetable or fruit group</th>
<th>Summer</th>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
<th>P value&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lettuce/salad</td>
<td>21.9±2.5&lt;sup&gt;x&lt;/sup&gt;</td>
<td>17.4±2.4&lt;sup&gt;y&lt;/sup&gt;</td>
<td>13.7±1.7&lt;sup&gt;x&lt;/sup&gt;</td>
<td>19.5±2.5&lt;sup&gt;y&lt;/sup&gt;</td>
<td>0.034</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>16.5±2.7&lt;sup&gt;y&lt;/sup&gt;</td>
<td>15.0±2.5&lt;sup&gt;y&lt;/sup&gt;</td>
<td>6.9±1.0&lt;sup&gt;x&lt;/sup&gt;</td>
<td>9.1±1.3&lt;sup&gt;y&lt;/sup&gt;</td>
<td>0.001</td>
</tr>
<tr>
<td>Carrots</td>
<td>8.7±1.9</td>
<td>7.6±1.4</td>
<td>7.0±1.6</td>
<td>8.5±1.5</td>
<td>0.884</td>
</tr>
<tr>
<td>Cucumbers</td>
<td>6.7±1.4</td>
<td>4.4±1.3</td>
<td>2.9±1.0</td>
<td>3.6±0.9</td>
<td>0.144</td>
</tr>
<tr>
<td>Broccoli</td>
<td>1.4±0.5</td>
<td>1.5±0.6</td>
<td>2.0±0.5</td>
<td>3.3±1.2</td>
<td>0.457</td>
</tr>
<tr>
<td>Bell peppers</td>
<td>3.3±0.6</td>
<td>3.1±0.7</td>
<td>3.1±0.8</td>
<td>5.7±1.3</td>
<td>0.327</td>
</tr>
<tr>
<td>Avocados</td>
<td>1.8±0.7</td>
<td>1.2±0.5</td>
<td>1.7±0.6</td>
<td>3.5±1.0</td>
<td>0.259</td>
</tr>
<tr>
<td>Fresh corn</td>
<td>4.7±1.2&lt;sup&gt;x&lt;/sup&gt;</td>
<td>1.9±0.6&lt;sup&gt;y&lt;/sup&gt;</td>
<td>0.0&lt;sup&gt;y&lt;/sup&gt;</td>
<td>0.6±0.3&lt;sup&gt;y&lt;/sup&gt;</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Spinach/kale</td>
<td>5.6±1.2</td>
<td>3.3±1.0</td>
<td>4.0±1.2</td>
<td>6.1±1.8</td>
<td>0.404</td>
</tr>
<tr>
<td>Sweet potatoes/pumpkin</td>
<td>2.7±1.0</td>
<td>7.3±1.8</td>
<td>6.9±1.8</td>
<td>4.5±1.4</td>
<td>0.077</td>
</tr>
<tr>
<td>Berries</td>
<td>21.7±3.3&lt;sup&gt;x&lt;/sup&gt;</td>
<td>11.2±2.8&lt;sup&gt;y&lt;/sup&gt;</td>
<td>7.8±2.3&lt;sup&gt;y&lt;/sup&gt;</td>
<td>13.4±2.4&lt;sup&gt;y&lt;/sup&gt;</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Peaches and nectarines</td>
<td>11.1±2.6&lt;sup&gt;x&lt;/sup&gt;</td>
<td>2.5±0.9&lt;sup&gt;y&lt;/sup&gt;</td>
<td>0.0&lt;sup&gt;y&lt;/sup&gt;</td>
<td>0.8±0.8&lt;sup&gt;y&lt;/sup&gt;</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Apples and pears</td>
<td>16.5±4.4</td>
<td>32.1±6.8</td>
<td>29.9±5.7</td>
<td>24.2±4.7</td>
<td>0.150</td>
</tr>
<tr>
<td>Melon</td>
<td>27.9±5.8&lt;sup&gt;x&lt;/sup&gt;</td>
<td>8.5±2.3&lt;sup&gt;y&lt;/sup&gt;</td>
<td>1.7±0.9&lt;sup&gt;y&lt;/sup&gt;</td>
<td>7.2±2.4&lt;sup&gt;y&lt;/sup&gt;</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Bananas</td>
<td>26.9±4.2</td>
<td>24.7±4.0</td>
<td>28.6±4.6</td>
<td>29.4±4.5</td>
<td>0.865</td>
</tr>
<tr>
<td>Grapes</td>
<td>13.0±2.3</td>
<td>10.3±2.6</td>
<td>6.2±2.0</td>
<td>6.2±2.1</td>
<td>0.088</td>
</tr>
<tr>
<td>Citrus fruits</td>
<td>4.7±1.5&lt;sup&gt;y&lt;/sup&gt;</td>
<td>9.2±2.8&lt;sup&gt;y&lt;/sup&gt;</td>
<td>36.8±8.9&lt;sup&gt;y&lt;/sup&gt;</td>
<td>30.5±7.5&lt;sup&gt;y&lt;/sup&gt;</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Fruit juice</td>
<td>32.0±8.4</td>
<td>29.0±6.5</td>
<td>25.4±5.4</td>
<td>15.7±4.5</td>
<td>0.198</td>
</tr>
</tbody>
</table>

<sup>a</sup>ASA24=Automated Self-Administered 24-Hour Recall.<sup>23</sup>
<sup>b</sup>Seasonal effects were tested using a mixed linear model.
<sup>c</sup>Values within seasons with the same superscript letters (x, y, z) are not significantly different (P>0.05) by Tukey contrasts.

colleagues,<sup>6</sup> also in the 1980s, reported that total vegetable intake did not differ throughout the year, but that fruit was consumed seasonally. More recently, Bernstein and colleagues<sup>11</sup> found no differences in food group intakes by season.

To our knowledge, only one study has examined alcoholic beverage consumption over a year, and it found no difference by season. During the winter holiday period, there was no difference found in the average amount of alcohol consumed compared with the nonholiday period. Half of participants reported not consuming any alcoholic beverages over the winter holiday season, compared with only 10% during the rest of the year. This may be due to social desirability bias, in which the women were consuming more drinks than normal and did not wish to disclose this to the researchers. Alternatively, the days of dietary collection during the holiday season could influence whether or not women are drinking alcoholic beverages. It is possible that women are more likely to indulge in alcohol on the specific day on which the holidays fall, so they may be less likely to drink alcoholic beverages on other days in or surrounding this time frame.

Studies of seasonality are heterogeneous. They vary not just in type of dietary assessment method used, but also how foods and nutrients are presented; that is, energy-adjusted or not, and by definition of season. In this analysis, the meteorologic definition of season was used because it is based on weather patterns to approximate the hottest and coldest seasons for summer and winter. It is also important to consider location when addressing the question of seasonality in the diet, because it has been reported that fruit and vegetable intakes of individuals living in rural agricultural areas are different depending on growing and harvesting seasons,<sup>20</sup> whereas those living in a metropolitan area do not vary seasonally.<sup>11</sup> Lack of seasonal variation in food intakes may be expected in locations that are temperate year-round, but the location for this study is one of the coldest in the United States during the winter; therefore, the association of season with local food availability and dietary intake was expected to be pronounced. In this study, although we found no differences in Whole Fruit or Total Vegetables HEI-2010 component scores during the calendar year, there were differences in the types of F/V consumed. More lettuce or salad, tomatoes, berries, and melons were eaten during the summer months, perhaps reflecting consumer preferences for locally grown, seasonal produce. This is the first study to report HEI-2010 diet quality scores for data collected throughout an entire year. The overall mean HEI-2010 score in this study population was markedly higher than that found in the total US population, including children (60 vs 53),<sup>10</sup> but was still low overall.
The strengths and limitations of the study warrant consideration. This sample is small in numbers, homogeneous, and geographically limited. These women were also willing to participate in a research study for an entire year; therefore, these results are not generalizable to the larger population of midlife US women. The women in this study were perimenopausal, which may have influenced their intake and also affects generalizability.

Self-reported dietary intake is subject to error and bias and may be substantially inaccurate, particularly with respect to underreporting of energy intakes. Objective measures of dietary intake, such as urinary protein or doubly labeled water, were not collected. Unannounced 24-hour recalls circumvent reactivity bias, but in this study participants received an e-mail every 10 days asking them to complete a recall for the preceding day. Therefore, participants may have anticipated recalls, introducing reactivity bias. Participants were asked to not change their eating behavior and to report as honestly as possible, but again, social desirability may have led to misreporting. If misreporting is more extreme during some seasons than others, such as greater underreporting of high-fat, high-sugar foods during winter holidays, true seasonal differences in intake may be missed. In this study, the lower HEI-2010 scores during winter holidays suggests that systematic misreporting during this period was not pronounced.

Strengths include the longitudinal study design, which allowed examination of seasonal variation in dietary intake. Attrition was low (4%), implying that the multiple 24-hour recalls were not too burdensome. The use of ASA24 is also a strength. ASA24 has recently emerged as a valid and feasible alternative to face-to-face interviewers for collecting 24-hour recall data. The HEI-2010 component and total scores reflect overall diet quality as recommended by the Dietary Guidelines for Americans and reflect recommendations for food groups and nutrients Americans should consume more or less of. These findings have implications for nutrition monitoring, for the evaluation of interventions to promote a healthy diet, and for clinicians.

**CONCLUSIONS**

These results suggest that, in this population, diet quality is very different during winter holiday periods, and that diet quality is similar across the remainder of the calendar year. Total Vegetable and Whole Fruit HEI-2010 component scores were not higher during summer or fall and there was no evidence of higher energy or percent energy from carbohydrate intake during the winter months. The Total Fruit HEI-2010 component score was higher during summer than other seasons. There were differences in the individual types of F/V consumed by season. HEI-2010 scores were mostly stable and low. These findings have implications for the collection of shorter-term dietary assessment methods, such as 24-hour recalls, in that any season may be representative of usual intakes of broad food groups throughout the year. Based on our results, it appears that season would not be a strong mediator when evaluating diet—disease associations; however, potential confounding should always be evaluated when the data exist to do so. Future research directions include an examination of seasonality in intake in localities with extreme summer weather and in studies that include men and children. Also of interest is the further examination of diet quality during the winter holiday season and its potential association with health outcomes. Nutrition and dietetics practitioners should continue to emphasize the importance of increasing diet quality and use evidence-based counseling strategies.
to help individuals to at least maintain usual diet quality during the winter holidays.

References


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