Validity of Adolescent Diet Recall 48 Years Later

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Few studies have evaluated the validity of adolescent diet recall after many decades. Between 1943 and 1970, yearly diet records were completed by parents of adolescents participating in an ongoing US study. In 2005–2006, study participants who had been 13–18 years of age when the diet records were collected were asked to complete a food frequency questionnaire regarding their adolescent diet. Food frequency questionnaires and diet records were available for 72 participants. The authors calculated Spearman correlation coefficients between food, food group, and nutrient intakes from the diet records and food frequency questionnaire and deattenuated them to account for the effects of within-person variation measured in the diet records on the association. The median deattenuated correlation for foods was 0.30, ranging from 0.53 for a beef, pork, or lamb sandwich to 0.99 for diet soda. The median deattenuated correlation for food groups was 0.31 (range: 0.48 for breads to 0.70 for hot beverages); for nutrient intakes, it was 0.25 (range: −0.08 for iron to 0.82 for vitamin B₁₂). Some dietary factors were reasonably recalled 3–6 decades later. However, this food frequency questionnaire did not validly measure overall adolescent diet when completed by middle-aged and older adults on average 48 years after adolescence.

Adolescent diet may be an important determinant of adult disease risk. For example, mathematical (1–3) and animal (4) models of breast carcinogenesis, as well as specific events in mammary gland development and differentiation (5–7), suggest that the period between menarche and first full-term pregnancy is a susceptible time window in the pathogenesis of this malignancy. Ideally, hypotheses regarding adolescent diet and adult disease risk should be evaluated in prospective studies with thorough assessments of diet during adolescence. However, it will take decades for ongoing studies of this nature (8, 9) to accrue enough cases to evaluate these hypotheses. Furthermore, it may be necessary to expand some of these studies or pool data across studies to obtain sufficient statistical power to detect significant associations between dietary exposures during adolescence and possible endpoints.

Although not ideal, the use of retrospectively assessed dietary data from adults in large ongoing cohorts could provide more timely and less expensive answers. Using this strategy, some investigators have reported associations of specific dietary factors during adolescence, such as intake of soy foods, red meat, vegetable fat, and vitamin E, with risk of breast cancer (10–13). The usefulness of this approach, however, hinges on the validity of dietary recall from the distant past.

We previously designed a food frequency questionnaire (FFQ), the high school FFQ, aimed at assessing diet during the high school years as recalled by middle-aged individuals and evaluated its validity in 2 ways. We compared the responses to the high school FFQ by middle-aged women with those provided by their mothers (14), and we also compared the responses to the high school FFQ by young adults with prospectively collected 24-hour recalls of their diet during adolescence, approximately 10 years earlier (15). Results from these studies suggest that the high school FFQ can adequately represent adolescent diet, but it remains unclear whether the same is true for dietary recall more than 40 years later.
how diet recalls of middle-aged individuals using the high school FFQ compare with prospectively collected diet records and whether the apparently good validity of recall previously observed extends to longer recall times. Here, we evaluate the validity of the high school FFQ by comparing the responses of middle-aged and older adults to this questionnaire with diet records collected between the 1940s and 1970s as part of the Fels Longitudinal Study, an ongoing US study of growth, development, and aging.

MATERIALS AND METHODS

Study participants

Study subjects were active participants of the Fels Longitudinal Study. The Fels Study was established in 1929 and is the oldest ongoing study of growth, development, and aging in the world (16). Participant recruitment is still ongoing, mostly through recruitment of children born to active participants, and approximately 1,300 people are currently under active follow-up. Each participant is followed from enrollment (usually birth) until death, regardless of changes in health. Scheduled examinations are not performed when transient medical conditions that could affect data collection occur. At each visit, extensive age-appropriate growth, body composition, and other health-related data are collected. Since study inception, the data collection protocol has specified that participant visits occur at birth and at 3, 6, 9, and 12 months of age; then every 6 months at half-birthdays and birthdays until age 18 years; and every 2–5 years afterward.

The current study was approved by the institutional review boards of the Fels Research Institute (Yellow Springs, Ohio), Wright State University (Kettering, Ohio), and Brigham and Women’s Hospital (Boston, Massachusetts).

Study design and dietary assessments

Between 1929 and 1970, parents of study participants completed one 7-day diet record every year from their child’s birth until age 18 years. The diet records were distributed to participants’ parents at their regularly scheduled visits. Parents were instructed to keep a record of all foods eaten by their child during 7 consecutive days, including details of portion size, and to return the records after completion. The records were almost always completed by the mother. Diet records were not checked for completeness upon return. In a subsequent review of the records, it was found that 97% of the diet records were completed for all 7 days and were returned to the investigators (17).

In total, 477 study participants were 13–18 years of age when the diet records were collected between 1943 and 1970. Between September 2005 and January 2006, we contacted by mail all surviving participants who remained under active follow-up (n = 96) and asked them to complete the previously described 125-item high school FFQ (13). Seventy-six of them returned a completed high school FFQ. One or more diet records for the relevant time period were located for 72 of these participants; one diet record was available for 24 participants, 2 diet records were available for 15 participants, and 3 or more diet records were available for 33 participants.

The high school FFQ was developed to retrospectively assess diet during adolescence among members of an ongoing cohort study (13). It focuses on foods commonly consumed by adolescents in the United States during the target historical period. For the current validation study, participants were asked to report how often, on average, they had consumed a range of foods, specifying brand names for some food items, and to provide details about fats and oils used in food preparation at home while they were in high school, approximately between the ages of 13 and 18 years. For each food, 9 frequency categories were offered, ranging from never or less than once per month to 6 or more times per day. Portion sizes were provided for each food as “natural” units (e.g., 1 apple, 1 egg, 1 slice of bread) whenever possible and otherwise were based on the most common serving size reported on the 1977–1978 US Department of Agriculture Nationwide Food Consumption Survey (18), the earliest available, nationally representative data on portion sizes for individuals eating occasion.

To estimate nutrient intakes from the FFQ, a nutrient database pertaining to the relevant time period was developed by a team of research dietitians (L. S., P. T., and C. W.) based on data from the US Department of Agriculture (19–25) and was complemented as necessary by other published sources (26–34). Nutrient intakes were calculated by summing the nutrient contributions of each food and nutrient supplement in the high school FFQ. To account for changes in food composition and fortification over time, the participants’ year of birth was used to assign different nutrient contents to specific foods. Because we were unable to find modern diet record analysis software that supported a nutrient database for the target historical period, diet records were analyzed by using the 1986 version of the CBORD Diet Analyzer System (The CBORD Group, Ithaca, New York). This package uses the 1986 version of the ESHA nutrient database (ESHA, Salem, Oregon), which is based on data from the US Department of Agriculture between 1975 and 1981 (24, 35).

Statistical analyses

Intakes of 4 food items included in the high school FFQ (diet soda without caffeine, seeds, Pop Tarts (Kellogg Company, Battle Creek, Michigan), alcoholic beverages) were not reported in any diet record, and an additional 5 food items (English muffins, tortillas, raw spinach, multivitamins, vitamin C supplements) were reported by too few people and therefore were not included in the analysis of food-specific validity of recall. Since food groups may be recalled better than individual food items (36, 37), we categorized all individual food items into 16 food groups. Nutrient intakes were log-transformed, adjusted for total energy intake by using the nutrient residual method (38) to account for extraneous variation in intakes, and subsequently back-transformed to the original scale for analysis. When more than one diet record was available for a participant, the average across all available diet records was considered the “gold standard” intake measure for the individual.
To evaluate validity of recall, we calculated Spearman correlation coefficients and their 95% confidence intervals (39) between food, food group, and nutrient intakes reported on the diet records and the corresponding intakes reported on the high school FFQ. We used an extension of the methods by Rosner and Glynn (39) and Perisic and Rosner (40) to correct Spearman rank correlation coefficients for measurement error in the presence of unbalanced data with a varying number of diet records (k) available for individual subjects. Specifically, for the subset of subjects for whom k weeks of diet record were available, we computed ranks for FFQ intake separately for each week of diet record intake and converted ranks to probit scores given by $H_i = \phi^{-1}\left[R_i/(n_k + 1)\right]$, where $R_i$ is the rank for the $i$th subject, $n_k$ is the number of subjects with $k$ weeks of diet record, and $\phi^{-1}$ is the inverse normal (or probit) transformation. We then computed the Pearson correlation between the FFQ probit scores and the average of $k$ computed ranks for weekly diet record probit scores ($\rho_{th,k}$). Next, we corrected $\rho_{th,k}$ for measurement error using standard methods (41), thus obtaining $\rho_{th,k}$ and transformed $\rho_{th,k}$ using Fisher’s $z$ transformation to obtain $z_{th,k}$. We then computed a weighted average of $z_{th,k}$, $k = 1, 2, 3$ using weights of $n_k - 3$ and obtained an overall estimate of $z_{th,average}$ using the sib-mean estimator described by Perisic and Rosner (40). Next, we calculated a 95% confidence interval for $z_{th,average}$ using variance estimates from Rosner and Willett (41) and used the inverse Fisher $z$ transform to obtain the corresponding 95% confidence interval for $\rho_{th,average} = (\rho_{th}^{(1)}, \rho_{th}^{(2)})$. The corresponding 95% confidence interval for the deattenuated rank correlation coefficient is given by $(\rho_{ts}^{(1)}, \rho_{ts}^{(2)})$, where $\rho_{ts}^{(q)} = (6/\pi) \sin^{-1}\left(\rho_{th}^{(q)}/2\right)$, $q = 1, 2$.

The rationale for the approach described above is that the relation between a rank and Pearson correlation coefficient for a normally distributed scale (such as the probit scale) is given by $\rho_z = (6/\pi) \sin^{-1}(\rho/2)$ (39). Furthermore, ranks are invariant in the probit and original scales. To obtain estimates of the intraclass correlation coefficient (ICC) for ranks of multiple weeks of diet record (ICC$_s$), we computed the ICC for weekly diet record probit scores (ICC$_d$) using random-effects analysis of variance and estimated ICC$_s$ by $(6/\pi) \sin^{-1}(\text{ICC}_d/2)$. ICC$_s$ can be interpreted as the correlation in ranks of intakes for a given dietary factor between any 2 random weeks over the 5-year period within the same subject.

**RESULTS**

High school FFQs were completed, on average, 48 years (range: 36–61 years) after diet records were collected. At the time of completion, the mean age of participants was 63 years (range: 49–76 years). Of the 72 respondents, 35 were female and 37 were male. Figures 1 shows the distribution of the observed and deattenuated Spearman correlation coefficients between food intakes assessed by diet record (1943–1970) and by food frequency questionnaire (2005–2006), United States. The values of the Spearman correlation coefficients for individual food items are presented in Web Table 1 (this supplementary table is posted on the Journal’s website (http://aje.oupjournals.org/)).

The median observed correlation was 0.15 and ranged from $-0.32$ for a beef, pork, or lamb sandwich to 0.73 for beef liver. We did not calculate deattenuated correlations for foods with an estimated ICC of less than 0. For the remaining 104 foods, as expected, correcting for the effects of random within-person variation improved the correlations overall. The median deattenuated correlation was 0.30, ranging from $-0.53$ to 0.99. Because the degree of correction depends on the ratio of within- to between-person variation, the degree of correction for foods with very high within-person variation (reflected in a low ICC) was large, leading to very high or very low deattenuated correlations. Furthermore, the wide confidence intervals for some of these foods suggested that the deattenuated estimate for foods with a low ICC was not informative. For example, the correlation for green peppers (ICC = 0.02) varied from 0.27 (95% confidence interval: 0.04, 0.47) to 0.91 (95% confidence interval: $-1.00$, 1.00). When foods with an ICC of less than 0.20 (i.e., when the within-person variation in intake was 4 times greater than the between-person variation) were excluded,
the median deattenuated correlation remained 0.30, with a range of −0.53 for a beef, pork, or lamb sandwich to 0.93 for hot breakfast cereal.

We also categorized all individual food items into 16 food groups. The validity of recall for food groups closely resembled that for individual food items (Table 1). The median observed correlation was 0.19 and ranged from −0.13 for breads to 0.44 for hot beverages, and the median deattenuated correlation was 0.31 (range: −0.48 to 0.70).

Correlations for nutrients intakes derived from diet records and the FFQ were slightly weaker than those for individual foods and food groupings (Table 2). The median observed correlation coefficient was 0.17, with a range of 0.03 for carbohydrates to 0.35 for cholesterol.

### Table 1. Observed and Deattenuated Spearman Correlation Coefficients (*r*) and 95% Confidence Intervals Between Food Group Intakes Assessed by Diet Record (1943–1970) and Food Frequency Questionnaire (2005–2006), United States

<table>
<thead>
<tr>
<th>Food Group</th>
<th>Observed <em>r</em></th>
<th>95% CI</th>
<th>Deattenuated <em>r</em></th>
<th>95% CI</th>
<th>ICCa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold beveragesb</td>
<td>0.24</td>
<td>0.00, 0.44</td>
<td>0.38</td>
<td>−0.01, 0.67</td>
<td>0.35</td>
</tr>
<tr>
<td>Hot beveragesc</td>
<td>0.44</td>
<td>0.23, 0.61</td>
<td>0.70</td>
<td>−0.13, 0.96</td>
<td>0.33</td>
</tr>
<tr>
<td>Milk and dairy foodsd</td>
<td>0.22</td>
<td>−0.02, 0.43</td>
<td>0.25</td>
<td>−0.02, 0.48</td>
<td>0.56</td>
</tr>
<tr>
<td>Eggs</td>
<td>0.39</td>
<td>0.17, 0.57</td>
<td>0.51</td>
<td>0.19, 0.74</td>
<td>0.41</td>
</tr>
<tr>
<td>Poultrya</td>
<td>0.24</td>
<td>0.01, 0.45</td>
<td>0.39</td>
<td>0.00, 0.67</td>
<td>0.35</td>
</tr>
<tr>
<td>Red and processed meatsf</td>
<td>0.14</td>
<td>−0.10, 0.36</td>
<td>0.20</td>
<td>−0.13, 0.50</td>
<td>0.32</td>
</tr>
<tr>
<td>Fish and seafoodg</td>
<td>0.20</td>
<td>−0.03, 0.41</td>
<td>0.37</td>
<td>−0.12, 0.71</td>
<td>0.16</td>
</tr>
<tr>
<td>Breads</td>
<td>−0.13</td>
<td>−0.35, 0.10</td>
<td>−0.48</td>
<td>−0.99, 0.96</td>
<td>0.21</td>
</tr>
<tr>
<td>Bakery products</td>
<td>0.16</td>
<td>−0.08, 0.38</td>
<td>0.20</td>
<td>−0.14, 0.49</td>
<td>0.39</td>
</tr>
<tr>
<td>Potatoes</td>
<td>0.29</td>
<td>0.07, 0.49</td>
<td>0.54</td>
<td>−0.28, 0.91</td>
<td>0.37</td>
</tr>
<tr>
<td>Breakfast cereali</td>
<td>0.30</td>
<td>0.07, 0.49</td>
<td>0.45</td>
<td>0.03, 0.73</td>
<td>0.51</td>
</tr>
<tr>
<td>Other starchesj</td>
<td>0.07</td>
<td>−0.16, 0.30</td>
<td>0.11</td>
<td>−0.20, 0.41</td>
<td>0.35</td>
</tr>
<tr>
<td>Fruits and fruit juicesm</td>
<td>0.18</td>
<td>−0.06, 0.39</td>
<td>0.39</td>
<td>−0.25, 0.80</td>
<td>0.15</td>
</tr>
<tr>
<td>Vegetablesn</td>
<td>0.07</td>
<td>−0.17, 0.30</td>
<td>0.10</td>
<td>−0.22, 0.39</td>
<td>0.36</td>
</tr>
<tr>
<td>Snacks and desserts</td>
<td>0.09</td>
<td>−0.15, 0.31</td>
<td>0.12</td>
<td>−0.32, 0.51</td>
<td>0.21</td>
</tr>
<tr>
<td>Frozen desserts</td>
<td>0.12</td>
<td>−0.12, 0.34</td>
<td>0.20</td>
<td>−0.15, 0.50</td>
<td>0.32</td>
</tr>
<tr>
<td>Median</td>
<td>0.19</td>
<td></td>
<td>0.31</td>
<td></td>
<td>0.36</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; ICC, intraclass correlation coefficient.

* Estimated by using the repeated 7-day diet records for each person between 13 and 18 years of age.
* Diet soda, regular soda, soda without caffeine, diet soda without caffeine, iced tea.
* Hot tea, coffee.
* Milk, chocolate milk, instant breakfast drink, yogurt, cottage or ricotta cheese; cheese, cream cheese, butter, margarine.
* Chicken or turkey main dish, chicken or turkey sandwich.
* Bacon, hot dogs, other processed meats, hamburger, meat loaf, beef or lamb main dish, pork main dish, beef, pork or lamb sandwich, beef liver, chicken liver.
* Canned tuna, dark-meat fish, breaded fish, other fish, shrimp/lobster/scallops.
* White bread, dark bread, cornbread, biscuits/rolls, English muffins, tortillas.
* Danish/sweet rolls, doughnuts, snack cakes, cake, cookies, brownies, pie, pancakes/waffles, muffins.
* French fries, baked/boiled/mashed potatoes, potato salad, potato chips.
* Cold breakfast cereal, hot breakfast cereal.
* Pasta, pizza, rice.
* Raisins, grapes, bananas, apples, applesauce, cantaloupe/melons, pears, orange/grapefruit, strawberries, peaches/plums/apricots, pineapple, orange juice, apple juice, other fruit juice.
* Tomatoes, tomato sauce, string beans, beans/legumes, broccoli, cauliflower, corn, peas/lima beans, mixed vegetables, cooked spinach, mustard/kale/greens, green peppers, eggplant/zucchini/squash, yams/sweet potatoes, cooked carrots, raw carrots, celery, radish, lettuce, cabbage, onions (garnish), onions (rings or soup), raw spinach.
* Corn chips, popcorn, pretzels, peanuts, other nuts, graham crackers, crackers; chocolate bar, other candy bar, candy without chocolate, seeds, Pop Tarts (Kellogg Company, Battle Creek, Michigan).
* Sherbet, ice cream, milk shake, Popsicles (Good Humor-Breyers Ice Cream Company, Green Bay, Wisconsin).
adjustment did not change the overall results. The median calorie-adjusted correlation was also 0.17 (range: −0.05 to 0.45). Deattenuation of the calorie-adjusted correlations improved the correlation between diet-record and FFQ-estimated nutrient intakes. The median deattenuated correlation was 0.25 and ranged from −0.08 for iron to 0.82 for vitamin B₁₂. When we excluded saturated fat (the only nutrient with an ICC below 0.20) and vitamin B₁₂ (whose confidence interval suggested that the estimate was uninformative) from the analyses, the median deattenuated correlation remained unchanged.

**DISCUSSION**

The availability of stored diet records from the Fels Longitudinal Study provided us with the unique opportunity to evaluate the validity of adolescent diet recall 48 years later. Some dietary factors, such as folate, vitamin C, and important contributors to intake of trans fatty acids (margarine and French fries), were reasonably recalled, with deattenuated correlations within the range reported in previous validation studies of widely used FFQs measuring current diet (42–47). However, the high school FFQ did not validly assess overall adolescent diet when completed, on average, 48 years after adolescence by free-living, middle-aged and older adults. Our results suggest that it may not be useful to retrospectively assess diet in epidemiologic studies when the recall time is as long as that in this study.

FFQs measure current diet in adults (44–47), and past diet when the recall time is relatively short, with adequate validity (48). In general, the validity of recall decreases as the recall time becomes longer, with average correlations between FFQs and original records of diet between 0.50 and 0.75 for recall times up to 10 years and between 0.35 and 0.55 for recall times of 10–15 years (48–55) (reviewed by Friedenreich et al. (55)). Longer recall times or recall of diet during adolescence could be of interest in epidemiologic studies of middle-aged and older adults, but few studies have assessed the validity of recalled adolescent diet, mainly because of the unavailability of original records of diet many decades in the past.

To date, we know of only one study that has evaluated whether diet during adolescence can be validly recalled after several decades. Dwyer et al. (36, 56) asked middle-aged individuals to complete a 46-item FFQ to recall, after 32 years, their diet at age 18 years, and they compared the recalled food intakes with those recorded in prospectively collected diet records. The median Pearson correlation between diet-record and FFQ-reported food intakes was 0.12

### Table 2. Observed and Deattenuated Spearman Correlation Coefficients (r) and 95% Confidence Intervals Between Nutrient Intakesa Assessed by Diet Record (1943–1970) and Food Frequency Questionnaire (2005–2006), United States

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Observed r</th>
<th>95% CI</th>
<th>Energy-adjusted r</th>
<th>95% CI</th>
<th>Deattenuated Energy-adjusted r</th>
<th>95% CI</th>
<th>ICCb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calories</td>
<td>0.13</td>
<td>−0.09, 0.34</td>
<td>0.19</td>
<td>−0.05, 0.40</td>
<td>0.28</td>
<td>−0.07, 0.57</td>
<td>0.38</td>
</tr>
<tr>
<td>Protein</td>
<td>0.20</td>
<td>−0.03, 0.40</td>
<td>0.19</td>
<td>−0.05, 0.40</td>
<td>0.28</td>
<td>−0.07, 0.57</td>
<td>0.38</td>
</tr>
<tr>
<td>Total fat</td>
<td>0.17</td>
<td>−0.05, 0.38</td>
<td>0.10</td>
<td>−0.13, 0.33</td>
<td>0.15</td>
<td>−0.25, 0.51</td>
<td>0.21</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>0.03</td>
<td>−0.19, 0.25</td>
<td>0.10</td>
<td>−0.13, 0.33</td>
<td>0.17</td>
<td>−0.19, 0.48</td>
<td>0.28</td>
</tr>
<tr>
<td>Fiber</td>
<td>0.06</td>
<td>−0.17, 0.28</td>
<td>0.11</td>
<td>−0.13, 0.33</td>
<td>0.17</td>
<td>−0.17, 0.48</td>
<td>0.30</td>
</tr>
<tr>
<td>Saturated fat</td>
<td>0.20</td>
<td>−0.03, 0.40</td>
<td>0.19</td>
<td>−0.04, 0.40</td>
<td>0.47</td>
<td>−0.38, 0.89</td>
<td>0.10</td>
</tr>
<tr>
<td>Monounsaturated fat</td>
<td>0.15</td>
<td>−0.07, 0.36</td>
<td>0.19</td>
<td>−0.05, 0.40</td>
<td>0.29</td>
<td>−0.06, 0.58</td>
<td>0.32</td>
</tr>
<tr>
<td>Polyunsaturated fat</td>
<td>0.16</td>
<td>−0.06, 0.37</td>
<td>0.11</td>
<td>−0.12, 0.34</td>
<td>0.18</td>
<td>−0.16, 0.48</td>
<td>0.34</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>0.35</td>
<td>0.13, 0.53</td>
<td>0.45</td>
<td>0.24, 0.62</td>
<td>0.70</td>
<td>0.00, 0.94</td>
<td>0.33</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>0.17</td>
<td>−0.05, 0.38</td>
<td>0.17</td>
<td>−0.06, 0.39</td>
<td>0.25</td>
<td>−0.07, 0.52</td>
<td>0.43</td>
</tr>
<tr>
<td>Vitamin B₁</td>
<td>0.03</td>
<td>−0.20, 0.25</td>
<td>0.22</td>
<td>−0.02, 0.43</td>
<td>0.35</td>
<td>−0.09, 0.67</td>
<td>0.20</td>
</tr>
<tr>
<td>Vitamin B₂</td>
<td>0.29</td>
<td>0.07, 0.48</td>
<td>0.17</td>
<td>−0.07, 0.38</td>
<td>0.25</td>
<td>−0.07, 0.52</td>
<td>0.44</td>
</tr>
<tr>
<td>Niacin</td>
<td>0.05</td>
<td>−0.18, 0.27</td>
<td>0.04</td>
<td>−0.20, 0.27</td>
<td>0.03</td>
<td>−0.26, 0.32</td>
<td>0.39</td>
</tr>
<tr>
<td>Vitamin B₆</td>
<td>0.07</td>
<td>−0.15, 0.29</td>
<td>0.13</td>
<td>−0.10, 0.35</td>
<td>0.17</td>
<td>−0.19, 0.48</td>
<td>0.28</td>
</tr>
<tr>
<td>Folate</td>
<td>0.25</td>
<td>0.03, 0.45</td>
<td>0.31</td>
<td>0.08, 0.51</td>
<td>0.50</td>
<td>0.01, 0.80</td>
<td>0.34</td>
</tr>
<tr>
<td>Vitamin B₁₂</td>
<td>0.31</td>
<td>0.10, 0.50</td>
<td>0.35</td>
<td>0.13, 0.54</td>
<td>0.82</td>
<td>−1.00, 1.00</td>
<td>0.23</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>0.22</td>
<td>−0.01, 0.42</td>
<td>0.30</td>
<td>0.07, 0.49</td>
<td>0.30</td>
<td>0.08, 0.56</td>
<td>0.56</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>0.13</td>
<td>−0.10, 0.34</td>
<td>0.08</td>
<td>−0.16, 0.30</td>
<td>0.15</td>
<td>−0.19, 0.45</td>
<td>0.34</td>
</tr>
<tr>
<td>Calcium</td>
<td>0.29</td>
<td>0.07, 0.48</td>
<td>0.22</td>
<td>−0.01, 0.43</td>
<td>0.31</td>
<td>−0.01, 0.58</td>
<td>0.44</td>
</tr>
<tr>
<td>Iron</td>
<td>0.05</td>
<td>−0.18, 0.27</td>
<td>−0.05</td>
<td>−0.28, 0.18</td>
<td>−0.08</td>
<td>−0.39, 0.24</td>
<td>0.31</td>
</tr>
</tbody>
</table>

Median: 0.17 0.17 0.25 0.33

Abbreviations: CI, confidence interval; ICC, intraclass correlation coefficient.

a Nutrient intakes include contributions from foods, food fortification, and nutrient supplements.
b Estimated by using the repeated 7-day diet records for each person between 13 and 18 years of age.

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and was better for food groups (median $r = 0.22$) than for individual foods (36, 56). These authors’ study design closely parallels that of the current study, with some differences. First, in Dwyer et al.’s study (36, 56), the subjects themselves provided the original record of adolescent diet; in the current study, the subjects’ mothers completed the original record of diet. Second, in Dwyer et al.’s study (36, 56), the recall period was different (age 18 years) than in our study (ages 13–18 years), and our questionnaire included nearly 3 times as many food items. Third, the average recall time was 16 years longer in our study. Despite these differences, the median observed correlations for recalled food and food group intakes, as well as the correlations for many specific foods and food groupings, are similar. Taken together, the data from these 2 studies suggest acceptable validity of recall for some selected foods and food groups but poor ability to recall overall diet after several decades.

We previously evaluated the validity of the high school FFQ in 2 settings. In one study (15), we asked a group of young adults (aged 23–29 years) to recall their diet during adolescence by using the high school FFQ, and we compared their responses with 3 prospectively collected 24-hour recalls completed 10 years earlier. The mean correlation for nutrient intakes between the three 24-hour recalls and the high school FFQ was 0.45 (range: 0.16–0.68) (15). In a separate study (14), we compared food and nutrient intakes derived from the responses to the high school FFQ by adult women (aged 34–53 years; recall time: 15–35 years) with the responses to the high school FFQ provided by their mothers 4 years later. The mean daughter-mother correlations for nutrient intakes were 0.40 (range: 0.13–0.59). The correlations between prospectively collected diet records and recalled adolescent diet using the high school FFQ in the present study (ages 50–76 years; recall: 36–61 years) were lower, and their range was wider than those in our previous evaluations. Taken together, these studies suggest that the high school FFQ provides a reasonable measure of adolescent diet for adults in their twenties, thirties, and forties when recall time does not exceed 35 years but is of limited use when people completing the questionnaire are older or recall time is substantially longer. Therefore, hypotheses regarding the role of adolescent diet on risk of adult onset of disease should be evaluated in studies with prospective assessments of adolescent diet or, if recall is necessary, studies of adults with the minimum possible recall time.

Some limitations of our study could have attenuated the correlations between diet records and the high school FFQ. First, diet records were completed by the mothers of the study participants rather than the participants themselves. This approach may have introduced some error regarding foods consumed away from home (which can contribute considerably to total energy intake in adolescents) and foods or beverages with negative social connotations. In an extreme example, alcohol intake was not reported in any of the 154 diet records analyzed, but 18% of participants reported in their FFQs that they consumed one or more alcoholic beverages per week between 13 and 18 years of age. Whether alcohol intake was unknown to mothers or was unreported because of other circumstances is unknown. Whether similar situations arose with other food items is also unknown but could also have attenuated our estimates of validity of recall.

Second, the nutrient databases used to analyze the high school FFQ and the diet records did not completely represent the same historical time period and included only a limited number of nutrients. Although a specific nutrient database was designed for the high school FFQ, which allowed for changes in food composition and micronutrient fortification over time, the diet record nutrient database may not have reflected the true nutrient composition of the target historical period since it did not allow for changes in food composition over time. This limitation in the diet record nutrient database may have added some error to estimation of diet record nutrient intake, leading to attenuation of the correlation coefficients, as suggested by the lower correlations observed for nutrients overall when compared with the correlations observed for foods and food groupings. An additional limitation was our small sample size. This problem precluded us from performing stratified analyses by recall time, gender, or age. In addition, the small sample size resulted in very broad confidence intervals, often including zero, for several foods and nutrients.

Strengths of our study include availability of prospectively collected diet records, which has proved to be the main limitation to adequately evaluating the validity of FFQs during early periods of life. In addition, multiple diet records were collected during the period of interest, which allowed estimation of within-person variability of diet during adolescence and deattenuation of the correlation coefficients.

In summary, our results suggest that the validity of recall of a few foods and nutrients is reasonable and may allow evaluation of hypotheses focused on these dietary factors. However, the high school FFQ does not validly measure overall adolescent diet when completed by middle-aged and older adults on average 48 years after adolescence. Since our previous evaluations of this questionnaire suggest that it can validly represent overall adolescent diet when completed by adults in their twenties, thirties, and forties, investigators interested in evaluating the role of adolescent diet in adult disease risk should assess adolescent diet retrospectively only if recall time is not excessive.

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Conflict of interest: none declared.

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