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Dietary Quality of Diverse, Rural Adolescents Using the Healthy Eating Index – 2010

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Abstract

Objective—We report baseline dietary intake using the Healthy Eating Index (HEI) – 2010 in rural, diverse adolescents from Minnesota.

Methods—In 2013–2014, 9th–10th graders who reported eating breakfast less than 3 or fewer times per week were recruited from 16 rural schools. Data included computer-based survey results, measured height and weight, and 24-hour dietary recalls. Schools provided student data on free/reduced meal status. The HEI-2010 was calculated from 24-hour dietary recalls. Regression models assessed demographic differences in HEI-2010.

Results—The sample mean HEI-2010 score was 52 out of 100 ($N = 732$ adolescents). Boys (mean HEI-2010=50.1) were statistically significantly lower than girls (mean HEI-2010=53.4). There was no significant difference by free/reduced price lunch or white versus students of color.

Conclusion—Rural adolescent breakfast skippers report poor dietary intake quality.

Keywords

adolescent health; healthy eating index; rural health; breakfast skippers

The nutritional quality of the diet of adolescents in the United States (US) is low,^{1,2} with most consuming a diet that is inconsistent with recommendations in the Dietary Guidelines for Americans.^{3,4} The Healthy Eating Index-2010 (HEI-2010)⁵ is a tool to assess how well US diets comply with the 2010 US Dietary Guidelines for Americans on a range of 1–100, with 100 indicating perfect compliance.³ Using data from the 2003–2004, 2005–2006, and

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Human Subjects Approval Statement

The University of Minnesota Institutional Review Board approved the BreakFAST study protocols.

Conflict of Interest Disclosure Statement

The authors report no conflicts of interest.

2007–2008 National Health and Nutrition Examination Survey (NHANES), the US Department of Agriculture (USDA) calculated the HEI-2010 score for a nationally representative sample of children age 2–17 and reported scores by year of 46.9, 47.1 and 49.3, respectively.⁶ The increase over time was not statistically significant, and the scores were sub-optimal. Dietary intake and quality are important contributors to obesity risk⁷ as well as an important factor in reducing risk for chronic disease,^{8,9} preventing nutrient deficiency conditions,¹⁰ and supporting academic success⁷.

Eating breakfast is correlated with improved dietary quality.^{11,12} Breakfast skipping is an important behavioral risk factor for obesity and poor dietary quality.^{10,13,14} Breakfast skipping is a more common practice among adolescents (31.5%) compared to 9–13 year-old children (20.1%).¹² Girls are more likely to skip breakfast than boys and racial/ethnic minorities, with the exception of Mexican-American/Hispanic children, also are more likely to skip breakfast.¹² There are no data available on breakfast skipping behavior specifically among rural youth. Rural adolescents in general are at greater risk of breakfast skipping and poor dietary intake quality because of reduced access to healthy food options^{15,16} and the consequence of poverty,¹⁷ both of which are more common in rural communities than urban communities. In addition, obesity, a consequence of poor dietary quality, is not evenly distributed in the population. Adolescents are at greater risk of being obese if they live in a rural setting,^{15,18,19} are low income,²⁰ and/or are from a racial/ethnic minority population.^{18,21}

Lazarou and Newby²² analyzed research on multiple dietary index tools used to assess diet quality among children in developed countries. Their review, across all identified indices, revealed significant associations between the dietary quality and age, sex, race/ethnicity, income, parental education, socio-economic status, place of living, and marital status of parents, with the most consistent significant associations between dietary quality and family income and sex.²² There was no specific information on differences in dietary quality by urban/rural environment. In fact, no current data were found describing healthy eating indices for rural populations or adolescents specifically.

Given the paucity of data and the increased risk of poor dietary quality among rural adolescents, specifically breakfast skippers, the purpose of this paper is to describe dietary quality among rural adolescent breakfast skippers. The sample in this study is diverse, allowing us to compare and confirm observed national and urban patterns of lower dietary quality patterns among boys compared to girls, racial/ethnic minority adolescents compared to white adolescents, and low-income compared to non-low income adolescents, but in a rural environment. The hypothesis is that dietary quality, as assessed using the HEI-2010, will be lower in rural adolescents who skip breakfast than what would be expected in the national or urban adolescents. However, the associations according to sociodemographic factors will be consistent with what is observed nationally or in urban context. This analysis will contribute to the literature as there are currently no known data for rural adolescents; moreover, it will inform further context-specific interventions aimed at improving dietary quality for a traditionally underserved population.

METHODS

This analysis uses baseline data from the Break-FAST Study (Fueling Academics and Strengthening Teens), a group randomized trial aimed at increasing school breakfast participation through policy and environmental-level school changes. Details about the study design and methods can be found elsewhere.²³ Briefly, 16 secondary schools in rural Minnesota were recruited to participate and were randomly assigned to intervention or control conditions. Rural is defined as a school located outside of the 7-county Twin Cities metropolitan area. All students in the 9th and 10th grade in all 16 schools present on the day of data collection (N = 5767) were asked to complete a brief screening survey. Table 1 provides a description of the sample. Students were surveyed to assess their eligibility. Students were eligible if they were in 9th or 10th grade, spoke and wrote English well (self-identified), had access to a phone at home or owned a cell phone, had access to the Internet at home, school, or library, were typically in school at the beginning of the day and ate breakfast on 3 or fewer days per 7-day week. There were 2512 students who were eligible to be randomly selected for the cohort. Hereafter, referred to as “breakfast skippers.” Between 50 and 85 eligible students, based on school size, were randomly selected from eligible adolescents from each high school and invited to participate in longitudinal data collection (N = 1253), with minority students oversampled. Parents were notified and were provided 10 days to inform the study team if they did not want their child to participate. The final child assented and parent passive consent sample size was 904.

Twenty-four hour dietary recall—We assessed dietary intake using 24-hour dietary recall for a target of 2 weekdays and 1 weekend day. The dietary recalls were collecting using the Nutrition Data Systems for Research (NDSR) nutrient calculation software. The NDSR is a computer-based software application developed by the University of Minnesota Nutrition Coordinating Center that allows for direct entry of dietary data using standardized protocols.²⁴ Students received a food amount booklet in the mail prior to the phone interviews as a tool to aid in estimating portion sizes. The recalls were conducted by interviewers who were trained and certified in the collection of dietary recalls using NDSR.

The HEI-2010 was calculated using the food and nutrient intakes estimated from the 24-hour dietary recalls. Dietary recall intake estimates were averaged if the student completed more than one recall. All students with at least one completed recall were included. The HEI is a standardized measure of diet quality as defined by the key diet-related recommendations of the 2010 US Dietary Guidelines.⁵ The procedures and code for calculating the HEI-2010 are well documented and publically available. The HEI has proven to be a valid measure of diet quality.²⁵ Individual components of the HEI also provide additional important insight.^{5,26} Briefly, the HEI includes 12 dietary components. Nine components assess adequacy of the diet including: (1) total fruit; (2) whole fruit; (3) total vegetables; (4) greens and beans; (5) whole grains; (6) dairy; (7) total protein foods; (8) seafood and plant proteins; and (9) fatty acids. Three components assess components that should be consumed in moderation, including: (1) refined grains; (2) sodium; and (3) energy from solid fats, alcohol and added sugars (SOFAAS). For each component, a higher score is better because for those components that should be consumed in moderation, a higher score represents lower

consumption.²⁷ The scores are weighted per 1000 kilocalories (kcal) and summed for a total score. The components and their standards can be found in Guenther et al.²⁶ The closer an HEI total score is to 100, the more consistent the diet is with 2010 US Dietary Guidelines recommendations. The US Department of Agriculture (USDA) suggests the following interpretation: HEI-2010 scores greater than 80 imply a good diet; between 51 and 80, a diet that needs improvement; and less than 51, a poor diet.²⁸

BMI—Student height and weight were measured by trained staff at school according to established protocols, available upon request.²³ Two staff members were present, one to measure, and one to record and verify. Student height without shoes was measured in centimeters using a portable stadiometer (Infant/Child/Adult wooden ShorrBoard, Weight and Measure, LLC (formerly Shorr Productions) Olney, MD) to the nearest 0.1 cm. Student weight was assessed using a portable scale (TBF-300) [Tanita/TBF-300/Tanita Corporation of America, Inc. in Arlington Heights IL]. We calculated BMI percentile from the height and weight data using the US Centers for Disease Control and Prevention growth charts.²⁹ Students with BMI percentile 85% or higher were classified as overweight or obese.

The schools provided data on whether or not the student received free or reduced price lunch (FRL). A computer-based survey was completed by students online at home or in the school's computer lab. The survey data was the source of sex, race and grade data. Participants who reported being students of color were oversampled to achieve 30% racial minority sample. Race was dichotomized to white and students of color because numbers in each category were too small for sub-analysis and participants were not selected based on one particular racial/ethnic category. The analytic sample for this analysis included 739 students from 16 schools who had at least one completed 24-hour dietary recall. Participants identified as white (N = 488), American Indian (N = 20), Asian (N = 15), black or African-American (N = 34), Native Hawaiian or other Pacific Islander (N = 2), mixed (N = 149) and missing (N = 31).

Data Analysis

Sample characteristics were summarized using means and proportions of student demographics. The HEI-2010 component and total scores were calculated according to recommended procedures. Means and standard deviations were calculated and presented for the key nutrient data, the HEI 2010 total scores, and the 12 component scores. To align the analyses with the group randomized trial design, adjusted mean scores of the HEI were provided using linear mixed models including random effect of school to account for clustering by school. Grade was included as a fixed effect. Total component and HEI-2010 mean scores were calculated by sex, FRL, and race. Fully adjusted models included random effect of school and fixed effect of sex, race, FRL and whether or not the recall was conducted on a weekday (yes/no). All analyses were performed using the Statistical Analysis System (SAS, version 9.3, 2011, SAS Institute, Cary, NC) and were completed in 2015. A 2-tailed p-value < .05 was considered statistically significant.

RESULTS

The analytic sample was comprised of 739 rural 9th and 10th grade students who completed at least one recall. Of breakfast skippers, 43% were boys, 36% students received FRL, and 31% were students of color. The students included in the analytic sample were similar to those not included in race, FRL status, and grade level; however, the analytic sample had a higher proportion of girls compared to the enrolled sample (57% vs 41%).

Mean energy intake was 1700 kcal per day (SD=650). Boys reported higher energy intake compared to girls (1953 vs 1512, $p < .001$); students receiving FRL reported lower energy intake compared to full priced lunch status (1593 vs 1761, $p < .01$), and white students reported higher intake compared to students of color, although not statistically significant (1730 vs 1651, $p = .12$).

Figure 1 displays the total mean HEI-2010 score by characteristics of the adolescents in the sample. The overall mean HEI-2010 score was 52 out of 100. Boys (HEI-2010=50.1) had a statistically significantly lower HEI-2010 score than girls (HEI-2010=53.4). There were no significant differences in scores by adolescent characteristics of FRL or not (52.3 vs 51.8) and white versus students of color (52.0 vs 52.3).

Table 1 presents scores for each component of the HEI and the overall HEI-2010 by sex, FRL status, and race. In no category did the average dietary quality of the rural adolescents in this sample achieve full points. The lowest proportion points achieved was for the greens and beans component of the index. Rural adolescents received an average score of 0.6 out of 5 for this component, or reaching only 12% of the total points possible. The next 2 lowest scoring components were seafood and plant protein (mean=1.3 out of 5), fatty acid ratio (mean=3.2 out of 10) and whole grain consumption (mean=3.5 out of 10). The average total fruit and vegetable component received less than 50% of the total possible points, being 2.0 and 2.1 out of 5 respectively. The highest points, meaning closer to optimal consumption, were for the categories of dairy (8.2 out of 10 or 82% of total points), total protein foods (4.1 out of 5 or 82% of total points) and SoFAAS (empty calories; 15.6 out of 20 or 78% of total points).

Statistically significant differences ($p < .05$) were predominantly present when comparing boys versus girls. Boys' scores were lower for greens and beans, total fruit, and whole fruit. In contrast, boys' scores were higher for the total protein food component compared to girls. Sodium per 1000 kcal was also higher in boys than girls resulting in a lower mean score for boys for the sodium component of the index. Students who receive FRL reported higher total fruit consumption and lower seafood and plant protein consumption per 1000 kcal resulting in statistically significantly different mean component points scores compared to full price lunch adolescents.

There were 3 significant differences in component consumption between white and nonwhite students. White students reported lower total fruit consumption and higher dairy and seafood and plant protein consumption per 1000 kcal compared to nonwhite students, resulting in statistically significantly different mean scores for the total fruit and dairy components.

Table 2 presents adjusted mean scores in a staged approach, each model including a random effect of school and adjusting for weekday or weekend recall results. The mean HEI score remained significantly lower in boys (was significantly different for boys (mean=50.0) versus girls (mean=53.4). There were no significant differences in mean HEI score by FRL or white/nonwhite. Model 4 examines all 3 characteristics (sex, FRL, and race). Adjusting for FRL, race, 24-hour recall day, and random effects of school continued to show boys with lower mean HEI scores compared to girls. There were no other statistically significant differences.

DISCUSSION

Rural adolescent breakfast skippers report dietary intake quality that ‘needs improvement’ for girls and ‘poor’ for boys according to USDA recommendations. On average, rural adolescents HEI-2010 scores are 52 out of 100, with boys reporting poorer dietary quality than girls; however, there were no significant differences by FRL status or race. The mean HEI score in our rural sample of adolescents who routinely skip breakfast is higher than that reported in national samples (46.9, 47.1 and 49.3 over 3 data collection years)⁶ but lower than among low-income African-American urban adolescents (59.93 to 62.83 from 2 samples).³⁰ It was hypothesized that the HEI-2010 scores in the rural environment would be lower than in the national sample and urban sample. Certainly, even among our high risk population, the HEI scores are unexpectedly higher than national levels. Regardless, dietary quality is suboptimal and in need of improvement.

It is possible that the differences in dietary quality in the current rural sample and the national sample are artifactual. First, the NHANES sample included children from 2-17 years of age whereas this rural sample was limited to 9th and 10th graders, specifically students who were breakfast skippers. Second, the NHANES data reference is from 2007–2008 whereas the current study is from 2013–2014. Third, the current study over sampled for minorities and is unweighted whereas NHANES is weighted to be nationally representative. Despite these comparative challenges, the information provided here on dietary quality of diverse, rural adolescents is unique and vital for developing effective interventions.

The least optimal dietary intake was in the categories of fruits and vegetables, whole grains, seafood, and plant protein. The current sample also needs to decrease intake of sodium and refined grains, and substitute poly-and monounsaturated fatty acids for saturated and trans fatty acids in the diet. Addressing these shortcomings is challenging for several reasons. Food access and availability are unique in rural communities. Across the US, empty calories from foods such as soda, fruit drinks, dairy desserts, and pizza contribute 40% of daily calories.^{3,31,32} Yet, rural youth may consume fewer of these items than a national sample as there is less availability of fast food restaurants in rural communities.³³ Unfortunately, rural communities also have poor access to supermarkets and healthy foods.³⁴ For example, the price of low-fat milk is more expensive in rural compared to urban communities.³⁵ And, although a major source of whole grain for adolescents includes ready-to-eat cereals (31%), yeast breads/rolls (21%) and crackers and salty grain snacks (21%),³⁶ supermarket availability may be problematic.

One potential way to enhance dietary quality among adolescents is through school meal programs and nutrition-related policies. Rural students are more likely to attend small schools and are more likely to live in poverty and be food insecure.³⁷ The school food environments in small towns and rural schools are trailing behind the positive food environment changes that have been happening in urban and suburban schools.^{38,39} Specifically, rural schools or those in small towns have been found to have significantly fewer policies that support healthy eating and ban food marketing.^{38,39} Schools in rural areas also may be less likely to offer healthy options at school celebrations or have fruits and vegetables in vending machines or stores in schools.^{38,39} Urban schools were less likely to have vending, school stores, advertise low nutrition, energy dense foods and sell sports drinks compared to rural schools.³⁹ This is especially true among high schools, including alternative high schools, where high-fat salty snacks and sugary drinks are still abundant in vending machines and school stores.⁴⁰

The current sample inclusion criterion was 'breakfast skipping'. Breakfast skipping is associated with higher BMI¹⁴ and poorer nutrient intake.¹⁰ Adolescents skip breakfast because they do not feel hungry in the morning or they do not have enough time to eat breakfast.⁴¹ Adolescent girls also report skipping breakfast as a form of weight control.⁴² Students who report more barriers to eating breakfast and fewer benefits to eating breakfast are more likely to be breakfast skippers.⁴³

Study Strengths and Limitations

It is important to examine rural youth specifically, as rural youth have a 26% greater odds of being obese compared to urban children.⁴⁴ In fact, Rural Healthy People 2020 identifies nutrition and weight status (4th) among its top 10 priorities.⁴⁵ Our sample is unique in that it represents 100% rural adolescents with approximately one-third being low income and one-third non-white, representing additional at-risk populations. The current study sample is also unique in that students were eligible for the study if they were 'breakfast skippers' (eat breakfast 3 times per week).

There are 2 primary limitations to this study. First, the student population eligible for the BreakFAST Study were breakfast skippers, so it is unknown if the findings from this analysis are generalizable to all rural adolescents. Second, as this is a descriptive, cross-sectional study, this study represents only a snapshot in time.

IMPLICATIONS FOR HEALTH FOR POLICY

The dietary quality of rural adolescents who skip breakfast is poor. This presents a significant opportunity for health behavior change policies and interventions. Specific areas of greatest opportunity may be policy change around availability and accessibility to nutrient rich school meal options and education about healthy eating. Such changes should focus on: (1) increasing fruit and vegetable intake, especially greens and beans; (2) substituting whole grains for refined grains in the diet; (3) substituting seafood and plant sources of protein for meat proteins; (4) substituting fats and oils rich in monounsaturated and polyunsaturated fatty acids for those rich in saturated fatty acids; and (5) reducing sodium intake. Boys should perhaps be a special focus because the overall score and score for several components

of the index were found to be lower for boys compared to girls. Public health measures are needed to improve the diets of rural adolescents. Addressing the school nutrition environment and meal policies and practices aimed at improving the availability of, and accessibility to, healthy breakfast, lunch, and snack options may go a long way in improving the dietary quality of rural adolescents, particularly those in poverty.

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Figure 1.
Total HEI-2010 Score for Rural Adolescents in Minnesota BreakFAST Study, 2014
(*Indicates Statistically Significant Difference $p < .05$)

Healthy Eating Index – 2010 Adjusted Mean Component Parts for Rural Adolescents in Minnesota by Population Characteristics, BreakFAST Study 2014

Table 1

HEI-2010 Component Scores	Overall			Boys (N = 315)		Girls (N = 424)		Full Priced Lunch (N = 472)		Free/Reduced Cost Lunch (N = 267)		White (N = 488)		Students of Color (N = 220)	
	Possible Range	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Components to Encourage															
Total Vegetables	0–5	2.0	1.2	2.0	1.3	2.1	1.2	2.0	1.2	2.1	1.2	2.1	1.3	1.9	1.1
Greens and Beans	0–5	0.6	1.3	0.5*	1.2	0.7	1.4	0.6	1.4	0.6	1.3	0.6	1.4	0.7	1.4
Total Fruit	0–5	2.1	1.7	1.7*	1.6	2.5	1.8	2.0*	1.7	2.4	1.8	2.0*	1.7	2.4	1.8
Whole Fruit	0–5	2.0	1.8	1.5*	1.6	2.3	1.9	1.9	1.8	2.2	1.9	1.9	1.8	2.1	1.9
Whole Grains	0–10	3.5	3.2	3.3	3.1	3.7	3.2	3.6	3.2	3.4	3.2	3.5	3.1	3.6	3.4
Dairy	0–10	8.2	2.4	8.3	2.4	8.2	2.4	8.3	2.4	8.1	2.5	8.5*	2.3	7.7	2.6
Total Protein Foods	0–5	4.1	1.2	4.3*	1.1	3.9	1.3	4.0	1.2	4.1	1.2	4.1	1.2	4.0	1.3
Seafood and Plant Protein	0–5	1.3	1.8	1.1*	1.8	1.5	1.9	1.4*	1.9	1.1	1.7	1.4*	1.9	1.1	1.7
Fatty Acid Ratio	0–10	3.2	2.9	3.2	2.9	3.3	2.9	3.1	2.9	3.5	3.0	3.1	2.9	3.6	3.0
Components to Discourage															
Sodium	0–10	4.2	3.0	3.7*	2.9	4.6	3.0	4.3	3.0	4.2	3.0	4.2	3.0	4.3	3.1
Refined Grains	0–10	5.0	3.2	4.9	3.3	5.2	3.2	5.0	3.3	5.1	3.2	5.1	3.3	4.9	3.2
SOFAS Calories	0–20	15.6	3.8	15.6	3.4	15.5	4.1	15.6	3.8	15.5	3.9	15.4	3.8	15.9	3.6

* Indicate a statistically significant difference of $p < 0.05$. P values are from linear mixed models that included fixed effect of primary variable and random effects of school

Table 2

Health Eating Index-2010 Adjusted Means According to Sex, Free or Reduced-cost Lunch Status and White or Non-white, Including a Combined Model.
BreakFAST Study 2014

	Model 1				Model 2				Model 3				Model 4			
	Intercept	Estimate	SE	p	Intercept	Estimate	SE	p	Intercept	Estimate	SE	p	Intercept	Estimate	SE	p
Boys	53.4	-3.35	0.77	<.01									48.8	-3.13	0.70	<.01
Girls		0												0		
Free or Reduced Cost Lunch					51.8	0.26	0.83	.75						-0.60	0.79	.45
Full Priced Lunch						0								0		
Students of Color									52.0	0.37	0.90	.68		0.98	0.84	.25
White										0				0		

Note

Models 1–3 include fixed effect of primary variable and random effects of school, model 4 includes fixed effects of FRL, race and sex, adjustment for weekday/weekend recall and random effect of school/recall data.