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Changes in Diet Quality in Youth Living in South Carolina from 5th to 11th Grade

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Abstract

OBJECTIVE.—To examine diet quality levels and changes in a diverse sample of youth from 5th to 11th grade, and interactions by race/ethnicity and socioeconomic status.

DESIGN.—Transitions and Activity Changes in Kids (TRACK) prospective cohort study

SETTING.—Elementary, middle, and high schools in South Carolina, USA

PARTICIPANTS.—N=260 5th grade students (n=106 boys and n=154 girls) with complete data at baseline and at least one time point in middle school and high school.

MAIN OUTCOME MEASURE.—Dietary intake assessed with the Block Food Screener for Kids (last week). Diet quality was assessed using energy-adjusted intakes of five food groups.

ANALYSIS.—Descriptive statistics and growth curve models for the total group and by gender for diet quality from 5th to 11th grade ($p < .05$).

RESULTS.—There were low levels of diet quality in boys and girls, which continued to decline through 11th grade. Significant main effects by race and poverty were observed, as well as a race by poverty interaction.

CONCLUSIONS AND IMPLICATIONS.—Programs and policies are needed that support healthy dietary patterns in children transitioning from elementary to middle and high school. Specific efforts that focus on nutrition disparities in children from low-income and minority backgrounds are warranted.

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Keywords

dietary quality; children; Healthy Eating Index-2010; disparities; growth curve analysis

INTRODUCTION

The 2015 – 2020 Dietary Guidelines for Americans state that individuals should follow a healthy eating pattern across the lifespan.¹ The Healthy Eating Index (HEI-2010) is one measure of diet quality in terms of adherence to the Dietary Guidelines for Americans, where higher scores (max 100) indicate a closer conformance with dietary guidance.² In a 2016 study using data from the National Health and Nutrition Examination Survey 2005–2010, mean HEI-2010 scores for children were reported to be at 52.1 (4–8 year olds), 46.9 (9–13 year olds), and 43.6 (14–18 year olds).³ Thus, national data indicate that the overall diet quality among all age groups of U.S. children is poor and negatively associated with age. Improving children's eating behaviors would support their nutritional needs, promote maintenance of a healthy body weight, and reduce the risk of chronic disease later in life.

Examining children's dietary trends over time is important to identify whether diet can be modified in certain age groups and to promote healthy eating patterns by implementing nutrition policies and guidelines. Few longitudinal studies have examined changes in children's diet quality over time. Four previous prospective cohort studies have investigated longitudinal changes in dietary patterns in children using non-U.S. samples.^{4–7} One recent study was conducted with 1001, 9-year-old children from socioeconomically disadvantaged families in Taiwan over a 5-year period.⁴ A second longitudinal study in Sweden tracked the dietary behavior in 452 participants (n = 273 younger cohort, assessed at age 9 and again at 15; and n = 179 older cohort, assessed at age 15 and again at 21).⁵ This study assessed tracking coefficients and the stability of specific food groups and nutrient intake over time. Another study assessed changes in diet quality by socioeconomic status (SES) in 7,301 children using two Australian cohorts (2–3 year-olds and 4–5 year-olds) over a 10-year period.⁶ A final study examined changes in fruit, vegetables, confectionery and sugar-sweetened beverages in n=1100 participants in the Norwegian Longitudinal Health Behaviour Study over 8 waves from ages 14 to 30 years.⁷ To date, only 2 U.S.-based studies have been conducted. One included 10th graders who were followed over 4 years into young adulthood,^{8,9} and the other followed children ages 8–12 over one year.¹⁰

In sum, longitudinal studies examining eating trajectories during childhood have been limited in U.S. cohorts, and have primarily occurred internationally. Only 3 studies, from Taiwan, Sweden, and the U.S., have characterized changes in diet quality in youth from 5th to 11th grade.^{4,5,8,9} Further, only 2 studies reported trajectories in 'total diet score' over time,^{6,8,9} while others examined specific dietary components (e.g. breakfast consumption, fruit and vegetable intake).^{4,7,11} Therefore, the purpose of this study was twofold: (1) to examine diet quality levels in a diverse sample of youth from South Carolina from 5th to 11th grade, and (2) to examine changes in diet quality over time and interactions by race/ethnicity and SES.

METHODS

Participants

Data were drawn from the Transitions and Activity Changes in Kids (TRACK) Study, a multi-level, longitudinal study of influences on the changes in children's physical activity as they transition from elementary (2010) to middle school (2012) and high school (2017). Children were recruited from 21 public elementary schools in 2 school districts in South Carolina. District approval was obtained through meetings with district superintendents and administrators prior to soliciting school participation. All 7 of the elementary schools in one district (Site A) and 14 of the 17 elementary schools in the other district (Site B) agreed to participate. Recruitment assemblies were held in all schools, during which 5th graders were invited to participate in the study and received information regarding the data collection procedures. Informed consent packets were sent home with the children for their parents to read, complete, and return. Consent and written assent were given in Grade 5 and Grade 9. In later grades, children provided verbal assent to continue their participation.

Sixty-four percent of 5th grade students at site A and 57% of 5th grade students at site B provided consent and assent. Students were excluded from the study only if they had: (a) an orthopedic or other condition that would invalidate the measure of physical activity (e.g., wheelchair-bound), and/or (b) intellectual limitations that would preclude appropriate completion of the survey instruments. Consenting students were representative of age, gender, and race/ethnicity of the students attending schools in those districts.

The original sample of 5th grade participants was $n=1083$. There were nearly equal numbers of boys and girls (54.4% female), with an average age of 10.5 (0.6) years and a racial/ethnic breakdown of 37.6% white, 34.1% black, 10.8% Hispanic and 17.6% Other/mixed race. The present analyses included $n=260$ students ($n=106$ boys and $n=154$ girls) who had complete data on the variables of interest at baseline and at least 2 later time points, at least 1 in middle school and at least 1 in high school (i.e., 5th grade AND 6th or 7th grade AND 9th or 11th grade). Cases were deleted from analysis if they had missing data for diet ($n=817$) or other demographics ($n=6$). With the exception of race, there were no other statistically significant demographic differences between the original sample of participants and those included in the final analytic sample.

Data were collected by a trained measurement team at the school during 2 sessions with each participant. These same procedures were repeated in grades 6 and 7, and 9 and 11 following parent re-consent and/or child assent. During Session 1, participants completed a survey, had their height and weight measured, and were also given a paper survey for their parents to complete. At Session 2, participants returned their completed parent surveys and received a modest incentive. The Institutional Review Board at the University of South Carolina reviewed and approved all study protocols.

Measures

Diet Quality.—Participants completed the Block Food Screener for Kids, which has been validated with 24-hour recalls in 10–17 year-olds, to assess dietary intake.¹² The screener asks whether 41 specific food items were consumed in the last week. If a child responded

“yes” to a food item, he or she was asked on how many days the item was consumed and the usual amount eaten. For the present study, a measure of diet quality using information from the food screener was created. Five of the 9 adequacy components of the HEI-2010 (but none of its moderation components) were chosen to reflect healthy dietary patterns. Higher scores indicated better diet quality, with each component having a maximum score of 10 points, for a total maximum score of 50 points. Standards for the maximum score and minimum score of 0 were identical that of the HEI-2010 components. Specifically, standards for the maximum scores included: total vegetables (including potatoes; 1.1 cup equiv./1000 kcal), total fruit (including fruit juice; 0.8 cup equiv./1000 kcal), whole grains (1.5 ounce equiv./1000 kcal), dairy (1.3 cup equiv./1000 kcal), and total protein (2.5 ounce equiv./1000 kcal). Values greater than 5000 kcal/day were considered implausible;¹³ n=6 in 7th grade, n=4 in 9th grade, and n=2 in 11th grade were excluded from the analysis.

Demographics.—Participants self-reported their age, gender, and race/ethnicity. For race, they were asked to check as many categories as applied (white, black/African American, Asian, American Indian/Alaskan Native, Native Hawaiian/Pacific Islander, and Other[please specify]). They were also asked to identify whether they considered themselves Hispanic or Latino. Race/ethnicity responses were re-coded as black, white, Hispanic and Other/mixed race. Parental education and neighborhood poverty status served as proxies for participant socioeconomic status (SES). Parents reported their highest level of education, and item responses were re-coded to ‘high school or less’ and ‘more than high school.’ Percent of residents living in poverty in the child’s census tract during the last year was obtained using data from the U.S. Census American Community Survey 5-year estimates for 2006–2010.¹⁴ The variable “Poverty status in the past 12 months” was based on the Census tract of each child’s place of residence. Participant height and weight were measured by trained staff at baseline using Seca 213 height boards and Seca model 869 scales (Seca, Hamburg, Germany). Child BMI was calculated using the standard equation (body weight [kg] / height [m]²), and children were classified as normal weight (BMI percentile < 85) or overweight/obese (BMI percentile ≥ 85) based on Centers for Disease Control (CDC) growth charts.¹⁵

Statistical analysis

Descriptive statistics (means, percentages) for sample characteristics were calculated for the total group and by gender. Mean (SD) diet quality scores and component scores were examined for the total group at each wave of data (i.e., 5th, 6th, 7th, 9th, and 11th grades). Diet quality and component scores were examined by gender and race/ethnicity at baseline. T-test or mixed ANOVA tests were used to determine whether there were differences by gender or race/ethnicity, respectively.

Growth curve analyses¹⁶ using PROC MIXED (SAS Institute Inc., Version 9.4, Cary, NC) were calculated for the total group and by gender to examine longitudinal change in diet quality. These models showed change over time by fitting the slope at the individual level (Level 1). A second level of analyses (Level 2) related predictors to interindividual differences in change. Three models were run for the total group and by gender, providing the unconditional or conditional estimate and standard error for each variable. Model 1 was an unconditional model with only time in the model, and Model 2 added the independent

variables of gender, race, parent education, and poverty. Model 3 tested an interaction between poverty and race. If the interaction by poverty and race was significant, a mean split of the poverty status variable was performed to divide the sample into 2 groups: low poverty (< 17% of residents in the child's census tract lived in poverty) and high poverty (≥ 17% of residents in the child's census tract lived in poverty). Time was coded as 0, 1, 2, 4, and 6, and intercept and time (i.e., slope) were modeled as random effects.

Statistical significance was set at $p < .05$. All analyses were conducted with SAS 9.3 (SAS Institute Inc., Cary, NC).

RESULTS

Sample Characteristics

Of the 260 participants, 59% were girls, 43% were Black, 33% White, 15% were „Other/mixed race, and 9% were Hispanic (Table 1). The Other/mixed race group ($n=40$) was comprised of $n=5$ Asian, $n=4$ more than one race, $n=9$ American Indian/Alaskan Native, $n=4$ Native Hawaiian/Pacific Islander, and $n=18$ Other. Over 1/2 of the sample had parents with more than a high school education (57.7%), and among the census tracts where the children lived, the average percentage of residents who lived in poverty was 17%. Nearly 48% were overweight or obese, with a mean BMI of 21.3 (4.9). There were no differences by gender for any of the demographic variables (results not shown).

Table 2 provides mean (SD) diet quality and component scores for children in 5th through 11th grades. Total diet quality declined over time ($p < .001$); at 5th grade, the total diet quality score was 29.7 (5.5) in the total group compared with 27.1 (5.7) in 11th grade. There were significant declines in total dairy ($p < .001$) from 5th to 11th grade, while whole grain ($p < .001$) and protein intake ($p = .01$) increased over time. There were no statistically significant differences in total vegetable or total fruit intake by grade.

There were no statistically significant differences between boys and girls in diet quality in any grade (results not shown). At baseline, there were no differences by gender in the diet quality total score or the components, with the exception of total protein (Boys: 5.3 [1.0] vs. Girls: 5.1 [1.0], $p < .05$; results not shown). Further, there were baseline differences by race/ethnicity in protein (Black: 5.0[1.0], Hispanic: 5.3[0.9], White: 5.4[1.0], Other/mixed race: 5.4[0.9]; $p < .05$) and dairy (Black: 6.7[2.7], Hispanic: 7.6[2.6], White: 7.7[2.3], Other/mixed race: 7.5[2.4]; $p < .05$; results not shown).

Unconditional growth models for diet quality are presented separately for the total group and by gender. In the total group, diet quality was 29.5 and declined by −0.4 point per year. Among 5th grade boys, diet quality was 29.3 and declined by −0.5 point per year. Among 5th grade girls, diet quality was 29.7 and declined by −0.4 point per year.

Conditional growth models for diet quality are presented separately for the total group and by gender (Table 3). Diet quality declined over time, and there were significant main effects for race and poverty. In the total group, black children had poorer diet quality than white children, and those children living in neighborhoods with more residents living in poverty

had poorer diet quality than those living in neighborhoods with fewer residents living in poverty. For both boys and girls (Table 3), there was a similar pattern in which diet quality declined over time. These associations were independent of race/ethnicity, parent education, and poverty. There were also significant main effects for race in both genders.

The race by poverty interaction was significant in the conditional models for the total group and boys. The interaction term was not significant for girls and thus was dropped from the model. To explore the interaction more fully, 2 groups were created by splitting the poverty variable above and below the mean: <17% for low poverty and 17% for higher poverty. In the total group, black and white children differed in the low poverty group ($p=.004$), with white children having higher diet quality scores on average than black children (Figure 1). In the high poverty group, children in the Other/mixed race group had higher diet quality than black children ($p=.02$), and white children ($p=.01$) (Figure 1). For boys in the low poverty group, boys from the Other/mixed race group also had higher diet quality than white boys ($p=.02$).

DISCUSSION

The purpose of this study was to examine diet quality levels and change in a diverse sample of youth from 5th to 11th grade, as well as interactions by race/ethnicity and SES over time. The study found that diet quality in the total group ranged between 29.5 (5th grade, ~10.5 years old) and 27.1 (11th grade, ~16 years old) out of a maximum score of 50. In 2005–2010, the estimated average HEI-2010 scores for U.S. children and adolescents were also lower in the older ages, decreasing from 46.9 for 9–13 year-olds to 43.6 for 14–18-year-olds (maximum score is 100).³ Taken together, these scores suggest that overall diet quality was poor in the current sample of children. These low scores are concerning given the current recommendations to follow a healthy eating pattern over time in order to support a healthy body weight and reduce the risk of chronic diseases.¹

Not only was overall diet quality low in the current study, it also declined significantly over time in this sample of children followed through adolescence. To date, only 2 other U.S.-based study has prospectively examined changes in diet quality in youth.^{9, 10} In the first study, some measures of diet quality improved modestly over time from 10th grade over 4 waves, but still remained suboptimal, while no change occurred in the HEI-2010 score, the index upon which the current diet quality measure was modeled. It is important to note that for that specific study, the HEI-2010 score reflected overall diet quality, while the other 2 indicators reflected overall dietary factors that are most notably underconsumed or overconsumed relative to the Dietary Guidelines. In the second study, 8–12 year old children were followed for one year, and this study reported no statistically significant change in diet quality in the sample.¹⁰

In the current study, total dairy intake decreased over time; however, whole grain and total protein intake increased over time. A previous study with adolescents in Sweden documented increases in poultry and poultry dishes in both the younger (9–15 year old) and older (15–21 year old) cohort over time.⁵ In contrast to the current study, a previous study with U.S. 10th graders followed over 4 waves found that whole grains significantly

decreased each year.⁹ In the present study, there were no statistically significant differences in total fruit or vegetable intake across grades. One previous study with 11, 13, and 15 year old Czech youth following for 13 years also found no statistically significant change in daily vegetable consumption over time.¹⁰ In contrast, previous studies with children have documented declines in fruit and vegetable intake.^{4,5,7,9,10} Similar declines have also been noted in older adolescents as they transition into young adulthood.^{5,17}

This study did not find any gender differences in diet quality scores at any grade. The current literature on gender differences in diet quality is mixed; some studies have suggested that girls consume higher quality diets than boys,^{9,10,18} while others report no gender differences.^{9, 19} This lack of gender difference exhibited here may suggest lack of variability within the data due to the low rates of diet quality overall in the sample. There is evidence that diet quality varies geographically in the United States, and dietary intake in the Southeastern United States is poorer than other areas.²⁰ In the current study, boys and girls also experienced similar rates of decline in diet quality over time. In contrast, studies examining changes in diet quality over time have reported significant gender differences.^{4,5} As such, the current study contributes to the literature and also highlights the need for more research to determine whether gender differences in diet quality and trajectories exist in youth.

The current study found significant main effects for both race and poverty in the total group, as well as a significant race by poverty interaction. In the total group, black children had poorer diet quality than white children, and those children living in neighborhoods with more residents living in poverty had poorer diet quality than those living in neighborhoods with fewer residents living in poverty. These findings are in-line with previous studies that have found lower availability and accessibility to healthy foods, the types of foods specifically assessed in this diet quality index, in neighborhoods with high poverty and a higher percentage of racial/ethnic minorities.^{21, 22} The current findings can also be interpreted in light of previous longitudinal studies that have examined differences in children's diet quality by SES factors. These studies have found that, in general, children from the lower SES quintiles or those who are most disadvantaged (assessed via parent education and household income) had the lowest dietary quality.^{4,6} In the U.S.-based study that examined changes in diet quality in 10th graders over 4 waves, higher diet quality scores were observed in Hispanic compared with white participants.⁹ In the current study, white children in the low poverty group had higher diet quality scores than black children in the low poverty group. However, in the high poverty group, children in the Other/mixed race group had higher diet quality than black and white children.

This is one of the first studies to examine longitudinal changes in diet quality using a U.S.-based, prospective cohort design, but the first to examine these changes in the transition from childhood into late adolescence. This study was further strengthened by its use of a diverse sample of participants, allowing examination of any interaction effects of race/ethnicity or SES in these trends. However, this study was not without limitations. The small sample size could have limited power and thus the ability to detect statistical significance. The Block Food Screener for Kids relies on memory of foods consumed over the last week and is subject to recall error and likely does not capture the full range of foods consumed by

this diverse sample living in South Carolina.²³ Previous diet quality trajectory studies have used other measures, including the HEI-2010,^{8,9} questions from the Youth Risk Behavior Surveillance System (YRBSS),⁸ HBSC,¹⁰ self-report questionnaire,^{4,6,7,10} or 24-hour recall,^{5,6,8,9} thus making comparisons difficult. Further, the diet quality assessment did not include undesirable dietary components that are typically over-consumed, such as refined grains, added sugars, saturated fats, and sodium. Differences between schools was not also examined; it is possible that any differences may have contributed to the observed changes in diet quality.

Implications for Research and Practice

This is the first study with children living in the U.S. that has examined changes in diet quality from 5th to 11th grade. This is an important age range because it covers children transitioning from elementary to middle to high school. In elementary school, children's diets are often controlled by parents and schools, whereas in middle school and high school, peers and individual autonomy exert more influence over dietary behavior.⁵ As such, it is not surprising to see diet quality levels decrease over time with increasing autonomy. However, this finding suggests the ongoing need for programs and policies to make attractive, affordable, and healthy options available and accessible to all youth, rather than bombarding them with unhealthy options at school and beyond. Ideally, youth need to be able to exercise independence and autonomy over their food, while being able to make healthy food choices and adopt healthy dietary patterns that will benefit them in the long term.

In conclusion, this study found overall low levels of diet quality in this diverse sample of 5th grade children living in South Carolina, and these levels continued to decline through 11th grade. The results were more varied regarding specific component scores and differences by grade; some declined, some increased, and some remained the same across the grades. Growth curve analyses also documented significant main effects by race and poverty, as well as a race by poverty interaction. Given that dietary behaviors track into adulthood,⁸ the findings from the current study support the need for programs and policies that intervene to promote healthy dietary patterns and support children as they transition from elementary school to middle and high school. Further, these data suggest that programs and policies to promote healthier diets in children from low-income and minority backgrounds are warranted, given these children are more likely to live in environments with reduced access and availability to support healthy eating behaviors.^{19–21} Overall, more research is needed to examine the complex relationships between diet quality, race, and SES more fully during this critical period of transition from childhood into late adolescence.

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Figure 1. Diet Quality by Race/Ethnicity and Poverty Level in Total Group.

In the low poverty group, * Black vs. White was significantly different ($p=.004$). In the high poverty group, # Black vs. Other/mixed race significantly different ($p=.02$), and † Other/mixed race vs. White significantly different ($p=.01$). Note: the low poverty group was defined as < 17% of residents in the child's census tract lived in poverty and the high poverty group was defined as ≥ 17% of residents in the child's census tract lived in poverty.

Table 1.

Characteristics of n=260 participants in the TRACK study followed from 5th to 11th grade, for the total sample and by gender

	Total	Boys	Girls
	n=260	n=106	n=154
Gender, % male	40.8%		
Race, %			
Black	43.1%	42.5%	43.5%
Hispanic	8.5%	9.4%	7.8%
Other	15.4%	18.9%	13.0%
White	33.1%	29.3%	35.7%
BMI, mean (SD)	21.3 (4.9)	20.9 (4.9)	21.6 (4.9)
Overweight/obese, %	47.3%	46.2%	48.1%
Parent Education > High School, %	57.7%	57.6%	57.8%
Poverty status, mean % (SD)	16.7 (6.3)	16.5 (5.5)	16.9 (6.8)

Note: BMI, body mass index; SD, standard deviation; Fewer participants had complete data on BMI (n=255); Poverty status indicated the percentage of residents living in poverty in the census tract for child's home address. T-test and chi-square tests determined there were no differences by gender for any demographic variable.

Table 2.

Total Diet Quality and Component Scores [mean (SD)] for the total sample by grade

Diet Variable	Grade					p-value
	5 th N=260	6 th N=240	7 th N=241	9 th N=230	11 th N=182	
Vegetables ^a	6.2 (2.6)	6.1 (2.7)	6.0 (2.6)	6.2 (2.5)	6.5 (2.5)	.14
Fruit ^b	8.0 (3.1)	7.6 (3.5)	7.3 (3.7)	7.4 (3.5)	7.2 (3.6)	.05
Whole Grains	3.1 (2.6)	5.0 (1.1)	5.1 (1.2)	5.2 (1.2)	5.3 (1.3)	<.001
Dairy	7.3 (2.5)	7.2 (2.7)	7.3 (2.7)	6.7 (2.9)	5.9 (2.9)	<.001
Protein	5.2 (1.0)	5.0 (1.1)	5.1 (1.2)	5.2 (1.2)	5.3 (1.3)	.01
Diet quality	29.7 (5.5)	29.0 (5.8)	28.6 (6.0)	27.9 (5.8)	27.1 (5.7)	<.001

NOTE: SD, standard deviation; P-values reflect differences across grades adjusted for gender and race/ethnicity.

^aTotal Vegetables included potatoes.^bTotal Fruit included fruit juice.

Table 3.

Diet Quality Growth Curve Analysis for the total sample and by gender

	Total		Boys		Girls	
	Unconditional Estimate (SE)	Conditional Estimate (SE)	Unconditional Estimate (SE)	Conditional Estimate (SE)	Unconditional Estimate (SE)	Conditional Estimate (SE)
Intercept	29.5 (.30) ***	32.4 (1.2) ***	29.3 (.48) ***	32.1 (2.3) ***	29.7 (0.4) ***	31.3 (0.9) ***
Time	−0.4 (.07) ***	−0.4 (0.1) ***	−0.5 (.10) ***	−0.5 (.10) ***	−0.4 (0.09) ***	−0.4 (0.1) **
Gender, boys		−0.5 (0.5)				
Race						
Black		−4.7 (1.7) *		−4.8 (3.0)		−2.0 (0.7) *
Hispanic		2.6 (3.1)		2.7 (5.9)		−0.3 (1.3)
Other		−2.5 (2.0)		−8.9 (4.5) *		0.3 (1.0)
White		Reference		Reference		Reference
Parent		0.1 (0.5)		0.01 (0.8)		0.3 (0.7)
Education < High School						
Parent Education x Race						
Poverty		−0.2 (0.1) *		−0.2 (0.1)		−0.1 (.05)
Poverty x race						
Poverty x Black		0.2 (0.1) *		0.3 (0.2)		
Poverty x Hispanic		−0.1 (0.2)		−0.1 (0.3)		
Poverty x Other		0.2 (0.1)		0.7 (0.3) *		
Poverty x White		Reference		Reference		

NOTE: SE, standard error;

*
p<.05,**
p<.01,***
p<.001