Research Article

Changes in Diet Quality in Youth Living in South Carolina From Fifth to 11th Grade

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ABSTRACT

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

Design: Transitions and Activity Changes in Kids prospective cohort study.

Setting: Elementary, middle, and high schools in South Carolina.

Participants: A sample of 260 fifth-graders (106 boys and 154 girls) with complete data at baseline and at least 1 time point each in middle school and in 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 5 food groups.

Analysis: Descriptive statistics and growth curve models for the total group and by gender for diet quality from fifth to 11th grade ($P < .05$).

Results: Both boys and girls had low levels of diet quality, which continued to decline through 11th grade. Significant main effects by race and poverty as well as a race by poverty interaction were observed.

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

Key Words: dietary quality, children, Healthy Eating Index 2010, disparities, growth curve analysis (*J Nutr Educ Behav.* 2020;000:1−7.)

Accepted March 2, 2020.

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−2010 (HEI) is 1 measure of diet quality in terms of adherence to the Dietary Guidelines for Americans, in which higher scores (maximum 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 scores for children were reported to be at 52.1 (ages 4−8 years), 46.9 (ages 9−13 years), and 43.6 (ages 14−18 years).[3] Thus, national data indicate that the overall diet quality among all age groups of children in the US is poor and negatively associated with age. Improving children's eating behaviors would support their nutritional needs, promote maintenance of 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. A 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-US samples.[4−7] One recent study was conducted with 1,001 children aged 9 years who are from socioeconomically disadvantaged families in Taiwan for over 5 years.[4] A second longitudinal study in Sweden tracked the dietary behavior in 452 participants (a younger cohort [n = 273] assessed when aged 9 years and again at 15 years, and an older cohort [n = 179] assessed when aged 15 years and again at 21 years).[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 2 Australian cohorts (aged 2−3 years and 4−5 years) over 10 years.[6] A final study examined changes in intake of fruits, vegetables, and confectionery and sugar-sweetened beverages in participants aged 14−30 years in the Norwegian Longitudinal Health

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Conflict of Interest Disclosure: The authors have not stated any conflicts of interest.

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https://doi.org/10.1016/j.jneb.2020.03.001

Behaviour Study over 8 waves (n = 1,100).[7] To date, only 2 US-based studies have been conducted. One included tenth-graders who were followed over 4 years into young adulthood,[8,9] and the other followed children aged 8−12 years for 1 year.[10]

In sum, longitudinal studies examining eating trajectories in childhood have been limited in US cohorts and have primarily occurred internationally. Only 3 studies, from Taiwan, Sweden, and the US, have characterized changes in diet quality in youth from fifth to 11th grade.[4,5,8,9] Furthermore, only 2 studies reported trajectories in *total diet score* over time,[6,8,9] whereas others examined specific dietary components (eg, breakfast consumption, fruit and vegetable intake).[4,7,11] Therefore, the purpose of this study was 2-fold: (1) to examine diet quality levels in a diverse sample of youth from fifth to 11th grade from South Carolina, 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 study, a multilevel, 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 before soliciting school participation. All 7 of the elementary schools in 1 district (site A) and 14 of 17 elementary schools in another district (site B) agreed to participate. Recruitment assemblies were held in all schools, during which fifth-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 by students in fifth and ninth grade. For sixth, seventh, and 11th grades, children provided verbal assent to continue their participation.

A total of 64% of fifth-grade students at site A and 57% of fifth-grade students at site B provided consent and assent. Students were excluded from the study only if they had (1) an orthopedic or other condition that would invalidate the measure of physical activity (eg, children who use a wheelchair), and/or (2) intellectual limitations that would preclude proper completion of the survey. Consenting students were representative of age, gender, and race/ethnicity of the students attending schools in those districts.

The original sample of fifth-grade participants included 1,083 children. There were nearly equal numbers of boys and girls (54.4% female), with an average age of 10.5 (SD = 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 260 students (106 boys and 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 (ie, fifth grade and sixth or seventh grade and ninth or 11th grade). Cases were deleted from analysis if they had missing data for diet (n = 817) or other demographics (n = 6). Except for 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. The same procedures were repeated for sixth, seventh, ninth, and 11th grades after 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 participants aged 10−17 years, to assess dietary intake.[12] The screener asked 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 consumed. For this study, a measure of diet quality was created using information from the food screener. Five of 9 adequacy components of the HEI (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 to those of the HEI components. Specifically, standards for the maximum scores were as follows: total vegetables (including potatoes; ≥1.1 cup Eq/1,000 kcal), total fruit (including fruit juice; ≥0.8 cup Eq/1,000 kcal), whole grains (≥1.5 oz Eq/1,000 kcal), dairy (≥1.3 cup Eq/1,000 kcal), and total protein (≥2.5 oz Eq/1,000 kcal). Values greater than 5,000 kcal/day were considered implausible[13]; 6 participants in seventh grade, 4 participants in ninth grade, and 6 participants 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 as 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 SES. Parents reported their highest level of education, and item responses were re-coded to *high school or less* and *more*

Table 1. Characteristics of Participants in the TRACK Study Followed from Fifth to 11th grade, for the Total Sample and by Gender

Characteristics	Total (n = 260)	Boys (n = 106)	Girls (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)

BMI indicates body mass index; TRACK, Transitions and Activity Changes in Kids.
Note: Fewer participants had complete data on BMI (n = 255); poverty status indicated the percentage of residents living in poverty in the census tract for the child's home address. The *t* and chi-square tests determined there were no differences by gender for any demographic variable.

than high school. The percentage of residents living in poverty in the child's census tract during the last year was obtained using data from the US 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 body mass index (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 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 (ie, fifth, sixth, seventh, ninth, and 11th grades). Diet quality and component scores were examined by gender and race/ethnicity at baseline. A *t* test or mixed ANOVA test was used to determine whether there were differences by gender or race/ethnicity, respectively.

Growth curve analyses[16] were calculated for the total group and by gender using PROC MIXED (version 9.4; SAS Institute Inc., Cary, NC, 2013) to examine longitudinal change in diet quality. These models showed change over time by fitting the slope at the individual level (level 1). The 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 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 (ie, slope) were modeled as random effects.

Statistical significance was set at $P < .05$. All analyses were conducted with SAS version 9.4.

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 composed of Asian (n = 5), more than 1 race (n = 4), American Indian/Alaskan Native (n = 9), Native Hawaiian/Pacific Islander (n = 4), and other (n = 18). Over half of the sample had parents with more than a high school education (57.7%), and among the census tracks in which 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 (SD 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 fifth through 11th grades. Total diet quality declined over time ($P < .001$); in fifth 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 fifth to 11th grade, whereas 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, except for total protein (boys, 5.3 [1.0] vs girls, 5.1 [1.0], $P < .05$;

Table 2. Total Diet Quality and Component Scores for the Total Sample by Grade

	Grade					
Diet Variable	**Fifth (n = 260)**	**Sixth (n = 240)**	**Seventh (n = 241)**	**Ninth (n = 230)**	**11th (n = 182)**	***P* value**
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

[a]Including potatoes. [b]Including fruit juice.
Note: Values are mean (SD). *P* values reflect differences across grades adjusted for gender and race/ethnicity.

results not shown). Furthermore, 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 (Table 3). In the total group, diet quality was 29.5 and declined by −0.4 points per year. Among fifth grade boys, diet quality was 29.3 and declined by −0.5 points per year. Among fifth grade girls, diet quality was 29.7 and declined by −0.4 points 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

Table 3. Diet Quality Growth Curve Analysis for the Total Sample and by Gender

	Total		Boys		Girls	
Variables	**Unconditional Estimate (SE)**	**Conditional Estimate (SE)**	**Unconditional Estimate (SE)**	**Conditional Estimate (SE)**	**Unconditional Estimate (SE)**	**Conditional Estimate (SE)**
Intercept	29.5 (0.3)[c]	32.4 (1.2)[c]	29.3 (0.5)[c]	32.1 (2.3)[c]	29.7 (0.4)[c]	31.3 (0.9)[c]
Time	−0.4 (0.1)[c]	−0.4 (0.1)[c]	−0.5 (0.1)[c]	−0.5 (0.1)[c]	−0.4 (0.1)[c]	−0.4 (0.1)[b]
Gender, boys		−0.5 (0.5)		–		–
Race						
Black		−4.7 (1.7)*		−4.8 (3.0)		−2.0 (0.7)[a]
Hispanic		2.6 (3.1)		2.7 (5.9)		−0.3 (1.3)
Other		−2.5 (2.0)		−8.9 (4.5)[a]		0.3 (1.0)
White		Reference		Reference		Reference
Parent education < high school		0.1 (0.5)		0.01 (0.8)		0.3 (0.7)
Parent education × race		–		–		–
Poverty		−0.2 (0.1)[a]		−0.2 (0.1)		−0.1 (.05)
Poverty × race						
Poverty × black		0.2 (0.1)[a]		0.3 (0.2)		–
Poverty × Hispanic		−0.1 (0.2)		−0.1 (0.3)		–
Poverty × other		0.2 (0.1)		0.7 (0.3)*		–
Poverty × white		Reference		Reference		–

SE indicates standard error.
[a]$P < .05$; [b]$P < .01$; [c]$P < .001$.

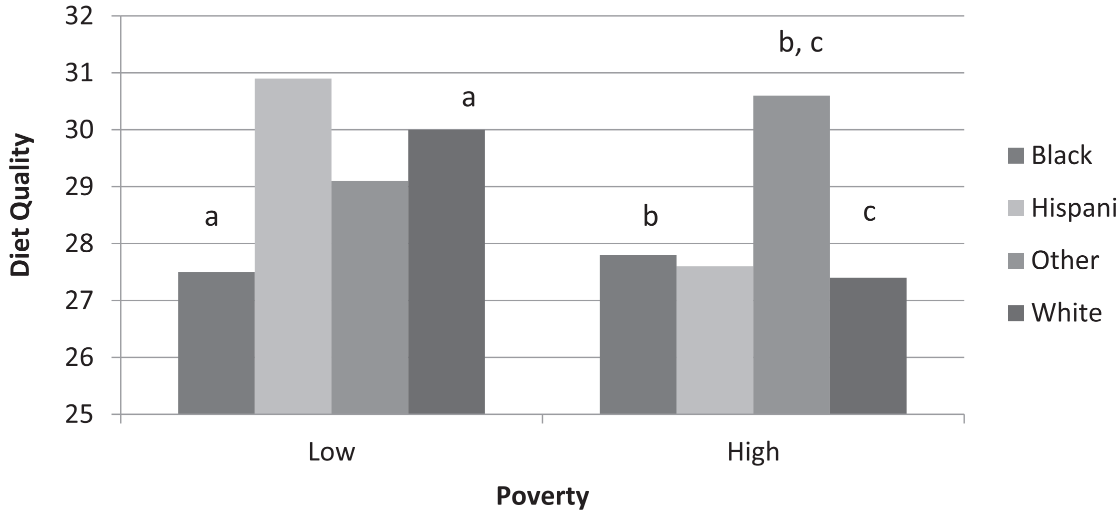

Figure. Diet quality by race/ethnicity and poverty level in total group. [a]In the low poverty group, black vs white was significantly different ($P = .004$); [b]In the high poverty group, black vs other/mixed race was significantly different ($P = .02$); [c]In the high poverty group, other/mixed race vs white was significantly different ($P = .01$). Note: The low poverty group was defined as <17% of residents in the child's census tract and the high poverty group was defined as ≥17% of residents in the child's census tract.

white children differed in the low poverty group ($P = .004$), with white children having higher diet quality scores on average than black children (Figure). 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). 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 fifth 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 (fifth grade, approximately aged 10.5 years) and 27.1 (11th grade, approximately aged 16 years) out of a maximum score of 50. In 2005−2010, the estimated average HEI scores for US children and adolescents were also lower in the older ages, decreasing from 46.9 for those aged 9−13 years to 43.6 for those aged 14-18 years (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 to support healthy body weight and reduce the risk of chronic diseases.[1]

Not only was overall diet quality low in the current study, but it also declined significantly over time in this sample of children followed through adolescence. To date, only 2 other US-based studies have 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. However, it remained suboptimal, although no change occurred in the HEI score, the index on which the current diet quality measure was modeled. It is important to note that for that specific study, the HEI score reflected overall diet quality. In contrast, the other 2 indicators reflected overall dietary factors that are most notably underconsumed or overconsumed relative to the Dietary Guidelines. In the second study, children aged 8−12 years were followed for 1 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 (aged 9−5 years) and older (15−21 years) cohort over time.[5] In contrast to the current study, a previous study with US 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 Czech youth aged 11, 13, and 15 years that were followed for 13 years reported 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 in 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] whereas others report no gender differences.[9,19] This lack of gender difference exhibited here may suggest a lack of variability within the data because of the low rates of diet quality overall in the sample. There is evidence that diet quality varies geographically in the US, and dietary intake in the Southeastern US is poorer than in 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 US-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 study is 1 of the first studies to examine longitudinal changes in diet quality using a US-based, prospective cohort design, and 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 the 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,[8,9] questions from the Youth Risk Behavior Surveillance System,[8] Health Behaviour in School-Aged Children,[10] self-report questionnaire,[4,6,7,10] or 24-hour recall,[5,6,8,9] thus making comparisons difficult. Furthermore, the diet quality assessment did not include undesirable dietary components that are typically overconsumed, such as refined grains, added sugars, saturated fats, and sodium. Differences between schools were not examined. In addition, any differences may have contributed to the observed changes in diet quality.

IMPLICATIONS FOR RESEARCH AND PRACTICE

To the best of the authors' knowledge, this study is the first to examine children living in the US and changes in diet quality from fifth to 11th grade. This age is an important 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 fifth-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. Furthermore, 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.

ACKNOWLEDGMENTS

This study was supported by a grant from the National Institutes of Health, National Heart, Lung, and Blood Institute (R01HL091002) awarded to R. R. Pate. The authors would like to thank Gaye Groover Christmus, MPH, for her editorial assistance on the manuscript.

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