Fruit and vegetable availability enables adolescent consumption that exceeds national average

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Abstract

The availability of fruit, juice, and vegetables (FJV) in home and school settings is positively associated with adolescent fruit and vegetable consumption. Less is known, however, about the influence on youths' consumption of the availability of FJV in community-based settings. This study examined fruit and vegetable consumption in a sample of 156 African American adolescents (mean age, 11.89 years; range, 10–14 years; 55% female) who were provided with 3 servings each of FJV (9 servings daily) for 3 consecutive days during summer camp programming in New York City youth services agencies. It was hypothesized that youths' mean intake (measured via direct observation) would exceed the mean intake of 3.6 daily servings found among similarly aged youths in the US population given the consistently high number of servings of FJV offered. Intake differences by sex, age, and meal were also examined. Youths' mean (SD) intake of 5.41 (1.51) daily servings was higher than the population mean intake of 3.6 daily servings ($P < .001$). Youths aged 10 years had higher intake than did youths aged 11, 12, and 13 years. Youths' FJV intake was lower at lunch than at breakfast and dinner meals. Across meals, youths consumed more juice than fruit or vegetables. Increasing the availability of FJV in community-based settings is a promising strategy for enabling fruit and vegetable consumption among African American adolescents. Youths may also benefit from intervention to prevent age-related declines in intake, increase consumption of FJV at lunch meals, and encourage higher consumption of vegetables and fruit.

Keywords

Nutrition environment; Community health; Fruit; Vegetables; Adolescents; African Americans; Eating behavior; Humans

1. Introduction

Substantial epidemiologic evidence supports the protective role of fruit, juice, and vegetables (FJV) in the prevention of cancer [1]. Although current dietary guidelines recommend consumption of between 5 and 13 daily servings of FJV [2], average American intakes are well below recommended levels [3]. Differences between recommended and actual intake are more pronounced among African Americans [4], underscoring the need for early intervention to promote adequate fruit and vegetable consumption in this population. Evidence of early consolidation and tracking of food intake patterns from adolescence

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through adulthood suggests that adolescence is an important time to intervene on fruit and vegetable consumption [5,6]. Essential to the development of dietary intervention programs to increase fruit and vegetable consumption among African American adolescents is understanding of modifiable determinants of youths' eating behavior.

There has been growing interest in environmental influences on adolescent food choices [7–9]. The availability of foods is an important characteristic of the food environment [8]. For individuals to meet current dietary recommendations, healthful choices must be available [9]. Home availability of FJV is among the determinants of child and adolescent fruit and vegetable consumption most consistently supported by evidence [10]. There is also evidence of an association between adolescent fruit and vegetable consumption and school availability of FJV served as part of school lunch programs and school fruit initiatives (ie, programs designed to provide students with FJV every school day) [11–13]. Less is known, however, about whether the availability of FJV in community-based settings such as after-school and summer camp programs positively influences fruit and vegetable consumption among youths in these settings.

Community-based settings are important environments for adolescent health promotion efforts [14]. After-school and summer camp programs serve more than 6.5 million youths annually [15]. They afford opportunities to reach sizable numbers of African American and Hispanic youths who are more likely than other youths to participate in these programs [15]. Dietary interventions delivered in community-based settings have the capacity to involve adult role models from the community who can positively influence youths' eating behaviors [16]. Youths in these settings are often engaged in informal activities. They may therefore be more receptive to interventions delivered in a community-based versus school setting where they are unaffected by the pressure of competition and grades [16]. Despite their promise, research on the availability of FJV in community-based settings is limited [14], and studies examining the influence of availability on youths' consumption are lacking. Moreover, little is known about whether youths' intake in these settings declines with age and whether it differs by meal as found in research conducted in the school setting [17–19]. If it is found to differ based on these factors, the observed differences can inform understanding of meals to target in community-based dietary intervention programs and the ages at which youths are ideally timed for intervention to prevent age-related declines in intake from occurring.

The positive influence of availability on intake has been previously established based on evidence of significant associations between measures of home and school availability of FJV and self-reported fruit and vegetable consumption [10]. Less attention has been devoted to the assessment of consumption measured using more objective measures (ie, direct observation) relative to the quantities of FJV offered in a given setting. Information on the amounts consumed of FJV relative to the availability of specific numbers of servings can serve as the basis for determining the optimum number of servings to offer when a particular consumption level is desired.

This study examined whether providing 9 daily servings of FJV (3 servings each at breakfast, lunch, and dinner meals) to African American adolescents enrolled in community-based summer camp programs for 3 consecutive days would positively influence youths' fruit and vegetable consumption. It was hypothesized that youths' mean 3-day intake would be higher than the average intake of 3.6 daily servings found among similarly aged youths in the US population given the consistently high number of servings of FJV offered. To test this hypothesis, the primary objectives of the study were to assess youths' mean intake (measured via direct observation) and to determine whether it differed significantly from the population mean intake of 3.6 daily servings. Demographic and by-meal intake differences

were also examined to facilitate comparisons with findings from research conducted in the school setting [17–19].

2. Methods and materials

2.1. Subjects

Data were provided by African American adolescents enrolled in a measurement validation study described elsewhere [20]. Youths were recruited through summer camp programs offered through youth services agencies in New York City. One hundred eighty-one youths between the ages of 10 and 14 years were enrolled.

Observational data on youths' fruit and vegetable consumption were collected during meals served over 3 consecutive days (as described below). Analyses were restricted to youths who were present at all meals and, thus, for whom complete observational data were available (n = 156). Following institutional review board approval, all youths provided written assent, and informed written consent was obtained from a parent or guardian.

2.2. Methods

Youths completed a brief questionnaire for assessing their sex and age and were served breakfast, lunch, and dinner meals at collaborating sites for 3 consecutive days. Youths were assembled for meals in large groups mixed based on sex and age (the format ordinarily used at the sites) and at intervals that coincided with mealtimes for each of the camps as a whole. At each meal, youths were given a tray with 3 servings each of FJV. They were then offered a variety of main course options. Serving amounts were defined according to Five A Day criteria and apportioned using measuring cups before being placed on youths' trays (ie, 1 medium-sized fruit, 1/2 cup raw, cooked, canned, or frozen vegetables or fruit; 1 cup leafy salad; 1/4 cup dried fruit; 3/4 cup 100% fruit or vegetable juice; and 1/2 cup cooked or canned beans or peas) [21]. The FJV served are shown in Table 1. Although foods other than those provided for the study were not included in meals, youths were offered a beverage other than 100% juice (ie, a 6-oz serving of milk) across meals. With the exception of corn and artichoke hearts (which were canned), fresh FJV were provided. Condiments were also provided but were limited to low-fat, low-energy dressings (for seasoning salad) and salt and pepper (for seasoning vegetables other than salad) to preserve the healthfulness of the items.

The selection of FJV served at meals was based on food frequency data obtained in earlier research [22]. With the assistance of a parent or guardian, youths were asked to recall FJV consumed over the past month and to list these items, considering all forms of each food (ie, fresh, canned, frozen, and dried fruit and raw, cooked, canned, and frozen vegetables). To facilitate the recall task, respondents were provided with a list of 123 FJV. After identifying the foods and juices, respondents reported the frequency of consumption of each item, using response options from a standardized fruit and vegetable screener that ranged from never to 5 or more times a day [23]. Fruit, juice, and vegetables listed by at least one fourth of respondents were identified, and frequencies of consumption were used to rank order the items. Items with high frequencies of consumption were selected to represent commonly consumed FJV, an approach used to ensure youths' familiarity with the foods and juices offered and increase the likelihood that they would be preferred. One item (artichoke hearts) was not among the identified foods; this item was included in accordance with an aim of the measurement validation study (ie, the assessment of youths' ability to record consumption of an item not represented in the test measure using a write-in option designed for this purpose) [20].

Trained research staff present at meals observed the amounts of FJV youths left after eating using the plate-waste-by-visual-estimate method [24]. They recorded the proportion consumed of each serving on a form that contained the following response options: none, 1/4, 1/2, 3/4, and all [24]. Each staff member observed different groups of up to 10 youths each; they did not concurrently observe the same groups of youths at each meal. Although youths were aware that for purposes of the measurement validation study [20], they would be asked to recall foods consumed at meals, they were unaware that staff present at meals were observing their intake.

Because youths were given 1 serving each of the FJV provided, the amounts consumed of each item were calculated as the difference between a 1-serving unit and the observed amount of the food or juice left after eating. The resulting quantities were summed across meals to derive composite measures of servings per day. Youths' mean 3-day intake was then calculated by averaging these amounts across days. Separate calculations were performed to determine youths' by-meal intake of each food type (ie, FJV). The amounts of FJV youths consumed at the same meal (ie, breakfast, lunch, and dinner) on the different days were summed across days to derive composite measures of servings per meal. These amounts were then averaged across the total number of servings of FJV provided at meals. The resulting estimates reflected youths' average consumption of FJV per servings provided. For example, across days, 6 servings of fruit were offered at breakfast. The total amount of fruit youths were observed eating at breakfast was divided by 6 to determine their average fruit consumption at breakfast per servings of fruit provided.

2.3. Statistical analyses

Differences in youths' fruit and vegetable consumption on each day were examined with one-way analysis of variance (ANOVA). The one-sample t test, a measure of inference appropriate for assessing a sample mean in relation to a specific population mean [25], was used to test the hypothesis for the research. With a sample size of 156, the study was sufficiently powered to detect a difference between sample and population mean intakes of at least one-half serving ($1 - \beta = .80$, $\alpha = .05$, 2-tailed). Independent samples t tests and one-way ANOVA were used to determine whether youths' mean 3-day intake differed based on sex and age and whether their per-serving intake of each food type differed within and across meals. Following ANOVAs, Bonferroni post hoc tests were used to identify statistically different pairs of means. Brown-Forsythe F tests were used in analyses where the homogeneity of variance assumption underlying ANOVA was violated. For these analyses, differences between pairs of means were examined with Games Howell post hoc tests. Data were analyzed with the Statistical Package for Social Sciences (version 12; SPSS Inc, Chicago, Ill). For all analyses, the level of significance was set at $P < .05$.

3. Results and discussion

Participants had a mean (SD) age of 11.89 (1.24) years and were 55% female. Youths' intake of FJV on the first day (mean ± SD, 5.37 ± 1.94) did not differ from their intake on the second (mean ± SD, 5.62 ± 1.53) and third (mean ± SD, 5.25 ± 1.93) days. Youths consumed, on average (SD), 5.41 (1.51) daily servings of FJV. Their average intake of 5.41 daily servings was significantly higher than the population mean intake of 3.6 daily servings ($t_{155} = 14.98$, $P < .001$) [3]. Youths' mean 3-day intake did not differ based on sex. However, youths aged 10 years had higher intake (mean ± SD, 6.57 ± 1.46) than did youths aged 11 (mean ± SD, 5.05 ± 1.22), 12 (mean ± SD, 5.35 ± 1.17), and 13 years (mean ± SD, 5.10 ± 1.64; $F_{4,151} = 4.73$, $P < .001$).

As shown in Table 2, youths' mean per-serving intake by food type differed within and across meals. At breakfast, youths' juice intake (mean ± SD, 0.78 ± 0.28) was higher than

their fruit intake (mean ± SD, 0.52 ± 0.24; $t_{300.39} = -8.54$, $P < .001$). At lunch, their juice intake (mean ± SD, 0.90 ± 0.22) was higher than their vegetable intake (mean ± SD, 0.40 ± 0.31), which was higher than their fruit intake (mean ± SD, 0.29 ± 0.40; $F_{2,461} = 165.14$, $P < .001$). At dinner, youths' juice intake (mean ± SD, 0.87 ± 0.23) was higher than their vegetable intake (mean ± SD, 0.60 ± 0.33), which was higher than their fruit intake (mean ± SD, 0.46 ± 0.33; $F_{2,465} = 75.07$, $P < .001$). Youths' total per-serving intake of FJV also differed by meal. Youths' consumed more FJV at dinner (mean ± SD, 0.65 ± 0.19) and breakfast (mean ± SD, 0.61 ± 0.21) than at lunch (mean ± SD, 0.55 ± 0.23; $F_{2,465} = 8.13$, $P < .001$).

Youths' consumed more fruit at breakfast (mean ± SD, 0.52 ± 0.24) and dinner (mean ± SD, 0.46 ± 0.33) than at lunch (mean ± SD, 0.29 ± 0.40; $F_{2,462} = 20.82$, $P < .001$). Their juice intake was lower at breakfast (mean ± SD, 0.78 ± 0.28) than at lunch (mean ± SD, 0.90 ± 0.22) and dinner (mean ± SD, 0.87 ± 0.23; $F_{2,464} = 11.55$, $P < .001$), and their vegetable intake was higher at dinner (mean ± SD, 0.60 ± 0.33) than at lunch (mean ± SD, 0.40 ± 0.31; $t_{310} = -5.73$, $P < .001$). Overall, youths' consumed more juice (mean ± SD, 0.85 ± 0.19) than fruit (mean ± SD, 0.48 ± 0.22) and vegetables (mean ± SD, 0.47 ± 0.25; $F_{2,465} = 145.37$, $P < .001$).

This study was undertaken to examine fruit and vegetable consumption in a community-based sample of African American adolescents who were provided with 9 daily servings of FJV for 3 consecutive days. Findings revealed that youths consistently consumed, on average, 5 daily servings of fruit and vegetables. Youths' mean 3-day intake of 5.41 daily servings was higher than the average intake found in a nationally representative sample of similarly aged youths [3], providing evidence to support the hypothesis for the research. The consistently high number of servings offered enabled youths to consume FJV in amounts that exceeded the national average. Youths' mean intake was similar to the average intake of 5.92 daily servings found among a community-based sample of African American adolescents who were provided with 9 daily servings of FJV during the course of a single day [22]. The present findings demonstrate that youths' intake is stable over time when the availability of FJV in community-based settings is held constant at 9 daily servings. Together, these findings suggest that promoting consumption of the minimum 5 recommended daily servings of FJV [2] may require making 9 daily servings regularly available.

Consistent with previous research, youths' fruit and vegetable intake decreased with their increasing age [17,18]. Surprisingly, age-related differences in intake were observed, even though the availability of FJV (a longitudinal correlate of intake) was held constant [26]. This finding may be an artifact of the short study duration. Buffering the age-related decline in intake that occurs during adolescence may require making FJV available on a regular and long-term basis. Alternatively, this finding may reflect age-related differences in psychosocial correlates of intake, for example, lower levels of self-efficacy and peer modeling and lower taste preferences for FJV common among older versus younger adolescents [27]. The age-related decline in intake may be an artifact of developmental differences between younger and older adolescents. Older adolescents exercise greater control over their dietary choices, in part, because they have acquired the ability to think abstractly and are able to make food decisions based on perceived outcomes, whereas younger adolescents tend to think and deal in concrete terms [28]. Their lower capacity for independent decision making may have made it difficult for younger adolescents to abstain from eating the FJV served.

At each meal, youths consumed more juice than fruit and vegetables. This finding may reflect a higher preference for juice than fruit and vegetables. This seems likely given that at

breakfast on each day and at lunch on 2 of 3 days, youths were provided with 2 servings each of fruit and vegetables, respectively, and 1 serving of juice. However, youths' mean per-serving intake of juice was consistently higher than their mean per-serving intake of fruit and vegetables at these meals despite the higher number of servings of fruit and vegetables offered. Youths' pattern of consuming more fruit (mostly via fruit juice) is consistent with intake patterns found among African Americans in other research [29]. Although 100% fruit juice counts toward meeting dietary recommendations for fruit intake [2], overconsumption of fruit juice is associated with increased energy intake and excess weight gain [30,31]. Youths may therefore benefit from intervention to raise awareness of the adverse health consequences of excess juice consumption and encourage the substitution of fruit for juice.

Youths' consumption of vegetables and fruit was higher at dinner than at lunch, suggesting that offering youths a variety of vegetables and fruit at these meals may positively influence their fruit and vegetable consumption. Dinner was a major contributor to vegetable consumption, as indicated by the high per-serving intake of vegetables at this meal, a finding that is consistent with intake patterns found previously [19].

A difference with findings from previous work was the lower intake of FJV found at lunch than at breakfast and dinner meals. Baranowski et al [19] found that FJV were most frequently consumed by youths at weekday lunch, a finding that was attributed to the positive association found between consumption at this meal and participation in the National School Lunch Program. Lunch is the least frequently consumed meal among adolescents [32]. Youths' lower consumption of FJV at lunch may therefore reflect a larger pattern of lower food consumption overall at this meal. Alternatively, the difference between findings may be due to differences between the availability of FJV offered as part of the school lunch program and the availability of these foods as provided in this study. Schools offer between 2.9 and 3.8 servings of FJV per lunch throughout the school year [12]. The lower consumption found may be explained by the lower number of servings (ie, 3 versus between 3 and 4 per meal) and shorter period (ie, 3 days versus throughout the school year) during which FJV were provided.

Findings implicate the need to target lunch meals in community-based interventions to increase youths' FJV intake. Changes in preparation methods or improvements in the presentation of FJV to make them more appealing are among strategies suggested for increasing youths' FJV at this meal [33]. Factors that may explain the lower intake of FJV at lunch than at breakfast and dinner meals also need to be explored.

Despite youths' higher than average intake, it is unclear why they consumed fewer FJV than were offered. One explanation is that although youths were provided with 9 daily servings of FJV, the availability of these items may not have been sufficient for enabling their consumption. In addition to increasing the availability and accessibility of FJV in community-based settings, efforts may also be needed to provide youths with nutrition education and behavior skills training to encourage greater consumption of these foods [33]. Taste preferences are known to be a key determinant of adolescent fruit and vegetable consumption [10]. The finding that youths consumed fewer FJV than were offered may therefore be explained by low preferences for some of the items. Because taste preferences were not measured in this study, conclusions regarding whether this was in fact the case must await further research. Findings from focus group discussions with African American adolescents reveal that the way in which FJV are prepared influences the decision to consume them [34]. For example, certain forms of FJV (ie, canned) were disliked, and a common theme was that vegetables had to be prepared with toppings (ie, sugar and cheese) if they were to be eaten [34]. Canned vegetables were served in this study, and almost all of the FJV were prepared without toppings. Possibly, the preparation methods used adversely

affected the sensory appeal of some items, a factor that may explain why all of the FJV were not eaten.

The use of a self-selected sample limits the generalizability of study findings. Participants may have differed from African American adolescents in other community-based summer camp programs. Youths did not have the option of selecting from among a variety of FJV at meals; thus, their observed intake may not reflect their true eating behavior. The availability of FJV was not manipulated, precluding assessment of the extent to which variations in availability influenced youths' consumption patterns. Previously identified correlates of adolescent fruit and vegetable consumption, that is, youths' level of hunger or satiety before mealtimes, FJV taste preferences, nutrition knowledge, and social support for healthful eating, were not measured in this study [10,35,36]. Thus, the potential effects of these variables on youths' intake are unknown. Although FJV are included in meals normally served to youths in the settings studied, they are not offered in the quantities that were provided. The novelty of mealtime offerings may therefore account for the higher than average intake found.

Despite these limitations, this study measured youths' fruit and vegetable consumption using direct observation, an approach superior to self-report intake measures [37]. Youths were unaware that their intake was being measured at meals, enhancing confidence that observed intake estimates were true estimates and were unaffected by social approval or social desirability response biases. This is the first study to examine fruit and vegetable consumption among African American adolescents when provided with 9 daily servings of FJV in community-based youth services agency settings. Findings therefore add to the limited data on youths' consumption patterns when offered a uniformly high number of servings of FJV in these settings.

Increasing the availability of FJV in youth services agency settings is a promising strategy for enabling fruit and vegetable consumption among African American adolescents. In addition to changing the agency food environment to make FJV regularly available, efforts are needed to provide youths with nutrition education and behavior skills training to heighten awareness of the adverse health consequences of excess juice consumption, encourage the substitution of fruit for juice, and increase consumption of vegetables and fruit, in particular, at lunch meals. Early intervention is critical to prevent the decline in intake that occurs during adolescence [17,18]. Recognition of youths' eating patterns, in particular, their tendency to consume more juice than fruit and vegetables, may allow for the design of more effective interventions.

Abbreviations

FJV   fruit, juice, and vegetables

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Table 1

FJV served at meals on each day

Food item	Meal (day) served
Fruit	
Apple	Breakfast (1); dinner (2,3)
Blueberries	Breakfast (1)
Grape tomatoes	Lunch (1)
Cantaloupe	Breakfast (3)
Banana	Breakfast (3); dinner (1)
Peach	Breakfast (2)
Grapes	Breakfast (2)
Juice (100%)	
Orange	Breakfast (1,3)
Apple	Breakfast (2); lunch (1,3)
Grape	Dinner (1)
Juice blend	Lunch (2); dinner (2)
Pineapple	Dinner (3)
Vegetables	
Corn	Dinner (1,2,3)
Carrots	Lunch (1)
Leafy salad	Lunch (2,3)
Artichoke hearts	Lunch (2)
Celery	Lunch (3)

Table 2

Mean (SD) amounts consumed of FJV per servings provided, by meal and food type (n = 156)

Food type	Breakfast		Lunch		Dinner		Total	
	Servings provided	Proportion consumed	Servings provided	Proportion consumed	Servings provided	Proportion consumed	Servings provided	Proportion consumed
Fruit	6.00	0.52 (0.24)[a,B]	1.00	0.29 (0.40)[b,C]	3.00	0.46 (.33)[a,C]	10.00	0.48 (0.22)[B]
Juice	3.00	0.78 (0.28)[b,A]	3.00	0.90 (0.22)[a,A]	3.00	0.87 (0.23)[a,A]	9.00	0.85 (0.19)[A]
Vegetables	–	–	5.00	0.40 (0.31)[b,B]	3.00	0.60 (0.33)[a,B]	8.00	0.47 (0.25)[B]
Total	9.00	0.61 (0.21)[a]	9.00	0.55 (0.23)[b]	9.00	0.65 (0.19)[a]	27.00	0.60 (0.28)

Dashes indicate that the food type was not served at that particular meal.

Row means with differing lowercase superscripts and column means with differing uppercase superscripts indicate significant differences at $P < .05$ as indicated by independent samples t tests and one-way ANOVA.