Research Reports

Summer Garden Programs Improve Children's Food Knowledge and Preferences: Evidence Using Stated and Revealed Preference Measures

Joanna Brown¹, Gregory Colson², Claire B. de La Serre³, and Nicholas Magnan^{2,4}

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SUMMARY. One reason for excessive body weight among youth is poor eating choices. Garden-based programs have the potential to educate children about fruits and vegetables and healthy eating generally, and improve their food preferences. This study examines the impacts of two community-based summer garden programs in Atlanta, GA, on children aged 5–14 years ($n = 71$). These programs spanned 1 to 2 weeks and included daily gardening activities and nutritional education. The study employs a pre- and postprogram questionnaire and a food choice experiment to evaluate changes in knowledge about and preferences for healthy and unhealthy foods. Results show that the programs substantially and significantly increased knowledge about nutrients ($P < 0.01$), plants ($P < 0.1$), and healthy foods ($P < 0.01$). The programs also increased the number of fruits and vegetables participants tried ($P < 0.1$) and their propensity to make healthy choices in the food experiment ($P < 0.1$). Regression analysis shows program impacts on plant knowledge ($P < 0.1$) and fruits and vegetables tried ($P < 0.1$) to be lower for African American children ($n = 38$) and all other program impacts to be statistically homogenous. At least in the short term, garden programs such as these can alter children's preferences and decisions regarding healthy eating. More research is needed to see if these effects persist and ultimately improve health outcomes into adulthood.

Childhood overweight [body mass index (BMI) $\geq$ 85th percentile] and obesity (BMI $\geq$ 95th percentile) are major problems in the United States. Children who are overweight are at increased risk for hypertension, diabetes, sleep apnea, asthma, and depression (Ebbeling et al., 2002). In 2012, $\approx 31.3\%$ of American children and adolescents aged 10–17 years were obese. Within this number, there are significant racial and regional disparities. In 2012, obesity prevalence was higher among Hispanic Americans (33.9%) and

non-Hispanic African Americans aged 10–17 years (41.6%), compared with non-Hispanic Caucasian 10–17 year olds (26.3%). These differences have been shown to exist even after controlling for community poverty measures (Wickrama et al., 2006). Childhood excessive body weight rates are especially high in the southern United States (Centers for Disease Control and Prevention, 2013b); in Georgia, among 10–17 year olds, 35.0% of all, 43.5% of Hispanic Americans, and 46.1% of African Americans were overweight or obese in 2012 (Child and

Adolescent Health Measurement Initiative, 2012).

A diet deficient in dietary fiber from fruits and vegetables and high in fat, sugar, and refined grains coupled with a lack of physical activity are the main culprits behind excessive body weight among children (Grigorakis et al., 2016). In the United States, 36.0% of adolescents report consuming fruits less than once daily and 37.7% report consuming vegetables less than once daily. Low fruit and vegetable consumption among adolescents is especially prevalent in Georgia ($42.9\% \leq$ one fruit per day, $43.1\% \leq$ one vegetable per day) and throughout the southern United States (National Center for Chronic Disease Prevention and Health Promotion, 2013). Given these high rates of excessive body weight and dismal statistics on fruit and vegetable consumption, scholars and policymakers are increasingly interested in understanding how food choices among children are shaped by environmental factors within the school and community (Capacci et al., 2012; Foltz et al., 2012; Stice et al., 2006; Unnevehr, 2013). Creating an environment that encourages healthy eating and physical activity may be especially important for children from low-income households and for African American and Hispanic American children, who have been shown to receive less parental support in these areas (Donnelly and Springer, 2015; Watt et al., 2012).

One type of intervention designed to create an environment conducive to healthy choices is gardening programs. Gardening provides participants with direct (although limited) access to fruits and vegetables, exposes them to new healthy foods, and provides a source of outdoor physical activity. The vast majority of garden programs investigated by researchers are school-based or after-school garden programs for children and adolescents (Blair, 2009; Langelotto and Gupta, 2012; Robinson-O'Brien et al., 2009). Although children are in school for 9 months of the year, summertime is often a period of accelerated weight gain. This is especially true for children who are already overweight and for African American and Hispanic American children, who are most likely to gain weight over the summer months (Downey and Boughton, 2007; Von Hippel et al., 2007). Summer garden

programs, therefore, offer a potential avenue to provide an environment that encourages healthy food choices and physical activity during a time when children are at an elevated risk of making unhealthy decisions.

Research on summer garden programs is limited, with mixed results. A 10-week program in Texas increased children's knowledge about fruits and vegetables, but did not change their preferences for them. However, it did increase children's self-reported healthy snack consumption (Koch et al., 2006). Children attending a 12-week summer garden program in Rochester, MN, were more likely to have tried a variety of vegetables and exhibited stronger preferences for eating fruits and vegetables, including asking for them at home (Heim et al., 2009). A summer garden program in the Minneapolis/St. Paul, MN area, also improved eating habits and attitudes toward healthy foods (Lautenschlager and Smith, 2007a, 2007b).

This study evaluates the impacts of two community-based summer garden programs on food knowledge and food preferences, on children aged 5–14 years, in Atlanta, GA. In addition to estimating overall impacts, this study tests for heterogeneous impacts on African Americans, who particularly are at high risk of childhood and adolescent obesity. A unique methodological feature of the study is the use of a hybrid of stated and revealed preference measures to assess the impact of the garden programs.

First, similar to other garden program studies (Heim et al., 2009; Koch et al., 2005; Lautenschlager and Smith, 2007a, 2007b; Poston et al., 2005), participants' stated attitudes

were elicited via a questionnaire about fruits, vegetables, and other foods and a knowledge test about fruits, vegetables, and nutrition as outcomes. Second, a unique nonhypothetical experiment conducted before and after program participation captured children's revealed preferences. In the experiment, study participants were offered a variety of healthy and less healthy snacks and drinks to consume at the time of the questionnaire and their choices were discreetly recorded. This approach provides a measure of actual decision-making by children that is less subject to potential hypothetical bias that is common in questionnaire responses (Harrison and Rutström, 2008). Combining both hypothetical stated preferences and nonhypothetical revealed preferences for fruits and vegetables yields a more robust assessment of the impact of the garden programs. The questionnaire and the experiment are described in more detail in the following section.

Materials and methods

STUDY SETTING. The sample for this study included participants from two concurrent summer garden programs in urban Atlanta, GA [Truly Living Well Center for Natural Urban Agriculture (TLW) and Piedmont Park Conservancy (PPC)], during Summer (June to Aug.) 2013. These organizations both aim to teach children about growing fruits and vegetables and the importance of healthy eating and physical activity. Both programs are day camps, where children stay from ≈8:00 A.M. to 5:00 P.M.

TLW camps were attended by children aged 6–14 years for 2 weeks. The location is a 5-acre (2.0 ha) urban farm where children gain hands-on experience growing fruits and vegetables. Lunches and snacks served at the camp incorporate freshly harvested fruits and vegetables from the camp, exposing participants to new and healthy foods. As part of the curriculum, a professional chef demonstrates how to use produce harvested by participants to prepare healthy meals. Outdoor physical activity is an important aspect of the camp, with a variety of activities such as garden bed installation, swimming, and scavenger hunts (which also help teach participants to identify plants and herbs).

PPC camps were attended by children aged 5–13 years, for 1 week.

The location is a large urban park that contains a 3000-ft² (278.7 m²) educational garden and orchard. Using the garden, participants learn about fruit and vegetable cultivation and identification. Participatory cooking demonstrations are used to teach participants how to create healthy meals using fruits and vegetables from the garden. Daily outdoor physical activities are also an important part of camp curriculum and include swimming, biking, and team sports. Both TLW and PPC promote themselves to families through websites, flyers and posters, and networking at Atlanta, GA, school assemblies. Participants are mostly from urban areas.

RECRUITMENT. Before the onset of each session, camp attendees from both camps were invited to participate in the study. First, camp directors introduced the study to all participating families. A follow up e-mail was then sent to each family. The e-mail contained details on the study objective and a summary of the questionnaire. As an incentive to participate, families from TLW were offered gift certificates worth \$20 of goods at the organization's farmers' market. PPC participants' families were offered gift certificates worth \$10 at a nearby farmers' market (\$20 certificates were initially offered to TLW management, but the study budget was not sufficient to also offer this amount to PPC participants). Informed consent forms were distributed and explained by enumerators, who then collected signed forms.

ADMINISTRATION OF THE STUDY. This study uses a pre-post design, with no experimental control, as is typical for garden program evaluations (Heim et al., 2009; Koch et al., 2005, 2006; Lautenschlager and Smith, 2007a, 2007b; Poston et al., 2005). Two graduate students orally administered both the precamp and postcamp surveys using visual aids. One enumerator administered the study individually to the child, whereas the other enumerator simultaneously administered a different survey (not the focus of this study) individually to the parent, thus allowing the child to give responses without the influence of the parent. The precamp questionnaire was administered before participation in any camp activities. Precamp questionnaires were conducted away from the camp environment when possible, and otherwise

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¹Foreign Agricultural Service, U.S. Department of Agriculture, Room 5532, 1400 Independence Avenue SW, Washington, DC 20250

²Department of Agricultural and Applied Economics, University of Georgia, 301 Conner Hall, Athens, GA 30602

³Department of Foods and Nutrition, University of Georgia, 280 Dawson Hall, Athens, GA 30602

⁴Corresponding author. E-mail: nmagnan@uga.edu.

at or near the camp away from the presence of camp staff and other camp participants and their parents. All post-camp questionnaires were conducted in the home or in a public location away from the camp. A priori, if the camp setting did influence responses, it would bias them toward fruits and vegetables at baseline, which would lead to downward bias in program impact estimates.

Enumerators conducted questionnaires coinciding with the gradual rollout of the camp sessions. TLW had four 2-week camp sessions limited to 25 children per session—although nine TLW participants attended two 2-week sessions and one TLW participant only attended 1 week—and PPC had eight 1-week sessions limited to 40 children per session. Conducting questionnaires at consistent time intervals after the conclusion of the participant's camp session proved very difficult given parents' schedules. In the end, the average span of time from the camp's conclusion to the post-questionnaire was 40 d, although some postquestionnaires were conducted within as few as 4 d and others after as many as 77 d, with all but two conducted at least 16 d after the session's conclusion. Our total sample size was 71 campers with 31 from TLW and 40 from PPC. The total number of TLW attendees was 53 and the total number of PPC attendees was 103, resulting in study participation rates of 58% and 39%, respectively.

DESIGN OF THE SURVEY. The survey consisted of questions covering food knowledge, foods tried, and food preferences to assess the effects of the TLW and PPC programs. These three areas of assessment were selected because of the program contents of the camps. Both camps centered on an educational garden and included activities and games on plant identification (e.g., plant scavenger hunts) designed to increase knowledge of healthy foods and nutrition. To expose participants to new nutritious foods and to highlight their positive qualities in terms of both taste and health, both camps included interactive cooking demonstrations with tastings, as well as daily meals and snacks featuring healthy foods.

Questionnaire modules and questions were modeled largely after those found in the widely used National

Health and Nutrition Examination Questionnaire of the Centers for Disease Control and Prevention (CDC) (CDC, 2013a) and to reflect the Teaching Gardens curriculum of the American Heart Association (American Heart Association, 2013). Similar questions have been used in previous studies assessing food preferences and food knowledge among children aged 5–15 years (Robinson-O'Brien et al., 2009). To assess the reliability of the instrument, comprehension by child participants, and for the presence of fatigue because of length, a pilot study was conducted with 10 children during the first session of the TLW camp. On the basis of feedback from the pilot study, the instrument was shortened to 100 very short multiple-choice questions across the different modules, which took ≈ 30 –40 min to complete. There were 27 questions in the food and nutrition module, 41 healthy fruits and vegetables in addition to 15 unhealthy foods included in the food preference and food experience module, and 13 questions eliciting demographics and lifestyle behaviors. In the remainder of this section, examples of questions from each module are presented, and

the complete instrument with high-resolution color photos is available from the authors on request.

Food knowledge questions were designed to test three areas of participant knowledge related to the aims of the garden camps: healthy foods, nutrients, and plants. "Healthy food" questions confronted respondents with five food options each for breakfast, lunch, snack, and dinner, and asked them to choose which three constituted healthy choices (Fig. 1). "Plant knowledge" questions asked respondents to identify herbs, fruits, and vegetables common in, but not limited to, Georgia. Respondents were shown three photos of each and asked to select the plant from four options (Fig. 2). "Nutrient knowledge" questions asked respondents to identify nutrients in the six major food groups: fruit, vegetables, grains, protein, dairy and fats/sugars (Fig. 3).

To find what foods children had tried, and how much they liked these foods, participants were asked "food preference" questions using a one to five point pictorial scale ranging from "dislike a lot" (two green unhappy faces) to "like a lot" (two yellow happy faces) (Fig. 4). If a respondent

Check the three foods that would make the MOST healthy snack:

☐	☐	☐	☐	☐

Fig. 1. Example of a "healthy food" question asking respondents which three of five foods make the healthiest snack: apples, rice cakes, yogurt, chocolate, and soda drink.

Click each of these that is a **FRUIT** in the adjacent picture:

☐	☐	☐	☐

Fig. 2. Example of a "plant knowledge" question asking campers to identify the fruit from a set of alternatives: eggplant (*Solanum melongena*), heirloom watermelon (*Citrullus lanatus*), common fig (*Ficus carica*), and watermelon.

Identify each of the foods that is high in vitamin C:

☐

☐

☐

☐

Fig. 3. Example of a “nutrient knowledge” question asking respondents which of the pictured sets of foods is a good source of vitamin C: limes (*Citrus aurantifolia*), lemons (*Citrus × limon*), grapefruit (*Citrus × paradisi*), and oranges (*Citrus × sinensis*); avocado (*Persea americana*), broccoli (*Brassica oleracea* var. *italica*), cheese, almonds (*Prunus dulcis*), yogurt, milk, and tuna; lemons, kiwifruit (*Actinidia deliciosa*), and grapefruit; peas (*Pisum sativum*) peanuts (*Arachis hypogaea*), chickpeas (*Cicer arietinum*), and several varieties of common beans (*Phaseolus vulgaris*).

Circle the smiley face that best describes how you like the following vegetable:

Beets

Never Tried ☐

☐

☐

☐

☐

☐

☐

Fig. 4. Example of a “food preference” question asking respondents if they have tried beets (*Beta vulgaris*) and if so, how much they like the fruit or vegetable.

never tried a certain food, zero points were assigned. The total number of points for fruits and vegetables were then aggregated and divided by the number of possible points to calculate a “fruit and vegetable preference score” ranging from 0% to 100%. Similarly, a “fast food and snacks preference score” was calculated. Factor analysis indicated acceptable levels of internal consistency within each category: Cronbach $\alpha = 0.923$ for fruits and vegetables and 0.763 for fast food and snacks. One concern was whether younger children could accurately and consistently answer these scaled questions. Factor analyses conducted separately for children less than nine years old revealed nearly identical levels of internal consistency among the younger children in the sample (Cronbach $\alpha = 0.928$ for fruits and vegetables and 0.755 for fast food and snacks).

The questionnaire also contained several demographic questions for parents such as the ethnicity of the child and the number of children in the household. Instead of asking about income, which can be a sensitive topic, median household income by zip code was used for our analysis, as is common practice. Median zip code income is an

imperfect proxy, and its causal effect should be interpreted as a geographic income effect rather than a household one (Geronimus and Bound, 1998). At the conclusion of the questionnaire, enumerators took height and weight measurements to calculate BMI and BMI percentile, which are used to characterize the sample at baseline.

DESIGN OF THE FOOD CHOICE EXPERIMENT. To complement the stated preference questionnaire, a simple food choice experiment was implemented to capture a real (as opposed to hypothetical) eating decision before and after camp participation. In the economics literature, this is referred to as a “revealed preference” measure, as opposed to “stated preference” measures like the ones captured by the questionnaire. The key advantage of this approach is that participants have a greater incentive to reveal their true preferences because there is a consequence to their action (i.e., they have to actually eat their selection). During the instructions for the questionnaire, children were casually told they could select a choice of one snack and one drink from a basket brought by the enumerator. They were not prompted toward healthy choices,

nor told that their choice was being recorded. The basket included fifteen food and drink options. Healthy options included apple (*Malus × domestica*) slices, peaches (*Prunus persica*), baby carrots (*Daucus carota*), celery (*Apium graveolens*), and mini cucumbers (*Cucumis sativus*) for snacks and water or 100% fruit juice for a drink. Unhealthy options included chips, crackers, oatmeal cream pies, fruit roll-ups (high in sugar), and chocolate-covered granola bars (high in saturated fat) for snacks and cola for a drink. Foods were classified as healthy or unhealthy using the U.S. Department of Agriculture (USDA) Dietary Guidelines for Americans (USDA, 2010) and the USDA Smart Snacks in School standards (USDA, 2015). Snacks that fall into the “foods to increase” category, such as fruits and vegetables, were classified as healthy, whereas foods that belong into the “foods to reduce” category, such as those with added sugars and high levels of saturated fat, were deemed unhealthy. Some children opted for no drink, which enumerators recorded as a healthy choice. The number of healthy choices (zero, one, or two) was used as the experiment outcome for the analysis that follows.

STATISTICAL METHODS. All data analyses were conducted using Stata (Release 12; StataCorp, College Station, TX). To estimate demographic differences between the TLW and PPC programs, two-sided t tests were used. To estimate demographic correlates of outcomes at baseline, multiple linear regressions were used. To estimate overall program impacts, paired t tests were used to compare pre- and postcamp outcomes. Because the garden camps should only improve outcomes, one-sided hypothesis test statistics were used. To estimate demographic correlates of program impact, multiple linear regressions were used.

Results

SAMPLE CHARACTERISTICS. The age of sample participants ranged from 5 to 14 years, with a mean age of 7.8 years. About half of the sample was male. The ethnic breakdown of the sample was 39% ($n = 28$) African American, 4% ($n = 3$) Hispanic American, 10% ($n = 7$) Asian, and 56% ($n = 40$) Caucasian, with the 14 biracial children in the sample counted across multiple categories. The racial makeup

Table 1. Sample averages of the summer garden day camp participants' demographic variables overall (N = 71), for Piedmont Park Conservancy (PPC) summer garden day camp participants (N = 40), and for Truly Living Well Center for Natural Urban Agriculture (TLW) summer garden day camp participants (N = 31). The data are from children aged 5–14 years attending a 1- or 2-week summer garden day camp in Atlanta, GA, from June to Aug. 2013.

Variable	Variable description	PPC and TLW	PPC	TLW	P value ^z
Age	Participant's age in years	7.82	7.42	8.32	0.08
Gender	Gender of participant, 1 = male, 0 = female	0.52	0.55	0.48	0.59
African American	Proportion of participants that are African American	0.39	0.17	0.68	0.00
Hispanic American	Proportion of participants that are Hispanic American	0.04	0.05	0.03	0.72
Asian	Proportion of participants that are Asian	0.10	0.12	0.06	0.40
Caucasian	Proportion of participants that are Caucasian	0.56	0.68	0.42	0.03
Overweight or obese	Proportion of participants that are overweight or obese	0.18	0.23	0.13	0.31
BMI percentile	Mean BMI percentile of participants	45.90	50.58	39.87	0.18
Income	Median income of zip code where the participant lives	70.98	77.37	62.74	0.03
N	Number of participants	71	40	31	—

^zProbability value for a two-sided *t* test of the difference in mean between PPC and TLW summer garden day camp programs.
BMI = body mass index.

Table 2. Ordinary least squares estimation results of the relationship between summer garden day camp participant demographics and four different measures of food knowledge (N = 71) measured at baseline (before summer garden day camp attendance). Mean score (of 100) across participants at baseline for Model 1 (aggregate knowledge) is 66.42, for Model 2 (healthy food knowledge) is 82.51, for Model 3 (plant knowledge) is 67.65, and for Model 4 (nutrient knowledge) is 49.09. The regressions use data from children aged 5–14 years attending a 1- or 2-week summer garden day camp in Atlanta, GA, from June to Aug. 2013.

Variables	Model 1		Model 2		Model 3		Model 4	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
African American	1.212	4.253	8.176	7.179	1.585	4.294	-6.125	5.423
Camp is TLW ^z	1.014	4.040	-0.922	6.821	6.119	4.080	-2.155	5.152
Age (years)	4.439***	0.819	3.042**	1.382	4.462***	0.827	5.815***	1.044
Male	3.158	3.413	-1.788	5.762	-0.851	3.446	12.11***	4.353
Zip code median income (\$1000)	-0.00658	0.0631	-0.00342	0.107	0.0305	0.0638	-0.0468	0.0805
BMI percentile	0.0279	0.0530	0.0310	0.0895	0.0239	0.0536	0.0288	0.0676
Constant	28.34***	8.353	55.66***	14.10	26.66***	8.434	2.686	10.65
R-squared	0.359	—	0.106	—	0.385	—	0.413	—

^zTruly Living Well Center for Natural Urban Agriculture summer garden day camp.
BMI = body mass index.
***, **, *Statistically different from zero at 1%, 5%, or 10% significance level, respectively.

of participants differed substantially between the two camps included in the study. Of PPC attendees, 68% (n = 27) were Caucasian and 17% (n = 7) were African American. In contrast, 68% of TLW attendees (n = 21) were African American and 42% (n = 13) were Caucasian. Neither program targeted overweight or obese children; attendees were generally in a normal weight range. Mean BMI in the sample was at the 46th percentile. Mean annual household income in participants' zip codes was \$70,980; this figure was higher for PPC participants (\$77,370) compared with TLW participants (\$62,740), both of which were higher than median city (\$48,485) and state (\$47,829) values. Table 1 contains these descriptive statistics for the study sample.

The first row of Table 2 contains preintervention means for food knowledge variables. At baseline, participants

correctly answered 82% of "healthy food" questions, 68% of "plant knowledge" questions, and 49% of "nutrient" questions. The mean weighted aggregate knowledge score was 66%. The first row of Table 3 contains preintervention means for food preference variables. Of the 42 fruits and vegetables on the survey, on average, participants said they had tried 34, or 82% of them. Mean fruit and vegetable preference score was 61% and mean fast food and snack preference score was 78%. On average, respondents selected 0.89 of a possible two healthy food choices in the experiment.

The remainder of Tables 2 and 3 present regression results for sociodemographic correlates of preintervention food knowledge and preferences, respectively. In this and subsequent analysis, significance levels of 0.1, 0.05, and 0.01 are considered as is customary in statistical analysis (Natrella, 2010).

For all of the knowledge scores and fruit and vegetable preference scores, older children exhibited significantly better outcomes than younger ones ($P < 0.05$). Males had a significantly higher nutrient knowledge score at baseline than females ($P < 0.01$), but a lower fruit and vegetable preference score ($P < 0.1$). For all of the knowledge scores, fruit and vegetable preference score, and fast food and snack preference score there was no significant difference between African Americans and other participants. Median income by zip code also had no significant effect on these scores at baseline. BMI percentile was positively correlated with fast food and snack preference ($P < 0.1$), but not with other knowledge or preference scores. The final column of Table 3 shows a large and statistically significant difference between African Americans and other participants; African Americans made 0.46 less healthy

Table 3. Ordinary least squares estimation results of the relationship between summer garden day camp participants' demographics and preferences and experience with healthy and less healthy foods (N = 71) measured at baseline (before summer garden day camp attendance). Mean score across participants at baseline for Model 1 (fruits and vegetables tried by the participant) is 81.92 (of 100), for Model 2 (fruit and vegetable preference score) is 60.56 (of 100), for Model 3 (fast food and snacks preference score) is 77.61 (of 100), and for Model 4 is (healthy choices made in the revealed preference experiment) is 0.89 (of 2). The regressions use data from children aged 5–14 years attending a 1- or 2-week summer garden day camp in Atlanta, GA, from June to Aug. 2013.

Variables	Model 1		Model 2		Model 3		Model 4 ^z	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
African American	4.454	3.951	7.076	4.565	6.330	3.930	−0.456**	0.190
Camp is TLW ^y	−3.011	3.754	−4.878	4.337	−2.311	3.734	0.209	0.180
Age (years)	2.601***	0.761	2.196**	0.879	−0.881	0.757	0.0398	0.0365
Male	−4.395	3.171	−6.731*	3.664	0.522	3.154	−0.465***	0.152
Zip code median income (\$1000)	0.0667	0.0587	0.0677	0.0678	−0.0787	0.0584	−0.000188	0.00282
BMI percentile	−0.0498	0.0493	−0.0702	0.0569	0.0891*	0.0490	−0.00337	0.00237
Constant	60.99***	7.760	44.66***	8.966	84.24***	7.719	1.075***	0.373
R-squared	0.199	—	0.171	—	0.131	—	0.232	—

^zHealthy choices refers to the number of healthy food options (zero, one, or two items) selected by the participant in the revealed preference experiment.

^yTruly Living Well Center for Natural Urban Agriculture summer garden day camp.

BMI = body mass index.

***, **, *Statistically different from zero at 1%, 5%, or 10% significance level, respectively.

Table 4. Comparison of summer garden day camp participant food knowledge, experience, and preferences pre- and postsummer garden day camp participation (N = 71). The data are from children aged 5–14 attending a 1- or 2-week summer garden day camp in Atlanta, GA, from June to Aug. 2013.

Measurements of participant food knowledge, experience, and preferences ^z	Precamp ^y	Postcamp ^y	Post-Pre difference	P value ^x
Aggregate knowledge quiz score (of 100)	66.42	74.32	7.90	0.001
Food knowledge quiz score (of 100)	82.51	91.55	9.04	0.003
Plant knowledge quiz score (of 100)	67.65	71.55	3.90	0.070
Nutrient knowledge quiz score (of 100)	49.09	59.86	10.76	0.001
Percent of F&V tried	81.92	85.08	3.15	0.088
F&V preference score (of 100)	60.56	63.90	3.33	0.101
FF&S preference score (of 100)	77.61	77.00	−0.61	0.955
Healthy choices ^w	0.89	1.08	0.20	0.045

^zF&V = fruits and vegetables, FF&S = fast food and snacks.

^yPrecamp refers to baseline measures obtained before participation in the summer garden day camp. Postcamp refers to posttreatment measures obtained after participation in the summer garden day camp.

^xProbability value from a one-sided *t* test of the significance of a change in score pre- and postsummer garden day camp.

^wHealthy choices refers to the number of healthy food options (zero, one, or two items) selected by the participant in the revealed preference experiment.

choices at baseline, on average ($P < 0.05$). We also found that males made 0.47 less healthy choices than females ($P < 0.05$). No other demographic variable was a significant determinant of the number of healthy food choices.

OVERALL PROGRAM IMPACTS. The garden camps had a substantial positive impact on knowledge (Table 4). Program participation increased aggregate knowledge scores by 7.9% points on average from a baseline mean of 66% ($P < 0.01$). Healthy food knowledge scores increased 9.0% points from a baseline mean of 82.5% ($P < 0.01$), nutrient knowledge scores increased 10.8% points from a mean of 49.1% ($P < 0.01$), and plant knowledge increased by 3.9% points from a mean of 67.7% ($P < 0.1$).

The programs also shifted preferences toward healthy food choices. Camp attendance significantly increased number of fruits and vegetables tried by 3.2% ($P < 0.1$). In addition, there was a trend toward an impact of the program(s) on fruits and vegetable preference score, increasing it by 3.3% ($P = 0.101$). The programs had no effect on fast food and snack preference scores. In addition to improving stated preferences for fruits and vegetables, the camps increased revealed preferences for healthy foods. After attendance, participants made an average of 0.2 more healthy food choices out of a possible two in the food choice experiment ($P < 0.05$).

IMPACT HETEROGENEITY. Because of the disparities in health outcomes

for African American and Hispanic American children (Child and Adolescent Health Measurement Initiative, 2012), it is important to know if garden camps affect these groups differently. The sample contained only three Hispanic American participants, so it was not possible to test for differential program impacts for this group; only differential impacts for African Americans were estimated. Since ethnicity is highly correlated with camp attended (PPC or TLW), it is necessary to control for camp effects. Age, sex, household income (at the zip code level), and BMI percentile at baseline were also controlled for.

Tables 5 and 6 contain estimates of the relationship between demographic variables and outcomes for food knowledge and preferences, respectively. The first row of each table contains mean changes in outcomes, and the remainder of the tables shows regression results for sociodemographic determinants of program impact. Of the eight outcomes examined, program impacts were significantly smaller for African Americans for two: plant knowledge and fruit and vegetables tried ($P < 0.1$). Program impacts also vary by sex. Males experienced significantly smaller gains in plant knowledge, nutrient knowledge, and aggregate knowledge than females ($P < 0.1$ for all). They did, however, exhibit larger gains in their fruit and vegetable preference scores ($P < 0.1$). No other explanatory variable had a significant effect on more than one outcome change.

Table 5. Ordinary least squares estimation results of the relationship between summer garden day camp participant demographics and the change in food knowledge between pre- and postsummer garden day camp participation (N = 71). Mean change between pre- and postcamp score across participants for Model 1 (aggregate quiz) is 7.9, for Model 2 (healthy food knowledge quiz) is 9.04, for Model 3 (plant knowledge quiz) is 3.9, and for Model 4 (nutrient knowledge quiz) is 10.76. The regressions use data from children aged 5–14 years attending a 1- or 2-week summer garden day camp in Atlanta, GA, from June to Aug. 2013.

Variables	Model 1		Model 2		Model 3		Model 4	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
African American	−4.933	4.163	−6.461	6.830	−10.31*	5.384	1.972	6.019
Camp is TLW ^z	0.181	3.955	2.405	6.489	−2.471	5.115	0.608	5.718
Age (years)	−1.020	0.802	−1.136	1.315	−1.757*	1.037	−0.166	1.159
Male	−6.581*	3.341	−2.028	5.481	−7.283*	4.321	−10.43**	4.831
Zip code median income (\$1000)	−0.0205	0.0618	−0.0315	0.101	−0.0940	0.0799	0.0640	0.0894
BMI percentile	−0.0512	0.0519	−0.00143	0.0852	−0.0245	0.0671	−0.128*	0.0751
Constant	24.97***	8.176	22.78*	13.41	34.37***	10.58	17.77	11.82
R-squared	0.133	—	0.031	—	0.185	—	0.129	—

^zTruly Living Well Center for Natural Urban Agriculture summer garden day camp.

BMI = body mass index.

***, **, *Statistically different from zero at 1%, 5%, or 10% significance level, respectively.

Table 6. Ordinary least squares estimation results of the relationship between participant demographics and the change in participants' food preferences between pre- and postsummer garden day camp participation (N = 71). Mean change between pre- and postsummer garden day camp preferences across participants for Model 1 (fruits and vegetables tried by the participant) is 3.15, for Model 2 (fruit and vegetable preferences) is 3.33, for Model 3 (fast food and snacks) is −0.61, and for Model 4 (healthy choices made in the revealed preference experiment) is 0.20. The regressions use data from children aged 5–14 attending a 1- or 2-week summer garden day camp in Atlanta, GA, from June to Aug. 2013.

Variables	Model 1		Model 2		Model 3		Model 4 ^z	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
African American	−7.389*	4.202	−5.625	3.948	4.403	4.269	−0.0980	0.245
Camp is TLW ^y	4.976	3.992	−1.317	3.751	7.512*	4.056	−0.102	0.233
Age (years)	−0.620	0.809	−0.892	0.760	0.767	0.822	−0.0413	0.0471
Male	2.327	3.372	5.941*	3.169	4.598	3.426	0.266	0.196
Zip code median income (\$1000)	−0.0847	0.0624	−0.119**	0.0586	0.0104	0.0634	0.00130	0.00364
BMI percentile	0.0789	0.0524	0.0176	0.0492	−0.00900	0.0532	0.000997	0.00305
Constant	9.920	8.252	17.62**	7.754	−14.34*	8.385	0.326	0.481
R-squared	0.111	—	0.143	—	0.171	—	0.065	—

^zHealthy choices refers to the number of healthy food options (zero, one, or two items) selected by the participant in the revealed preference experiment.

^yTruly Living Well Center for Natural Urban Agriculture summer garden day camp.

BMI = body mass index.

***, **, *Statistically different from zero at 1%, 5%, or 10% significance level, respectively.

Discussion

In the short term, the two garden programs evaluated in this study largely achieved their objectives of creating an environment outside of school that educated children about fruits and vegetables, and nutrition more broadly. Of the eight outcomes considered, the programs had a significant (or near significant) impact on seven: overall knowledge, food knowledge, plant knowledge, nutrient knowledge, fruits and vegetables tried, stated fruit and vegetable preference score, and revealed food choice.

These results are consistent with the literature, but more comprehensively positive than any single study. Koch et al. (2006) found that a summer garden camp increased fruit and vegetable knowledge and led to healthier self-reported

snack choices, but did not change participants' stated preferences for fruits and vegetables. Heim et al. (2009) found that a summer garden camp increased vegetable (but not fruit) preference, the number of fruits and vegetables tried, and the likelihood of asking for fruits and vegetables at home. They did not find, however, that the camp improved self-reported snack choices. Lautenschlager and Smith (2007b) found that a summer garden camp increased fruit and vegetable consumption, but only for boys.

A unique aspect of this study is that it tests for heterogeneous impact by ethnicity. It is discouraging that for two outcomes, plant knowledge and fruits and vegetables preference score, the impact for African American participants was smaller than for other participants. For both, the negative effect associated

with being African American is greater than the positive mean effect of the camp, meaning that the programs ultimately did not improve these outcomes for African American participants. A potential partial explanation for this is that African Americans scored slightly better (although not statistically significantly so) at baseline along both of these dimensions. Program impacts on knowledge outcomes were smaller for male participants, but impacts on stated fruit and vegetable preference scores were slightly larger. Small sample size and low statistical power make these findings somewhat tenuous, but indicate that more research on program impacts using large, diverse, and ethnically balanced samples is needed.

The span of time from the end of the camp to the collection of end line

data was short, ranging from less than one (in two cases) to 11 weeks. Clearly, this is not enough time to confidently speak of long-term effects on outcomes measured in this study, or on other long-term effects like BMI, scholastic achievement, or psychological well-being. This is a common shortcoming of evaluations of garden programs, and future studies should aim to take a longer view. This is not an easy objective, as many factors could lead to changes in food preference and consumption over long periods of time.

Finally, it is important to remember that the children participating in this study chose to attend these garden programs, or their parents chose for them. It is likely, therefore, that these children and/or their parents had an interest in healthy foods, and even in gardening, before the program began. These children were also mostly of healthy weight before the program. These factors limit generalizability. However, the results do add to a small body of evidence that garden camps are effective in changing knowledge about and preferences for healthy foods in a variety of geographical settings.

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