

2018

Gardening Experience Is Associated with Increased Fruit and Vegetable Intake among First-Year College Students: A Cross-Sectional Examination

Jennifer Loso
University of Florida

Daniel Staub
University of Florida

Sarah E. Colby
University of Tennessee, Knoxville

Melissa D. Olfert
West Virginia University

Kendra Kattelman
South Dakota State University

See next page for additional authors

Follow this and additional works at: <https://digitalcommons.unl.edu/nutritionfacpub>

 Part of the [Human and Clinical Nutrition Commons](#), [Molecular, Genetic, and Biochemical Nutrition Commons](#), and the [Other Nutrition Commons](#)

Loso, Jennifer; Staub, Daniel; Colby, Sarah E.; Olfert, Melissa D.; Kattelman, Kendra; Vilaro, Melissa; Colee, James; Zhou, Wenjun; Franzen-Castle, Lisa; and Matthews, Anne E., "Gardening Experience Is Associated with Increased Fruit and Vegetable Intake among First-Year College Students: A Cross-Sectional Examination" (2018). *Nutrition and Health Sciences -- Faculty Publications*. 121.
<https://digitalcommons.unl.edu/nutritionfacpub/121>

This Article is brought to you for free and open access by the Nutrition and Health Sciences, Department of at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Nutrition and Health Sciences -- Faculty Publications by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

Authors

Jennifer Loso, Daniel Staub, Sarah E. Colby, Melissa D. Olfert, Kendra Kattelmann, Melissa Vilaro, James Colee, Wenjun Zhou, Lisa Franzen-Castle, and Anne E. Matthews



Gardening Experience Is Associated with Increased Fruit and Vegetable Intake among First-Year College Students: A Cross-Sectional Examination



Jennifer Loso; Daniel Staub; Sarah E. Colby, PhD, RDN; Melissa D. Olfert, DrPH, RDN; Kendra Kattelman, PhD, RDN; Melissa Vilaro, PhD, MPH; James Colee, MS; Wenjun Zhou, PhD; Lisa Franzen-Castle, PhD, RD; Anne E. Mathews, PhD, RDN

ARTICLE INFORMATION

Article history:

Submitted 14 April 2017
Accepted 11 September 2017
Available online 30 November 2017

Keywords:

Gardening
Fruit and vegetable intake
College students
Childhood
Gardening frequency

2212-2672/Copyright © 2018 by the Academy of Nutrition and Dietetics. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).
<https://doi.org/10.1016/j.jand.2017.09.005>

ABSTRACT

Background Gardening interventions have been shown to increase fruit and vegetable (F/V) intake among school-aged children. It is unknown whether these effects persist into later adolescence or adulthood, and little is known about whether gardening in later adolescence is related to F/V intake.

Objective To identify the relationship between both childhood and recent (within the past 12 months) gardening experiences and current F/V intake among college students.

Design/participants A cross-sectional evaluation of 1,121 college freshmen with sub-optimal F/V consumption from eight US universities.

Main outcome measures Participants completed the National Cancer Institute Fruit and Vegetable Screener and questions about gardening experiences. Respondents were grouped as having gardened or not gardened during childhood and recently.

Statistical analyses performed A linear mixed model was used to evaluate the relationship between childhood and recent gardening and current F/V intake.

Results Of the student participants, 11% reported gardening only during childhood, 19% reported gardening only recently, 20% reported gardening both as a child and recently, and 49% of students reported never having gardened. Students who gardened both during childhood and recently had a significantly higher mean current intake of F/V compared with students who never gardened (2.5 ± 0.6 vs 1.9 ± 0.5 cup equivalents [CE], respectively; $P < 0.001$). In addition, F/V intake increased with frequency of recent gardening engagement when comparing students who did not garden with those who gardened monthly or weekly (2.1 ± 0.5 CE, 2.4 ± 0.6 CE, and 2.8 ± 0.7 CE, respectively; $P < 0.001$).

Conclusions This analysis suggests that the combination of childhood and recent gardening experience is associated with greater current F/V intake among first-year college students not currently meeting national F/V recommendations. In addition, a greater frequency of gardening experience may further enhance this effect.

J Acad Nutr Diet. 2018;118:275-283.

GARDENING INITIATIVES HAVE AGAIN GAINED momentum in the United States over the past 2 decades. Historically, active gardening programs have been used to address economic crises related to war, promote sustainable and environmentally friendly farming practices, and encourage active learning in school curricula.¹ More recently, gardening initiatives have gained popularity as a way to encourage positive dietary behaviors, specifically increased fruit and vegetable (F/V) consumption.² More than 25% of US public elementary schools report having a garden

The Continuing Professional Education (CPE) quiz for this article is available for free to Academy members through the MyCDRGo app (available for iOS and Android devices) and through www.jandonline.org (click on "CPE" in the menu and then "Academy Journal CPE Articles"). Log in with your Academy of Nutrition and Dietetics or Commission on Dietetic Registration username and password, click "Journal Article Quiz" on the next page, then click the "Additional Journal CPE quizzes" button to view a list of available quizzes. Non-members may take CPE quizzes by sending a request to journal@eatright.org. There is a fee of \$45 per quiz (includes quiz and copy of article) for non-member Journal CPE. CPE quizzes are valid for 1 year after the issue date in which the articles are published.

on campus³ and 35% of households in America grow food at home or in a community garden.⁴

Current literature suggests, with mixed results, that gardening interventions increase F/V intake among school-aged participants during or immediately after the intervention period.^{5,6} However, the long-term influence of actively growing F/V on F/V consumption is unknown. Eating a diet rich in F/V is important for health and is associated with reduced risk for several chronic diseases, including hypertension, cardiovascular disease, and cancer.⁷⁻¹⁰ A recent meta-analysis of 95 peer-reviewed publications concluded that an estimated 5.6 million premature deaths annually could be attributed to low F/V intake (<3 cup equivalents [CE]).¹¹

Despite the accumulation of evidence on the benefits of adequate F/V intake, fewer than half of children and adolescents aged 4 to 18 years consume the recommended five or more CE of F/V per day.¹² Because dietary habits developed in childhood tend to persist well into adulthood,¹³ interventions that establish greater F/V consumption among children and adolescents may have promising long-term health benefits.

Gardening programs in schools and communities have successfully promoted F/V intake among participants in the short-term follow-up range of 6 months to 1 year after program implementation.^{5,14-18} School gardening programs often combine lessons in nutrition with opportunities for students to work in a garden. Studies examining the short-term effects of school gardening programs have found gardening experiences increase both nutrition knowledge and vegetable preferences.¹⁴⁻¹⁸ Community gardens have helped families in both rural and urban settings acutely increase their F/V intake.¹⁹⁻²¹ Participation in community gardening once a week can significantly increase F/V intake for adults and children, even when only one member of a household participates.²⁰⁻²²

Some college students participate in university gardening programs, although much less is known about the relationship between gardening and eating behaviors in this population. Of the few studies that have looked at gardening among college students, it was found that many gardening programs focus on emotional and mental health benefits rather than nutrition education or improved nutrition habits.^{23,24} A literature search resulted in only one publication comparing F/V intake between college students who gardened and those who did not. This study enrolled 18 participants from a small southern college and provided gardening plots for each participant. Researchers conducted follow-up interviews after students had been gardening for 3 months and found that students enjoyed gardening as a means of obtaining fresh produce, but identified emotional benefits, like stress relief and relaxation, as the primary benefits of participation.²⁵ Students who participated in gardening in this study did not have a higher F/V intake as a result of gardening, which investigators attributed to the substitution of store-bought produce with the freshly grown produce.²⁵ A large-scale, quantitative study is necessary to fill gaps in understanding the relationship between gardening and F/V intake among college students.

College students and other young adults face specific challenges as they transition from being cared for to caring for themselves. This transition period can have significant effects on health and health behaviors.²⁶⁻²⁸ College students

RESEARCH SNAPSHOT

Research Question: Is there an association between having gardening experiences in childhood and later adolescence and higher fruit and vegetable intake among first-year college students?

Key Findings: In this cross-sectional cohort of 1,121 college freshmen with suboptimal fruit and vegetable intake from eight US universities, those who gardened both during childhood and recently had a significantly higher current mean daily intake of fruit and vegetables compared with students who never gardened (2.5 ± 0.6 vs 1.9 ± 0.5 cup equivalents, respectively; $P < 0.001$). In addition, fruit and vegetable intake increased with frequency of recent gardening engagement when comparing students who did not garden with those who gardened monthly ($P < 0.001$) or weekly ($P < 0.001$).

may gain unwanted weight over the course of their academic experience, with the most rapid weight gain usually occurring during their first year.^{26,27,29} Weight gain during the collegiate years is often associated with increased consumption of convenience and readily available food²⁶ that is typically energy-dense and nutrient-poor.³⁰ In addition, a decrease in physical activity and an increase in sedentary behaviors can contribute to weight gain among college students.^{31,32} Therefore, identification of effective strategies for countering this decline in diet quality and physical activity is needed.

Gardening initiatives among children appear to hold promise for increasing F/V intake, but it is unclear whether similar initiatives may be successful for older adolescents and college students. Furthermore, the vast majority of previous studies involving children have short follow-up periods: typically within 1 year post-intervention. Therefore, there is a lack of information regarding long-term implications of gardening interventions. The primary objective of this study is to examine the long-term influence of childhood gardening as well as the influence of recent gardening experiences (within the past 12 months) on current F/V intake among a diverse sample of first-year college students not currently consuming the recommended 5 CE/day of F/V.

MATERIALS AND METHODS

Study Overview

Data for this cross-sectional evaluation of gardening experiences and F/V intake were collected as a substudy of the Get your Fruits and Vegetables (GetFRUVED) project, a US Department of Agriculture-funded multi-institutional study with the goal of promoting health behaviors and preventing excess weight gain among college freshmen. This analysis includes data obtained at baseline from eight different US universities. Data collection occurred during the fall 2015 academic semester on each university campus. All study procedures were approved by the institutional review boards of each participating university, and written informed consent was obtained from all participants before completing the questionnaire and assessment procedures. This study was

registered at Clinicaltrials.gov with the identifier code NCT02941497.

Participant Recruitment and Enrollment

Recruitment of freshmen participants began in late summer 2015 and extended into early fall. Researchers employed a variety of recruitment strategies to reach incoming freshmen. These strategies included sending E-mail messages to newly enrolled freshmen, posting flyers on campuses, manning tables at orientation events, and advertising through various listservs. Interested freshmen were invited to take a short survey to determine eligibility. In addition to being enrolled as a first-year student at one of the eight participating institutions and being aged 18 years or older, eligibility criteria included consuming <2 CE of fruits or <3 CE of vegetables daily, on average.

Investigators opted to include one other criterion demonstrated in the literature to increase risk for poor health behavior habits and/or lifetime obesity risk for the purpose of targeting students that may benefit most from participation. This additional criterion included any one of the following: have a body mass index (BMI) ≥ 25 , be a first-generation college student, have a parent who is overweight or obese, be of a low-income background, or identify as a racial minority. These eligibility criteria were established in accordance with the objectives of the GetFRUVED study, a project designed to improve F/V intake and other health behaviors of college freshmen. As such, the sample used in the present investigation was limited to those who investigators believed could benefit most from the support of the larger project.

Measures

Assessments were held during the fall 2015 semester onsite at each campus. Visits were held in areas typically used for human research within each university department, such as a clinical nutrition laboratory equipped with research-grade equipment, including a body weight scale and stadiometer. Researchers trained in data collection procedures assisted with assessments of all freshmen participants. After providing consent, participants completed anthropometric measurements and lifestyle and health-related questionnaires that were delivered through a secure web-based format on a project laptop or tablet computer. Questionnaires relevant to this investigation included a set of questions about gardening experience, a survey of F/V intake, and some general demographic questions. All questions included a response option of "Choose not to answer."

Gardening Experience

Childhood and recent gardening experience was assessed with a series of four questions about participants' active involvement growing F/V. These questions were developed by investigators and reviewed and modified by experts for content and clarity and then underwent evaluation before data collection.

To assess childhood gardening experience, participants were asked: "Growing up, did you ever participate in growing vegetables/fruits on a small or large scale (can include pots on the porch, in-ground garden, community garden, etc.?)" and could answer "Yes" or "No." If the respondent selected "Yes,"

they were asked to identify the setting(s) where the gardening experience occurred from the following options: "Home," "4H Club," "Church," "Community Garden," or "Other." Participants were then asked how often they had engaged in gardening activities during the previous 12 months, which we define as "recent gardening" for the purposes of this investigation, and were presented with 5 response options that included "Never," "One day per month," "2 to 3 days per month," "One day per week," and "Daily." Those who selected any level of involvement (ie, choosing an answer other than "Never") in recent gardening were asked to identify setting(s) in which this occurred. For the purposes of this investigation, gardening in the previous 12 months was defined as "recent" gardening, and for this population captured gardening experiences during the year before participants enrolled at a university. To evaluate the relationship between gardening experience and current F/V intake, participants were grouped into one of four gardening experience categories: students who gardened during childhood only, students who gardened recently only, students who gardened both during childhood and recently, and students with no gardening experience (never gardened as a child or recently).

F/V Intake

To determine daily F/V intake, participants completed the National Cancer Institute's (NCI) Fruit and Vegetable Screener.^{33,34} The NCI Fruit and Vegetable Screener is a 19-item survey that asks survey respondents to reflect on F/V intake during the past 30 days. The survey assesses both frequency and amount of F/V (either cooked or raw and in any setting) consumed. Response options for servings were listed in cups and converted to CE for analysis according to provided instructions. The NCI Fruit and Vegetable Screener has been validated by comparing responses from the screener to data collected from 24-hour recalls and other food frequency questionnaires.³³

Control Variable Measures

Anthropometry. Height and weight were measured to calculate participants' BMI, which served as a covariate for analyses. Each measurement was taken by trained research assistants who had undergone interrater reliability testing before data collection. Measurements were obtained following a standardized protocol with equipment that was calibrated daily at each site. Weight and height were taken with shoes and heavy clothing removed. Weight was measured to the nearest 0.1 kg using a digital scale and height was measured to the nearest 0.1 cm using a portable or wall-mounted stadiometer. Height and weight measurements were repeated two times, and measurements within a prespecified margin of error (ie, 0.2 kg difference for weight and 0.2 cm difference for height) were averaged. A third measurement was taken when the difference between the first two measurements was above the criteria.

Demographic Characteristics. The web-based survey asked students to select the university at which they were enrolled, to select the sex they were assigned at birth, current age, race and ethnicity with the option to select all that apply, and most recent grade point average (GPA). GPA response options included 0.5-point range options from <2.0 to 3.5 to 4.0.

Data Analysis

All data were analyzed using SAS version 9.14 statistical software.³⁵ Descriptive statistics were used to characterize the study participants. Cohen's κ for yes/no gardening responses and weighted κ scores for ordinal variables were calculated to assess test–retest reliability of gardening survey questions with a separate group of undergraduate students before data collection. A linear mixed model was conducted to understand the relationship between childhood and/or recent gardening experience and current F/V intake. F/V intake was analyzed on the log scale to meet the assumption of the model. Race/ethnicity, sex, BMI, and GPA were included as control variables in each analysis and university was treated as random effect as each of these was shown to influence the relationship between gardening experience and F/V intake. Level of statistical significance was set at $P < 0.05$.

RESULTS

Participant Eligibility and Sample Size

A total of 5,426 eligibility surveys were completed from all eight universities combined. Of these 5,426 students, 15% were excluded for reporting either age younger than 18 years or not being a first-year student. Most students (87%) met the eligibility criteria of consuming < 2 CE/day of fruit or < 3 CE/day of vegetables.

Seventy-six percent of these students met at least one other eligibility characteristic stipulated in the last criterion. A total

of 2,757 freshmen were eligible based on survey results and subsequently invited to officially enroll in the study and complete an onsite assessment. Across the eight campuses, 1,150 (42%) of eligible participants attended an assessment (see Figure 1). A few participants from each university failed to fully complete the survey once started or selected the response option of “Choose not to answer,” leaving data from 1,121 (97%) participants for this investigation.

Participant Characteristics

Participant characteristics are shown in the Table. The majority of study participants were women (66.1%) and white (53.6%). With respect to ethnicity, 18.9% of respondents self-identified as Hispanic or Latino. The mean BMI of all participants was 24.4 ± 4.9 and 79% reported a grade point average above 3.0. The proportion of students from each of the eight participating universities ranged from 6.0% from South Dakota to 26.6% from Florida.

Among the 1,121 first-year students, 11.4% of students reported only gardening as a child, 19.2% reported only gardening recently, 20.4% reported gardening both as a child and recently, and 49.0% reported no form of gardening experience. Reported F/V intake ranged from 0.8 to 21.4 CE/day with an average of 2.5 ± 2.2 CE/day.

Test–Retest of Gardening Questions

To establish the test–retest reliability, a separate cohort of college students from one university ($n = 78$, 86% women)

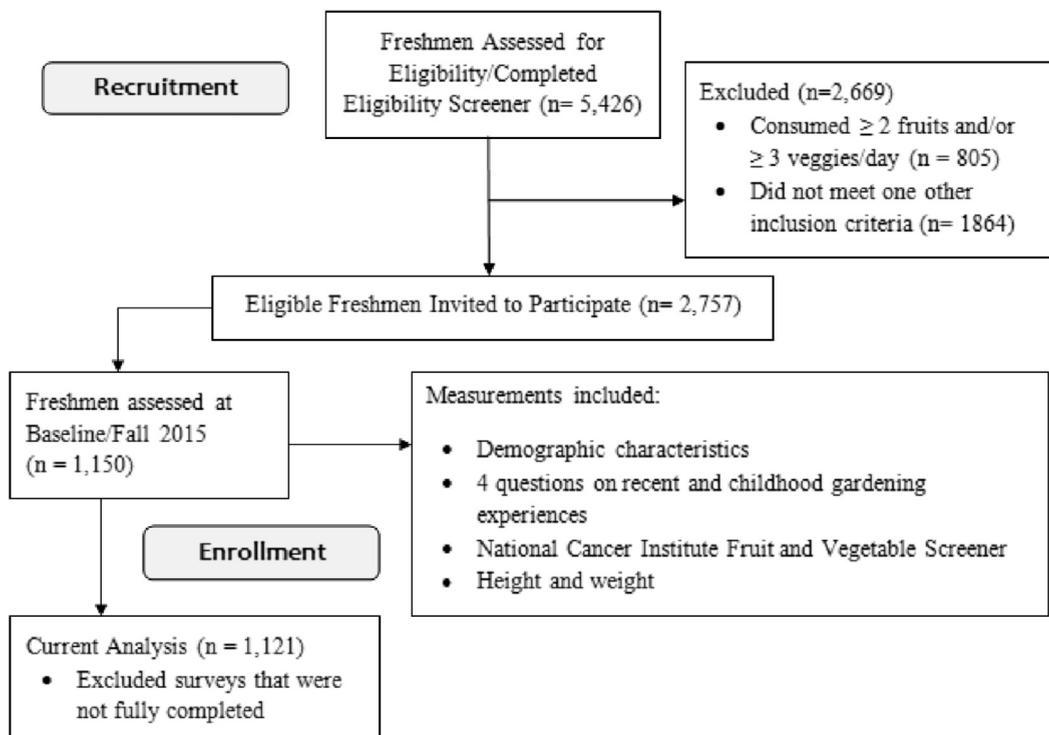


Figure 1. Overview of recruitment, enrollment, and data collection. During summer and early fall of 2015, students from the eight participating universities were informed of the study and invited to take a brief screening survey related to their demographics and health behaviors. Eligible students were subsequently invited to officially enroll in the study by attending an in-person assessment in the fall of 2015. After providing informed consent, participants completed survey questions related to their demographics, gardening experiences, and fruit and vegetable intake, as well as several anthropometric measurements.

Table. Sociodemographic characteristics and gardening experience of 1,121 college freshmen participants who completed survey measures related to demographics, gardening experience, and fruit and vegetable intake

Factor	Total n	Percent of sample	Childhood Gardening Only	Recent Gardening ^a Oy	Childhood and Recent Gardening	Never Gardened
←————— n (%) —————→						
Gender assigned at birth						
Male	375	33.45	42 (11.20)	78 (20.80)	73 (19.47)	182 (48.53)
Female	741	66.10	84 (11.34)	136 (18.35)	155 (20.92)	366 (49.39)
Choose not to answer	5	0.45	2 (40.00)	1 (20.00)	1 (20.00)	1 (20.00)
Ethnicity						
Hispanic or Latino	202	18.02	15 (7.43)	35 (17.33)	33 (16.34)	119 (58.91)
Not Hispanic or Latino	909	81.09	110 (12.10)	179 (19.69)	195 (21.45)	425 (46.75)
Choose not to answer/do not know	10	0.90	3 (30.00)	1 (10.00)	1 (10.00)	5 (50.00)
Race						
Black only	117	10.41	17 (14.53)	17 (14.53)	12 (10.26)	71 (60.68)
White only	602	53.56	70 (11.63)	126 (20.93)	155 (25.75)	251 (41.69)
Other/biracial	405	36.03	41 (10.12)	74 (18.27)	62 (15.31)	228 (56.30)
Location of university attended						
Alabama	73	6.51	5 (6.85)	16 (21.92)	5 (6.85)	47 (64.38)
Florida	298	26.58	38 (12.75)	42 (14.09)	34 (11.41)	184 (61.74)
Kansas	110	9.81	9 (8.18)	22 (20.00)	35 (31.82)	44 (40.00)
Maine	161	14.36	16 (9.94)	36 (22.36)	54 (33.54)	55 (34.16)
New York	152	13.56	18 (11.84)	29 (19.08)	27 (17.76)	78 (51.32)
South Dakota	67	5.98	7 (10.45)	18 (26.87)	25 (37.31)	17 (25.37)
Tennessee	165	14.72	20 (12.12)	28 (16.97)	32 (19.39)	85 (51.52)
West Virginia	92	8.21	14 (15.22)	24 (26.09)	16 (17.39)	38 (41.30)
Choose not to answer	3	0.27	1 (33.33)	0 (0.00)	1 (33.33)	1 (33.33)

^aRecent gardening refers to gardening within the past 12 months.

completed the questions at two time points. The time gap between test and retest time points was 19.6 ± 7.7 days (median=19). Scores for the two questions used to assess prevalence and frequency of childhood and recent gardening experiences, independent variables of the primary analysis, both achieved substantial agreement (0.68 and 0.76) based on Landis and Koch criteria. The κ scores for the two additional questions used to describe the settings where gardening experiences occurred, but not used in the current analysis, ranged from weak to near perfect agreement (0.21 to 0.91).

Gardening Experience

The Table also displays gardening experience by pertinent demographic characteristics. Although there were no differences in gardening experience between sexes, there were significant differences by ethnicity ($P=0.001$) and race ($P<0.001$). The prevalence of students with any gardening experience (ie, either in childhood or recently) was 41.1% among Hispanics/Latinos compared with 53.2% among non-Hispanics/Latinos. The variation in prevalence was more

pronounced when analyzed by race, ranging from <40% among black students to nearly 60% among white students. Significant heterogeneity in the prevalence of gardening experience was seen between universities ($P<0.001$). South Dakota and Maine had the highest rates of students reporting gardening experience (74.6% and 66.8%, respectively), whereas Alabama and Florida had the lowest rates (35.6% and 38.3%, respectively).

Participants who indicated they had gardening experience during childhood and/or recently reported the setting(s) in which they gardened. The majority of students who gardened during childhood identified home (62%) as the primary setting of this experience. Students also identified community gardens (10%), church (8%), 4-H clubs (4%), and other organizations (16%) because sites of their childhood gardening experience. Students who recently gardened mostly participated in family gardening (51%). Less common settings included a friend's home (15%), potted garden at their own home/dorm (14%), community gardens off-campus (7%), teaching garden on campus (4%), and other gardens (9%).

F/V Intake

The primary outcome, F/V intake, varied among the four gardening experience groups. Students who gardened both during childhood and recently had a significantly higher intake of F/V compared with students who never gardened (2.5 ± 0.6 CE vs 1.9 ± 0.5 CE, respectively; $P < 0.001$). Students who gardened only during childhood or gardened only recently did not report a significantly different F/V intake than those who never gardened (see Figure 2).

The frequency of recent participation in gardening was also compared with current F/V intake. More than half of students indicated no recent gardening experience (60%), whereas 31% reported gardening on a monthly basis (1 to 3 times per month) and 9% reported gardening weekly (at least once per week). Based on these groupings, gardening frequency was positively associated with F/V intake. Average F/V intake was 2.1 ± 0.5 CE among those reporting no participation in recent gardening, 2.4 ± 0.6 CE among those reporting monthly participation and 2.8 ± 0.7 CE among those reporting weekly participation (see Figure 2). Differences in F/V intake were significantly higher in the monthly ($P < 0.001$) and weekly ($P < 0.001$) gardening groups compared with students who had not gardened recently.

DISCUSSION

This study presents findings for four categories of gardening experience as well as three categories of gardening frequency in relation to current F/V intake among a subset of college students. For gardening experience, our results show that average F/V intake among students with both childhood and recent gardening experience was significantly higher compared with students with no gardening experience. The F/V intake among participants who reported gardening as a child only or gardening recently only compared with those who never gardened was not significantly different. When looking more closely at recent gardening experiences, F/V intake increased across each level of frequency of participation. Students gardening weekly had the highest F/V intake, followed by students who gardened monthly. Both of these groups had a significantly higher F/V intake than students with no recent gardening experience. Although the difference in F/V intake between monthly and weekly gardeners (0.4 CE)

may have practical significance, no statistical difference was found. Future projects should explore this potential relationship between gardening frequency and F/V intake.

These results suggest that, whereas gardening experience is associated with adolescent F/V consumption, it is the pattern of experience over time, and possibly the frequency of engagement, that dictates the magnitude of this potential influence. More specifically, it appears that gardening experience may be needed at multiple time points and at a sufficient frequency to render a significant effect on F/V intake. This concept may explain the mixed results seen in the literature regarding the influence of gardening on youth and adolescent F/V intake^{5,6} because nearly all studies have been limited to gardening over a single time point, especially following a gardening intervention. Likewise, the need for multiple exposures over time, or lack of a sustained gardening experience throughout the life course, may explain why the results in our study show higher F/V consumption among students who gardened either during childhood only or recently only (compared with never gardeners), but failed to reach significance. These results are in contrast to those of Mecham and colleagues,²⁵ who did not find a relationship between gardening and F/V intake among college students. This difference in findings may be explained by the larger sample size and quantitative nature of our study compared with the study conducted by Mecham and colleagues.²⁵

The findings related to frequency of gardening and F/V intake provide further support for the importance of regular gardening for influencing F/V consumption. Based on these observations, it appears that gardening may render a dose-dependent effect on F/V consumption in terms of both patterns of exposure (ie, occurring over multiple time points) and frequency. We were unable to detect differences in F/V intake among students who gardened weekly vs monthly, although average intake in the weekly group was 0.4 CE/day higher than that of the monthly group. Although not statistically different, future gardening studies should consider a more detailed data collection strategy that provides additional frequency response options to investigate the relationship between gardening frequency and F/V intake.

Taken together, these results support gardening as a potential strategy for increasing F/V intake among college-aged

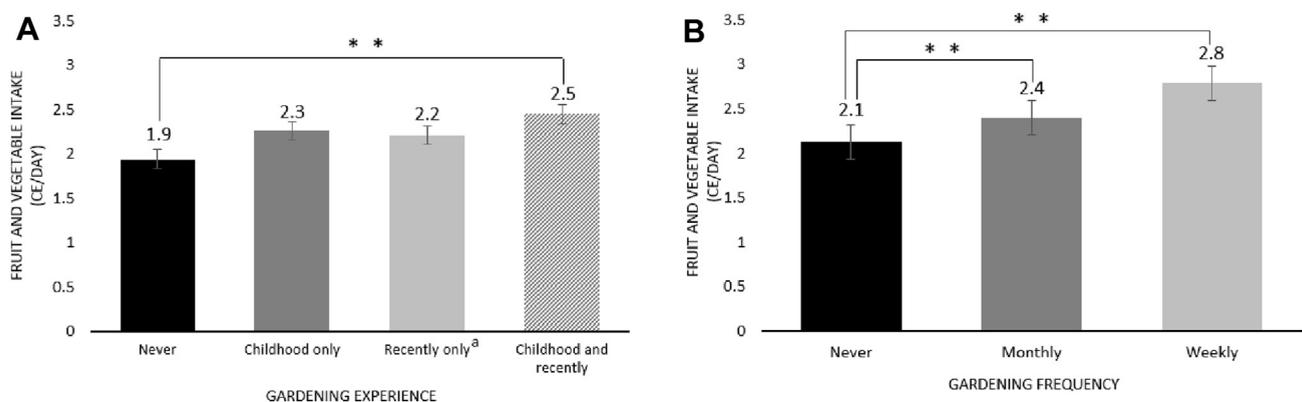


Figure 2. Fruit and vegetable intake by gardening experience (2a) and by frequency of gardening in the past 12 months (2b), $n=1,121$. Fruit and vegetable intake displayed are the back transformed least square mean \pm standard error. University attended, race, sex, body mass index, and grade point average included as covariates. ^aRecent gardening experience was defined as gardening within the past 12 months. ****** $P < 0.001$.

students, particularly when gardening is a sustained behavior and enacted with regular frequency. School- and community-based gardening initiatives offer opportunities for gardening across the lifespan and may be particularly effective in increasing F/V intake. Policy makers should consider promoting recurrent accessibility to gardening from elementary school through high school, and colleges and universities should seek to extend this by developing gardening programs within the institution—perhaps through the school's wellness program, gardening, or other hands-on agricultural classes—or by providing space and support for gardening near residence halls or other convenient campus areas.

Universities could also promote gardening and gardening service opportunities within the local community. Based on our results, nearly half of students enter college without any type of gardening experience, highlighting the need for such initiatives. Efforts focused on increasing gardening accessibility among Hispanic/Latino and black populations may be particularly valuable given that gardening experience was significantly less prevalent among these students. When interpreting these findings, it is important to consider that our study sample was restricted to those not meeting national recommendations for F/V. Although this may be viewed as a limitation, the vast majority (87%) of students met this criterion. This is consistent with national figures for adolescent F/V intake, which estimate 80% to 90% of adolescents do not meet the recommend intake.³⁶ With such a small minority of adolescents meeting F/V recommendations, it could be argued that the sample in this study was more suitable for identifying an association between the outcomes of interest. By limiting the sample to those not meeting recommendations, we not only focused on those who could most benefit from the potential influence of gardening, but mitigated the presence of extraneous factors that could confound the association of interest.

Another important consideration is that recent gardening experience for this study's population does not necessarily refer to gardening while in college. Although participants were college students, recent gardening experience was defined as "within the past 12 months." Because data collection occurred during the fall semester, this 12-month timeframe primarily encompasses the period during which the student was not yet in college. Nevertheless, the results show the potential for recent and frequent gardening experience to optimize the effect on F/V intake and, for a population of college students, a college-based gardening initiative would be a logical extension of these findings.

This investigation has several limitations. Most notably, the cross-sectional and retrospective nature of the study limits the ability to suggest a causal relationship with respect to our findings. Without a controlled intervention, it is difficult to isolate the effect of gardening on F/V intake, because students with a predisposition to engage in gardening may inherently be more health conscious. Therefore, applying these findings to support gardening interventions must be done with caution. Furthermore, the study sample was limited to freshmen students with sub-optimal F/V intake and at least one other characteristic believed to be related to increased risk for obesity. Therefore, one must use caution in extending these results to college students in general. Although mean F/V intake of participants in this sample was similar to the national average for this age

group, the exclusion of those meeting F/V recommendations limits the interpretation of the prevalence of gardening experience in this population. If F/V consumption is positively influenced by childhood and recent gardening experience as suggested by these findings, then students with gardening experience were presumably underrepresented in this sample. Future investigations without this limitation of higher FV intake may present a more accurate snapshot of the prevalence of childhood and recent gardening experience among this population. In addition, this investigation did not attempt to assess frequency of gardening during childhood because it was determined during the planning stages that recall would be unreliable. Long-term prospective studies are needed to address this potentially important variable.

This study also has several strengths. The observational design permitted the inclusion of all types of gardening experience, including past gardening (ie, family, community, and school), rather than a single prescribed intervention. Furthermore, this study allowed us to examine the importance of patterns of exposure over time and, to our knowledge, is the only study that addresses both childhood and adolescent experience to examine associations between childhood and recent gardening experiences and current F/V intake. In addition, as opposed to intervention studies, there was a low risk of bias because researchers did not know which students had gardening experience during the data collection process. Finally, the large sample size (N=1,121) of students from eight geographically and demographically diverse institutions enabled us to provide an accurate representation of the population of interest.

Future observational research in this area should seek to incorporate a sample of college students representative of their respective institutions regarding year in school, age, race and ethnicity. Future studies should also quantify and individually assess the frequency and duration of all gardening experiences, as well as the setting and time points at which they occurred in each participant's life, to understand how gardening experiences can have the greatest influence on F/V intake. Studies utilizing a controlled intervention, or ideally a series of interventions, would be a valuable extension of our work. The GetFRUVED study can extend this work by following college freshmen and their gardening practices throughout college.

CONCLUSIONS

Gardening experience is positively associated with F/V intake in terms of both history of experience (childhood and recent experience compared with no experience) and frequency of engagement (monthly and weekly engagement compared with no recent engagement) among this subset of first-year college students. Although we did not observe a dose-dependent relationship between weekly and monthly gardening and F/V intake, the data suggest this warrants further investigation. The intensity of engagement in gardening activities may potentiate this effect, and future studies should examine this more closely among students who report gardening regularly at different frequencies. School- and community-based wellness initiatives should strive to increase youths' and adolescents' exposure to gardening to promote positive health changes. Likewise,

colleges and universities should seek to extend these efforts by promoting gardening opportunities as a strategy for establishing and maintaining healthy eating habits during the transition from adolescence to adulthood.

References

1. Kurtz H. Differentiating multiple meanings of garden and community. *Urban Geogr.* 2013;22(7):656-670.
2. Corrigan MP. *Growing What You Eat: Developing Community Gardens and Improving Food Security* [dissertation]. Athens, OH: Ohio University; 2010.
3. Turner L, Sandoval A, Chaloupka FJ. *School Garden Programs Are on the Rise in US Public Elementary Schools, but Are Less Common in Schools with Economically Disadvantaged Student Populations - A BTG Research Brief*. Chicago, IL: Bridging the Gap Program, Health Policy Center, Institute for Health Research and Policy, University of Illinois at Chicago; 2014.
4. Food gardening in the U.S. at the highest levels in more than a decade according to New Report by the National Gardening Association [news release]. http://garden.org/about/press/press.php?q=show&id=3819&pr=pr_nga.
5. Savoie-Roskos M, Wengreen H, Durward C. Increasing fruit and vegetable intake among children and youth through gardening-based interventions: A systematic review. *J Acad Nutr Diet.* 2017;117(2):240-250.
6. Evans C, Christian M, Cleghorn C, et al. Systematic review and meta-analysis of school-based interventions to improve daily fruit and vegetable intake in children aged 5 to 12 y. *Am J Clin Nutr.* 2012;96(4):889-901.
7. Boeing H, Bechthold A, Bub A, et al. Critical review: Vegetables and fruit in the prevention of chronic diseases. *Eur J Nutr.* 2012;51(6):637-663.
8. Hjartaker A, Knudsen M, Tretli S, et al. Consumption of berries, fruits and vegetables and mortality among 10,000 Norwegian men followed for four decades. *Eur J Nutr.* 2015;54(4):599-608.
9. Reiss R, Johnston J, Tucker K, et al. Estimation of cancer risks and benefits associated with a potential increased consumption of fruits and vegetables. *Food Chem Toxicol.* 2012;50(12):4421-4427.
10. Micha R, Penalvo JL, Cudhea F, et al. Association between dietary factors and mortality from heart disease, stroke, and type 2 diabetes in the United States. *JAMA.* 2017;317(9):912-924.
11. Aune D, Giovannucci E, Boffetta P, et al. Fruit and vegetable intake and the risk of cardiovascular disease, total cancer and all-cause mortality – A systematic review and dose response meta-analysis of prospective studies. *Int J Epidemiol.* 2017;1-28.
12. Robinson-O'Brien R, Story M, Heim S. Impact of garden-based youth nutrition intervention programs: A review. *J Am Diet Assoc.* 2009;109(2):273-280.
13. Larson NI, Neumark-Sztainer D, Hannan PJ, et al. Family meals during adolescence are associated with higher diet quality and healthful meal patterns during young adulthood. *J Am Diet Assoc.* 2007;107(9):1502-1510.
14. Hermann J, Parker S, Brown B, et al. After-school gardening improves children's reported vegetable intake and physical activity. *J Nutr Educ Behav.* 2006;38(3):201-202.
15. Morris J, Zidenberg S. Garden-enhanced nutrition curriculum improves fourth-grade school children's knowledge of nutrition and preferences for some vegetables. *J Acad Nutr Diet.* 2002;102(1):91-93.
16. Davis J, Spaniol M, Somerset S. Sustenance and sustainability: Maximizing the impact of school gardens on health outcomes. *Public Health Nutr.* 2015;18(13):2358-2367.
17. Gibbs L, Staiger P, Johnson B, et al. Expanding children's food experiences: The impact of a school-based kitchen garden program. *J Nutr Educ Behav.* 2013;45(2):137-146.
18. Ratcliffe M, Merrigan K, Rogers B, et al. The effects of school garden experiences on middle school-aged students' knowledge, attitudes, and behaviors associated with vegetable consumption. *Health Promot Pract.* 2011;12(1):36-43.
19. Litt J, Soobader M, Turbin M, et al. The influence of social involvement, neighborhood aesthetics, and community garden participation on fruit and vegetable consumption. *Am J Public Health.* 2011;101(8):1466-1473.
20. Barnidge E, Hipp P, Estlund A, et al. Association between community garden participation and fruit and vegetable consumption in rural Missouri. *Int J Behav Nutr Phys.* 2013;10(1):128-135.
21. Alaimo K, Packnett E, Miles R, et al. Fruit and vegetable intake among urban community gardeners. *J Nutr Educ Behav.* 2008;40(2):94-101.
22. Carney P, Hamada J, Rdesinski R, et al. Impact of a community gardening project on vegetable intake, food security and family relationships: A community-based participatory research study. *J Commun Health.* 2012;37(4):874.
23. Hoffman J, Thompson D, Cruz A. Gardening, self-efficacy and self-esteem. *Community Coll Enterpr.* 2004;10(1):91-101.
24. Hoffman J, Knight L, Wallach J. Gardening activities, education, and self-esteem. *Urban Educ.* 2007;42(5):403-411.
25. Mecham N, Joiner L. Even if we never ate a single bite of it; it would still be worth it: College students' gardening experiences. *J Ethnogr Qual Res.* 2012;6(4):231-242.
26. Finlayson G, Cecil J, Higgs S, et al. Susceptibility to weight gain. Eating behaviour traits and physical activity as predictors of weight gain during the first year of university. *Appetite.* 2012;58(3):1091-1098.
27. Deliens T, Clarys P, Van Hecke L, et al. Changes in weight and body composition during the first semester at university. A prospective explanatory study. *Appetite.* 2013;65:111-116.
28. Hebden L, Chan H, Louie J, et al. You are what you choose to eat: Factors influencing young adults' food selection behaviour. *J Hum Nutr Diet.* 2015;28(4):401-408.
29. Nelson M, Story M, Larson N, et al. Emerging adulthood and college-aged youth: An overlooked age for weight-related behavior change. *J Obes.* 2008;16:2205-2211.
30. Laska M, Graham D, Moe S, et al. Young adult eating and food-purchasing patterns: Food store location and residential proximity. *Am J Prev Med.* 2010;39(5):464-467.
31. Deforche B, Van Dyke D, Deliens T, et al. Changes in weight, physical activity, sedentary behavior and dietary intake during the transition to higher education: A prospective study. *Int J Behav Nutr Phys.* 2015;12:16.
32. Nelson M, Kocos R, Lytle L, et al. Understanding the perceived determinants of weight-related behaviors in late adolescence: A qualitative analysis among college youth. *J Nutr Educ Behav.* 2009;41(4):287-292.
33. Thompson F, Subar F, Smith A, et al. Fruit and vegetable assessment: Performance of 2 new short instruments and a food frequency questionnaire. *J Am Diet Assoc.* 2002;102(12):1764-1772.
34. National Cancer Institute. Fruit and vegetable screeners in the Eating at America's Table Study (EATS): Scoring. <http://appliedresearch.cancer.gov/diet/screeners/fruitveg/scoring/>. Accessed March 12, 2017.
35. SAS [computer program]. Version 9.14. Cary, NC: SAS Institute Inc; 2013.
36. US Department of Agriculture, Agricultural Research Service, Beltsville Human Nutrition Research Center, Food Surveys Research Group and US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics (Hyattsville, MD). What We Eat in America, NHANES 2001-2004 and 2007-2010. <https://www.ars.usda.gov/northeast-area/beltsville-md/beltsville-human-nutrition-research-center/food-surveys-research-group/docs/wweianhanes-overview/>. Accessed April 4, 2017.

AUTHOR INFORMATION

J. Loso is a medical student, D. Staub is a doctoral student, M. Vilaro is a postdoctoral associate, J. Colee is a statistician, and A. E. Mathews is an assistant professor, University of Florida, Gainesville. S. E. Colby is an associate professor and W. Zhou is an assistant professor, University of Tennessee, Knoxville. M. D. Olfert is an associate professor, West Virginia University, Morgantown. K. Kattelman is a professor, South Dakota State University, Brookings. L. Franzen-Castle is an associate professor and Extension nutrition specialist, University of Nebraska-Lincoln.

Address correspondence to: Anne E. Mathews, PhD, RDN, University of Florida, PO Box 110370, Gainesville, FL 32611-0370. E-mail: anne.mathews@ufl.edu

STATEMENT OF POTENTIAL CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

FUNDING/SUPPORT

Funding for this work was provided by Agriculture and Food Research Initiative grant no. 2014-67001-21851 from the US Department of Agriculture National Institute of Food and Agriculture.

This study was registered at [Clinicaltrials.gov](https://clinicaltrials.gov) with the identifier code NCT02941497.

ACKNOWLEDGEMENTS

A. E. Mathews, M. D. Olfert, and M. Vilaro worked on the conception of the research design and designed the study tool that was used to collect information about gardening practices. A. E. Mathews, J. Loso, D. Staub, S. E. Colby, M. D. Olfert, K. Kattelman, and M. Vilaro collected data; J. Colee, W. Zhou, and J. Loso led data analysis; J. Loso, D. Staub, and A. E. Mathews wrote the first draft with contributions from S. E. Colby, M. D. Olfert, K. Kattelman, M. Vilaro, J. Colee, W. Zhou, and L. Franzen-Castle. All authors reviewed and commented on subsequent drafts of the manuscript.