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Short Communication

Home gardening and associations with fruit and vegetable intake and BMI

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Abstract

Objective: To understand who engages in home gardening and whether gardening is associated with fruit and vegetable intake and weight status.
Design: A national cross-sectional survey.
Setting: Online survey panel in the USA.
Participants: Adults aged 18–75 years representing the US population with respect to gender, age, race/ethnicity, income and geographic region (*n* 3889).
Results: Approximately 30 % of survey respondents reported growing edible plants in a home garden. Gardeners were more likely to be White or Asian, employed, have higher income, be married, have children in the household and live in rural areas. Gardeners were less likely to be obese and more likely to meet US dietary recommendations for fruit and vegetable consumption. In multivariable analyses, home gardens remained associated with fruit and vegetable intake and BMI when controlling for a range of socio-demographic characteristics and level of rurality.
Conclusions: The current study identifies who is gardening in the USA and provides useful information for public health efforts to increase gardening as a nutrition intervention. Future research should examine the benefits of home gardening and interventions to increase home gardening using more rigorous designs.

Keywords
Garden
Obesity
Fruit and vegetable intake

Home gardens have existed for centuries, but research on them is relatively rare in developed countries[1–3]. The few published studies on home gardening in the USA are pilot studies[4] or mixed methods studies in a single community[1,5,6]. These studies suggest that home gardens may offer a range of benefits similar to those observed in community gardens[1,2,7–9], including increased fruit and vegetable intake[4,5,10], physical activity[4,5], social capital[5,6], food security[5,6,10,11] and connections to cultural heritage[6]. In an evaluation of a home gardening initiative in San Jose, CA, participants reported increased vegetable consumption, gardening-related physical activity, cost savings and new and strengthened connections with neighbours[5]. Bail *et al.*[4] observed increased physical activity in a pilot study of home gardening among cancer survivors and a trend towards increased vegetable consumption. Taylor and Lovell[6] described a mixed methods study of home gardens in Chicago. Qualitative findings suggested that home gardens contributed to household food budgets by reducing the need to purchase vegetables during the growing season and the practice of preserving the harvest through freezing. Sharing of produce was common, and gardening served as a means of continuing cultural practices through food (e.g. growing collards, chillies or bitter melons).

Gray *et al.*[5] discuss how home gardens are emerging as a potential new strategy within the food justice movement due, at least in part, to barriers to community gardens in urban settings, including high property values, long waiting lists for participation and the challenges of time and transportation to community locations for low-income households. Thus, gardening can not only encourage a more

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nutritious diet and increased physical activity but also has the potential to address food access and food security, especially when fresh produce may not be available or accessible due to cost and distance[1,7,10–12].

Studies that have examined the prevalence of home and/or community gardening show a much higher rate of home-based over community gardening among the general population[13]. A study by the National Gardening Association showed that 35 % of households in the USA grew food in 2013[14]. The vast majority of those gardened at home (88·2 %). To our knowledge, no national studies have examined the associations of home gardening with fruit and vegetable intake or BMI. Understanding who has home gardens in the USA and whether gardens are associated with nutrition and weight-related outcomes will help to lay the foundation for future efforts to use home gardens as a potential intervention strategy for obesity prevention.

Methods

Data used for the current analysis are from a cross-sectional, national home food environment survey administered in the fall of 2015 to participants aged 18–75 years, living in the USA and capable of reading English. Quotas were used in order to increase national representativeness in terms of age, gender, race and ethnicity, income and geographic region. Participants were recruited via email through Lightspeed Global Market Insite (GMI), using their existing panellist profile data (http://www.lightspeedresearch.com). Participants provided consent and then started the survey which took approximately 30 min to complete. The study protocol was approved by the Emory University Institutional Review Board.

A total of 4942 individuals completed the survey (39·9 % of those consented); the remainder of panel members who initiated the survey process were deemed ineligible due to quota requirements (30·7 %), only completed part of the survey (24·2 %) or were terminated by Lightspeed GMI due to in-survey quality control checks (5·2 %). The analytic sample for the primary analyses reported here (*n* 3889) additionally excludes those for whom addresses could not be geocoded (*n* 726), those who had invalid fruit and vegetable intake responses (*n* 193) and those with missing values on key study variables (*n* 134).

Measures

Gardening. The presence of a home garden was assessed by asking: 'The next questions are about home gardens: do you (or anyone in your household) grow edible plants in a garden?' with response options 'yes' and 'no'. The presence of edible plants in containers or pots was also assessed.

Neighbourhood type was assessed by asking respondents to indicate whether the area in which they live is rural, a small town, suburban or urban. *Social capital* was assessed at the neighbourhood level using a seven-item measure[15]. A higher score indicates higher social capital.

Rural-Urban Continuum Codes. Geocodes and county names were assigned to each residential address in the data set using the geocode feature in Google Earth Pro©. In cases where an address was not identified using Google Earth Pro©, it was supplemented with Census-identified counties and geocodes using the address locator tool on the Census website[16]. Each observation was assigned a Rural-Urban Continuum Code (RUCC) which is a categorisation scheme that classifies the US counties into three metro and six non-metro categories[17]. RUCC were collapsed into three categories of counties: (i) urban (1–3), (ii) semi-urban (4–6) and (iii) rural (7–9).

Fruit and vegetable intake. Fruit and vegetable consumption was measured using a National Cancer Institute screener that asked about frequency and quantity of consumption of fruits and vegetables (e.g. lettuce salad and tomato sauce)[18,19]. Daily intake in cups was calculated, and values above three times the interquartile range were excluded. The variable was dichotomised for use in regressions as 'Not Meeting Recommendations' (<4·5 cups/d) or 'Meeting Recommendations' (≥4·5 cups/d) based on the Dietary Guidelines for Americans 2015–2020[20].

Weight status. BMI (kg/m^2) was calculated using participant-reported height in feet and inches and weight in pounds, as adapted from the Behavioral Risk Factor Surveillance System[21].

Demographics. Socio-demographic information was collected including age, gender, race/ethnicity, state of residence, employment status, educational attainment, marital status, household size, composition and income[21,22].

Data analysis

Analyses were conducted using SAS software (SAS version 9.4; SAS Institute Inc.). *T* tests and χ^2 tests were used to explore the relationships between participant characteristics and presence of a home garden. Generalised estimating equation (GEE) models were used to control for the effect of clustering at the county level. Generalised estimating equation models assessed associations between (i) demographic variables and presence of a home garden, (ii) presence of a home garden (primary exposure variable) with binary fruit and vegetable intake (meeting/not meeting recommended intake) and (iii) presence of a home garden with continuous BMI. The models were adjusted for gender, age, race, income and level of rurality. As sensitivity analyses, we (i) compared the findings from our analytic sample (which was reduced due to geocoding) and the full sample and (ii) looked at fruit and vegetable intake as a continuous measure both in its raw metric and log transformed for the multivariable models.

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Results

Description of respondents

The average age was 46·3 (SD 15·5) years, with 53·7 % women. African Americans, Hispanics and Asian Americans comprised 12·2, 13·8 and 5·3 % of the sample, respectively, with 68·0 % White (Table 1). Over half had a college degree (51·4 %). Approximately 11·2 % lived on annual household incomes <$15 000 and 22·1 % on ≥$100 000/year. Over half were married (51·0 %) or living with a partner (8·1 %), and 33·8 % had children in the home. Almost three-quarters (73·5 %) lived in urban areas defined by RUCC 1–3. The majority did not meet recommended guidelines for fruit and vegetable consumption (87·6 %). Mean BMI was 27·7 (SD 6·6) kg/m^2, and 30·2 % were obese. Thirty percentage of participants reported a home garden that produced edible plants. Of those with no home garden, 12·7 % grew edible plants in a container.

Associations between demographic characteristics and home gardens

Table 1 presents bivariate associations between those who have a home garden and those who do not. The presence of a home garden varied significantly by all variables examined, with the exception of age. Asian Americans were the most likely to have a garden (39·3 %), followed by Whites (32·3 %), Hispanics (28·4 %) and African Americans (15·0 %). Those with a college degree were slightly more likely to have a garden (31·7 %), as were those who were employed (33·8 %) and with higher annual household incomes. Participants who were married (36·7 %) and had children at home (36·3 %) were also more likely to have a garden.

Rurality was associated with home gardens; 36·0 % of residents within counties with a RUCC of 7–9 reported a garden in contrast to 28·5 % in urban counties (RUCC of 1–3). Similar patterns were observed for self-described neighbourhood types; 45·2 % of respondents in a rural area reported a garden in contrast to 24·3 % in urban areas. Social capital was significantly higher among those with a home garden ($P < 0·0001$). Those with a home garden were more likely to meet fruit and vegetable intake guidelines ($P < 0·0001$) and had lower BMI (26·9 *v.* 28·1, $P < 0·0001$).

In the multivariable model (Table 2), results show that several bivariate associations remained significant. Specifically, African Americans are less likely to have a home garden than Whites (OR 0·44, 95 % CI 0·34, 0·56), and Asian Americans are more likely to have a home garden than Whites (OR 1·40, 95 % CI 1·003, 1·95). Households with higher annual incomes are more likely to have a home garden than those with an annual household income <$15 000. Those with an income >$74 99 were more than twice as likely to have a home garden than those in the lowest income category. Residents of semi-urban counties and rural counties are more likely to have a home garden than urban residents (OR 1·38, 95 % CI 1·10, 1·72 and OR 1·52, 95 % CI 1·18, 1·96, respectively). Sensitivity analyses showed that the findings did not differ qualitatively (i.e. the same significant relationships remained) when including participants whose addresses could not be geocoded in the analyses see online supplementary material, Supplemental Table 1), except for age where the difference between the groups (i.e. with and without a home garden) was larger in the full sample and reached significance.

Multivariate models of fruit and vegetable intake and BMI

The second multivariable model examines associations of home gardens with fruit and vegetable intake. When controlling for demographics and rurality, home gardens are associated with more than twice the odds of meeting national guidelines for fruit and vegetable intake (OR 2·08, 95 % CI 1·69, 2·55). The significance and directionality of effects did not differ for fruit and vegetable intake when modelling it as a continuous variable in its raw metric or log transformed (see online supplementary material, Supplemental Table 2). Home gardens remained a significant predictor in both models.

The third multivariable model examines associations of home gardens with BMI. When controlling for demographics and rurality, BMI is significantly associated with home gardening in the expected direction ($b = –0·94$, 95 % CI –1·36, –0·52), indicating a lower BMI among those with a home garden.

Discussion

We found that 30 % of respondents in our study had a home garden. This is almost the same as the National Gardening Association finding that 30·8 % of US households garden at home[14]. In our study, home gardens were more common among individuals living in rural areas, as well as among those who had children in the home, were employed, had higher annual household incomes and had greater educational attainment. That said, one-quarter of participants with lower incomes and/or no employment reported a home garden, suggesting that gardening is feasible for low-income households. Results from the National Gardening Association survey corroborated our findings that income was associated with gardening; importantly for public health, they also documented growth in gardening among low-income residents from 2008 to 2013[14]. Higher rates of gardening in rural areas may be due to family traditions and culture, distance to towns with supermarkets and farmers markets and readily available land. Urban living may be less conducive to home gardening due to lack of space, costs associated with raised beds or concerns about prior uses of the land and possible soil contamination[23].

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Table 1 Description of survey respondents by home garden status

	All participants		Have home garden		Do not have home garden		
	n	%	*n*	%	*n*	%	*P*
Sample size	3889		1167	30	2722	70	
Age							
Mean	46·3		46·0		46·5		0·4335
SD	15·5		14·8		15·7		
Gender							
Male	1801	46·3	569	31·6	1232	68·4	0·0451
Female	2088	53·7	598	28·6	1490	71·4	
Race							
White	2643	68·0	855	32·3	1788	67·7	<0·0001
African American/Black	474	12·2	71	15·0	403	85·0	
Hispanic	538	13·8	153	28·4	385	71·6	
Asian	206	5·3	81	39·3	125	60·7	
Other	28	0·7	7	25·0	21	75·0	
Education							
High school, General Education Diploma or less	666	17·1	202	30·3	464	69·7	0·0189
Some college or technical school	1224	31·5	331	27·0	893	73·0	
College degree or more	1999	51·4	634	31·7	1365	68·3	
Employment							
Employed for wages	1866	48·0	630	33·8	1236	66·2	<0·0001
Self-employed	267	6·9	83	31·1	184	68·9	
Out of work	338	8·7	79	23·4	259	76·6	
Homemaker	389	10·0	111	28·5	278	71·5	
Student	218	5·6	51	23·4	167	76·6	
Retired	811	20·9	213	26·3	598	73·7	
Income							
<$15 000	437	11·2	85	19·5	352	80·5	<0·0001
$15 000–24 999	441	11·3	109	24·7	332	75·3	
$25 000–34 999	387	10·0	86	22·2	301	77·8	
$35 000–49 999	528	13·6	151	28·6	377	71·4	
$50 000–74 999	740	19·0	228	30·8	512	69·2	
$75 000–99 999	497	12·8	190	38·2	307	61·8	
≥$100 000	859	22·1	318	37·0	541	63·0	
Marital status							
Married	1985	51·0	728	36·7	1257	63·3	<0·0001
Living with partner	314	8·1	77	24·5	237	75·5	
Single	1050	27·0	251	23·9	799	76·1	
Previously married	540	13·9	111	20·6	429	79·4	
Children							
No	2576	66·2	690	26·8	1886	73·2	<0·0001
Yes	1313	33·8	477	36·3	836	63·7	
Type of neighbourhood							
Rural	516	13·3	233	45·2	283	54·8	<0·0001
Small town	599	15·4	174	29·0	425	71·0	
Suburban	1721	44·3	504	29·3	1217	70·7	
Urban	1053	27·1	256	24·3	797	75·7	
Rural urban continuum codes							
Rural (7–9)	445	11·4	160	36·0	285	64·0	0·0015
Semi-urban (4–6)	586	15·1	193	32·9	393	67·1	
Urban (1–3)	2858	73·5	814	28·5	2044	71·5	
Social capital score							
Social capital							<0·0001
Mean	3·2		3·4		3·1		
SD	0·8		0·8		0·8		
Container gardening							
No	2941	75·6	565	19·2	2376	80·8	<0·0001
Yes	948	24·4	602	63·5	346	36·5	
Fruit and vegetable intake							
Not meeting recommendations (<4·5 cups/d)	3408	87·6	949	27·8	2459	72·2	<0·0001
Meeting recommendations (≥4·5 cups/d)	481	12·4	218	45·3	263	54·7	
BMI							
<18·5, underweight	116	3·0	44	37·9	72	62·1	0·0002
18·5–24·9, normal	1422	36·6	457	32·1	965	67·9	
25–29·9, overweight	1177	30·3	369	31·4	808	68·6	
>30, obese	1174	30·2	297	25·3	877	74·7	
BMI (continuous)							
Mean	27·7		26·9		28·1		<0·0001
SD	6·6		6·1		6·8		

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Table 2 Generalised estimating equation regression results for the presence of a home garden, fruit and vegetable intake and BMI (*n* 3889)

Predictor variables	Regression 1: presence of a home garden			Regression 2: fruit and vegetable intake (meeting suggested intake/ not meeting)			Regression 3: BMI		
	OR	95 % CI lower	95 % CI upper	OR	95 % CI lower	95 % CI upper	Estimate	95 % CI lower	95 % CI upper
Garden (1 = yes, 0 = no)				2·08*	1·69	2·55	–0·94*	–1·36	–0·52
Gender (1 = female, 0 = male)	0·89	0·77	1·02	0·93	0·76	1·13	–0·76*	–1·18	–0·34
Age	1·00	0·99	1·00	0·99*	0·99	1·00	0·07*	0·06	0·09
Race									
White (reference)	1·00			1·00					
Black	0·44*	0·34	0·56	1·45*	1·10	1·92	1·06*	0·41	1·70
Asian	1·40*	1·003	1·95	0·86	0·56	1·30	–3·19*	–3·96	–2·41
Hispanic	0·94	0·77	1·14	0·96	0·71	1·29	0·45	–0·13	1·02
Income									
<$15 000 (reference)	1·00			1·00					
$15 000–24 999	1·33	0·99	1·78	1·16	0·71	1·90	–0·60	–1·55	0·36
$25 000–34 999	1·25	0·90	1·73	1·01	0·59	1·73	–0·80	–1·77	0·17
$35 000–49 999	1·67*	1·24	2·25	1·32	0·87	1·99	–1·03*	–1·92	–0·13
$50 000–$74 999	1·80*	1·37	2·37	1·53*	1·03	2·27	–1·28*	–2·20	–0·36
$75 000–99 999	2·52*	1·91	3·32	1·77*	1·19	2·65	–1·76*	–2·67	–0·85
≥$100 000	2·33*	1·77	3·06	2·04*	1·39	2·99	–1·91*	–2·77	–1·05
RUCC									
RUCC 1 (urban) (reference)	1·00			1·00					
RUCC 2 (semi-urban)	1·38*	1·10	1·72	0·95	0·70	1·29	0·82*	0·18	1·46
RUCC 3 (rural)	1·52*	1·18	1·96	0·84	0·61	1·16	0·67	–0·06	1·41

RUCC, Rural-Urban Continuum Code.
*Significant at the 5 % level.

Consistent with research on community gardens and fruit and vegetable consumption[13,24–27], we found positive associations between home gardening and fruit and vegetable intake[4,5]. We also found that home gardens were associated with lower BMI. Research on gardening and BMI is rare; Zick *et al.* [28] found that community gardeners in Salt Lake City had lower BMI than their siblings and neighbours. Bail *et al.*[4] examined weight and BMI among cancer survivors in a home gardening intervention but found no impact on either. Consistent with other studies, we saw a positive association between gardening and higher social capital[7].

The current study has several limitations. Data are cross-sectional thereby limiting our ability to disentangle whether gardens are causally linked to fruit and vegetable intake and lower BMI. Data are also self-reported and may be vulnerable to social desirability bias. For example, weight may be under-reported. In addition, due to the use of an online recruitment panel service, US adults without internet access would have been systematically excluded from the current study.

The current study identifies who is gardening in the USA and provides useful information for public health efforts to increase gardening as a nutrition intervention. Findings suggest that home gardening may have beneficial public health outcomes. Future research should examine the benefits of home gardening using more rigorous study designs that allow for attribution of the outcomes to gardening (e.g. comparison group, longitudinal, process measures of garden productivity and measurement of behavioural pathways from gardening to improved diet or weight). Intervention research could examine a range of strategies to increase home gardening among different populations, such as peer gardeners, technical assistance from the Cooperative Extension's Master Gardener Program or provision of reduced cost or free gardening supplies. Our finding of higher levels of gardening among families with children and a notable proportion of low-income households suggests that interventions to promote home gardening may be an effective strategy for reaching families with children and those at risk of food insecurity. Future intervention research could evaluate strategies to promote home gardens among populations at risk of lower dietary quality and obesity.

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design the study, coordinated data collection and wrote parts of the Methods section; D.W. drafted part of the Introduction; K.A. assisted with data analysis; R.H. helped design the study and advised on data analysis. All authors reviewed and edited the full manuscript. *Ethics of human subject participation:* The current study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving study participants were approved by the Emory University Institutional Review Board. Online written informed consent was obtained from all participants.

Supplementary material

To view supplementary material for this article, please visit https://doi.org/10.1017/S1368980020001329

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