Harvesting More Than Vegetables: The Potential Weight Control Benefits of Community Gardening

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Objectives. We examined the association of participation in community gardening with healthy body weight.

Methods. We examined body mass index (BMI) data from 198 community gardening participants in Salt Lake City, Utah, in relationship to BMI data for 3 comparison groups: neighbors, siblings, and spouses. In comparisons, we adjusted for gender, age, and the year of the BMI measurement.

Results. Both women and men community gardeners had significantly lower BMIs than did their neighbors who were not in the community gardening program. The estimated BMI reductions in the multivariate analyses were –1.84 for women and –2.36 for men. We also observed significantly lower BMIs for women community gardeners compared with their sisters (–1.88) and men community gardeners compared with their brothers (–1.33). Community gardeners also had lower odds of being overweight or obese than did their otherwise similar neighbors.

Conclusions. The health benefits of community gardening may go beyond enhancing the gardeners' intake of fruits and vegetables. Community gardens may be a valuable element of land use diversity that merits consideration by public health officials who want to identify neighborhood features that promote health. (*Am J Public Health.* 2013;103:1110–1115. doi:10.2105/AJPH.2012.301009)

There were more than 18 000 community gardens in the United States and Canada in 2011, and their numbers are growing.[1] Researchers assessing the impact of community gardening have concluded that they confer social benefits to neighborhoods[2–5] as well as nutritional,[6–11] physical activity,[9,12,13] and general health[9,13,14] benefits to participating gardeners. However, many of these studies rely on data from small numbers of gardeners[8–10,12,14] or surveys with very low cooperation rates (i.e., 8%–15%).[6,13] These methodological shortcomings have led to calls for more rigorous quantitative investigations of community gardens' benefits.[15,16] We used unique administrative data to examine the relationship between community gardening and a previously unexamined outcome, body mass index (BMI; defined as weight in kilograms divided by the square of height in meters).

We focused on BMI and the associated risk of being overweight or obese, as they are summary measures that jointly reflect caloric intake and physical activity. The decision to garden likely influences both caloric intake and physical activity. Overweight and obesity are known risk factors for numerous life-threatening health conditions, including coronary heart disease, stroke, hypertension, and type 2 diabetes. Thus, any observed relationship between gardening and the risk of being overweight or obese may also have implications for other health outcomes.

Ideally, community gardening would be assessed by a random assignment of people to garden or to a control group of nongardeners. This would ensure that any differences observed between the 2 groups were a function of gardening rather than of other participant characteristics.[17] Because we did not have the ability to randomly assign people to gardening treatment and control groups, we utilized a posttest-only comparison group design to assess the impact of community gardening on BMI.[18] This quasi-experimental design had the advantage of maximizing the power of our study by relaxing the need for both pregardening and postgardening BMI observations that would be available for only a select subset of our gardeners. In addition, it allowed for the inclusion of multiple comparison groups. However, we could not make strong statements regarding causal inferences with the posttest-only comparison group because of the selection threats inherent in the study design.[18]

Our treatment group consisted of community gardeners. We compared the BMIs of these gardeners to their counterparts in 3 control groups: (1) unrelated individuals who lived in the gardeners' neighborhoods, (2) siblings of the community gardeners, and (3) the spouses of the community gardeners (i.e., comparing women [men] gardeners to the wives [husbands] of men [women] gardeners). Comparisons of gardeners with these 3 groups had the potential to provide unique insights. Unrelated individuals living in the same neighborhood share the same physical environment (e.g., opportunities for walking and other physical activities, proximity to retail food outlets) and are likely to be of similar socioeconomic status as the gardeners. Same-gender adult siblings may or may not share socioeconomic status or neighborhood residential characteristics, but they do share familial genetic predispositions for body types and they may share eating and exercise preferences that were established growing up in the same family. Finally, spouses of gardeners likely share the nutritional benefits of the produce that is harvested. They may also participate in some community gardening activities along with their partners who garden, and these activities may increase their energy expenditures. Thus, we hypothesized that we would observe the largest BMI differences between community gardeners and the unrelated individuals in their neighborhoods; that we would observe smaller differences between the community gardeners and their siblings; and that BMI differences between community gardeners and their spouses would be very small or nonexistent.

METHODS

We drew study data from 2 sources: Wasatch Community Gardens (WCG) and the Utah Population Database (UPDB). WCG is a community-based nonprofit organization located in Salt Lake City, Utah. For more than 20 years, it has provided individuals with the opportunity to grow their own food in urban gardens located throughout the Salt Lake City Valley. These gardens are part of a larger network of community gardens that WCG supports through community gardener leadership development. WCG also offers a youth gardening program, workshops on gardening and eating locally, a lending library focused on gardening resources, community events, and a "sharing backyards" program that links landowners to aspiring gardeners.

WCG staff provided the names and addresses of the 423 adults who gardened in 1 of WCG's community garden plots for at least 1 year between 1995 and 2010. WCG staff also verified that gardeners were not growing produce for sale.

The UPDB, housed at the University of Utah, is a multifaceted data resource that health researchers use. The central component of the UPDB is a vast set of Utah family histories that the Utah Genealogical Society has compiled. Genealogy records in the UPDB include information on persons who do and do not belong to the Church of Jesus Christ of Latter-Day Saints. Individuals in the UPDB are linked to related individuals (through birth and marriage) and to additional high-quality population-based data sets. Included in these data sets are Utah Driver License Division (DLD) data and Utah birth certificate data. The DLD records contain information on an individual's height, weight, age, gender, and residential address. The birth certificate records contain education and race/ethnicity information for individuals who have had a child born in Utah.

Before submitting the research protocol to the University of Utah's institutional review board, WCG staff informed current WCG gardeners of the proposed study via e-mail and asked them if they had any concerns. No gardeners raised any concerns. Our proposed analyses involved the use of information from publically available administrative records (i.e., driver's licenses and birth certificates) for gardeners and their spouses, siblings, and neighbors. The absence of any concerns from current gardeners, the impracticality of obtaining informed consent from thousands of neighbors, and the reliance on public administrative records led to our request to waive the consent requirement for the study. We used the names and addresses of the 423 WCG gardeners (253 women and 168 men) to link to their records in the UPDB. A total of 375 gardeners successfully linked to the UPDB with BMI information, for a linkage rate of 88.7%. Once the information was linked, we used the information from the DLD records to identify a sample of individuals matched to the gardeners on the basis of age, gender, and neighborhood of residence (as defined by the census block group).

We used UPDB information on the gardeners' familial relationships to identify all siblings of gardeners who had a Utah DLD record and the spouses of married gardeners who also had a Utah DLD record. We identified biological siblings and spouses through multiple sources in the UPDB, including Utah marriage and divorce records dating back to 1978, Utah birth certificates dating back to 1942, and genealogical records. Birth certificates provided information regarding parents' marital status as well as the information used to identify biological siblings.

Information about age and self-reported height and weight came from the DLD records of all study participants. We converted this information to BMI and a categorical measure of overweight or obese (BMI $\geq$ 25.0). To ensure confidentiality, UPDB staff did all data linkage and returned a deidentified data set to us for analysis.

Our data had the advantage of relatively extensive coverage of individuals engaging in community gardening. At the same time, these data relied on self-reported height and weight, and there was a time lag between the initiation of gardening and weight measurement. Self-reported height and weight data tend to underestimate BMI[19,20]; nevertheless, self-reported weights, such as those in the Centers for Disease Control and Prevention Behavioral Risk Factor Surveillance System, have proven valuable for monitoring Americans' obesity trends.[21] With regard to the time lag, it is important to note that we obtained gardeners' and their spouses' height and weight data from the closest DLD renewal that occurred after they began gardening.

Of the 375 gardeners (107 spouses) who linked to the UPDB, 198 (67 spouses) had BMI information that postdated their (their spouses') beginning gardening dates. For individuals in the comparison groups, we obtained height and weight data from their most recent renewal. In all multivariate analyses, we controlled for the year we obtained the BMI information. Renewals are required every 5 years or after address changes, name changes, or loss of license. Because of self-reported weight underestimation, the time lag involved with the driver's license data, and the fact that adults typically gain weight over time,[22] our estimates are likely conservative estimates of current weight. As long as underreporting did not vary systematically across the groups, this should not have created bias.

To minimize the influence of self-selection into community gardening activities, we controlled for age and gender in all analyses; this information was available as part of the administrative records. In addition, for the subset of individuals who have had at least 1 child born in Utah, we were able to undertake analyses that controlled for education and race; this information was available on the birth certificate records. The estimates that controlled for education and race did not differ markedly from the estimates derived from the larger sample, and thus we elected to focus on the analyses derived from this latter group. (The estimates that controlled for education and race are available as a supplement to the online version of this article at http://www.ajph.org.)

Ideally, our regressions would also have controlled for who in the household consumed the gardening produce, but, unfortunately, there was no such information in the administrative records. Information on activities, such as paid employment, that take both gardeners and their neighbors outside their immediate neighborhood, and thus may expand their access to physical activity and healthy food options, was also unavailable. However, the omission of this variable is unlikely to have biased our results, as we have no reason to believe that gardeners are more or less likely than are their neighbors to travel outside their neighborhood.

We estimated gender-specific regressions that included gardeners and their respective controls. We used ordinary least squares (OLS) regressions when BMI was the dependent variable. We used logistic regressions when overweight or obese was the dependent variable. All regressions controlled for age and the year the BMI data were reported.

Although there were 198 gardeners in the analyses, the sample of gardeners changed depending on the control group being studied. When contrasting community gardeners with controls living in the same neighborhood, it was necessary to link each gardener's address to a census block group. We were able to link the addresses of 115 women community gardeners and 70 men community gardeners to their census block groups, giving a geographic linkage rate of 93%. When contrasting community gardeners with their sibling controls, we included a gardener only when we could identify at least 1 sibling who also had a Utah driver's license. This translated into samples of 121 women gardeners and 77 men gardeners. Finally, we restricted the analyses that contrasted the community gardeners with spouses to married community gardeners. For example, in the case of women gardeners, the spouse comparison was with the wives of the men gardeners. In this way, we controlled for gender-related BMI differences. If both spouses were listed on the WCG records as gardeners, we deleted them from this analysis. Thus, in the final analysis we included the 44 married women gardeners and the 20 married men gardeners. The spouse sample counts differed from the community gardener sample counts because of the requirement that the individual in question have a BMI measurement after the gardener began gardening.

Power calculations suggested that the gardener–neighbor equations would have strong statistical power, whereas the gardener–sibling and gardener–spouse comparisons were somewhat underpowered.[23] In an attempt to address this potential shortcoming, we generated bootstrapped estimates for the 2 smaller comparison groups. These estimates and their associated SEs (available from the authors on request) did not differ markedly from the traditional OLS and logistic regression estimates. Thus, we elected to present the OLS and logistic regression estimates to maintain consistency with the gardener–neighbor analyses.

RESULTS

Descriptive statistics for the samples appear in Table 1. The community gardeners, neighbors, and siblings were all typically in their middle 40s with the only exception being married men gardeners and their wives, both of whom were in their early 50s. The gender composition and average age of community gardeners was very similar to the gender mix and average age reported in prior large sample, single-community studies.[6,10,11]

Despite their similar ages and year of BMI measurement, bivariate comparisons of the BMIs and proportions overweight or obese revealed striking contrasts. The women community gardeners' average BMI was 1.48 lower than their neighbors', and they were 34% less likely to be overweight or obese. For men gardeners compared with their neighbors, differences were similar with gardeners having an average BMI that was 2.52 lower than their neighbors', and there was a 36% reduction in the likelihood of being overweight or obese. As expected, the differences shrunk when we focused on the other 2 comparison groups, but in all cases we observed that community gardeners had lower average BMIs. No clear patterns emerged, however, when we compared the overweight or obesity risk of gardeners to that of their siblings or spouses.

Tables 2 and 3 show the multivariate analyses of the differences in BMIs and risks of being overweight or obese for community gardeners relative to each of the 3 comparison groups. We centered the ages and years when we obtained the BMI information from the DLD records (i.e., they are deviations from their respective grand means) so that the constant term in the regressions reflected the average BMI for the nongardener who was the average age and whose BMI information came from the average DLD record year.

As hypothesized, we found large, significant differences in BMI and overweight and obesity risk when comparing community gardeners to their neighbors. The BMI difference for women gardeners was −1.84, whereas for men gardeners the estimate was −2.36. This translated into approximately an 11-pound weight

TABLE 1—Characteristics of Community Gardeners: Community Gardening and Weight Control; Salt Lake City Valley, UT; 2001–2010

Variable	Comparison 1, Mean (SD) and Proportion				Comparison 2, Mean (SD) and Proportion				Comparison 3, Mean (SD) and Proportion			
	Women Gardeners	Women Neighbors	Men Gardeners	Men Neighbors	Women Gardeners	Women Siblings	Men Gardeners	Men Siblings	Women Gardeners	Women Spouses[a]	Men Gardeners	Men Spouses[a]
Age	47.13 (14.81)	44.62 (13.36)	46.00 (12.44)	47.41 (13.51)	47.30 (14.53)	43.75 (14.11)	46.79 (13.85)	40.47 (12.30)	48.16 (11.98)	52.07 (14.19)	54.35 (17.68)	47.70 (11.71)
Year	2006 (2.35)	2006 (2.97)	2006 (2.81)	2006 (3.08)	2006 (2.32)	2004 (5.78)	2006 (2.85)	2005 (4.70)	2007 (2.21)	2007 (2.39)	2006 (2.77)	2007 (1.93)
BMI[b]	23.98 (5.29)	25.46 (5.66)	24.65 (4.29)	27.17 (4.82)	23.86 (5.22)	25.16 (5.55)	25.10 (4.63)	25.63 (4.63)	24.29 (5.00)	26.61 (12.81)	25.34 (3.07)	27.89 (5.83)
Proportion with BMI ≥ 25.0[c]	0.29	0.44	0.43	0.67	0.29	0.39	0.47	0.47	0.41	0.33	0.50	0.63
Total no. of individuals	115	7997	70	4555	121	134	77	182	44	27	20	40

Note. BMI = body mass index (defined as weight in kilograms divided by the square of height in meters).
[a]If the gardener is a woman, the spouse comparison is with the spouses of the men gardeners. In this way, we controlled for gender-related differences in BMI.
[b]Bivariate tests reveal statistically significant differences ($P < .05$) in BMI for all group comparisons.
[c]Bivariate tests reveal statistically significant group differences ($P < .05$) in the probability of being overweight or obese for all group comparisons except married women gardeners compared with the wives of men gardeners, and men gardeners compared with brothers.

TABLE 2—Parameter Estimates of Body Mass Index Equations: Community Gardening and Weight Control; Salt Lake City Valley, UT; 2001–2010

	Women Comparisons, OLS (*t*-Ratio)			Men Comparisons, OLS (*t*-Ratio)		
Variable	Gardeners and Neighbors	Gardeners and Siblings	Gardeners and Spouses	Gardeners and Neighbors	Gardeners and Siblings	Gardeners and Spouses
Constant	25.51** (410.59)	25.30** (54.29)	24.80** (20.80)	27.03** (379.82)	25.93** (76.43)	27.32** (39.92)
Age, centered	0.08** (16.87)	0.04 (1.84)	0.19** (3.82)	0.05** (10.25)	0.07** (3.30)	0.05 (1.31)
Year, centered	0.25** (11.67)	0.16* (2.10)	0.43* (1.89)	0.20** (8.47)	0.27** (4.13)	0.22* (1.72)
Gardener, 1 = yes	−1.84** (−3.54)	−1.88** (−2.66)	−0.64 (−0.45)	−2.36** (−4.15)	−1.33* (−2.12)	−0.60 (−0.52)
Adjusted R^2	0.04	0.03	0.12	0.03	0.08	0.01
F Statistic	119.68**	3.65*	5.98**	56.19**	8.02**	1.33

Note. OLS = ordinary least square.
*$P < .05$; **$P < .01$.

difference for a 5-feet, 5-inches tall woman and about a 16-pound weight difference for a 5-feet, 10-inches tall man. Similarly, the odds ratios (ORs) indicate that women gardeners were 46% less likely to be overweight or obese than were their female neighbors, whereas men gardeners were 62% less likely to be overweight or obese than were their male neighbors.

We observed statistically significant differences in both the BMIs and overweight and obesity ORs for women gardeners compared with their sisters. In the case of men gardeners, only the BMI difference was statistically significant. Participating in community gardening was associated with a −1.88 BMI for women gardeners compared with their sisters. This again translates into approximately an 11-pound difference for a 5-feet, 5-inches tall woman. In the case of the men gardeners, the BMI difference was −1.33 or about 9 pounds for a 5-feet, 10-inches tall man. We also observed that the odds of women gardeners being overweight or obese were 45% less than were their sisters' odds. Although the OR estimate associated with men gardeners compared with their brothers had the expected sign, it did not reach conventional levels of statistical significance.

Finally, comparing married women (men) gardeners to the wives (husbands) of married gardeners, we found no statistically significant difference in BMI or the odds of being overweight or obese. We expected this null finding because we hypothesized that spouses would likely enjoy the dietary advantages of the community garden and might also help with the physical demands of maintaining a garden plot. It is important to note, however, that we derived these comparisons from substantially smaller samples.

DISCUSSION

Our analyses add to the nascent work of researchers examining the health benefits of community gardening. We found that community gardeners have lower BMIs than do same-gender and same-aged nongardeners living in their neighborhoods. Individuals living in the same census block group likely shared access to similar retail food environments and opportunities for physical activity other than gardening. Thus, it is unlikely that the observed BMI differences are attributable to differences in socioeconomic status or the physical attributes of the neighborhoods in which gardeners and their neighbors live.

We also observed a BMI advantage for community gardeners relative to their same-gender siblings. There was also a significant reduction in overweight and obesity risk for women gardeners compared with their sisters. The sibling comparisons essentially controlled for shared genetic predispositions for weight and family of origin influences on diet and exercise. The gender difference in sibling comparisons hints that gardening activities may be a more important, modifiable weight

TABLE 3—Analysis of Overweight or Obese: Community Gardening and Weight Control; Salt Lake City Valley, UT; 2001–2010

	Women Comparisons, OR (95% CI)			Men Comparisons, OR (95% CI)		
Variable	Gardeners and Neighbors	Gardeners and Siblings	Gardeners and Spouses	Gardeners and Neighbors	Gardeners and Siblings	Gardeners and Spouses
Age, centered		1.01 (1.00, 1.03)	1.03 (0.99, 1.07)	1.03 (1.02, 1.03)	1.06 (1.03, 1.08)	1.03 (0.99, 1.07)
Year, centered	1.08 (1.07, 1.10)	1.04 (0.98, 1.10)	1.02 (0.82, 1.26)	1.09 (1.07, 1.12)	1.14 (1.06, 1.22)	1.14 (0.90, 1.45)
Gardener, 1 = yes	0.44 (0.29, 0.67)	0.55 (0.32, 0.96)	1.54 (0.55, 4.32)	0.38 (0.24, 0.62)	0.63 (0.35, 1.14)	0.61 (0.18, 2.02)
χ^2	380.48**	6.38	2.05	189.55**	29.57**	3.80

Note. CI = confidence interval; OR = odds ratio. Overweight or obese is defined by a body mass index (defined as weight in kilograms divided by the square of height in meters) ≥ 25.0.
**$P < .01$.

regulator for women than for men. We were not able to ascertain whether it operates through improving dietary intake or through physical activity, but it is noteworthy that past research has found that women are typically less physically active than are men[24]; this may be an area worthy of future research.

As expected, we observed no difference between community gardeners and spouses of community gardeners, suggesting that those who live in the same household as a gardener also benefit from the produce and the physical demands of gardening. This null finding is consistent with the argument that community gardening may have numerous positive spillover effects for the family members and neighbors of gardeners.[15]

Our investigation has several methodological strengths relative to past research that has focused on assessing the benefits of community gardening. First, we derived our analyses from relatively large numbers of community gardeners. Past studies have relied on small samples or used surveys with very low response rates. Second, we used a quasi-experimental design that contrasted the BMIs of gardeners with those of statistical controls who did not participate in community gardening. Only 2 previous studies have compared community gardeners to nongardeners, and those studies focused on assessing the differences in fruit and vegetable intake.[6,7] Third, we used genetic relatives to adjust for familial and gene effects that may influence BMI. Finally, to the best of our knowledge, ours is the first study to associate participation in community gardening with BMI and overweight and obesity risk, thus highlighting a new potential health benefit of community gardens.

Limitations

Despite the strengths of our analyses, caution should be used in drawing definitive conclusions from our study. We drew the data from participants in 1 community gardening organization; thus, the findings may not generalize to gardening organizations located elsewhere. Limitations of our administrative records prevented us from controlling for other factors such as household income, occupation, physical activity unrelated to gardening, and who in the household consumed the produce. If other important factors such as these vary systematically by gardener status, our estimates may be biased. In addition, it is possible that individuals who elect to join a community garden have relatively greater preferences for physical activity and healthy diets. Finally, it may be that some individuals in our samples of neighbors and siblings gardened either in their own yards or through some other community garden organization. Thus, we cannot make strong causal inferences on the basis of our analyses.

A definitive assessment of community gardening's impact on participants' weight should be performed in the context of a randomized field experiment or perhaps a quasi-experiment in which individuals on a gardening waiting list are used as controls. Evidence derived from more sophisticated study designs such as these would increase our ability to draw conclusions regarding causation. In addition, community gardening organizations often offer a range of programming activities beyond garden plots (e.g., cooking classes, backyard sharing initiatives). In this context, community gardens may be an important "third place"[25] where community is created and healthy habits are reinforced. We did not assess the impact of these ancillary programs, but it would seem that some assessment of their effectiveness and efficiency in promoting healthy lifestyle outcomes would be instructive. Nor did we examine the relative cost-effectiveness of community gardening.

Conclusions

The results of our exploratory study provide suggestions for future research that would advance our understanding of gardening benefits and costs. Specifically, to gain a more definitive picture of the weight benefits associated with community gardening, future analyses should include controls for a wider range of weight-related covariates, or they should employ a randomized field experiment design. It is also vitally important that concerns regarding external validity be addressed by gathering data on gardeners living in a range of communities. Finally, the costs associated with initiating and maintaining community gardens may be substantial, and future research should investigate the relative cost-effectiveness of various options designed to enhance urban residents' access to fresh produce (e.g., community gardens, farmers markets).

The importance of building on our study is reinforced by the fact that the percentage of Americans living in urban areas continues to grow.[26] With this growth comes the opportunity to design new urban communities and redesign older urban communities so they contain features that promote healthy lifestyles.[27] In recent years, public health researchers and urban planners have focused on how the "3 Ds"—neighborhood design, population density, and land use diversity—might promote greater physical activity and lower BMI.[28–39] Our exploratory analyses suggest that community gardens may be a valuable element of land use diversity that merits the consideration of public health officials and urban planners who want to identify neighborhood features that promote health. ■

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Contributors

C. D. Zick took primary responsibility for the study conceptualization, study design, and the writing of this article. K. R. Smith, L. Kowaleski-Jones, C. Uno, and B. J. Merrill assisted with the study conceptualization, study design, interpretation of the results, and writing. K. R. Smith also took primary responsibility for the data analysis.

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Human Participant Protection

The University of Utah's Resource for Genetic and Epidemiologic Research Review Committee and the University of Utah's institutional review board approved this study.

References

1. The American Community Gardening Growing Community Across the U.S. & Canada. Available at: http://communitygarden.org. Accessed September 14, 2011.

2. Alaimo K, Reischl TM, Allen JO. Community gardening, neighborhood meetings, and social capital. *J Community Psychol.* 2010;38(4):497–514.

3. Armstrong D. A survey of community gardens in upstate New York: implications for health promotion and community development. *Health Place.* 2000;6(4):319–327.

4. Ferris J, Norman C, Sempik J. People, land and sustainability: community gardens and the social dimension of sustainable development. *Soc Policy Adm.* 2001; 35(5):559–568.

5. Waliczek TM, Zajicek JM, Lineberger RD. The influence of gardening activities on consumer perceptions of life satisfaction. *HortScience.* 2005;40(5):1360–1365.

6. Alaimo K, Packnett E, Miles RA, Kruger DJ. Fruit and vegetable intake among urban community gardeners. *J Nutr Educ Behav.* 2008;40(2):94–101.

7. Blair D, Sherman S, Giesecke CC. A dietary, social and economic evaluation of the Philadelphia Urban Gardening Project. *J Nutr Educ.* 1991;23(4):161–167.

8. Johnson DB, Smith LT. Testing the recommendations of the Washington State Nutrition and Physical Activity Plan: the Moses Lake case study. *Prev Chronic Dis.* 2006;3(2):A59.

9. Kingsley JY, Townsend M, Henderson-Wilson C. Cultivating health and wellbeing: members' perceptions of the health benefits of a Port Melbourne community garden. *Leisure Stud.* 2009;28(2):207–219.

10. Lackey JF. *Evaluation of Community Gardens: A Program of the University of Wisconsin Cooperative Extension.* Madison, WI: University of Wisconsin Cooperative Extension; 1998.

11. Litt JS, Soobader M-J, Turbin MS, Hale JW, Buchenau M, Marshall JA. 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.

12. Blake A, Cloutier-Fisher D. Backyard bounty: exploring the benefits and challenges of backyard garden sharing projects. *Local Environ.* 2009;14(9):797–807.

13. van den Berg AE, van Winsum-Westra M, de Vries S, van Dillen SME. Allotment gardening and health: a comparative survey among allotment gardeners and their neighbors without an allotment. *Environ Health.* 2010;9:74–85.

14. Wakefield S, Yeudall F, Taron C, Reynolds J, Skinner A. Growing urban health: community gardening in South-East Toronto. *Health Promot Int.* 2007;22(2): 92–101.

15. Draper C, Freedman D. Review and analysis of the benefits, purposes, and motivations associated with community gardening in the United States. *J Community Pract.* 2010;18(4):458–492.

16. McCormack LA, Laska MN, Larson NI, Story M. Review of the nutritional implications of farmers' markets and community gardens: a call for evaluation and research efforts. *J Am Diet Assoc.* 2010;110(3):399–408.

17. Rossi PH, Lipsey MW, Freeman HE. *Evaluation: A Systematic Approach.* 7th ed. Thousand Oaks, CA: Sage; 2004.

18. Langbein L, Felbinger CL. *Public Program Evaluation: A Statistical Guide.* Armonk, NY: M. E. Sharpe; 2006.

19. Nawaz H, Chan W, Abdulrahman M, Larson D, Katz DL. Self-reported weight and height: implications for obesity research. *Am J Prev Med.* 2001;20(4):294–298.

20. Gorber SC, Tremblay M, Moher D, Gorber B. A comparison of direct vs. self-report measures for assessing height, weight and body mass index: a systematic review. *Obes Rev.* 2007;8(4):307–326.

21. *Health Risks in the United States: Behavioral Risk Factor Surveillance System at a Glance 2007.* Atlanta, GA: Centers for Disease Control and Prevention; 2007.

22. US Department of Health and Human Services; US Department of Agriculture. *Dietary Guidelines for Americans.* 6th ed. Washington, DC: US Government Printing Office; 2005.

23. *Pass 11* [computer program]. Kaysville, UT: NCSS, LLC; 2011.

24. Troiano RP, Berrigan D, Dodd KW, Masse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. *Med Sci Sports Exerc.* 2008; 40(1):181–188.

25. Oldenburg R. *The Great Good Place: Cafes, Coffee Shops, Community Centers, Beauty Parlors, General Stores, Bars, Hangouts, and How They Get You Through the Day.* New York, NY: Paragon House; 1989.

26. Johnson K. *Demographic Trends in Rural and Small Town America.* Durham, NH: University of New Hampshire; 2006.

27. Nelson AC. *Toward a New Metropolis: The Opportunity to Rebuild America.* Washington, DC: Brookings Institution; 2004.

28. Doyle S, Kelly-Schwartz A, Schlossberg M, Stockard J. Active community environments and health: the relationship of walkable and safe communities to individual health. *J Am Plan Assoc.* 2006;72(1):19–31.

29. Frank LD, Andresen MA, Schmid TL. Obesity relationships with community design, physical activity, and time spent in cars. *Am J Prev Med.* 2004;27(2):87–96.

30. Giles-Corti B, Macintyre S, Clarkson JP, Pikora T, Donovan RJ. Environmental and lifestyle factors associated with overweight and obesity in Perth, Australia. *Am J Health Promot.* 2003;18(1):93–102.

31. Lopez R. Urban sprawl and risk for being overweight or obese. *Am J Public Health.* 2004;94(9):1574–1579.

32. Lopez-Zetina J, Lee H, Friis R. The link between obesity and the built environment. Evidence from an ecological analysis of obesity and vehicle miles of travel in California. *Health Place.* 2006;12(4):656–664.

33. Pendola R, Gen S. BMI, auto use, and the urban environment in San Francisco. *Health Place.* 2007;13 (2):551–556.

34. Ross NA, Tremblay S, Khan S, Crouse D, Tremblay M, Berthelot J-M. Body mass index in urban Canada: neighborhood and metropolitan area effects. *Am J Public Health.* 2007;97(3):500–508.

35. Rundle A, Roux AVD, Freeman LM, Miller D, Neckerman KM, Weiss CC. The urban built environment and obesity in New York City: a multilevel analysis. *Am J Health Promot.* 2007;21(4 suppl):326–334.

36. Smith KR, Brown BB, Yamada I, Kowaleski-Jones L, Zick CD, Fan JX. Walkability and body mass index: density, design, and new diversity measures. *Am J Prev Med.* 2008;35(3):237–244.

37. Stafford M, Cummins S, Ellaway A, Sacker A, Wiggins RD, Macintyre S. Pathways to obesity: identifying local, modifiable determinants of physical activity and diet. *Soc Sci Med.* 2007;65(9):1882–1897.

38. Zick CD, Smith KR, Fan JX, Brown BB, Yamada I, Kowaleski-Jones L. Running to the store? The relationship between neighborhood environments and the risk of obesity. *Soc Sci Med.* 2009;69(10):1493–1500.

39. Cervero R, Kockelman K. Travel demand and the 3Ds: density, diversity, and design. *Transp Res Part D Transp Environ.* 1997;2(3):199–219.