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Safe Community Gardening Practices: Focus Groups with Garden Leaders in Atlanta, Georgia

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Abstract

Although best management practices have been recommended by government agencies and non-profit organizations to reduce community gardeners' potential exposure to soil contaminants such as lead, some gardeners do not perform these practices. Understanding gardeners' beliefs and motivations is critical for effective promotion of safer gardening practices. This study, grounded in the Theory of Planned Behavior (TPB), employed five focus groups to investigate Atlanta community garden leaders' perspectives concerning three gardening practices: composting, hygiene behaviors, and mulching. These general practices are also considered safe gardening practices in that they can reduce exposure to toxicants in urban gardens. Qualitative analysis identified advantages and disadvantages; supporters and non-supporters; and barriers and facilitators that might influence gardeners' opinions regarding these behaviors. Gardeners expressed that more funding, volunteers, and training are needed to promote these behaviors. Gardeners noted that mulch and compost provided advantages such as improving soil quality, but a primary barrier was concern about contamination of source materials. Focus group participants did not directly associate composting and mulching with reduction of exposure to soil contaminants. Behavioral challenges related to hygiene included concerns about decreased exposure to salubrious bacteria, inadequate access to potable water, and limited availability of gloves and wipes. These study findings characterize factors that community garden stakeholders should consider when promoting safe gardening practices and interventions.

Keywords

Community gardens; urban agriculture; beliefs; soil contaminants; Theory of Planned Behavior; environmental psychology

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Introduction

Community gardens promote social capital (Alaimo, Reischl, and Allen 2010; Firth, Maye, and Pearson 2011), food justice (Horst, McClintock, and Hoey 2017), increased access to and consumption of nutritious foods (Litt et al. 2011; Alaimo et al. 2008; Algert, Baameur, and Renvall 2014), environmental sustainability (Okvat and Zautra 2011; Holland 2004), and provide many other benefits (Santo 2016; Al-Delaimy and Webb 2017; Alaimo et al. 2016; Draper and Freedman 2010; Laycock Pedersen and Robinson 2018). In many areas of the United States, vacant lots and brownfields have been revitalized into spaces for community gardens and urban agriculture, providing increased access to healthy foods; offering job and training opportunities; promoting social cohesion; and fostering community empowerment (White 2011; Greever-Rice; Drake and Lawson 2014; McClintock, Cooper, and Khandeshi 2013). In Atlanta, GA, recent initiatives to support urban agriculture have strengthened with the implementation of an urban agriculture ordinance, the appointment of the first Urban Agriculture Director in the U.S, and the development of the AgLanta “Grows-A-Lot” program to promote urban gardening and farming on city-owned vacant lands (City of Atlanta Mayor’s Office of Resilience 2018). However, gardening on vacant lots and other urban areas may also present environmental health risks, such as potential exposure to legacy contaminants in the soil and toxicants from adjacent sites that can translocate to garden soils (Al-Delaimy and Webb 2017; Mitchell et al. 2014; Wortman and Lovel 2013). Several studies have demonstrated that heavy metals such as lead and cadmium can exceed safe concentrations in urban community garden soils (Laidlaw et al. 2018; Mitchell et al. 2014; Witzling, Wander, and Phillips 2010; McBride et al. 2014; Clark, Hausladen, and Brabander 2008; Clarke, Jenerette, and Bain 2015). Exposure to these chemicals has been associated with adverse health outcomes, particularly among vulnerable populations such as pregnant women and children (Laidlaw et al. 2016; Ciesielski et al. 2012; Calderon et al. 2001; von Ehrenstein et al. 2007; Cao et al. 2016; Moya, Bearer, and Etzel 2004). For example, lead exposure may cause behavioral and learning problems, decreased IQ scores, and premature birth (Agency for Toxic Substances and Disease Registry 2007). Moreover, several studies have shown that soil lead is strongly associated with children’s blood lead levels (Zahran, Mielke, et al. 2013; Filippelli and Laidlaw 2010; Zahran, Laidlaw, et al. 2013; Laidlaw et al. 2005)

Best management practices to reduce exposure to contaminants in urban gardens include: 1) conducting a garden site history; 2) locating gardens away from heavily trafficked roadways and older buildings; 3) testing soil and maintaining a near neutral soil pH; 4) installing raised beds; 5) amending soil with phosphorus and compost; 6) mulching to cover bare soil; and 7) implementing hygiene behaviors (U.S. Environmental Protection Agency 2011; Brown, Chaney, and Hettiarachchi 2016; Kessler 2013; Mitchell et al. 2014; Scheckel et al. 2013; Hannick 2016; U.S. Environmental Protection Agency 2014). The first four behaviors are optimally conducted at the beginning of garden installation, although soil testing is appropriate both prior to garden installation and during garden maintenance. The last three behaviors (composting, mulching, and hygiene) are typically implemented during garden maintenance, often for advantageous results that may be unrelated to reducing toxicant exposures.

While these three behaviors may be implemented to obtain other beneficial gardening outcomes, they are considered safe-gardening behaviors because their implementation can reduce toxicant exposures. For example, chemicals in soil amendments such as phosphorus fertilizer and compost may bind to toxicants in soil to decrease their soil mobility and bioavailability (Park et al. 2011; Brown et al. 2003; Attanayake et al. 2014; Scheckel et al. 2013; Attanayake et al. 2015). Covering bare garden areas with mulch can minimize exposure to windblown contaminants within the garden (Kessler 2013). Lastly, hygiene practices, which include wearing gloves, leaving gardening shoes and gear outside, thoroughly washing hands and produce, and peeling produce, can limit direct contact with potentially contaminated soil (U.S. Environmental Protection Agency 2011).

Extension County Offices, government agencies, universities and non-profit organizations have conducted activities such as training, outreach, and distribution of factsheets and other informational materials to promote the adoption of safe gardening practices among community gardeners and other farmers (U.S. Environmental Protection Agency 2011; Vaouli and Pomales-Schickli 2015; Witzling, Wander, and Phillips 2010; Ramirez-Andreotta et al. 2015; Rouillon et al. 2017). However, community gardeners have varied knowledge, challenges, and concerns about soil contaminants and may fail to implement safe gardening practices that could minimize contaminant exposures (Kim et al. 2014; Chaifetz et al. 2015; Henson, Tenorio Fenton, and Tikalsky 2017; Wong, Gable, and Rivera-Núñez 2017). Several studies have illustrated that increased educational outreach and knowledge alone are not sufficient to change environmental health-related behaviors (Stern 2011; Gifford and Nilsson 2014; Pilling et al. 2008). Understanding a broader range of factors that influence behavior is essential to constructing safe interventions for gardeners and other growers (Tobin et al. 2013; Marine et al. 2016; Soon and Baines 2012).

The Theory of Planned Behavior (TPB) (Figure 1) is a useful framework for assessing beliefs that influence environmental (Staats 2003) and health-related (McEachan et al. 2011) behaviors. A key strength of TPB is that incorporates a systematic process to elucidate beliefs and constructs that can be targeted for behavioral interventions in multiple fields (de Leeuw et al. 2015; Fife-Schaw, Sheeran, and Norman 2007). The TPB proposes that attitude, subjective norms, and perceived behavioral control are primary determinants that influence an individual's intention to conduct a behavior (Ajzen 1991). Underlying these three determinants are corresponding beliefs salient to behavioral intention: behavioral, normative, and control beliefs. Behavioral beliefs are underlying positive or negative convictions that the behavior will produce a given outcome, and behavioral beliefs serve as an antecedent of the attitude toward the behavior. Normative beliefs are perceived behavioral expectations of significant people/groups or the social forces that may influence behavior. The opinions of referents may promote or discourage specific behaviors. Control beliefs are beliefs about the presence of factors that may serve as barriers or facilitators to performing the behavior. Thorough investigation of these beliefs related to adoption of safe gardening activities can serve as the basis for targeted interventions to reduce potential soil contaminant exposures.

Qualitative research methods can elucidate the context and processes that affect behaviors which may not be sufficiently described by a survey, biological assessment, or environmental sample (Patton 2015). Investigating the meanings, motivations, and

experiences of behaviors in environmental contexts may be better explored through qualitative methods such as focus groups, semi-structured interviews, or key informant interviews (Lobdell et al. 2005; Scammell 2010). Focus groups are effective in identifying intangible influences such as social norms, and the group interaction may provide richer information on social norms than individual interviews. This study utilized focus groups to explore the advantages and disadvantages (related to behavioral beliefs), supporters and non-supporters (related to normative beliefs), and facilitators and barriers (related to control beliefs) for the following soil contamination mitigation behaviors: composting, hygiene habits, and mulching.

Methods

Five focus groups including 26 Atlanta metropolitan area community garden leaders were conducted from February to April 2017. To recruit the focus group participants, purposive non-random sampling (Krueger 2014) was employed through email solicitation of prominent Atlanta, Georgia community gardening organizations, food advocacy groups, and county extension offices. Persons were eligible to participate in the study if at least 18 years of age and engaged at their community gardening site in metropolitan Atlanta counties for at least 3 months. Gardeners who met the study eligibility criteria were invited to participate in focus groups near their community garden location. The focus groups were administered in private rooms in Atlanta libraries and county extension offices. Before participating in the focus groups and follow up demographic survey, study participants signed written informed consent forms. The study protocol and forms were reviewed and determined exempt by Emory University Institutional Review Board.

A semi-structured focus group guide based on the TPB elicitation study framework (Francis et al. 2004) was developed to guide the discussions. The focus group guide began with questions about community garden benefits, soil contaminant knowledge and risk perception, and soil testing; these findings are reported elsewhere (Hunter et al. 2019; Emory University HERCULES Exposome Research Center Community Engagement Core 2019). Next, the guide centered on the advantages and disadvantages; supporters and non-supporters; and barriers and facilitators of composting, hygiene habits, and mulching in community gardens. Behavioral beliefs were assessed by questions such as: *What do you think are the advantages of adding compost amendments to the soil during the next growing season? What do you believe are the disadvantages of adding compost amendments to the soil during the next growing season?* Normative beliefs were evaluated through the following questions: *What people or groups would expect you to add compost amendments to the soil? What groups would discourage composting?* Control beliefs were measured through questions such as: *What factors or circumstances would make it easier for gardeners to add compost amendments to the soil? What makes it difficult for gardeners to add compost amendments to the soil?*

Each focus group ran 75–90 minutes, was audio-recorded, and transcribed verbatim. As an incentive for participation, all focus groups participants were offered a free heavy metal soil test (valued at \$35), as well a gardening gift bag that consisted of seeds, gloves, trowels, and factsheets on reducing soil contamination exposure in urban community gardens. The study

protocol and forms were reviewed and determined exempt by Emory University Institutional Review Board.

Based on the research questions and review of focus group transcripts for emergent discussion topics, the primary author (C.H.) developed a codebook to outline and define specific themes (codes). The primary author and another analyst individually examined and coded the transcripts. After reviewing the codes independently, the analysts met to discuss, review and resolve code discrepancies. This process was conducted by reviewing each manuscript, comparing codes, and explaining rationale for each coded section (Hennink, Hutter, and Bailey 2010; Patton 2015). After comparing and reconciling conflicting codes, the analysts developed a revised codebook (Appendix A). Using the revised codebook, the analysts recoded the transcripts, and the final coded themes were entered into NVivo 10 (QSR International Pty Ltd, Melbourne, Australia) software. Study team members reviewed NVivo summary reports by Node output and developed matrices to identify primary themes. These matrices were organized to understand frequency of mentions, to assess consistency of themes across focus groups, and to characterize TPB patterns (Patton 2015). Specific TPB themes were organized by each of the three primary behaviors (i.e., composting, hygiene behaviors, and mulching) investigated in the study. Quotes that represent the strongest themes as defined by highest frequency of mentions are included in the results section.

Results

Characteristics of study participants and their community gardens

The study sample was 77% female, 69% non-Hispanic white, 26% non-Hispanic black, and 40% between the ages of 36–55 (Table 1). Four fifths of the study population had attained a college degree, and 57% of the participants had an annual household income of at least \$50,000. Most of the focus group participants were community garden leaders (80%), who are typically responsible for garden management including coordination of volunteers/members, communication, site maintenance, and educational workshops. Most of these community garden leaders had previously participated in garden training (79%). More than half of participants identified their community gardens as neighborhood gardens (58%), and sixty-percent of participants' gardens had at least 30 garden members (60%) (Table 2). Slightly fewer than half of the community gardeners in the sample were working on gardens sited on land owned by their organizations, and most gardens were sited on at least 0.25 acres of land.

Composting

Advantages and Disadvantages—Participants shared some beliefs that were relevant to all three of the safe gardening practices (Table 3). However, most of these beliefs were specific to a particular safe gardening behavior. During the discussion about compost, participants most frequently mentioned the benefit of compost to improve soil quality. More specifically, some participants expressed that compost can help to dilute harmful bacteria and fungi (e.g., downy mildew), neutralize pH, and improve soil texture and water retention. Several participants emphasized that compost breaks up soil and allows nutrients to be better

absorbed by plants, thereby creating healthier, more nutrient-dense food. Example quotes from participants regarding advantages of compost are repeated below:

“It creates a high nutrient content in the soil. You know what you’re putting in. It increases the level of earthworms that are doing their job and, it just makes the soil very dense and very beautiful...it’s pretty fascinating to just watch things just kind of decompose, and I think it adds another level of health to the soil”

“Because if you ever put it[compost] down, if you ever look underneath it later on and see what it’s doing to that clay soil, it starts breaking it up, and if you mix that clay in with it, it makes a really nice combination. Georgia clay sometimes has a bad reputation, but if you break it up and get it in there with that compost- They really help each other”

Other advantages discussed were that compost serves as a good waste reduction mechanism, promotes environmental stewardship, saves money for fertilizer, and provides a teaching opportunity for students to reduce waste and promote sustainability principles.

The most commonly perceived disadvantages of compost related to the challenges of identifying and monitoring source or feedstock materials. Additional challenges were availability of source materials (e.g., attaining enough green material, kitchen peels) and potential diseases and contamination in source materials from chemical spraying (intentional and unintentional runoff) and diseased plants. For example, one participant shared concerns about compost during rain and flooding events related to uncured compost leachate leaking from the compost bin as well as the introduction of contaminants to the compost from adjacent site run-off. Participants shared that lack of education and motivation on composting properly could result in bad odors, rodents, and wildlife at or near the composting area.

“Sometimes if people don’t do it correctly, some folks have problems with rodents and things like that, so I guess neighbors could become upset if you had a compost bin and it attracted wildlife.”

“Sometimes it’s hard to know the source of your materials...it could be full of weed seeds. That could be a challenge. I’ve read some pretty gnarly articles about cardboard, like not really knowing the source of that cardboard.”

Moreover, participants mentioned the extensive amount of time, energy, and labor to create, monitor, and maintain compost piles was also a deterrent to composting. Also, participants discussed the varied quality of imported compost (donated and purchased) and the feasibility of composting based on the scale of the garden.

“I think the problem with most community gardens is composting isn’t done at a large enough scale that it’s practical. I mean, we have a demonstration area. We’ve got like five beds. When you consider the labor requirements to really do it right, it’s a challenge.”

Supporters and Non-Supporters—Supporters of compost included businesses (e.g., Terra Nova Compost, restaurants, tree companies), garden leaders, Master gardeners,

gardening experts, non-profit organizations (e.g., Captain Planet Foundation, Trees Atlanta, Trees Georgia, Foodwell Alliance, Metro Atlanta Urban Farmers, Georgia Organics), County Extension Services, Arborists, as well as local and federal agencies (e.g., Centers for Disease Control and Prevention, US Department of Agriculture). Restaurants and neighbors concerned about odors and property values were mentioned as potential non-supporters. One participant noted that restaurants can be supporters or non-supporters depending on their motivations and willingness to input additional resources into sorting scraps:

“Restaurants can be a great resource, but sometimes they’re hard to work with because you only want certain things, and then maybe they don’t want to add anything extra to their routine.”

Facilitators and Barriers—Facilitators of composting were resources (e.g. bins, space, materials, and instructions about composting) and increased awareness of compost availability by having compost pick up and drop off services or donated compost. Additionally, hosting free composting workshops and increasing the accessibility of source material (through restaurants and/or requesting leaves from neighbors and companies) were mentioned as excellent facilitators. To increase compost accessibility on site, one gardener suggested that it should be required labor of gardeners to compost:

“If there was more required labor expected out of each member of the garden, and you had three or four people that were going to come out every weekend, somebody who was going to supervise them and get the job done, it [composting] could be done, because people certainly do it in their own yards, and there’s ownership in your own yard, so you know what you’re doing and you’ve bought into that method, but it takes oversight and follow through.”

Likewise, barriers of utilizing compost in community gardens included time and labor of turning the compost; maintaining a steady supply of green material and other source materials; lack of awareness on how to compost; potential for feedstock contamination; not knowing what’s in donated/bought/created compost; and composting at large enough scale that’s practical. A common barrier was difficulty of recruiting gardeners to participate in composting educational workshops due to other competing priorities. One participant shared:

“They have a program on composting and how important it is to the soil, and why you need to chop it up so that it will decompose within a reasonable amount of time. The hardest thing about doing these classes is getting people to attend.”

Hygiene Behaviors

Advantages and Disadvantages—Participants shared that hygiene behaviors (e.g. handwashing, removing gardening shoes prior to entering the home, wearing gloves) had advantages such as reducing dirt and dust in the home, lessening housework and cleaning, minimizing the introduction of diseases (such as Mosaic Virus/Tobacco Disease) into the garden, and decreasing the transport of diseases from one plant to another. A consistent disadvantage to implementing hygiene habits was concern regarding exposure to healthy organisms/microbes in the soil (particularly for children).

“I’ll rinse dirt off my hands, and beyond that, maybe I’m a slob or something, not very hygienic, but I figure to some degree healthy soil is healthy for people too--the microbes and all that stuff”

“But again, then are you going to eat off those hands? (laughs)...It’s levels of how serious you want to get about this, and I tend to think that we’ve gotten into a very sanitized living where we don’t want the least little bit of dirt, and I think sometimes people have more allergies and things like that because our bodies have stopped building up that immunity.”

Other challenges mentioned were that disposable gloves and wipes generated additional waste. Some participants cited that gloves made gardening more difficult particularly if not correctly sized. There were also concerns about “where the soapy water was going” after washing hands and equipment.

Supporters and Non-supporters—Supporters of hygiene habits included teachers and some garden leaders. Teachers and some garden leaders were also mentioned as potential detractors along with parents/volunteer leaders. There was a sentiment that children should be exposed to more physical activity, outdoor work, and soil.

“The teacher at one of our schools wanted them to get dirty, because they’re affluent children and they don’t get dirty very much apparently.”

“I’m notorious. I like to get my hands dirty, so I want the kids playing in the dirt. I want them to feel it, smush it, because after a while they start playing anyway, so I’m not a huge stickler for hygiene in the garden.”

Facilitators and Barriers—Participants expressed that availability of materials (e.g., gloves, hand sanitizer, handwashing station; tippy tap, hand wipes, first aid kits) at the garden site or asking gardeners to bring these materials would make it easier for them to implement various sanitation behaviors. Additionally, gardeners expressed that having training and education on the importance of these behaviors would facilitate more compliance. A few gardeners mentioned that having a gardening agreement or physical signs around the garden to emphasize certain behaviors such as banning pets and pesticides could emphasize the importance of these hygiene behaviors. One participant shared,

“I also think like just education around foodborne illnesses and proper signage too, just making it easy, like mentally easy enough for everyone to see -- You know, because I’ll forget to wash my hands or something like that, but if there’s a sign constantly reminding you or something like that then it takes less mental energy and it’s more likely to get done.”

Barriers to implementing hygiene behaviors included not having access or funding for on-site potable water and costs of resources such as gloves and first aid kits. A participant stated,

“We harvest spring water...we also are near a community center, so we have access to [potable] water. But other places that I know of may not have access to running water on the site.”

Several gardeners also mentioned that these behaviors were very specific to each gardener and that it was difficult to control individual gardener behavior. One gardener shared that a barrier was gardeners' lack of awareness about foodborne illnesses and transmission, *"We're very concerned about people who harvest for the food pantry to realize that it's food, and there are things that you don't do to food. We really are advocating that and educating the community on those principles, because 85% of the foodborne illnesses come from vegetables. We tell people, look, if you're sick, don't harvest."*

Mulching

Advantages and Disadvantages—Key advantages of mulching included suppression of weeds, reduction of leaves/waste in landfill dumps, control of soil temperature and moisture, and decomposition of the mulch to create fertilizer. Gardeners also mentioned that mulching was an inexpensive method to beautify the garden while conserving water. Disadvantages of mulching were the potential for different types of diseases and pests added to the garden depending on the source material, mold (if too much moisture retained), and time and work to reapply mulch throughout the year. A participant shared *"But one of the bad things, because I did have a lot of tree cover, is it[mulch] did harbor mosquitoes because it retains water."* One gardener also mentioned *"Mulching and leaving it on through the winter makes it harder to start seedlings the following spring because of slugs and pill bugs and stuff."*

Supporters and Non-Supporters—Tree and maintenance companies and community garden leaders were mentioned as supporters of mulching; however, no non-supporters of mulching were identified in the focus groups.

Facilitators and Barriers—A facilitator of mulching is that it was viewed as readily available from multiple sources. Participants shared that some companies will drop off the mulch at the gardening site, which improves accessibility and reduces transportation time. Barriers to mulching included the time and labor to apply the mulch and uncertainty about the mulch source material: *"We're a little wary about the wood chips we get from tree companies, because you don't know if those trees were sprayed or not."* Other participants added that barriers to mulch included harboring pests and promoting fungi growth: *"We discovered that because of the termites that come out later, or the mushrooms... we're not allowed to have it[mulch] close to the building."*

Discussion

This qualitative study examined the behavioral, normative, and control beliefs of Atlanta community garden leaders about composting, hygiene behaviors, and mulching. Although these gardening practices are often recommended by government agencies, universities, and non-profit organizations to reduce potential soil contaminants exposures among gardens, few studies have utilized a theory-based framework to examine the underlying beliefs that shape why the recommended safe gardening behaviors may or may not be adopted. By investigating gardeners' salient beliefs, this study fills research gaps that can be applied to the development of interventions that promote safe gardening and to the design of quantitative studies that investigate gardeners' behaviors.

Exploration of the behavioral beliefs of gardeners in this study revealed that heathy soil was perceived as a key advantage to composting and mulching. Other studies have confirmed that compost and mulching contribute to improved soil quality in community gardens, but application of these practices may depend on social demographic factors (Egerer et al. 2018). Participants' behavioral beliefs related to hygiene centered around the benefits of minimizing the spread of dirt in homes. The themes identified in this study also illuminated barriers and facilitators to implementing safe gardening practices among urban community gardeners. Comparable to other studies, community garden leaders in this study discussed two major control beliefs that challenged implementation of all three behaviors: resources (e.g., funding, potable water, volunteers, compost source material), and training (Drake and Lawson 2015; Harms 2011; Henson, Tenorio Fenton, and Tikalsky 2017). Control beliefs also included concerns about contamination of materials used for compost and mulch, as well as availability of water for handwashing. A key finding was that compost and mulch were perceived as practices that could introduce soil impurities such as pesticides and weeds; therefore, these practices were not viewed as mechanism to reduce exposure to chemical contaminants. Several county extension articles have issued warnings about potential herbicide contamination of donated compost and other materials (Jon Traunfeld 2013; Daughtry 2018). While handwashing was discussed as a practice to reduce transfer of bacteria and foodborne illnesses, it was not directly discussed in the context of chemical soil contaminants. Participants identified potential supporters and non-supporters (normative beliefs) that could influence gardeners' opinions regarding these behaviors. Community garden leaders were cited as supporters of all three behaviors. However, since most focus group participants were community garden leaders, more research should be conducted to understand whether garden participants are motivated to conduct behaviors supported by their garden leaders.

Study participants shared that improvement of soil quality to grow nutritious food was a key stimulus for compost production and utilization. Participants also discussed other compost advantages such as promotion of sustainability and advancement of children's environmental education. Similar to another study, participants desired more educational resources and instruction regarding how to compost to improve soil quality (Kaiser et al. 2015). Participants expressed concerns regarding the feasibility of producing compost onsite or acquiring compost through purchases or donations. As highlighted in other compost related reports (Foodwell Alliance 2017; Ahead 2015), common challenges identified were accessibility, affordability, and sustainability of obtaining quality, uncontaminated compost and compost source materials. To generate and use compost properly and consistently, participants shared that sufficient training, time, labor, resources, and land were key facilitators. Research studies suggest using compost thermometers and locating compost bins downhill to reduce introduction of contaminants are best practices for composting safely (Chaifetz et al, 2015).

Participants discussed multiple advantages of executing different hygiene behaviors related to gardening. Although participants expressed the importance of handwashing, produce washing, and removing shoes to reduce spread of potential diseases, several participants shared that these behaviors could also minimize exposure to good microbes. This sentiment was frequently mentioned in discussion of children's access to the garden and exposure to

dirt. Similar to other handwashing behavioral studies, reducing barriers to handwashing were viewed as strongly influencing handwashing intention (York et al. 2009; Soon and Baines 2012). To promote hand hygiene at the community garden site, study participants expressed that access to potable water, handwashing stations, and other resources (e.g., gloves, first aid kit, handwashing signs at the garden) would be beneficial. Moreover, gardening training and educational materials that follow evidence-based risk communication best practices such as clear language, graphics, risk perception and narratives (Jacob, Mathiasen, and Powell 2010) may also help encourage healthy garden hygiene behaviors.

Focus group participants shared several favorable opinions about mulching related to availability, soil quality, water conservation, and garden aesthetics. However, gardeners did not mention the importance of mulching in reducing windblown soil contaminants. It should be noted that incorporation of mulch will not reduce contaminant exposures from surrounding sites, which can be a challenge in urban settings where activities such as demolition can translocate dust and other pollutants. Primary challenges discussed were related to contamination of mulch source material, which could result in harmful chemicals and pests in the garden soil. Other mulch-related challenges included excessive soil moisture and lack of labor resources for mulch application and maintenance. To combat these barriers, advocates of mulching that participants identified in this study, as well as volunteer organizations could assist with mulch testing, application, and training.

This study has several limitations. First, while the researchers strived to recruit diverse perspectives of gardeners from different community garden settings (e.g., neighborhood, schools, faith-based communities, and parks), the focus group participants may not reflect the broader population of Atlanta community gardeners. Demographic factors such as race, income, and garden location may be associated with gardeners' perspectives on soil management and safe practices (Henson, Tenorio Fenton, and Tikalsky 2017; Wong, Gable, and Rivera-Núñez 2017; Egerer et al. 2018). Therefore, the study findings may fail to appropriately characterize the varied perspectives and experiences that influence adoption of the practices among gardeners in Atlanta. Second, time constraints limited the depth of the discussion regarding some behaviors. For example, hygiene behaviors encompass multiple actions including handwashing, glove wearing, produce washing, and leaving gardening materials outside of the home. Each of these behaviors could comprise the emphasis of an entire focus group with each behavior discussed individually. Third, the TPB framework guided the discussion toward individual beliefs; therefore, social ecological factors (e.g., city policies related to urban agriculture, social networks, community empowerment) that could influence gardening practices were not explicitly explored in the focus group discussion. Since human behavior can be impacted by a variety of influences, TPB has been criticized for not directly considering factors such as identity and moral norms (Miller 2017). Given the collective nature of community gardens, exploration beyond the individual-level beliefs to the interaction of community, environmental, and policy elements may be important areas for research (Okvat and Zautra 2011). Although participant interaction during focus groups can enrich the discussion, a limitation of the focus group method is that participants may have provided responses that were perceived as socially acceptable by other participants (Podsakoff, MacKenzie, and Podsakoff 2012). To combat this social desirability bias,

observations related to these practices at the garden may be informative instead of relying on solely on self-reporting through focus groups or surveys.

Similar to other cities, current land use activities and site history can contribute to increased levels of harmful chemicals in Atlanta soils (Deocampo, Reed, and Kalenuik 2012) that could present a risk to community gardeners. For example, five of the eight vacant lots chosen for the Atlanta “Grows-A-Lot” program had a least one soil toxicant that was above the cautionary limit, warranting the use of safe gardening practices (Groundwork Atlanta 2018). Atlanta community gardens contribute not only to strengthening local food efforts, but also providing educational, cultural, youth, and senior programs (Foodwell Alliance 2016; Alliance 2017). Since community gardens constitute key components of several educational (Doyle and Krasny 2003; Aftandilian and Dart 2013), public health (Smith et al. 2013; Centers for Disease Control and Prevention 2015), and urban planning (Goldstein et al. 2011; Horst, McClintock, and Hoey 2017) strategies, it is likely that diverse populations will be in contact with community garden soils. In addition to potential exposure to soil and road dust contamination, some gardeners may also disproportionately experience exposures to other environmental hazards and other environmental justice concerns. It has been well documented that built environment and social inequities can contribute to minority and low income communities’ exposures to hazardous waste sites, air pollution, harmful odors, landfills, illegal dumping, food deserts and other stressors (Wilson 2010; Schulz and Northridge 2004; Banzhaf, Ma, and Timmins 2019). Therefore, these study findings have implications for stakeholders that engage community gardeners in multiple contexts. Application of these study findings to educational programs, policies, and other initiatives can support the sustainability and safety of urban agriculture in other cities.

The TPB provided this study a logical framework to explore the underlying beliefs and motivations about safe gardening practices. Gardeners expressed multiple benefits of conducting these practices; however, they are not thinking of these practices in the context of reducing exposure to soil contaminants. Therefore, safe gardening interventions should consider both the perceived benefits and barriers of these practices, as well as improve awareness regarding mitigation of soil contaminants as an additional advantage. Examples of remaining knowledge gaps include 1) Will interventions that incorporate these study-identified beliefs result in sustainable change related to gardeners’ behavior? 2) How do community garden setting (e.g., neighborhood, school, park), gardener sociodemographic characteristics, and other external factors interact to influence whether these practices are implemented? Future research could build upon the TPB behavioral, normative, and control beliefs explored in this study to quantitatively investigate how attitudes, subjective norms, and perceived behavioral control are associated with intention to conduct these safe gardening behaviors. Case studies should examine strategies of stakeholders such as community members, universities, food policy councils, urban planners, and government leaders that have successfully utilized their resources to promote these safe gardening behaviors in different community garden settings. From a socioecological perspective, individual, community, and policy level approaches are needed to comprehensively protect vulnerable populations from potential soil contaminant exposures in community gardens.

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Appendix: Focus Group Discussion Guide

Note to Moderator-- Phrases in ***bold and italics*** are transition phrases to read between sections. The phrases in *italics* are probes for follow-up. Use them to elicit more detailed discussion if the participants do not cover these areas in response to the first question. The probes marked as “optional” are to be used if the participants need more prompting to understand the question.

Number of Participants _____ (# women: ____ # men: ____) Start Time _____

Introduction:

Hello, and thanks for agreeing to participate in this discussion today. We greatly appreciate you taking time to share your insights with us. My name is _____ and I’m a PhD student in the Environmental Health Sciences Program at the Emory Rollins School of Public Health. This is _____ (note-taker), who is also a student in _____. As part of a dissertation research study, we are hosting focus group discussions with Atlanta community garden leaders to record experiences related to behaviors to reduce contact to harmful metals in soil. At this point, I would like to give you the consent form. If you have any questions regarding the consent form, please let me know.

(5 min wait for completion of consent form and survey).

We have some codes of behavior to help make the discussion go smoothly. These include:

- You don’t have to agree among yourselves, and there are no right or wrong answers.
- If you have different points of view from the others, feel free to share them.
- Try not to talk all at once – take turns talking.
- Speak up so we can hear you on the recorder.
- We encourage everyone to participate, but there may be times when you choose not to say anything.
- Please be respectful of your colleagues, and don’t share anything from today’s discussion with others.

We have a number of questions to get through, so I’ll try to keep the discussion moving. If I rush you at any time, it is because I want to get your ideas on each topic – it is nothing

personal. Our discussion will last about 75 to 90 minutes. At the end of the discussion, will you be given a brief survey. Please silence or turn off all cellphones. Let's begin.

[Start Recording Now!!!]

I'm going to begin with a question about you and your connection to community gardening. [5 min]

1. To start with, please introduce yourself by saying your community garden name, and briefly describe how you've been involved in your community garden.

Now I'm going to ask a few questions about potential hazards while gardening. [15min]

2. Please describe any hazards or risks that community gardeners may encounter while gardening.
 - Hazard/Risk Probe: Physical hazards (fencing, ergonomic, mosquitos), Chemical hazards (contaminants such as lead, pesticides, fertilizers, etc.) Biological (pathogens from animal waste, untreated irrigation water).
 - Past Behavior probe: Have these hazards happened in your garden? What types of contaminants? How did you handle the contaminant?
 - Perceived risk probe: Please explain how concerned you are about these risks?
3. Where do gardeners get information about potential risks or challenges that may arise during gardening activities? [Subjective/Information Norms]
 - Probe: Internet, Workshops, Other gardeners
4. Chemicals in soil include heavy metals such as lead, cadmium, and arsenic. Tell me whether gardeners in your context [whether it be school, neighborhood, senior center, or other type of community garden] have concerns about potential risks from chemical soil contaminants [Attitude/Perceived Risk].
 - Knowledge/ Social Norms Probe: Please describe the types of soil contaminants gardeners are aware of? Why do you think they have that concern? How do you think these risks may affect their health?

My next questions are related to behaviors and best practices that can minimize gardener exposure to heavy metals in soil.

Let's begin with soil testing. Soil testing provides a baseline of the soil quality and contaminant levels. Heavy metal soil testing involves understanding the amount of chemicals such as lead, arsenic, and cadmium in the soil [20 min].

5. What do you think are the advantages of heavy metal soil testing during the next growing season? [*Behavioral Beliefs*]
6. What do you believe are the disadvantages of heavy metal soil testing during the next growing season? [*Behavioral Beliefs*]

7. Please list all the people that you think might approve of you conducting soil testing. These can be individuals or organizations. *[Normative Beliefs]*
Probe: Advice from other gardeners, extension agents, friends, family, government organizations
8. Explain whether there are people or groups that might be against or have mixed feelings regarding soil testing. Why or why not? *[Normative Beliefs]*
Probe: Groups and/or people previously identified
9. What factors or circumstances would make it easier for community gardeners to conduct soil testing? *[Control Beliefs]*
10. What makes it difficult for gardeners to conduct soil testing? *[Control Beliefs]*
Probe: other priorities, cost, liability, interpretation of results, don't know where to get soil tested
How much control do gardeners feel they have over implementing these practices in their gardens?

Now I'd like to focus on another behavior - soil amendments. Examples of soil amendments include compost and phosphorus [20 min].

11. What do you think are the advantages of adding compost amendments to the soil during the next growing season? *[Behavioral Beliefs]*
12. What do you believe are the disadvantages of adding compost amendments to the soil during the next growing season? *[Behavioral Beliefs]*
13. Explain whether you believe that people or groups that you previously identified/fellow gardeners would expect you to add compost amendments to the soil. *[Normative Beliefs]*
14. What factors or circumstances would make it easier for gardeners to add compost amendments to the soil *[Control Beliefs]*
15. What makes it difficult for gardeners to add compost amendments to the soil? *[Control Beliefs]*
Probe: other priorities, cost, liability, interpretation of results, don't know where to get soil tested

Hygiene habits include wearing gloves, leaving gardening shoes and equipment outside, removing shoes prior to entering homes, and thoroughly washing hands to limit soil contact [20 min].

16. What do you think are the advantages implementing these hygiene habits during the next growing season? *[Behavioral Beliefs]*
17. What do you believe are the disadvantages of implementing these hygiene habits during the next growing season? *[Behavioral Beliefs]*

18. Explain whether you believe that people or groups that you previously identified/fellow gardeners would expect you to implementing these hygiene habits.
[Normative Beliefs]
19. What factors or circumstances would make it easier for gardeners to implement these hygiene habits 1 [Control Beliefs]
20. What makes it difficult for gardeners to implement these hygiene habits?
[Control Beliefs]

Probe: other priorities, cost, liability, interpretation of results, don't know where to get soil tested

Before we close, I'd like to ask if you have any additional questions for me. Thank you so much for your time and for sharing your opinions. End Time_____

We will now distribute a brief survey for you to complete. If you elected to have your soil screened, you will be given information on how to collect and mail your soil sample for screening..

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Figure 1.
Theory of Planned Behavior Framework

Table 1.

Focus Group Participant Demographics

Garden Role	N (%)
Community Garden Leader	21 (80.8)
Gardener/ Garden plot owner	1 (0.04)
Volunteer	3 (0.12)
Other	1 (0.04)
Garden Training	
No	5 (20.8)
Yes	19 (79.2)
Type of Garden training	
No (have not participated in training)	2 (9.1)
Nonprofit Gardener Training	8 (36.4)
Master Gardener Training	10 (45.5)
Other	6 (27.3)
Age	
18–35	4 (16.0)
36–55	10 (40.0)
56–65	5 (20.0)
66–75	6 (24.0)
Gender	
Female	20 (76.9)
Male	6 (23.1)
Ethnicity	
Hispanic/Latino	3 (11.5)
Not Hispanic/Latino	23 (88.5)
Race	
American Indian or Alaska Native	0(0.0)
Asian	0(0.0)
Black or African American	7(26.9)
Native Hawaiian or Other Pacific Islander	0(0.0)
White	18 (69.2)
Other (Bi-racial)	1 (3.9)
Highest Level of Education	
High School Graduate or less	0 (0.0)
Vocational/Technical School	1 (4.0)
Some College	2 (8.0)
University/College Graduate	14 (56.0)
Graduate School or Higher	8 (32.0)
Annual Household Income	

Garden Role	N (%)
Less than \$24,999	4 (17.4)
\$25,000 to \$49,999	6 (26.1)
\$50,000 to \$99,999	7 (30.4)
\$100,000 or more	6 (26.1)

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Table 2.

Focus Group Participants' Community Garden Information

Garden Type	N(%)
Neighborhood	15(57.7)
Park	6 (23.1)
School	2(.08)
Faith-based	1(.04)
Senior Center	1(.04)
Other	1(.04)
Land Ownership Status	
Owned	10(40.0)
Leased	2 (8.0)
Community Land Trust	1(4.0)
Municipal Agreement	5(20.0)
Other	7(28.0)
Estimated Garden Size	
Less than .25 acre	6(24.0)
.25 acres-.49 acres	6(24.0)
.5 acres-1 acre	11(44.0)
Greater than 1 acre	2(8.0)

Table 3:

Summary of Participants' Beliefs of the Safe Gardening Practices

Belief Type	Primary Themes	
Behavioral Beliefs	Advantages	Disadvantages
	<ul style="list-style-type: none"> • Improve soil quality • Minimize waste • Create nutrient-rich food • Increase exposure to healthy bacteria • Promote sustainability 	<ul style="list-style-type: none"> • Introduce disease and pests (mulching and compost only) • Generate waste (e.g. disposal gloves, wipes) • Reduce garden yield if improperly implemented
Normative Beliefs	Supporters	Non-Supporters
	<ul style="list-style-type: none"> • Community Garden Leaders • Master gardeners and other gardening experts • Cooperative Extension Office • Non-profit organizations • Businesses (e.g., restaurants, tree maintenance companies) • Local and federal government agencies 	<ul style="list-style-type: none"> • Community Garden Leaders • Neighbors • Businesses
Control Beliefs	Facilitators	Barriers
	<ul style="list-style-type: none"> • Financial resources • Human capital (volunteers) • Training • Gardener participant Agreements • Access (e.g. potable water, mulch and compost source materials) • Garden signage and tools (e.g handwashing stations, compost bins) 	<ul style="list-style-type: none"> • Time and labor requirements • Contamination of source materials • Scale practicality • Lack of control over individual gardener behavior • Lack of awareness of behaviors and potential consequences