



## Adaptation and study protocol for harvest for health together Arizona: A mentored community garden intervention for survivors of cancer

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### ABSTRACT

**Background:** Current health behavior recommendations for skin cancer prevention, treatment, and survivorship are the same for survivors of other cancers; they include eating a healthy diet, being physically active, maintaining a healthy weight, and minimizing ultraviolet (U.V.) exposure. Few interventions exist to support health behaviors beyond U.V. exposure. We adapted Harvest for Health, a home-based mentored gardening intervention for cancer survivors, for implementation in Arizona as a community-based intervention.

**Methods:** Stakeholder-informed adaptations for Harvest for Health Together Arizona (H4H2-AZ) included updating intervention materials to be relevant to the arid desert environment, emphasizing the importance of sun safety in cancer survivorship, and shifting from a home-based to a community-based delivery model. Participants will be enrolled in cohorts aligned with growing seasons (e.g., spring, monsoon, fall) and matched to an individual 30 ft<sup>2</sup> community garden plot for two growing seasons (6 months). Original intervention components retained are: 1) Master Gardeners deliver the intervention providing one-to-one mentorship and 2) gardening materials and supplies provided. This pilot six-month single-arm intervention will determine feasibility, acceptability, and appropriateness of an evidence-based adapted mentored community gardening intervention for survivors of skin cancer as primary outcomes. Secondary outcomes are to explore the effects on cancer preventive health behaviors and health-related quality of life.

**Discussion:** This pilot single-arm intervention will determine feasibility, acceptability, and appropriateness of an evidence-based adapted mentored community gardening intervention for survivors of skin cancer. If successful, the intervention could be widely implemented throughout existing Master Gardener programs and community garden networks for survivors of other cancers.

**Trial registration:** ClinicalTrials.gov identifier: NCT05648604. Trial registered on December 13, 2022.

### 1. Introduction

Skin cancers are the most common cancers diagnosed annually in the United States (U.S.), with non-melanoma skin cancers [NMSC; (i.e.,

basal cell and squamous cell carcinomas)] diagnoses significantly outnumbering melanoma [1,2]. Due to improved screening efforts and recent advancements in curative therapies for metastatic disease, skin cancers are some of the most survivable cancers [3]. Treatment for skin cancers includes medical, surgical, and radiation therapies [4], similar

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**List of abbreviations**

NMSC	non-melanoma skin cancer
HR-QOL	health-related quality of life
U.V	Ultraviolet
RE-AIM	Reach, effectiveness, adoption, implementation, maintenance
FACT-M	Functional Assessment of Cancer Therapy- Melanoma
CHAMPS	Community Health Activity Model Program for Seniors
PCCE	Pima County Cooperative Extension
CES	Cooperative Extension Services
CGT	Community Gardens of Tucson
H4H2-AZ	Harvest for Health Together Arizona
UArizona	University of Arizona
BMI	Body Mass Index
NDSR	Nutrition data system for research

to approaches for other solid tumor cancers [5]. The sequelae of symptoms and side effects resulting from these treatments are also not unlike other cancers [6]. Ultraviolet (U.V.) exposure (e.g., sunlight, tanning beds) is the primary modifiable behavioral risk factor for skin cancer [2]. Concerns regarding continued U.V. exposure and toxicities from skin cancer treatment can hamper health-related quality of life (HR-QOL).

Survivorship care focuses on the physical, psychosocial, and economic strain that patients experience consequential of skin cancer diagnosis and treatment [7], including targeting lifestyle factors to mitigate consequences and reduce risk for new or recurrent cancers [4]. Survivors of any skin cancer are at an increased risk for secondary cancer diagnosis including breast and prostate, cancers associated with poor dietary quality and physical inactivity [8–11]. Current health behavior recommendations for skin cancer prevention, treatment, and survivorship are the same for survivors of other cancers. These recommendations include but are not limited to: eating a healthy diet, being physically active, maintaining a healthy weight, and minimizing U.V. exposure [12–14]. Adherence to current diet and physical activity recommendations is associated with lower cancer incidence and mortality and may alleviate the consequences of skin cancer treatment and further prevent subsequent chronic disease [15,16]. Further, some phytochemicals found in vegetables and fruits have been shown to be protective, with the greatest evidence for carotenoids [17,18]. However, population adherence to these recommendations remains low [19,20]. Education and social influence can improve cancer preventive behaviors among survivors of all cancers [21]. Few interventions supporting skin cancer survivorship are implemented in community settings and clinical practice and are often limited to skin cancer screening or only sun exposure behaviors [22]. Interventions to promote dietary quality and physical activity are essentially nonexistent for survivors of skin cancer, despite the protective effects of these synergistic health behaviors. Moreover, a skin cancer diagnosis may be exclusionary in dietary interventions [23], resulting in underrepresentation of this population and substantial gap in the current literature. Cancer diagnosis and subsequent treatment can motivate health behavior change, and survivors with social support often adopt healthier habits [24–26]. Many survivors of skin cancer do not change their behaviors after treatment [27,28]; therefore, this underserved population may benefit from interventions promoting diet and physical activity while emphasizing sun safety.

A beneficial strategy to promote all three cancer preventive behaviors may be through community gardening. Community gardens are community-based, collaborative efforts to grow food often through a system of individual plots of land [29]. A recent systematic review found that community gardening had positive effects for food-related and psychosocial outcomes [30]. Dietary fiber intake and physical activity

significantly increased among healthy adults participating in a community gardening intervention [31,32]. Notably, community gardening may be an acceptable intervention among survivors of skin cancer as it provides opportunity to integrate U.V. exposure reduction behaviors, offering a more holistic approach to health behavior promotion [33]. Among cancer survivors, gardening in a community setting has been associated with perceived greater fruit and vegetable intake, improved mental and physical health, and social support [34]. Community gardening may be a beneficial intervention to improve adherence to evidence-based health behavior guidelines for cancer survivorship.

Harvest for Health, a mentored gardening program for cancer survivors, demonstrated high acceptability and retention as well as increased vegetable and fruit accessibility and consumption, improved physical function, enhanced social support, and attenuated central adiposity among older cancer survivors in Alabama [35–37]. Remote study delivery of Harvest for Health, necessitated by COVID-19 pandemic, has been successful with standardized protocols [38]. Harvest for Health and the remote delivery has been successfully adapted for New Mexico, and also showed high rates of acceptability, retention, and increased vegetable intake [39,40]. Harvest for Health also demonstrated sustainability among survivors of cancer and stakeholders [41]. The intervention core infrastructure is one-on-one mentorship from gardening experts through the Cooperative Extension Service (CES) Master Gardener Program. To expand Harvest for Health into other states and translate into practice, evidence is needed to support scaling, implementation, and dissemination across various networks to achieve desired health impacts [42].

In continuing efforts to facilitate the expansion and sustainability of Harvest for Health, we aimed to adapt the intervention for the regional context of Arizona through a systematic approach [43]. This paper describes and documents the adaptation procedures to bridge Harvest for Health from a home-based to a community-based mentored gardening intervention and details the pilot study protocol.

## 2. METHODS/DESIGN

### 2.1. Guiding framework for adaptation process

#### 2.1.1. Harvest for Health (H4H) gardening intervention

Originally developed at the University of Alabama at Birmingham in partnership with the Alabama CES at Auburn University, Harvest for Health is a theoretically-informed intervention to promote behavior change [35–37]. Certified Master Gardeners provide mentoring to promote gardening self-efficacy, guide participants throughout the intervention in establishing and maintaining a garden, provide motivation and support as needed, and assist in successfully navigating challenges. The participant and Master Gardener work together to plan, plant, maintain, and harvest seasonal gardens at participants' homes while the Master Gardener provides additional social support and knowledge transfer. Participants receive garden supplies (i.e., plants and seeds) and materials (i.e., printed handouts on gardening safety, health, and nutrition). Throughout the intervention, participants and Master Gardeners interact every two weeks. Southwest Harvest for Health was the first adaption of Harvest for Health in collaboration with the University of New Mexico Comprehensive Cancer Center and the New Mexico State University CES [39,40].

#### 2.1.2. Adaptation process and documentation

The primary aim of this study was to systematically adapt Harvest for Health for successful implementation in Arizona. To balance study fidelity with adaptation, the core components of the original intervention (one-on-one mentoring of the cancer survivor by a certified Master Gardener and provision of gardening materials and supplies) remained. In alignment with adaptation processes for Southwest Harvest for Health [39], we followed recommended steps for intervention adaptation and documentation of processes to identify changes needed for our

population and local context (Table 1) [43,44].

### 2.1.3. Adaptations for harvest for health together Arizona (H4H2-AZ)

The two critical components of the original intervention remain; all participants are matched to a Master Gardener mentor and provided with gardening materials and supplies. Three primary adaptations were made for H4H2-AZ (Table 2). This included updating intervention materials to be relevant for the arid desert environment, emphasized sun safety in cancer survivorship, and shifted from a home-based to a community-based delivery model. Specifically, the adaptation from a

home-based to a community-based mentored gardening intervention was completed to reduce the resources and costs associated with water and land space, provide a social environment and support, and utilize the network of available community gardens present in Arizona. Survivors of skin cancer were selected as the targeted population due to underrepresentation and high need as well as being the most prevalent cancer in Arizona. Additional modifications included significant updates to the intervention handbook with nutrition information and recipes, integrating hybrid educational workshops from Pima County Cooperative Extension (PCCE), monitoring U.V. exposure through wearable

**Table 1**

Harvest for health to harvest for health together Arizona (H4H2-AZ): Process for intervention adaptation.

Step	Adaptation	Description
1	Assess Community	<p><i>National</i></p> <ul style="list-style-type: none"> <li>Based on our literature review, the benefits, potential risks, and safety profile of community gardening for older adults and cancer survivors were identified.</li> <li>Limited epidemiological evidence suggests health behaviors are often below recommendations and remain unchanged among skin cancer survivors.</li> <li>Skin cancer is a cancer control priority for the state of Arizona and the mountain west region of the United States.</li> </ul> <p><i>Local</i></p> <ul style="list-style-type: none"> <li>No behavioral interventions currently exist to support cancer preventive health behaviors for skin cancer survivors in Arizona.</li> <li>Melanoma diagnoses in Arizona ranks above national average.</li> <li>Health disparities related to skin cancer exist in Arizona.</li> <li>The University of Arizona Pima County Cooperative Extension (PCCE) Master Gardener program has the capacity to provide, and support through an available pool of over 100 active Master Gardener volunteers.</li> <li>The majority (76%) of currently active Master Gardeners indicated initial interest in volunteering as mentors in a community gardening intervention.</li> <li>PCCE has existing workshops that can be delivered by Master Gardeners in person or virtually to support intervention educational components.</li> <li>In Tucson, AZ, Community Gardens of Tucson has 14 active community garden plots with available space of 3'x21' raised or sunken garden beds available to lease at a low cost monthly. Plot rentals include soil, water, irrigation, and access to gardening tools. Each plot has a site coordinator to facilitate orientation to the community garden.</li> </ul>
2	Understand the Selected Intervention	<ul style="list-style-type: none"> <li>Behavior change theory informing intervention design and core intervention elements were identified.</li> <li>Original intervention materials for Harvest for Health and Southwest Harvest for Health were shared with the H4H2-AZ research team.</li> </ul>
3	Consult With Experts and Stakeholders	<ul style="list-style-type: none"> <li>Consult with intervention developers and PCCE leadership.</li> <li>Stakeholder engagement included local gardeners, community program coordinators, melanoma survivors, Master Gardeners, cutaneous oncologists, dermatologists, public health epidemiologists, non-profit organizations, and policymakers.</li> <li>Expert advice and stakeholder feedback incorporated into intervention design and delivery.</li> </ul>
4	Decide What Needs Adaptation	<ul style="list-style-type: none"> <li>Determine how original and new target population/context differ: <ul style="list-style-type: none"> <li>Arizona arid environment and year-round growing seasons</li> <li>Skin cancer-specific concerns and participants' abilities</li> </ul> </li> <li>Identify potential new ways to implement the new program: <ul style="list-style-type: none"> <li>Community garden locations</li> <li>Existing PCCE educational workshops</li> <li>Timing and duration of intervention</li> <li>Attendance/adherence tracking and garden journal</li> <li>Hybrid delivery</li> </ul> </li> <li>Retain fidelity to core elements of the original program: <ul style="list-style-type: none"> <li>Vegetable gardening</li> <li>Providing necessary supplies</li> <li>Connecting participants to Master Gardener mentor</li> <li>Updating participant intervention handbook</li> </ul> </li> <li>Document process from the beginning (for later evaluation): <ul style="list-style-type: none"> <li>FRAME (Table 2) documents adaptations in detail</li> </ul> </li> </ul>
5	Adapt Original Intervention	<ul style="list-style-type: none"> <li>Work with original developers and content experts to ensure adapted procedures and materials maintain accuracy of originals.</li> <li>Update intervention handbook for regional context.</li> <li>Make cultural adaptations continuously.</li> <li>Shift to community gardening model and hybrid delivery.</li> <li>Consider environment and social context such as demographics (e.g., age, sex, gender, race/ethnicity, household, college degree, income), health factors (e.g., number of comorbidities, general well-being, time since cancer diagnosis, treatment received, such as chemotherapy, radiation, surgery, etc.), individual health behaviors and social support.</li> <li>Selected health outcomes determined through stakeholder discussions.</li> </ul>
6	Train Staff	<ul style="list-style-type: none"> <li>Master Gardeners were recruited from PCCE. After acknowledging their role, Master Gardeners (n = 8) completed training on research ethics followed by the intervention content, roles, and responsibilities to ensure quality implementation and intervention fidelity.</li> <li>Research assistants are trained through a complimentary work-study program.</li> </ul>
7	Test and Implement	<ul style="list-style-type: none"> <li>The intervention is currently being pilot tested with 30 skin cancer survivors over six months, spanning two growing seasons, with seasonal enrollment.</li> <li>All participants receive a subsidized community garden plot rental for the duration of the study and gardening materials and supplies.</li> <li>Master Gardeners are matched to participants based on participant preferences for mentor as well as location proximity and time availability.</li> </ul>
8	Evaluate	<ul style="list-style-type: none"> <li>Evaluate study processes and outcomes of the adapted program using RE-AIM framework.</li> <li>If necessary, we will make any modifications needed during the process upon consulting with community stakeholders, Master Gardeners, and participants before fielding larger randomized controlled trials.</li> </ul>

**Table 2**  
Detailed adaptations for harvest for health together Arizona (H4H2-AZ).

Program Components	Harvest for Health Together Arizona	Decision Makers	Reasons
Target Population	Survivors of skin cancer	Patient Advocate, Clinical Provider, Study Investigators	High-need population with limited available supportive care interventions, funding specifically for U.V. exposure
Duration of Study	6-month intervention with 2 seasonal gardens	Community Stakeholders, Study Investigators	Five growing seasons permits for gardening year-round in Arizona. (Spring: early March – mid May; Summer: late May – mid June; Monsoon: mid July – late August; Fall: early September – mid November; Winter: mid January – late February)
Participant Materials	A five-module intervention handbook with basic study information and educational content refined and updated for the local context with an additional module added for navigating cancer survivorship. A planting calendar and harvesting table was included. Intervention handbook was customized by a graphic designer.	Community Stakeholders, Patient Advocate, Clinical Provider, Original Intervention Developers, Study Investigators	Improve engagement with intervention handbook and increase participant motivation and readiness.
	Basic recipes that were simple to prepare with minimal ingredients for each growing season were provided in the handbook. A virtual online community was custom built for participants through Google Classroom, which provided links to additional resources if participants wanted to learn more about a particular subject. Participation in the online community is an optional part of study participation. The virtual classroom is regularly monitored for participant questions or posts by the research team.	Patient Advocate, Clinical Provider, Original Intervention Developers, Study Investigators Community Stakeholders, Clinical Provider, Study Investigators, Program Manager	Provide ideas on how to add produce grown in the garden onto a plate with five ingredients or fewer. Reduce information overload by providing additional resources to the intervention handbook in an organized piecewise manner, improve communication between participants and staff, and offer an opportunity for socialization and connection between participants.
Gardening Materials and Supplies	Native and arid-adapted seeds and plant starts for each growing season will be provided. All participants receive gardening hand tools (spade, aerator, transplanter), a kneeling pad, and gloves at the beginning of the intervention. Throughout the study, participants will also receive SPF 50 sunscreen, a long sleeve U.V. blocking shirt, and a wide-brimmed sun hat. Materials are provided during in-person workshop or delivered to home.	Community Stakeholders, Patient Advocate, Clinical Provider, Study Investigators	Available resources and accessibility and reduce barriers and increase motivation and participant retention.
Educational Workshops	Existing PCCE Master Gardener Program workshops were adapted and updated to align with handbook module content and were offered both in-person and virtually by Master Gardeners. An entirely new workshop was developed in partnership on navigating cancer survivorship. Virtual workshops were prerecorded and available to watch at the convenience of the participant. We collaborated with the Garden Kitchen through the CES to offer a cooking demonstration in-person workshop during month four of the study, where participants would learn how to cut and prepare different types of vegetables growing in their garden.	Community Stakeholders, Patient Advocate, Clinical Provider, Study Investigators, Program Manager	Provide information in a structured more formal way while considering knowledge, skill level, and regional and cultural context.
Gardening Journal (Intervention Adherence)	A digital Gardening Journal was created in REDCap. To protect participant privacy, a Q.R. code linking to the Gardening Journal is provided at each community garden plot as a customized tile marker. The journal allows for the upload of photos taken by the participant at their garden to share with the UArizona research team. An alternative paper Gardening Journal template is available for participants that do not wish to use the digital Gardening Journal.	Community Stakeholders, Original Intervention Developers, Study Investigators	Improve accessibility and study flow for the participant and research staff within resource constraints and provide a cue to action for the participant to remember to complete attendance.
Garden Site	CGT- Each rental plot provides a participant with a 3'x20' garden bed with soil, compost, and mulch, as well as water and irrigation.	Community Stakeholders, Patient Advocate, Study Investigators	Reduce resource and cost burden on participants related to water and land space, increase motivation for participation by providing a social environment and support, wide network of available and established community gardens with available resources.
Assessments	Added in wearable sensors to measure physical activity in addition to U.V. exposure and additional health and well-being measures. Dietary intake measured by 24-h dietary recall over survey.	Patient Advocate, Clinical Provider, Original Intervention Developers, Study Investigators	Outcomes of clinical interest and social context and resource availability within restraint of participant burden.
Evaluation	We integrated a protocol for each seasonal harvest to estimate garden yield and the nutritional content grown by each participant. Participants will receive a nutrient report for each seasonal garden which estimates macronutrients and micronutrients as well as the total servings of the produce grown.	Community Stakeholders, Clinical Provider, Study Investigators, Program Manager	Increase participant motivation and readiness and engagement with the evaluation process.
Sustainability	CGT community garden plot renewals and semi-structured interviews will provide process data on sustainability of the intervention.	Community Stakeholders, Original Intervention Developers, Study Investigators, Program Manager	Understand the intervention in the social context and existing infrastructure.

*Note.* Only modifications from the original intervention detailed, all modifications occurred pre-pilot and were proactive adaptations. Abbreviations: CGT- Community Gardens of Tucson; PCCE- Pima County Cooperative Extension; CES- Cooperative Extension Service.

sensors, and providing a community garden plot through a partnership with Community Gardens of Tucson (CGT).

## 2.2. Harvest for health together Arizona: study protocol

### 2.2.1. Study design and setting

H4H2-AZ is a six-month single-arm pilot feasibility intervention ([ClinicalTrials.gov](https://clinicaltrials.gov) identifier: NCT05648604). The study protocol was reviewed and approved by the University of Arizona (UArizona) Human Subjects Protection Program Institutional Review Board (STUDY00002169). We aim to enroll 30 participants as cohorts of up to 12, who will start the intervention aligned with the beginning of a growing season (e.g., Spring, Monsoon, Fall). The purpose of this study is to test the feasibility and acceptability of a mentored community gardening intervention among survivors of skin cancer and to explore whether H4H2-AZ improves fruit and vegetable intake, physical activity, sun-protective behaviors, and HR-QOL. The UArizona research team manages participant enrollment, monitoring, and data collection.

### 2.2.2. Community partnerships

This study is conducted in Pima County, the most populous county in Southern Arizona [45], in collaboration with clinical and community partners. Community gardens with individual 30 square foot garden plots are owned and maintained by CGT, a non-profit organization with 17 community garden locations in the Tucson metro area where individual garden plots are available to rent ([Supplemental Fig. 1](#)). Irrigation and water, soil and compost, and most gardening tools are available at each CGT community garden. CGT receive payments for monthly plot fees (\$22 USD per month per plot) for their collaboration with the study, from which CGT created a scholarship program for participants to cover their plot rental fees for the duration of the study with the opportunity to extend their rental period. Arid adapted and native seed varieties for each growing season were obtained from Native Seeds Search, a local conservation non-profit organization in Tucson, AZ. Seeds include heritage crops such as corn, beans, and squash. Stakeholders from the Arizona Melanoma Task Force, an organization that is part of the Arizona Department of Health Services to promote skin cancer control statewide, were engaged in informing intervention adaptation and supporting local recruitment efforts. We established a clinical partnership with the UArizona Division of Dermatology for recruitment and to pilot the integration of the intervention into survivorship care plans. The Division sees dermatology patients at the Banner University Medicine Dermatology clinic and the UArizona Cancer Center. Specialty clinics are held throughout the week, including general high-risk non-melanoma skin cancer clinics, the Cutaneous Oncology Program clinical activities, and the Pigmented Lesion Clinic.

**2.2.2.1. Master gardener mentors.** The Master Gardener Program is offered by the CES, which provides education and outreach through land-grant universities across all 50 U.S. states, three U.S. territories, 12 Canadian provinces, and the Cayman Islands. The CES is a partnership between federal, state (province), and county agencies to reach rural and urban communities. Building on available strengths, connections, and assets, the CES is an existing infrastructure that can promote health and wellness and address disparities [46,47]. Master Gardeners are highly-trained experts in sustainable regional gardening practices who provide community volunteer service. Master Gardener Programs vary by location and are determined by community needs, but most often provide community food gardening, plant clinics, gardening education, and demonstration garden maintenance [48]. The PCCE Master Gardener Program provides a wide variety of outreach activities and education on environmentally responsible gardening to the public. Eight PCCE Master Gardeners completed training on the study protocol with the UArizona research team before being matched with participant mentees. The average distance from a CGT community garden plot to

Master Gardener is 3.3 miles.

### 2.2.3. Participant eligibility criteria and informed consent

At the time of informed consent and enrollment, participants are eligible if they: 1) have a history of skin cancer (any stage, including basal cell, squamous cell, and melanoma); 2) are 18 years of age or older at their last birthday; 3) self-report good general health; 4) can speak and understand English with the ability to understand and provide written informed consent to participate; 5) have access to an internet-enabled mobile device with a camera; 6) are willing to complete study assessments; 7) report ability to participate in gardening activities (i.e., kneel, sit, bend and carry ten pounds) with or without the use of assistive mobility devices; 8) are currently or plan to reside in Pima County for a minimum of six months. Additionally, eligible participants should express a willingness to learn more about and participate in sustainable desert gardening, self-report no uncontrolled intercurrent illness (i.e., ongoing or active infection, symptomatic congestive heart failure, unstable angina pectoris, cardiac arrhythmia, or psychiatric illness) or immunosuppression by medication or disease (i.e., steroids, immunosuppressants, or AIDS) which would inhibit intervention participation or cause undue risk of additional illness or injury. A potential participant is considered ineligible if they do not meet any of the above inclusion criteria without reasonable accommodations or if they are not able to provide informed consent. All interested and eligible persons will complete the informed consent process with a UArizona research team member before the collection of any data or conduct in study activities.

### 2.2.4. Recruitment strategies

Recruitment is planned to occur in cohorts to align with the start of growing seasons and minimize the burden on Master Garden mentors. Enrollment for the study opened on February 1, 2023, and is planned to close on December 1, 2023. Recruitment approaches include clinical and community methods informed by stakeholder feedback. Study flyers will be distributed in community locations such as libraries, grocery stores, community centers, outreach events, and cancer support groups in Pima County. Clinical providers, including but not limited to dermatologists, oncologists, and social workers, can refer their patients directly to the study during a patient's regularly scheduled appointments. Stakeholder recommendations highlighted easing individuals into the idea of gardening as it may be an unfamiliar and overwhelming concept, resulting in a decline in participation. To address this concern and to increase willingness, we developed seed start recruitment kits. The seed start recruitment kit includes seeds for an easy-to-grow herb (e.g., basil), a growing medium, a customized container to grow the seedling, instructions, and study-specific contact information ([Supplemental Fig. 2](#)). These recruitment kits are available to clinical providers and at local community events.

### 2.2.5. Study procedures and flow of events

The UArizona research team will complete all screening, enrollment, consent, and assessment processes, after which participants receive a community garden plot allocated from CGT, a Master Gardener mentor from PCCE, and gardening materials and supplies ([Supplemental Fig. 3](#)). The matching of a community garden plot and mentor for each participant is individualized and determined through consideration of residence location, transportation access, availability of community garden plots, and participant and Master Gardener proximity. Participants will complete assessments during a  $\pm 4$ -week window from intervention start and end. All self-report data will be collected using REDCap (Research Electronic Data Capture, Vanderbilt University, Nashville, TN, USA) surveys [49]. During the six-month H4H2-AZ intervention ([Supplemental Table 1](#)), participants will be responsible for gardening activities, including planning, planting, maintaining, and harvesting two seasonal vegetable gardens. Master Gardener mentors will meet with participants bi-monthly (either by phone, text message, email, videoconference, or in-person at the community garden) to check in with how participants

are doing with their gardens (e.g., troubleshoot issues or offer advice). After each meeting, Master Gardener mentors send a summary of the meeting with the participant to the UArizona research team via REDCap. During each gardening session, participants will complete an entry into a garden journal, which will provide documentation of intervention adherence and garden progress. Each community garden plot has a quick response (Q.R.) code garden marker that links to the garden journal where they can upload a photo of their garden to share with the UArizona research team. In addition to tending to their garden, participants attend monthly hybrid educational workshops aligned with the intervention handbook module content.

**2.2.5.1. Participant retention.** Participants receive a six-month scholarship to cover a community garden plot rental from CGT for the study. They will receive gardening materials and supplies throughout the intervention, including gardening tools, protective clothing (i.e., wide-brimmed hat and long sleeve shirt), and native and arid-adapted seeds and plant starts. Additional strategies to retain participants include regular contact with the research team (including study staff and master gardener mentors), tiered disbursement of gardening materials and supplies aligned with study activities (Supplemental Fig. 3 and Table 1), an emphasis on study benefits, remote assessment of study outcomes, and easy-to-follow study protocols. Educational workshops are provided monthly with hybrid delivery in an effort to keep participant motivation high throughout the intervention. Communication throughout the study occurs through frequent contact with the UArizona team, twice monthly Master Gardener mentor meetings, and an optional online virtual classroom to engage with other participants and receive encouraging prompts and messages from the UArizona research team.

## 2.2.6. Outcomes and measures

Details regarding measures collected at which time point are provided in Supplemental Table 2. All assessments are collected remotely.

**2.2.6.1. Demographics and clinical Characteristics.** Demographics and clinical history will be collected by self-report at enrollment. Demographics include age, sex, ethnicity, race, education, employment, insurance status, income, marital status, and living arrangements. Clinical history includes cancer history, treatment, current medications and supplements, and parity. Body mass index (BMI, kg/m<sup>2</sup>) will be calculated using self-reported height and weight using standardized cut points [50]. The Fitzpatrick classification will be used for skin phototyping an individual's tendency to sunburn and ability to tan [51].

**2.2.6.2. Primary outcomes.** The primary outcomes are measures of implementation: feasibility, acceptability, and appropriateness. The selected outcome is a self-report 12-item measure with ordinal responses on a 5-point Likert scale that captures participants' perceptions of engaging with the intervention and has demonstrated good validity and reliability [52]. Other feasibility benchmarks will be measured by enrollment of  $\geq 50\%$  interested and eligible participants, adherence (i.e., completed garden journal entries indicating attending to garden on 80% of weeks), and participant retention (80% of enrolled participants through 6 months). Safety of the intervention will be evaluated by adverse event reporting. Additional acceptability and appropriateness outcomes will be assessed at study completion using semi-structured interviews.

### 2.2.6.3. Secondary exploratory outcomes

#### 2.2.6.3.1. Cancer preventive health behaviors

##### 2.2.6.3.1.1. Dietary intake

Dietary quality and fruit and vegetable consumption will be assessed

using 24-hour dietary recalls [53]. Trained staff will complete the 24-hour dietary recalls via telephone on one weekday and one weekend day. Prior to the interview, participants receive a booklet detailing common foods and serving sizes to support the interview. Participants are interviewed using a multiple-pass approach to collect all foods, beverages, and supplements consumed in the previous 24 hours [54]. The collected data is input into the Nutrition Data System for Research (NDSR), which provides a comprehensive output on averaged individual dietary intake of macronutrients and micronutrients [55]. Variables related to dietary quality will be used to calculate a Healthy Eating Index score and total fruit and vegetable servings consumed. Interviewer-administered 24-hour dietary recalls reduce recall bias and improve precision in estimates in cancer survivors [56].

#### 2.2.6.3.1.2. Physical activity and sedentary time

Objective activity data will be collected using the ActiGraph GT9X Link triaxial accelerometer (ActiGraph, LLC, Pensacola, FL, USA). The GT9X Link provides validated estimates of physical activity per day, intensity, and total energy expenditure, including sedentary time [57]. Following a previously established protocol, participants will wear the accelerometer on their nondominant wrist for seven consecutive days [58]. Self-report activity will be measured using the Community Health Activities Model Program for Seniors (CHAMPS) questionnaire [59], a 41-item measure that is a reliable measure of physical activity among cancer survivors [60,61]. Calibrated to accelerometry, CHAMPS provides estimates for weekly energy expenditure for moderate-vigorous intensity physical activity [metabolic equivalent (METs)  $> 3.0$ ] and sedentary time (MET =  $\leq 1.5$ ) [62].

#### 2.2.6.3.1.3. U.V. Exposure and sun protection habits

Cumulative U.V. exposure will be measured using a wearable sensor worn on the dominant wrist for seven consecutive days during normal wake-time activities. The Scienterra Dosimeter Version 2 is a small wearable device that accurately measures personal broadband U.V. exposure [63]. The device's calibration function converts raw data into an erythemally weighted U.V. index and irradiance (w/m<sup>2</sup>) [64]. Self-reported sun exposure and sun protective habits will be measured using a reliable brief questionnaire [65].

#### 2.2.6.3.2. Health related quality of life (HR-QOL) and social support.

HR-QOL will be assessed through the 51-item Functional Assessment of Cancer Therapy- Melanoma (FACT-M) version 4 [66]. Five domains are assessed, including physical well-being, social/family well-being, emotional well-being, functional well-being, and a melanoma subscale, on a 5-point Likert scale (0 'not at all' to 4 'very much' with a score ranging from 0 to 108, where a higher score indicates better quality of life). The minimally important difference (MID) for FACT-M is 2–4 points [67]. The 12-item Cancer Loneliness Scale and Cancer-related Negative Social Expectations Scale will assess social support [68].

## 2.2.7. Power and sample size

Due to the pilot single-arm design of this study, the determination of sample size was based on building capacity and establishing feasibility [69]. The accrual target of 30 participants, assuming 5% attrition, will provide sufficient data on magnitude of effect and variability to inform power calculations for future large-scale randomized controlled trials. Both Harvest for Health and Southwest Harvest for Health demonstrated high retention of participants (95% and 100%, respectively) [37,40].

## 2.2.8. Analysis plan

Descriptive statistics will be conducted to characterize the enrolled study population as well as calculate feasibility benchmarks (i.e., enrollment, retention, adherence, safety) and summarize feasibility, acceptability, and appropriateness quantitative measures. Paired *t*-tests and chi-square tests will be conducted to detect changes in secondary exploratory outcomes. The standardized mean difference between groups using Hedge's *g* will be used to calculate effect sizes for secondary exploratory outcomes to inform sample size determination for future large-scale randomized controlled trials [69,70]. Statistical

analysis will be completed using STATA 18.0 (Stata Corp, LLC, College Station, TX, USA).

### 2.2.9. Program evaluation and sustainability

Potential intervention effectiveness related to social support and self-efficacy will be measured using modified questionnaires [71]. We will investigate sustainability through process data collected from CGT and PCCE, participant surveys, and semi-structured interviews. Interviews will be audio recorded, transcribed verbatim, and analyzed to identify key themes. We will conduct a process evaluation guided by RE-AIM (reach, effectiveness, adoption implementation, maintenance) planning and evaluation framework [72].

## 3. Discussion

Community gardening may be a beneficial integrated strategy to promote a healthy diet and physical activity, and also serve as a channel to provide guidance on U.V. protection among survivors of skin and other cancers. Numerous health benefits, including improved quality of life have been observed for older adults and survivors of cancer who garden in urban settings [73,74]. Activities required for gardening act as consistent behavioral cues and minimize direct access barriers to fresh fruits and vegetables [34,74]. Community gardens are dedicated, safe green spaces that may catalyze sustained long-term health behavior change as a supportive physical and social environment [29,30,74]. As an inherently outdoor activity in nature, gardening may increase potential U.V. exposure, highlighting the importance of copromotion of sun safety. H4H2-AZ builds on the implementation efforts of mentored gardening among survivors of cancer.

Community gardening holds promise as a strategy to promote a trifecta of cancer preventive health behaviors: diet, physical activity, and sun safety. While the importance of dietary quality and physical activity have been established for survivors of all cancers, it may be particularly of significance for survivors of skin cancers. Further, many lifestyle interventions to date have not been tailored to, or have explicitly excluded, survivors of skin cancer. High dietary quality and, specifically, consuming fruits and vegetables decreases subsequent skin cancer risk [17]. Antioxidants found in fruits and vegetables, including vitamin E, vitamin C, and beta-carotene may mitigate cellular damage from U.V. exposure [18]. Although literature on physical activity in survivors of skin cancer has had inconsistent findings, physical activity can contribute to the management of fatigue, pain, and cognitive impairment that can result from previous cancer treatments, improving HR-QOL [6]. Additionally, encouraging social participation and physical activity through interventions such as mentored community gardening may improve long-term health among older cancer survivors [75].

The present study documents the adaptation process of an existing evidence-based mentored home gardening intervention to a community-based delivery model in an arid-environment with enhanced programming on sun safety. While maintaining fidelity to the original intervention, the majority of adaptations were made in consideration of the regional context of Arizona with stakeholder engagement. The intervention is currently being pilot tested which will inform on the feasibility, acceptability, and appropriateness. If successful, results from this study will provide early evidence for the potential health benefits of mentored gardening in a community setting for survivors of cancer. Future efforts should include culturally and contextually relevant adaptations for diverse populations residing in Arizona including Indigenous and Hispanic populations through additional stakeholder engagement.

### 3.1. Conclusion

H4H2-AZ is an adapted mentored, community-based vegetable gardening intervention for survivors of cancer in Arizona. The continued

adaptation of Harvest for Health for regional contexts is crucial to widely scale, disseminate, and implement this evidence-based health behavior intervention for diverse populations and environments. Results from this single-arm pilot feasibility trial will inform the next stage pragmatic randomized clinical trial to identify implementation strategies and increase widespread adoption of Harvest for Health across CES Master Gardener programs and community garden networks.

### Ethics approval and consent to participate

The Institutional Board at the University of Arizona (STUDY00002169) reviewed this research and has approved this research. All research procedures described in this research are in accordance with relevant guidelines and regulations including the Declaration of Helsinki and its later amendments or comparable ethical standards. All participants will provide informed consent prior to participation in study activities.

### Trial status

The study began in February 2023. Recruitment and data collection for T1 and T2 for first two cohorts (growing seasons) are complete. Recruitment and T1 data collection for additional growing seasons is underway.

### Consent for publication

Not applicable.

### Availability of data and materials

Materials and protocols for the current study are available from the corresponding author on reasonable request.

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### CRediT authorship contribution statement

**Meghan B. Skiba:** Conceptualization, Investigation, Methodology, Supervision, Visualization, Writing – original draft. **Dylan Miller:** Investigation, Project administration, Writing – original draft. **Delaney B. Stratton:** Conceptualization, Investigation, Resources, Supervision, Writing – original draft. **Caitlyn A. Hall:** Conceptualization, Methodology, Supervision, Writing – review & editing. **Sharon McKenna:** Methodology, Writing – review & editing. **Cindy K. Blair:** Conceptualization, Methodology, Writing – review & editing. **Wendy Demark-Wahnefried:** Methodology, Writing – review & editing.

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence

the work reported in this paper.

## Data availability

Data will be made available on request.

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We respectfully acknowledge the University of Arizona is on the land and territories of Indigenous peoples. Today, Arizona is home to 22 federally recognized tribes, with Tucson being home to the O'odham and the Yaqui. Committed to diversity and inclusion, the University strives to build sustainable relationships with sovereign Native Nations and Indigenous communities through education offerings, partnerships, and community service.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.conctc.2024.101290>.

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