THESIS

EVALUATING THE IMPACT OF A HEAT-RELATED ILLNESS PREVENTION TRAINING PROGRAM: BEHAVIOR CHANGES IN CROP/AGRICULTURAL WORKERS IN COLORADO

Submitted By

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ABSTRACT

EVALUATING THE IMPACT OF A TRAIN-THE-TRAINER HEAT-RELATED ILLNESS PREVENTION TRAINING PROGRAM AMONG COLORADO AGRICULTURAL WORKERS

Agricultural workers are at a high risk for heat-related illnesses due to exposure to extreme environmental conditions. In recent years, regulations for heat stress prevention in agricultural workers have been evolving, leading several states to implement rules that address the increasing risks. Although many efforts have been focused on establishing these strategies, adherence remains insufficient and the evaluation of the effectiveness of heat illness prevention trainings has been limited. The objective of this study was to evaluate the effectiveness of a training strategy focused on preventing heat-related illnesses among agricultural workers in Colorado under a train-the-trainer model adapted from the Western Agricultural Health and Safety Center at the University of California Davis materials in accordance with Colorado State regulations. In spring 2024, five virtual training sessions were held in English and Spanish, allowing 64 trainers to complete the training. During the same season, the trainers then trained over 750 farmworkers in Colorado. Using Kirkpatrick's framework and a series of surveys and focus groups, the evaluation assessed changes in the level

of reaction, with trainers reporting high satisfaction with the training. The learning level assessment showed significant improvement in trainers' knowledge and the ability to recognize symptoms, understand the risk of heat stress, and strategies to prevent it. At the behavioral level, trainers and farmworkers reported adopting positive changes in their work practices. Finally, the results showed an increase in risk awareness, the importance of participatory leadership, and greater confidence among trainers and workers in protecting themselves from the risk of heat illness. The findings demonstrated that a strategically structured program adapted to agricultural worker's needs can lead to significant changes in learning, workplace behaviors and overall, a better-established safety culture. These activities not only protect workers' health but may also improve their well-being and productivity in the long term.

ACKNOWLEDGEMENTS

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To High Plains Intermountain Center for Agricultural Health and Safety (HICAHS), for allowing me to be part of this experience, which cultivated in me the admiration and constant desire to work for a community that deserve better working conditions, like the agricultural workers.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

Agricultural workers have a high risk for heat-related illnesses due to constant exposure to extreme environmental conditions. Some state regulations are aimed at protecting workers in “higher risk conditions.” It has been found that among many strategies, hydration is a key point to prevent heat-related illnesses, as is the provision of shade and rest, becoming a group of strategies that are easy to implement, in accordance with state standards. Although many efforts have been focused on establishing these strategies, adherence remains insufficient, keeping the risk to the health and safety of workers latent. Evaluating the effectiveness of training strategies focused on preventing heat-related illnesses among agricultural workers is essential to improve their adherence and consequently the safety and well-being of this susceptible population.

The purpose of this study was to evaluate the effectiveness of a heat illness prevention training program for agricultural workers in Colorado, implemented through a "train-the-trainer" model. Reactions to the training were evaluated, and also aspects related to learning, behavioral changes, and workplace safety practices among trainers and farmworkers. The project evaluated a series of trainings hosted in 2024 using surveys and focus groups in 2024 and 2025.

This project contributes to improving strategies aimed at preventing heat-related illnesses in the agricultural sector by evaluating and supporting the effectiveness of

future training programs designed to protect the health and safety of agricultural workers.

2. BACKGROUND AND LITERATURE REVIEW

2.1. Heat Stress Illnesses Among Workers and Regulation in U.S.

Heat-related illnesses represent a significant public health problem in the United States, with an average of approximately 700 heat-related deaths each year across the U.S. general population. A portion of these are work-related cases. According to the Bureau of Labor Statistics, U.S. Department of Labor (2023), from 2011-2021 there have been 436 work-related deaths caused by environmental heat exposure, 44 on average per year. Extreme weather events and severe heat pose significant hazards to the safety and health of workers, leading to increased accidents, mortality, and morbidity during hot climate conditions (Habibi et al., 2024). A study by the Centers for Disease Control and Prevention (CDC) revealed the extreme impact of the June 2021 heat wave in the northwestern United States, particularly in Oregon and Washington, where 1,038 heat-related illness visits were recorded, compared to just nine visits for the same period in 2019 (Schramm et al., 2021). A financial analysis report provided evidence about how heat stress affects work productivity when workers are exposed to heat (Adrienne Arsht-Rockefeller Foundation Resilience Center, 2021). It highlights that elevated temperatures increase the rate of workplace injuries, creating dangerous conditions for workers, further reducing labor productivity (Adrienne Arsht-Rockefeller Foundation Resilience Center, 2021).

The National Institute for Occupational Safety and Health (NIOSH), recommends a comprehensive program to address heat stress in the workplace should include risk

assessment, limiting heat exposure, reducing metabolic heat load, acclimating workers, recommending staying hydrated, and regular training on the heat stress and heat-related illnesses. Workplace educational programs have been shown to increase workers' knowledge of heat-related illnesses (El-Shafei et al., 2018). The evolution of heat stress prevention programs for workers in the United States is a process that is still under construction. Since the passage of the Occupational Safety and Health Act in 1970, which established OSHA, to the present, important but intermittent steps have been taken to address heat stress. In the 1970s, NIOSH conducted crucial studies on the effects of heat on workers, recommending the adoption of occupational standards (NIOSH, 1972). However, it was not until 2005 that California implemented the first detailed heat protection standard, marking a significant milestone (Cal/OSHA Heat Illness Prevention Program & California State OSHA, n.d.). Since then, only four other states have followed suit (Colorado, Minnesota, Oregon, and Washington). At the federal level, progress has been slower, with the Biden administration only in 2021 beginning the process to develop a national heat standard. Currently, pending OSHA's proposal, heat stress protection remains a patchwork of state regulations and federal guidelines, reflecting the complexity and challenges in implementing large-scale workplace safety policies (Public Citizen, 2024).

2.2. Agricultural Workplace Conditions & Worker Demographics

Agricultural workers face an elevated risks of heat related illnesses, during 1992--2006, a total of 68 crop workers died from heat stroke, representing a rate nearly 20 times greater than for all U.S. civilian workers. The majority of these deaths were in adults aged 20-54 years; a population not typically considered to be at a high risk for

heat illnesses. In addition, the majority of these deaths were among foreign-born workers (Centers for Disease Control and Prevention [CDC], 2008). Their risk derives both from the nature of the work—outdoors and with high physical demands—and from compounding vulnerabilities such as poverty, migrant status, language barriers, and barriers to adequate health care. Modifiable workplace factors generate additional risk for agricultural workers; for example, the absence of shade, limited opportunities to adequately hydrate, and payment structures such as piece-rate payment, which incentivizes working harder and minimizing breaks (Johansson, Rask, & Stenberg, 2010).

As reported by the U.S. Department of Labor's Bureau of Labor Statistics (2023), in the United States in 2021, Hispanic or Latino workers represented 47.5% of foreign-born employees, with approximately 12.5 million workers. Among them, the agricultural industry ranked fourth in the number of deaths of foreign-born Hispanic or Latino workers. The state of Colorado ranks 10th for all work-related deaths among this group of foreign-born workers.

2.3. U.S. Heat Regulations for Agricultural Workers

In recent years, regulations for heat stress prevention in agricultural workers have been evolving, leading several states to implement rules that address the increasing risks. California and Washington have led these efforts in creating standards for preventing heat-related illnesses. Under California regulations that apply to all outdoor places of employment including agriculture, employers must provide water, shade, break rest, and annual training to their employees, in addition to developing emergency response procedures. Washington's rules mention implementing buddy systems and

workers' vapor barrier clothing among their specifications. In addition to them, other states have been working on heat protection measures including Oregon, Minnesota and Colorado. Colorado has passed agricultural worker rights legislation, moving closer to developing more comprehensive heat stress prevention regulations that are still in progress.

Under Agricultural Labor Rights and Responsibilities Act (ALRRA), Colorado has required agricultural employers to: monitor outdoor temperature and people for symptoms of heat stress; provide drinking water and shade; maintain effective communication and proper and immediate response to workers experiencing heat stress; and deliver annual worker training on heat stress risks, prevention, and first aid.

House Bill 25-1286 was recently introduced in the Colorado General Assembly. It aims to protect workers exposed to extreme temperatures, including cold or heat, through new workplace health and safety regulations. It requires employers to establish a Temperature-Related Injury and Illness Prevention Plan (TRIIPP), and concerning with the training, requires all workers to receive annual training on heat and cold risks, including worker rights, in a language they understand. This proposal seeks to extend beyond agriculture to sectors such as construction, transportation, and others that require workers to be exposed to outdoor work.

OSHA proposed a new federal standard formally published in the Federal Register in August 2024 entitled Heat Illness and Injury Prevention in Indoor and Outdoor Work Environments. The public comment period closed in January 2025, and as of the date of writing this document, the public hearing period and the final decision are still pending.

2.4. Previous Heat Stress Prevention Training Efforts

For all industries with heat stress as a hazard, CDC and OSHA recommend employers provide effective heat stress training for workers and supervisors. Training should include the recognition of signs and symptoms of heat illness, the importance of hydration, air conditioning, scheduled breaks, and early reporting of signs and symptoms, as well as screening for personal and environmental risk factors (CDC, 2024; OSHA, n.d.). Over time, the importance of applying andragogy principles to adult training has also been emphasized, especially in the field of occupational safety, allowing workers to understand the training objectives from the outset. When workers actively participate in training and understand its rationale, they are more likely to incorporate the concepts and put them into practice (Galbraith & Fouch, 2007). Likewise, incorporating role-playing educational methodologies serves as a reflective experience to reinforce learned concepts and competence gaining (Winardy & Septiana, 2023b).

In construction and general industry, well-structured heat stress training prevention programs have led to significant increases in awareness of heat illness risks and prevention practices among workers (Marchiori et al., 2024). In the agricultural sector, a study in Washington State on culturally and linguistically adapted training led to increased knowledge on heat-related illnesses prevention and positive behavioral changes among farmworkers compared to those who received non adapted approaches (Marquez et al., 2022). Additionally, it has been reported that the involvement of farmers in safety trainings results in greater adherence and a greater likelihood of behavioral changes among the workers involved (Coman et al., 2020).

Efforts aimed at protecting the health of agricultural workers in the United States have led states like California, Washington, and Colorado to implement training programs on heat stress due to the high risk related to working in high temperatures. California's program mandates that agricultural workers receive training in advance of heat exposure. According to Cal/OSHA research, 46% of reported heat illness cases occurred on the first day of work, 80% within the first four days, and none of the victims of heat-related illnesses had received any type of training on the subject (California State OSHA, n.d.). The Washington heat rule was implemented in 2008. However, in a survey study conducted in 2013 among Washington farmworkers, only about one third of workers reported receiving heat training in the past year, suggesting that training may not always be memorable, effective, or provided (Dehdashti, Fatemi, & Poureghtedar, n.d.).

2.5. HICAHS Heat Prevention Training Series

After legal protections were established for agricultural workers in Colorado in 2021, described above, to support Colorado's agricultural employers to meet new requirements and protect workers, the High Plains Intermountain Agricultural Health and Safety Center (HICAHS; a NIOSH-funded Agricultural Health Safety Center) acquired training materials from the Western Agricultural Health and Safety Center at the University of California Davis to be adapted and promoted in accordance with Colorado state regulations in 2022. This material was called "Train-the-Trainers" and was tailored to the training required by agricultural workers in Colorado regarding heat stress prevention. This training was adapted to be delivered as a webinar and was aimed at

farm owners, crew leaders, human resources personnel, managers, and staff belonging to community organizations.

In 2023, HICAHS launched a media campaign to maximize the reach of this initiative, utilizing platforms such as social media, email, community event promotion, and partnerships with agricultural industry allies in Spanish and English, to invite all those interested in heat stress disease prevention in Colorado to participate.

In the spring of 2024, the HICAHS Outreach team hosted five training sessions (three in English and two in Spanish). The training consisted of participating in a trivia game using the Kahoot app, which included questions on concepts related to heat illness prevention. They then received the training, which consisted of nine sections lasting one hour and 30 minutes. These sessions covered topics such as understanding heat illness, its signs and symptoms, the importance of hydration, environmental and personal risk factors, what to do in an emergency, and understanding heat regulations in Colorado, among others. Upon completion of the training, they received digital and physical support resources in English and Spanish, along with scripts and visual materials, which they used during the training.

Table 1 presents a comparative description of the topics that training must cover according to the current and proposed occupational heat-illness related regulations and the topics covered in the HICAHS training.

Table 1

Comparative Table of Required Training Topics

Training Topic	HICAHS Training	Colorado ALRRA	Colorado's Proposed Protecting Workers from Extreme Temperatures Bill	OSHA Proposed Rule
Recognizing Heat Related Illnesses	✓	✓	✓	✓
Preventive Measures (Water, Breaks & Shade)	✓	✓	✓	✓
Acclimatization	✓	✓	✓	✓
Temperature Monitoring	✓	✓	✓	−
Environmental & Personal Risk Factors	✓	−	✓	✓
Basic First Aid	✓	−	✓	✓
Emergency Preparedness	✓	✓	✓	✓
Adapted to Workers Language	✓	✓	✓	✓
Employers' Obligations	−	−	✓	✓

✓ Required/Covered − Partial Required/Covered ✗ No Required/Covered

2.6. Evaluation Framework Kirkpatrick Model

The Kirkpatrick model has been widely used to evaluate the impact of training programs. The latest version (2016) bases its structure on four levels: Level 1 – (Reaction), how the trainers responded to the training; in Level 2 – (Learning), how

much they learned to improve their skills; in Level 3 – (Behavior), how the trainers apply the knowledge learned; and in Level 4 – (Results), the final impact of the training based on the behavioral changes observed in the farmworkers (Kirkpatrick & Kirkpatrick, 2016). The Kirkpatrick model provides one technique for appraisal of the evidence for training programs. Moreover, the model can be used to determine whether a favorable outcome is limited to self-reported staff attitudes and practices, or whether there are improvements to relevant knowledge acquisition and application, and even positive impacts on operating costs (Smidt, Balandin, Sigafoos, & Reed, 2009), reflected in farmworkers' performance after the program to consider its effectiveness in the workplace.

3. STUDY PURPOSE & RESEARCH QUESTIONS

As summarized in the background and literature section, the previous research on agricultural heat illness demonstrates the need and potential for heat illness prevention training to protect agricultural workers from heat-related illness. However, there is a gap in understanding of effectiveness of agricultural heat illness prevention training and the effectiveness of the HICAHS “Train-the-Trainers” webinar in particular.

Study Purpose

The project used a mixed-methods approach and the Kirkpatrick model to evaluate the HICAHS training and to partially address the gaps in the existing literature on the effectiveness of heat illness prevention training among agricultural workers. It had four research questions to understand the effectiveness of the HICAHS "Training the Trainers" training webinar on heat illness prevention. Each question aligned with a level within the Kirkpatrick model.

- Research Question One (Level 1 Reaction): How did trainers react to the content, format, and usefulness of the training?
- Research Question Two (Level 2 Learning): To what extent did the training improve the trainers' knowledge of heat-related illness prevention and comfort in training others after the training?
- Research Question Three (Level 3 Behavior): Did the trainers apply the acquired knowledge and skills to train others in their workplaces?

- Research Question 4 (Level 4 Results): What impact did the training have on the trained farmworkers' behaviors?

4. METHODS

The methods used for this project were reviewed by Institutional Review Board at Colorado State University and determined to be exempt (Protocol number 5548).

4.1. Data Collection

Data collection occurred in three phases: Pre-training, post-training and follow up. The combined data were used to evaluate the training on trainers' knowledge retention and behavior changes over time as well as the impact on farmworkers who received training from the trainers.

4.1.1. Kahoot Pre-Post Knowledge Test.

At the start of each training, a game-mode 10-question test was administered to the trainers by using the Kahoot application, which was repeated at the end of the training to measure trainers' knowledge retention. The quiz included questions covering key topics for heat illness prevention, such as hydration, acclimatization, symptom recognition, and emergency response.

These questions were based on material shared by the training from the Western Center for Agricultural Health and Safety and the University of California at Davis. The full list of questions is available in Appendix A.

This tool addresses Level 2 (Learning) of the Kirkpatrick model and the second research question related to knowledge improvement.

4.1.2. Surveys.

After the training, two surveys were sent to all trainers via email to be completed anonymously and voluntarily in their preferred language (English or Spanish). The first survey was sent immediately after the training and the second was sent approximately three months after the training. Of the 64 trainers, 31 completed the first survey and 19 completed the second survey. These surveys were based on the Western Center evaluation forms and adapted to fit the Kirkpatrick model. Questions included topics such as the number of training sessions they led with farmworkers, their experience with the materials, and their sense of comfort in leading the training. The full list of survey questions is available in Appendix B and C.

This tool addresses Level 1 (Reaction) and Level 3 (Behavior) of the Kirkpatrick model and the first and third research questions related to the trainers' initial feedback and the trainers' experience leading workplace trainings.

4.1.3. Focus Groups.

Two focus groups were conducted in Northern Colorado. The purpose of the focus groups was to gather information from farmworkers (crop workers) about their experience receiving the training and the impact of the training on their behaviors. The focus groups were conducted in the workers' native language, Spanish, without the presence of authority figures who could bias their responses. Farmworkers were recruited based on the farms where the trainers conducted the training approximately four months previously. Two focus group sessions were conducted with the participation of 17 workers in total, conducted on the farm premises. Questions included topics such

as experience receiving the training, effectiveness of the format and materials used, practical application of the information acquired in their workdays, as well as barriers and factors that facilitated its implementation, among others. Each focus group session lasted between one and one and a half hours. Facilitation was led by one researcher and detailed notetaking was led by a research assistant in Spanish. Note-taking and translation were done by a bilingual note-taker, who attended the focus groups, took notes in Spanish, and then translated the notes into English for the researchers to analyze. Farmworkers who participated in the focus groups completed a verbal consent process and were provided with food and a $25 cash incentive.

The focus groups addressed Level 4 (Results) of the Kirkpatrick model and the last research questions related to the impact of the training in farmworkers' behavior.

4.2. Data Analysis

To answer the research questions, this project consisted of analysis of the Kahoot data (Research Question 2), survey data (Research Questions 1, 2, and 3), and the focus group data (Research Question 4). The data analysis was conducted in three phases: descriptive analysis, quantitative analysis, and qualitative analysis.

4.2.1. Descriptive Analysis.

The descriptive analysis described the demographic characteristics of the trainers who attended the training webinar. Analysis of the data collected from the trainers' survey responses allowed for a clearer overview of trainers' characteristics and responses that served as a starting point for the following phases of analysis. This step

also included calculating frequencies in trainers' survey responses for questions that addressed reactions (Research Question 1), self-reported knowledge gains (Research Question 2), and how trainers used the skills and knowledge they gained (Research Question 3).

4.2.2. Quantitative Analysis.

Kahoot and survey data were analyzed to learn about the trainers' immediate change in knowledge and long-term knowledge retention (Research Question 2). To evaluate the trainers' pre-post change in knowledge, a paired t-test was used. This analysis used trainers' test responses conducted before and after each session with the trainers in game mode with the Kahoot application. To measure the trainers' longer-term knowledge retention, their responses from the anonymous surveys were analyzed. These responses did not have identifiers, so they were evaluated at the group-level. Quantitative analysis was conducted in R, a statistical program use to run tests and analyze the data.

4.2.3. Qualitative Analysis.

Qualitative data analysis was conducted through a thematic analysis of farmworkers' responses to open-ended survey questions and detailed focus group notes. The qualitative analysis initially used a deductive approach following the structure of the Kirkpatrick model's Level 4 as a guide. Then an inductive approach was used, identifying main themes and subthemes from the farmworkers' responses without previously establishing categories, facilitating a better contextualized understanding of the impact of the training (Research Question 4).

The inductive step of the qualitative analysis followed the Braun and Clarke method (2006), which identified thematic patterns from the data to define and organize them and construct a final report that allows for understanding farmworkers' responses. Coding and analysis were conducted by two researchers who coded the dataset individually and then compared and refined the coding to obtain the final results. This qualitative analysis was supported by the online coding software Dedoose, and the inter-rater reliability was examined based on Cohen's Kappa statistical measure, within the Dedoose software's Training center, to evaluate the level of agreement between the two coders. The Inter-rater reliability between the coders was 91%, according to Cohen's Kappa statistics, indicating an almost perfect level of agreement in the coding between the researchers (McHugh, 2012).

5. RESULTS

5.1. Participant Characteristics

This research involved two groups of participants, all directly or indirectly related to the agricultural sector. The first group consisted of the trainers who received the virtual training, participated in the Kahoot quizzes, and subsequently became trainers in their workplaces. Their experiences with the training received and subsequently delivered in their workplaces were shared through surveys that were completed anonymously.

Among the 31 trainers who completed the post-survey, 33% were producers or farmers and 29% were representatives of community organizations. The majority (83%) had never received training on heat illness before attending the training. Prior knowledge about heat illness prevention varied among trainers, while 33% rated themselves as somewhat knowledgeable, 19% reported having no prior knowledge on the topic. Regarding how comfortable they felt training others before the training, 49% reported that they were uncomfortable or very uncomfortable doing so (see Table 2).

The second group of participants consisted of 17 Hispanic agricultural workers, with an average of fifteen years of work experience in farms in Northern Colorado, who received training from the trainers, with the materials shared during the webinar. The information from this second group was collected from the focus groups conducted at their workplaces.

Table 2

Trainer Characteristics and Training Background

Variable	Response	% (n)
Job Role	Grower/Farmer	33 (7)
	Community Organization Representative	29 (6)
	Researcher / Promotor	10 (2)
	Government Official/Representative	10 (2)
	Industry Representative	10 (2)
	Supervisor/Safety Officer/Human Resources	10 (2)
Safety Trainings Conducted	None	41 (11)
	1 to 10	37 (10)
	10-19	7 (2)
	More than 20	15 (14)
Previous Heat Illness Training	No	83 (25)
	Yes	17 (5)
Knowledge of Heat Illness Prevention Before Training	Very Knowledgeable	7 (2)
	Knowledgeable	26 (7)
	Somewhat Knowledgeable	33 (9)
	Neutral	15 (4)
	Not Knowledgeable	19 (5)
Comfort Level Before Training	Very Comfortable	0 (0)
	Comfortable	21 (6)
	Neutral	31 (9)
	Uncomfortable	28 (8)
	Very Uncomfortable	21 (6)

5.2. Research Question One (Level 1 Reaction) Results from Post-Training.

In response to the first research question, the trainers reacted positively to the content, format, and usefulness of the training.

The results showed trainers had a positive reaction to the training ;100% of them strongly agreed that they would recommend the training to others. All trainers agreed that the materials were relevant to their work (78% strongly agreed and 22% agreed). After the training, 92% of the trainers felt prepared to train others after the training (52% strongly agreed, 40% agreed), and 86% indicated they had the necessary materials to train others (see Table 3).

Table 3

Trainers' Reaction to the Training

Survey Question	Strongly Agree	Agree	Disagree	Strongly Disagree
Training materials were relevant	78%	22%	0%	0%
I feel prepared to train others	52%	40%	4%	4%
I have materials to train others	50%	36%	9%	5%

Note: n= 31 trainers

5.3. Research Question Two (Level 2 Learning) Pre-Post Training Results.

In response to the second research question, the training improved the trainers' knowledge of heat-related illness prevention and comfort in training others after the training. The results of the paired t test revealed a significant difference between trainers' knowledge before and after training ($t(44) = 2.0225$, $p = 0.04923$; see Figure 1). The mean test score or percent of correct answers increased from 50.6% before the training to 70.9% after the training. The mean difference between the pre- and post-test was 9.88 percentage points (95% CI: [0.00035, 0.19718]), indicating a statistically significant and meaningful improvement in learning after training.

Additional self-reported knowledge gains were obtained through the survey sent three months after receiving the training. The number of trainers with the lowest level of

knowledge decreased significantly after training, from 19% to 0% for those who initially considered themselves not knowledgeable. In contrast, the percentage of trainers who considered themselves very knowledgeable increased from 7% to 52%, indicating a significant improvement in perceived knowledge after training (see Figure 2).

The level of comfort also showed a considerable increase. Before the training, 0% of the trainers considered themselves comfortable enough to train others. After the training, the percentage of those who said they had acquired this comfort increased to 63% (see Figure 3).

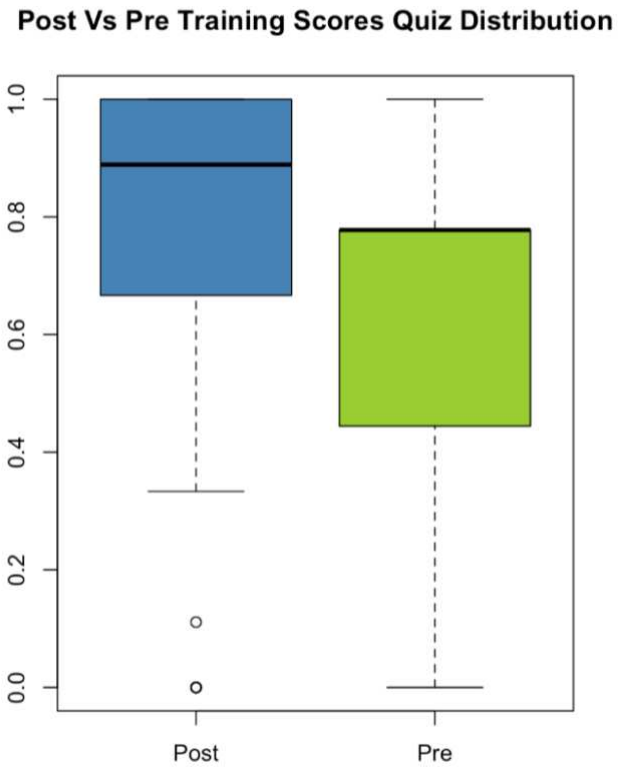

Figure 1. *Trainers' Learning Improvement (Training Scores Quiz Distribution)*

Note: The boxplot shows the median (center line), interquartile range (box), and outliers (dots) of the scores before (green) and after (blue) training. A significant difference was observed between the pre- and post-training medians ($p < .05$). Note: n= 64 trainers

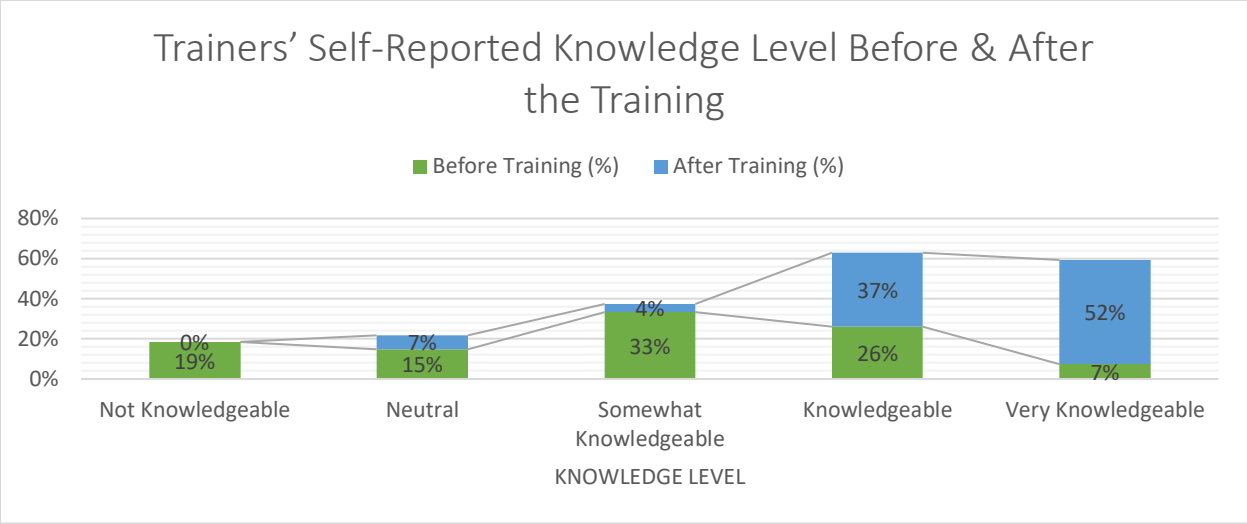

Figure 2. *Trainers' Self-Reported Knowledge Level Before & After the Training*

Note: The figure shows trainers' self-reported level of knowledge before (green) and after (blue) training. *n pre*= 31 trainers, *n pos*= 19 trainers

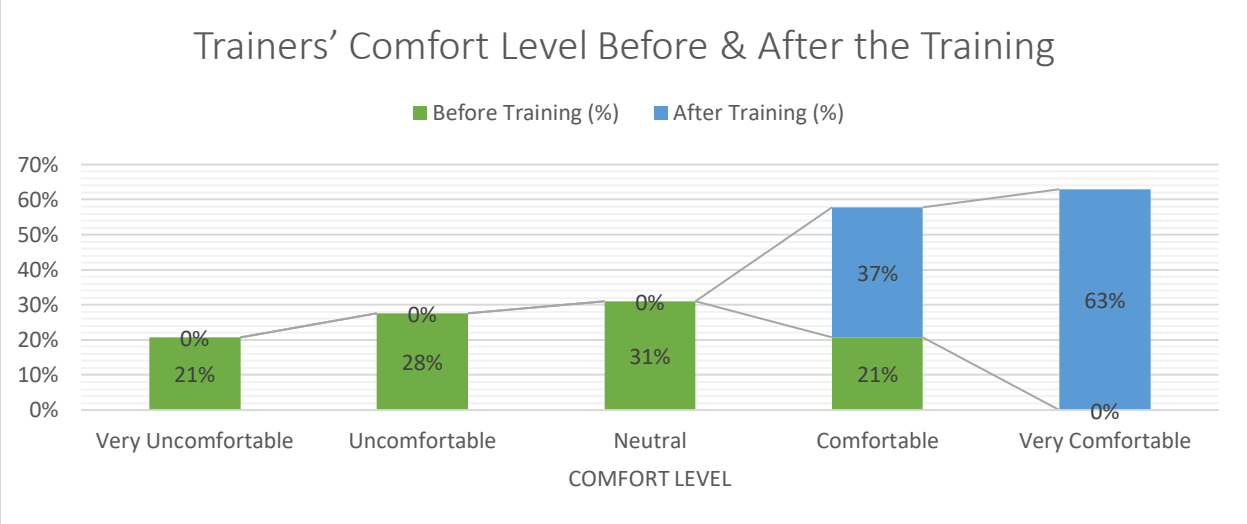

Figure 3. *Trainers' Comfort Level Before & After the Training*

Note: The figure shows trainers' self-reported level of comfort before (green) and after (blue) training. *n pre*= 31 trainers, *n post*= 19 trainers

5.4. Research Question Three (Level 3 Behavior) Follow Up Survey.

In response to the third research question, the trainers applied the acquired knowledge and skills to train others in their workplaces. The results indicated that the webinar enabled attendees to train approximately 750 agricultural workers, with 33% of the trainers reporting that they trained more than one hundred workers (see Figure 4). The professional roles of the trainers included agricultural workers (31%) and general public, administrative staff, contractors, and producers (see Figure 5).

In an open-ended question, trainers were asked which concepts they learned in the webinar that they applied to their workplace training. More than a third of responses (39%) were related to heat stress prevention strategies including hydration, shade, breaks, and the buddy system. Another 33% related their responses to understanding heat risk and workplace safety practices described in their words. For example, one trainer wrote that they learned "*when to know if you are dehydrated. Steps to take when someone is suffering heat stroke*" (see Figure 6).

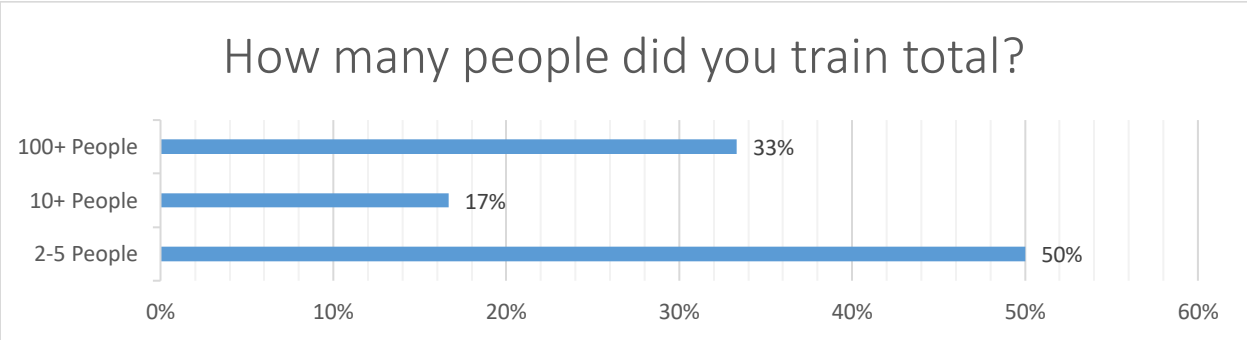

Figure 4. *Number of People Trained.*

Note: The figure shows the number of people trained by the trainers in the respective workplaces *(n*= 19 trainers).

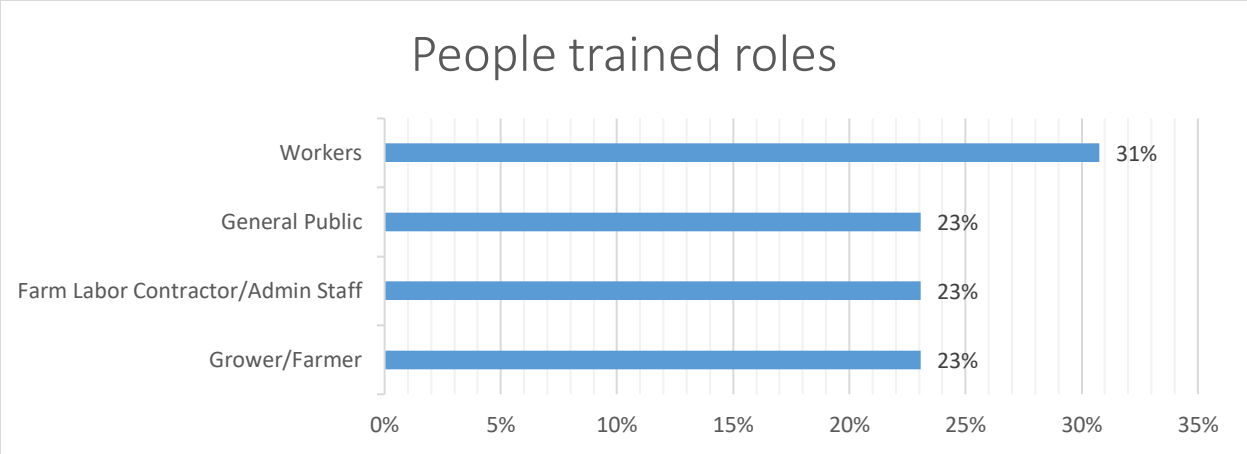

Figure 5. *People Trained Roles.*

Note: The figure shows the distribution of roles of people who received training from trainers in the workplace *(n*= 19 trainers).

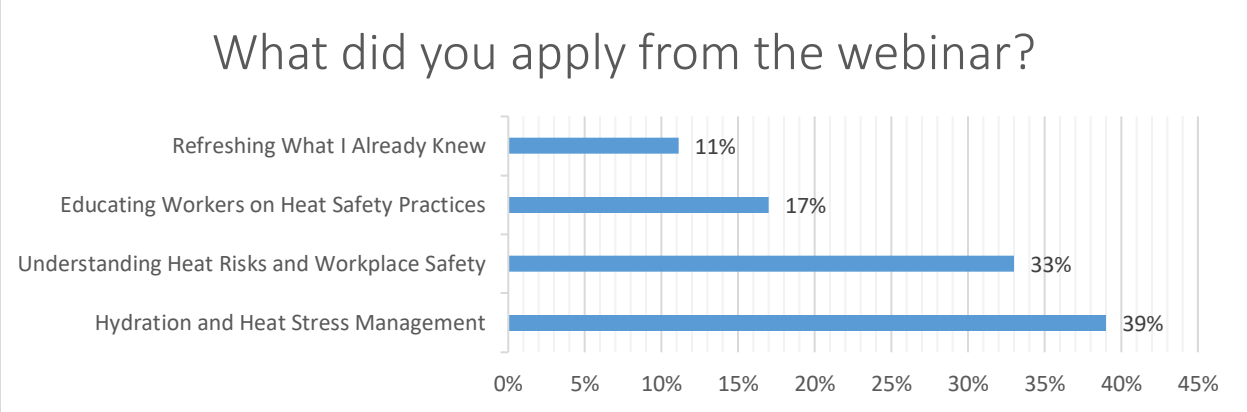

Figure 6. *Webinar Learning Application*

Note: The figure shows which of the concepts learned in the webinar were most used by trainers for training in their workplaces *(n*= 19 trainers).

5.5. Research Question Four (Level 4 Results) Focus Groups with Agricultural Workers.

In response to the fourth research question, trained farmworkers described how they made changes in their behaviors and workplaces due to the training they received from trainers. The main themes (see Table 4) included changes in farmworkers' behavior and perceptions after the training, barriers and facilitators to change, and recommendations to improve the training.

Regarding farmworkers' changes, they described changes in their perceptions about their health and safety. As one farmworker said, "*Our well-being should be a priority*." They also described improvements in their understanding about heat illness prevention, including the importance of hydration, shade, and breaks as key factors in protecting against heat-related illness, as well as recognizing heat-related illness symptoms in themselves and their peers. Changes in their personal behaviors included both changes at work and outside of work. At work, these changes included self-reported strategies for ensuring hydration, self-care routines, and the importance of taking care of themselves and their coworkers during workdays. As one farmworker said, "*Before the talks, I didn't drink much water, but now I do; I even have my own water bottle to take to the field*." Another said, *"I check the weather or ask my coworkers what the temperature will be tomorrow."* Outside of work, changes included activities related to self-care after a workday and preparing for the next one.

Farmworkers described changes in their work practices and culture as a result of the training. As one farmworker said, "*We learned to take care of ourselves and to take care of our coworkers too*." These themes demonstrated how they began to include strategic

planning of work schedules to prevent exposure to heat spikes, the adoption of strategies such as shaded breaks to prevent heat stress in workers during fieldwork, effective communication, and the importance of leadership in maintaining safe practices.

Farmworkers shared barriers and facilitators to making changes to prevent heat illness at work. Specifically, they highlighted that one of the barriers to hydration is that the water source is extremely far from the workplace, so they limit their water consumption to avoid wasting time commuting. They also mentioned external factors such as the fact that, regardless of working conditions, all they can do is resign themselves to the hot working conditions, as these are inherent to their work. As one farmworker said, "*I resign myself; either way, we always have to work, regardless of the weather*." On the other hand, they emphasized that feeling supported and accompanied by their farm owners/managers/supervisors encourages the adoption of safety practices. As one farmworker said, *"(About employers) It's good that they walk with the people (farmworkers). It's nice that they care, if we're learning, if we're doing things right*."

Overall, participants valued the training and had positive reactions to it. Specifically, they mentioned that the training made them more aware of the risks of heat illness and the importance of taking care of their well-being. As one farmworker said, "*We also remember how to recognize the signs when the body needs hydration and that we should notify the supervisor or a coworker if we feel unwell.*" Regarding the type and clarity of the format, they found the format and content clear and easy to understand compared to traditional video-based formats used in workplaces to conduct training. For

example, one farmworker said, “*We can express our opinions and draw our conclusions, as well as group conclusions; we can't do that with a video*.”

Farmworkers also shared recommendations for future training on heat illness prevention and training in general. Specifically, they mentioned that they would like to include practical activities where they can test their acquired knowledge, they would like to have a clearer understanding of what procedures to follow in case of an emergency or first aid, and they would like to have additional support materials (brochures) in frequently used places so they could refer to them if they had any further questions. Farmworkers also mentioned that maintaining this "talks" format for training, in small groups, makes employees more engaged, gives them a clearer understanding by being able to clarify questions in real time, and therefore feels more confident applying it to their workday.

Table 4

Themes and Subthemes from Focus Groups with Illustrative Quotes

Theme	Description	Illustrative Quote, Translated into English
Changes		
In Perceptions of Work	How training influenced farmworkers' risk perception	“Now we are more aware of what can happen if we do not work safely.”
In Safety Culture	How training influenced collective changes in the workplace supporting health and safety at work	“Employees are more important than the work.”
In personal Behavior at Work	How training influenced individual farmworkers’ behavior in the workplace related to:	“We are more aware of our well-being, how we feel, and knowing when we need help.”

Hydration	The importance of drinking water to prevent dehydration	“Sometimes I would hold back from getting water, but after the talk, I don’t; I come and drink water when I feel thirsty because I feel my body needs it.”
Clothing	The importance of selecting clothing that protects them from heat exposure in the field	“I prepare my hat, my clothes, my sunscreen, and my cooler of water.”
Shade	Access to shade for farmworkers to prevent heat stress	“I don’t need to take another break, but we can find shade even in the field and rest for 5 minutes.”
Breaks	Pauses in work to allow workers to prevent heat stress	“They take breaks when they feel they need them.”
Aware & Prioritize Health	The recognition of the value of well-being and self-care	“After the talks, we learned that our health is a priority.”
In personal Behavior Outside of Work	How training influenced individual workers' behavior outside of work	“I check the weather or ask my coworkers what the temperature will be tomorrow.”.
Others’ Behaviors Change	How training influenced the behavior of colleagues in the workplace	“The guys hardly drank any water, but after the talk, they realized it was for their own good; if they feel bad, they can take the day off.”
In Workplaces Practices	How training influenced routine practices in the workplace	“We come earlier so we can leave earlier, that way we don’t hit the hottest hour in the field.”
Barriers & Facilitators		
Barriers to Learning	Challenges that hindered farmworkers' learning	“There were distractions; the groups are not large, but some still get distracted easily.”
Barriers to Change	Obstacles that prevented the adoption of safe work practices	"A lot of times people don't do things not because they don't care, but because they feel ignored."
Facilitators to Change	Factors that supported the successful implementation of new safe practices in the workplace	“(About employers) They remind us that if we feel or see someone feeling bad, we should inform them or help them while they take care of it.”

Reactions		
Positive Reactions	Immediate and favorable responses from farmworkers to the training	“Everyone contributes for themselves; the talks were very good, they paid attention, took it into account, and a change has been noticed.”
Memorable Content	Key messages, concepts, or activities from the training that farmworkers remember and found impactful	“We remember that we must hydrate a lot, seek shade to rest, and take necessary breaks.”
Knowledge Gained	Information acquired by farmworkers through training	“We remember that we must hydrate a lot, seek shade to rest, and take necessary breaks.”
Recommendations	Suggestions for improving training effectiveness	“However, they (farmworkers) suggested there be more interactive moments. “We hear how to do it, but it would be good to practice and actually do it.”

6. DISCUSSION

The effectiveness of a “Train-the-Trainer” training program as a strategy for preventing heat illness in farmworkers in Colorado using the Kirkpatrick model was evaluated in this study, which provides a four-level structure for analyzing the impact across trainers' farmworkers’ experiences. By measuring feedback, learning, reported behavioral changes, and results, a comprehensive observation was obtained (Kirkpatrick & Kirkpatrick, 2016; Smidt et al., 2009).

Results revealed a meaningful change in trainers’ and farmworkers' knowledge, awareness, and behavior regarding risk recognition, hydration, heat protection, and changes in work practices. The results are consistent with El-Shafei et al., 2018, statement about the fundamental role that training programs play in improving trainers and farmworkers awareness and promoting preventive behaviors that can reduce risk is highlighted. Results indicated a high level of awareness about the risk of heat stress in agricultural work, demonstrated not only in the ability to recognize heat stress symptoms, but in the way in which this learning was practically adopted in positive behaviors. Those behaviors included drinking more water during the workday, taking breaks in the shade, checking the temperature, and even wearing appropriate clothing to reduce the impact of heat during the development of their work (California State OSHA, n.d).

Regarding the proposed training model, the results contrast with the previous experience of farmworkers, who traditionally report having been trained with a video-

based model in their workplaces, which they report is ineffective in terms of not allowing them to ask questions or engage with the information making it more confused and difficult to apply. In this project, the results show that implementing a format that allows workers greater participation and personal interaction favors knowledge retention, avoids conceptual confusion by allowing a participatory environment of questions and answers with the trainer in real time, and presents clear and simple information through the use of the provided physical and digital materials that favor different learning modalities: visual and auditory, in addition to practice related to hands-on activities, which were widely recommended by workers as part of their feedback.

Likewise, the literature states that training per se may be sufficient to achieve sustainable behavioral changes over time, as noted by El-Shafei et al., 2018, who found that workplace educational programs increase workers' knowledge regarding heat illness. However, the results of the current study corresponded with Coman et al., 2020, regarding that the success of a training program depends not only on providing information but on involving all members involved in leadership positions that accompany the change, support it and reinforce positive practices.

6.1. Research Outcomes/Impact

The HICAHS training involved the integration of strategies aimed at promoting and protecting workers’ health and different communication initiatives to allow trainers to have the knowledge, comfort, and materials necessary to increase the probability of positively impacting workers' behavior. The concepts taught and the behaviors promoted the concept of safety culture, which is expected to be represented long term in the decrease in negative impact of heat risk on workers’ health. The findings in this

study align with those by El-Shafei et al. (2018), which similarly found that Workplace educational programs increase workers' knowledge of heat-related illnesses.

The findings indicated sustained changes in the knowledge of the trainers, visualized in a transversal way in the behavior and discourse of the workers. It promoted the cooperative attitude and teamwork on safety workplace practices, and highlighted the role of the trainers, as a leadership role in issues related to health and safety at work.

Given the significant risk that farmworkers are exposed to due to heat exposure, supported by CDC findings of 2008 citing high mortality rates for this population group, this study provide evidence on how heat illness prevention training programs can play a critical role in mitigating this risk. By promoting risk recognition, safe practices, and workplace adaptations, these programs can serve as an effective intervention in preventing heat illness in the agricultural sector.

6.2. Limitations

This project has several important limitations, and the results should be viewed within the following constraints. The study used a convenience sample. Participation in both the webinar training and the evaluation was voluntary and driven by the interests and availability of participants. For this reason, no sample size calculation was used for the project evaluation. Instead, all webinar attendees were invited to complete the evaluation activities. The farmworkers were recruited from farms located in Northern Colorado, supported by organizations with an evident interest in prioritizing their health and well-being, so they may not reflect conditions in more precarious environments or in other regions of the country.

The fact that part of the project evaluation was conducted during the harvest season influenced the response rate and participation of the trainers, potentially reducing the representativeness of the data obtained. Similarly, there was no control or comparison group, which limits the ability to attribute the changes seen exclusively to the training received.

Implementation of workplace-based training led by trainers was not assessed. Trainers were not directly observed training farmworkers in the workplace, limiting understanding of the fidelity with which content was delivered and materials provided during training were used.

Finally, due to the scope of the study, rates of heat-related illness among trained farmworkers were not assessed. However, this represents an opportunity for future studies to include long-term follow-up in parallel with occupational health records.

6.3. Implication for Future Training Programs

Based on the results and feedback shared by farmworkers, it is recommended that future HICAHS trainings include more participatory activities that encourage engagement within the training materials. Implementing activity models with role-plays and scenarios may further improve knowledge retention and confidence. Additionally, it is recommended to maintain the adaptation of training, activities, and materials to the languages of workers, according to the specific needs of each population, guaranteeing accessibility for all workers.

Understanding the evolving needs of this workforce and coordinating efforts as regulations change is critical to ensuring effective strategies. It is recommended to

conduct periodic needs assessments in line with regulatory changes, and adjust the content and resources offered so that current and future strategies respond to the dynamics of heat-related illnesses and the working population. A study analyzing post-training heat-related illness rates is also recommended to determine the training's impact at the state level.

7. CONCLUSION

This mixed-methods evaluation of a Colorado-based train-the-trainer education program on heat illness prevention for farmworkers demonstrates that training programs can improve the knowledge and skills of trainers while leading to the adoption of heat-illness prevention behaviors among farmworkers. Recommendations from trainers and farmworkers emphasize the importance of adapting training to the specific needs of the workers. Creating more participatory training environments that actively engage workers can be reflected in greater commitment to maintaining safe practices that go beyond a simple regulatory compliance. These activities not only protect workers' health but also could improve their well-being and productivity in the long term.

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APPENDICES

Appendix A. Kahoot Pre-Post Knowledge Test Questions

- *What can I do to protect myself from the heat?*
- *What is the first sign that your body does not have enough water?*
- *How can you monitor if you are drinking enough water?*
- *What is acclimatization?*
- *How long does it take for a person to acclimatize/get used to the heat?*
- *Which of these are symptoms of heat exhaustion? Which of these are symptoms of heat stroke?*
- *What are the first things that need to happen if a worker shows symptoms of heat exhaustion?*
- *Which of these are procedures to follow during an emergency due to heat illness?*

Appendix B. Post Training Survey Questions

- *What was your goal for attending the training today? (open-ended)*
- *Have you attended training on heat illness prevention in the past?*
- *Approximately how many safety trainings on any topic have you conducted?*
- *Prior to the training, how comfortable did you feel in your ability to train your workers on Heat Illness Prevention?*
- *Now after the training, how comfortable do you feel in your ability to train your workers on Heat Illness Prevention?*
- *Prior to the training, how knowledgeable did you feel about what you are required to do to protect workers from heat illness under the Colorado Heat Illness Prevention Regulations?*
- *Now after the training, how knowledgeable do you feel about what you are required to do to protect workers from heat illness under the Colorado Heat Illness Prevention Regulations?*
- *Do you have the necessary training tools/materials at your workplace to train your workers on Heat Illness Prevention?*
- *What tools/materials would make you feel more prepared to train your workers on Heat Illness Prevention?*
- *I would recommend this training to others. (scale of agreement)*
- *The training materials were relevant to my job. (scale of agreement)*
- *Having government representatives available for questions was helpful. (scale of agreement)*
- *I have the materials I need to train others to prevent heat illness at my work. (scale of agreement)*
- *What was the most relevant and valuable information you learned in the training?*
- *What, if anything, did you learn from the training that you plan to apply in your work?*
- *What did you wish you learned more about to help you train others to prevent heat stress and heat-related illnesses at work?*
- *Are there any other materials that you would find helpful as a supervisor or trainer?*

Appendix B. Follow Up Survey Questions

- *What is your role? (select all that apply)*
- *What, if anything, did you learn from the HICAHS webinar that you have applied in your work?*
- *What changes, if any, did you make to your heat illness prevention practices because you attended the webinar?*
- *How often have you used the resources from the webinar to train others to prevent heat stress and heat-related illnesses at your workplace or elsewhere?*
- *How many people did you train total?*
- *What were their roles? (select all that apply)*
- *What parts of the webinar or resources provided were most helpful in supporting you to train others?*
- *What were the biggest reasons you didn't use the resources provided in the webinar?*
- *What has been the most challenging when using the skills and practices you learned in the heat illness training webinar?*
- *If you could choose the format of the HICAHS-led heat illness training next season, which format would you pick?*
- *If you could choose the timing of the HICAHS-led heat illness training next season, when would you pick?*
- *What support does your workplace need to continue to protect workers against heat illness in the future?*
- *Did you receive any other training about heat illness prevention other than the session you attended in the spring with HICAHS?*
- *Did you use any heat illness prevention resources or materials other than those you received from HICAHS?*
- *What was the focus of the additional materials and where did you get them?*