THESIS

THERE'S SOMETHING IN THE AIR: STUDYING THE BEHAVIORAL INTENTION OF

OUTDOOR WORKERS TO PROTECT THEIR HEALTH DURING AIR QUALITY EVENTS

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ABSTRACT

THERE'S SOMETHING IN THE AIR: STUDYING OUTDOOR WORKERS AND AIR

QUALITY EVENTS IN FORT COLLINS, COLORADO

Poor air quality has been an issue in the United States for decades and has been made more prevalent due to the world's changing environment. Exposure to poor air quality can lead to both short- and long-term health effects that can range in severity. There are a number of health-protective measures an individual can take in order to reduce the effects of poor air quality. The purpose of this study is to research what motivates outdoor workers to take health-protective measures during periods of poor air quality. This study utilizes the Health Belief Model (HBM) and a qualitative approach. Through focus groups with outdoor workers from the City of Fort Collins (n = 18), this study aimed to find out what motivates outdoor workers to take health-protective measures during air quality events. Main findings were that outdoor workers at the City of Fort Collins have experienced air quality events and have the knowledge of what health-protective measures they can take to limit their exposure. It was evident that there is limited action in taking health-protective action during periods of poor air quality. The study concludes with suggestions for ways that current functions of the City of Fort Collins can be improved to further support the outdoor workers for taking health-protective action from poor air quality.

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CHAPTER 1. INTRODUCTION

1.1 Overview and Rationale:

1.1.1 The History of Air Quality in the United States

Air quality both contributes to and is impacted by climate change affecting people's lives every day (Environmental Protection Agency, 2023a). According to the World Meteorological Organization, September 2023 was the hottest September on record with 2023 on track for being the hottest year ever recorded (World Meteorological Organization, 2023). This increase in temperature impacts "extreme events, water resources, coastal erosion, ecosystems, wildfires, food production, human health, amongst many others" (Melamed et al., 2016, p. 85). There is a long history of poor air quality in the United States. During the 1940s and 50s, air pollution episodes in the United States were similar to modern-day China (Williams, 2013). One region in the United States, the Monongahela River Valley, a region near Pittsburgh, Pennsylvania, had a three-day air quality disaster in 1948 that killed 20 people and put over 7,000 others in the hospital (Williams, 2013). The disaster, called the Donora Smog, was caused by toxic smoke coming from the U.S. Steel Corp. Donora Zinc Works and the American Steel & Wire factory - a factory that employed nearly half of the town's 14,000 residents (Williams, 2013). Following this disaster, and a number of others in the United States around the same period, President Eisenhower signed into law the Air Pollution Control Act of 1955 (Tang et al., 2003). According to Tang et al. (2003), the signing of the Act did not enable any kind of regulations but acknowledged that poor air quality existed. Federal funding was allocated for research into poor air quality, but it was not until 1962 when the Kennedy Administration made an amendment to the Air Pollution Control Act that federal funding was allocated for public health research regarding the impacts of poor air quality (Tang et al., 2003). The Clean Air Act and the creation

of the Environmental Protection Agency (EPA) in 1970 were significant federal responses that resulted in more government involvement in air pollution control (United States Environmental Protection Agency, 2022b; Williams, 1993).

There is evidence that air quality has improved in the United States over the past 50 years (Carlin, 2020; United States Environmental Protection Agency, 2020). With the creation of the Environmental Protection Agency and the Clean Air Act in 1970, national attention for better air quality was at the forefront (Carlin, 2020). According to a fact sheet from the EPA entitled, Our Nation's Air, emissions from six main pollutants dropped by 77 percent in the past 50 years in the United States (2020). Despite this progress, air quality still remains a top public health threat today (Jacobs et al., 2018; Jonas, 2014). Bakersfield, California is one of the largest agricultural areas in the United States alongside being one of the largest regions for rail and oil. These industries, alongside the changing environment, make Bakersfield one of the worst areas in the United States for air quality. In an article by the Guardian, a local activist in Bakersfield was concerned that air quality was trending back to where it was 50 years ago (Berg, 2017). These air quality concerns that are felt in California are experienced across the United States. Colorado also has a long history of poor air quality. Denver in the 1980s was notorious for having a 'brown cloud' loom over the city (Brooke, 1998). This encouraged the city to take a number of proactive measures such as banning wood-burning fireplaces, reducing the amount of sand put on streets, and starting the first oxygenated fuels program (Brooke, 1998). These measures have helped with air pollution in Colorado, but the changing climate continues to be a large contributor to poor air quality in Colorado (Santoro, 2022).

In 2022, the Colorado Department of Public Health and Environment's Air Pollution Control Division released a report about a state-wide study that interviewed residents and their

perspectives on climate change (Colorado Department of Public Health and Environment, 2022).

After interviewing more than 100 people from across the state between April and June 2022, one

of the top concerns of the participants was the poor air quality (Colorado Community

Perspectives on Climate Change, 2022). This report made it evident that air quality is an issue

that is important to Colorado residents.

1.1.2 Air Quality Pollutants and the Air Quality Index (AQI)

1.1.2.1 Particle Pollution

There are a number of pollutants that contribute to poor air quality such as particle

pollution and ozone (United States Environmental Protection Agency, 2022d). Particle pollution

contributors are classified into two groups: coarse particulates and fine particulates. The

difference between these two types of particulates is the diameter and density of the particle

(Wilson et al. 2002). Coarse particulates are more dense, larger than 2.5 micrometers in diameter

(United States Environmental Protection Agency, 2021). According to Wilson et al. (2002) these

particles are usually formed mechanically such as dust or dirt from erosion (1011). Conversely,

fine particulates are smaller than 2.5 micrometers in diameter (United States Environmental

Protection Agency, 2021). According to Wilson et al. (2002) particles this small are "generated

from combustion or formed from gasses" (1011). Some examples of these types of particles are

emissions from vehicles, emissions from lawn and garden equipment, and smoke from wildfires.

1.1.2.2 Health Effects from Exposure to Particulate Matter

According to the Center for Disease Control and Prevention (2022), both coarse and fine

particulates are dangerous since the coarse particles can "irritate your eyes, nose, and throat"

while fine particles are especially "dangerous because they can get into the deep parts of your

lungs — or even into your blood" (2022, para. 8). The Clean Air Act required the EPA to

regularly review the science and literature published surrounding the health effects of particulate pollutants. The most recent Integrated Science Assessment for Particulate Matter review published in May 2022 garnered a number of findings about particulate matter focusing on both the short- and long-term health effects of particulate matter exposure. The review of the 2019 Integrated Science Assessment for Particulate Matter found that:

"Substantial scientific evidence exists across disciplines (i.e., animal toxicology, controlled human exposure, and epidemiology) showing that both short- and long-term $PM_{2.5}$ exposure can result in a range of health effects" (Sacks et al., 2022, p. 3).

According to the 2019 review, short- and long-term exposure to PM 2.5 is likely to have a causal relationship with respiratory effects, nervous system effects, and cancer (Environmental Protection Agency, 2019). Additionally, short and long-term exposure to PM 2.5 has a causal relationship with cardiovascular effects and non-accidental mortality (Environmental Protection Agency, 2019). Alongside particle pollution and its health effects, ozone is another contributor to poor air quality and a health concern. According to the EPA (2022d), ozone exists naturally in the stratosphere, but in the lower atmosphere, most ozone pollutants are man-made air pollutants. According to Ebi and McGregor (2008), "Ground-level ozone is a known pulmonary irritant that affects the respiratory mucous membranes, other lung tissues, and respiratory function" (p. 1449). Extended exposure to ozone can lead to higher levels of hospitalizations, chronic obstructive pulmonary disease, and asthma (Ebi & McGregor, 2008).

1.1.2.3 Air Quality Index

With so many different pollutants contributing to poor air quality, the EPA developed a tool to aggregate and display air quality information: the Air Quality Index (AQI). Divided into six sections each with a corresponding color, the AQI dial visually indicates how good or bad the

air quality is and which pollutant is contributing to elevated AQI levels. According to AirNow, a government organization that is home to air quality information in the US, air quality can be thought of as a "yardstick that runs from 0 to 500. The higher the AQI value, the greater the level of air pollution and the greater the health concern" (AirNow, 2023).
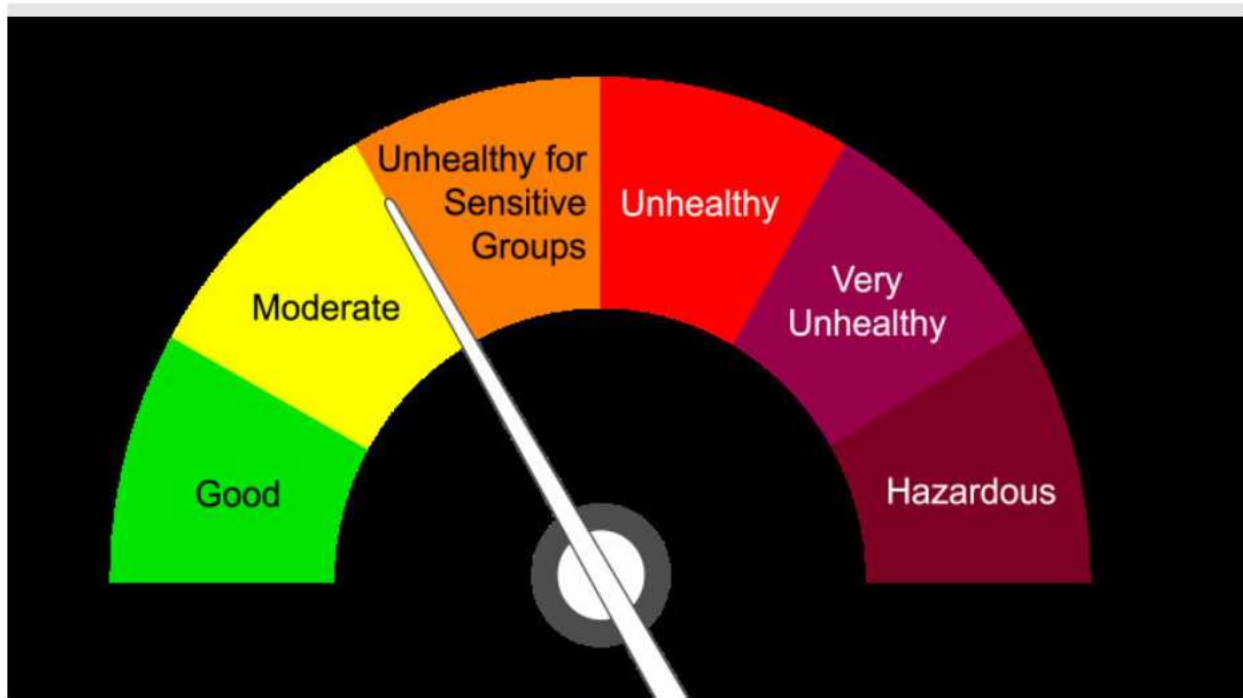
Figure 1. Image of the Air Quality Index dial from Oklahoma Environmental Air Quality (Oklahoma Environmental Air Quality, 2023).

1.1.3 Air Quality in Colorado and Recommended Health-Protective Behaviors

In Colorado, there are a number of different situations that contribute to poor air quality besides particle pollution and ozone. Based on the geographical attributes of the state such as the Rocky Mountains and the Eastern Plains, various regions in the state are susceptible to inversions. In Colorado, an inversion is where pollution is trapped against the foothills creating hazy conditions (Doesken, 2007). In addition to inversions, Colorado's population has grown significantly in recent years. According to US Census data, Colorado's population grew by 700,000 people in the past 10 years (Bradbury & Burness, 2021). With a growing population comes more pollution from sectors like transportation. According to the Denver Post, pollution

from transportation grew 3% between 2010 and 2020 (Finley, 2020). Alongside pollution from humans, there is also pollution from natural sources such as wildfires. In Colorado, the wildfire season has grown hotter and longer. According to The Guardian (2021):

> What the US Forest Service once characterized as a four-month-long fire season starting in late summer and early autumn now stretches into six to eight months of the year. Wildfires are starting earlier, burning more intensely and scorching swaths of land larger than ever before (Canon, & Kamal, 2021).

There are a number of factors that influence the prevalence and probability for fires, including extreme heat, overgrown forests, and longstanding droughts (Michel, 2014). In 2020, Colorado experienced its worst wildfire season in history, three fires burned over 400,000 acres including the East Troublesome Fire, the Pine Gulch Fire, and the Cameron Peak Fire (Swayze et al., 2021; Beese, 2021). The Cameron Peak Fire was the largest fire to ever burn in Colorado burning over 200,000 acres in an area west of Fort Collins and north of Rocky Mountain National Park (Encyclopedia Staff, 2022). Triggering over 110 air quality alerts in Larimer County and surrounding counties, this fire made a lasting impact on Colorado land and its residents (de Yoanna, 2021).

Poor air quality also comes with a number of health implications. Long-term exposure to poor air quality increases the risk of respiratory infections, heart disease, stroke, and lung cancer (Environmental Protection Agency, 2023b). There are also short-term health implications, such as irritation to the nose, throat, eyes, or skin (Rutledge et al. 2022). According to the EPA (2022c), fine particulate matter, specifically particulate matter from wildfire smoke, can be invisible to the naked eye. As an invisible threat of sorts, with mild to moderate immediate impacts, this can make health information surrounding wildfire smoke difficult to communicate.

Some health-protective measures the EPA recommends are reducing time spent outdoors by shortening or rescheduling activities, choosing less strenuous activities, spending less time near busy roads, wearing properly fitting N95 respirator masks, and using HEPA air filters to reduce particles indoors (Environmental Protection Agency, 2022a). These health recommendations are valuable but are not necessarily applicable to all air quality situations. The EPA uses a recommended actions chart for periods of poor air quality (Environmental Protection Agency, 2022a). This chart utilizes the same color scheme as the AQI dial and includes health recommendations based on the air quality. Figure 2 shows how the information on the chart is displayed and the various health recommendations. It is important to note that there are not health-protective recommendations that are specifically designed for groups of people who spend a lot of time outdoors such as outdoor workers.

Air Quality Index	Who Needs to be Concerned?	What Should I Do?
Good 0-50		It's a great day to be active outside.
Moderate 51-100	Some people who may be unusually sensitive to particle pollution.	**Unusually sensitive people:** *Consider reducing* prolonged or heavy exertion. Watch for symptoms such as coughing or shortness of breath. These are signs to take it easier. **Everyone else:** It's a good day to be active outside.
Unhealthy for Sensitive Groups 101-150	Sensitive groups include **people with heart or lung disease, older adults, children and teenagers.**	**Sensitive groups:** *Reduce* prolonged or heavy exertion. It's OK to be active outside, but take more breaks and do less intense activities. Watch for symptoms such as coughing or shortness of breath. **People with asthma** should follow their asthma action plans and keep quick relief medicine handy. **If you have heart disease:** Symptoms such as palpitations, shortness of breath, or unusual fatigue may indicate a serious problem. If you have any of these, contact your heath care provider.
Unhealthy 151 to 200	**Everyone**	**Sensitive groups:** *Avoid* prolonged or heavy exertion. Move activities indoors or reschedule to a time when the air quality is better. **Everyone else:** *Reduce* prolonged or heavy exertion. Take more breaks during all outdoor activities.
Very Unhealthy 201-300	**Everyone**	**Sensitive groups:** *Avoid all* physical activity outdoors. Move activities indoors or reschedule to a time when air quality is better. **Everyone else:** *Avoid* prolonged or heavy exertion. Consider moving activities indoors or rescheduling to a time when air quality is better.
Hazardous 301-500	**Everyone**	**Everyone:** *Avoid all* physical activity outdoors. **Sensitive groups:** Remain indoors and keep activity levels low. Follow tips for keeping particle levels low indoors.

Figure 2. EPA recommended actions during periods of poor air quality (Environmental Protection Agency, 2022a)

1.1.4 The Case of Outdoor Workers in Colorado

In the United States, 4.3 percent of the workforce spends at least two-thirds of their

workday outside (Bureau of Labor Statistics, 2021). This includes individuals like landscapers,

construction laborers, and recreational protective services. For this sector of the workforce,

health recommendations during periods of poor air quality, such as choosing less strenuous

activities, spending less time near busy roads, and using HEPA air filters to reduce particles

indoors, may directly contradict the nature of their work. Outdoor workers might not have the

option to take these health-protective measures while working, especially when outdoors.

Instead, other health-protective behaviors such as wearing a properly fitted face mask and

adjusting work schedules are more feasible for outdoor workers. In California, the Department of

Industrial Relations and Occupational Safety and Health Administration (OSHA), have put into

place regulations to protect outdoor workers from particulate pollution (State of California

Department of Industrial Relations, 2021). In California, when particulate matter in the air is

above 151 on the AQI, employers are required to "move the work to a location where air is

filtered, move work to where the AQI is lower, change work schedules, reduce work intensity, or

provide more rest periods" (State of California Department of Industrial Relations, 2021). If the

AQI is still above 151, employers must provide respirators to all employees for voluntary use

(State of California Department of Industrial Relations, 202). Only when the AQI is above 500,

is it required for all workers to wear respirators (State of California Department of Industrial

Relations, 2021). Similarly in 2022, Oregon adopted a similar OSHA rule to protect workers

from wildfire smoke (Oregon OSHA, 2022). This regulation requires employers to follow a

range of regulations depending on the current AQI (Oregon OSHA, 2022). For AQI between 101

and 250, employers must monitor AQI, provide employee training, implement two-way

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communication, implementing engineering and administrative controls, and providing properly

fitting respirators for optional use (Oregon OSHA, 2022). For AQI above 251, employers must

follow all of the above regulations, but respirators must be provided for mandatory use (Oregon

OSHA, 2022). These regulations put into place by the State of California Department of

Industrial Relations and Oregon OSHA are beneficial to outdoor workers during periods of poor

air quality, but regulations of this kind do not exist in Colorado today.

1.1.5 Geography of Colorado

To better understand this study, it is important to understand some of the characteristics

of the City of Fort Collins, the location where this study took place. Fort Collins is a municipal

town in Northern Colorado. Fort Collins has a population of roughly 169,249 people (United

States Census Bureau, 2022). The city is nestled again the foothills of the Rocky Mountains.

There are a number of contributors to poor air quality in Fort Collins including smoke from local

wildfires and transport smoke from long-distance wildfires and ozone.

1.2 Goal and Research Question:

In Colorado, contributors to poor air quality include particle pollution, ozone, and

inversions. It is evident from the Colorado Community Perspectives on Climate Change study

(2022) that air quality is a concern for many citizens in Colorado. Exposure to poor air quality

can have a number of both short and long-term health effects (United States Environmental

Protection Agency, 2022a). With regard to the health and safety of outdoor workers in Colorado,

it is important to further research what encourages this sector of the workforce to take health-

protective measures during periods of poor air quality. **The goal of this study is to explore what**

motivates the health-protective behavioral intentions of outdoor workers during periods of

poor air quality. Because this study examines what motivates people to take health-protective

actions, the Health Belief Model (HBM) is a useful theoretical lens to organize the inquiries of

the data and further explicate implications for communication and behavior change. In this study,

I will examine how HBM concepts such as perceived susceptibility, perceived severity,

perceived benefits, cues to action, efficacy, and barriers contribute to the outdoor workers'

motivations to take health-protective actions during periods of poor air quality.

CHAPTER 2. LITERATURE REVIEW

2.1 Health Belief Model:

Because outdoor workers spend the majority of their days outside, they are at a higher

risk of being exposed to poor air quality. This can result in both short- and long-term health

effects. In order to gauge what motivates outdoor workers in Colorado to take health-protective

behaviors during periods of poor air quality, this research study will utilize the HBM. The HBM

was first created by the social psychologists Rosenstock, Hochbaum, Kegeles, and Leventhal in

the 1950s (Rosenstock, 1974). Initially, the scientists developed the model to focus the efforts of

those who sought to improve public health by understanding why people failed to adopt a

preventative health measure (Carpenter et al., 2010). But now the HBM is used more widely

utilizing the six components of the HBM (perceived susceptibility, perceived severity, perceived

benefits, cues to action, self-efficacy, and perceived barriers) to determine what influences

someone to take health-protective measures.

In the past 70 years, studies have used the HBM for researching and finding the best

ways for communicating health information to people (Carpenter et al., 2010). Research from

Sheppard and Thomas (2021) looked at the best ways for pharmacists to communicate with

patients during the COVID-19 pandemic. Since pharmacists would have direct interactions with

many patients, Sheppard and Thomas (2021) utilized the HBM framework as a communications

guide that would move patients toward behaviors that will limit the spread of COVID-19.

Additionally, the HBM has been used to study smoking prevention in youths. Work from

Mantler (2013), reviewed 10 studies that used the HBM for the development of youth smoking

cessation campaigns. Mantler concluded that the HBM approach is beneficial for developing

smoking cessation and prevention campaigns (2013). It is evident that the HBM is a widely used

and accepted model in studies related to researching the adoption of health-protective behaviors. As a widely accepted model that can be used in a variety of contexts related to health communication, the HBM is directly relevant to this research. For the purpose of this study, it is important to understand the different factors of the HBM and how these influence the adoption of health-protective measures.

The HBM posits that there are a number of factors that influence an individual in taking health-protective measures: perceived susceptibility, perceived benefits, perceived severity, perceived barriers, cues to action, and self-efficacy. In this review, I will define each of these concepts and discuss further how they relate to outdoor workers taking health-preventative measures during periods of poor air quality.

2.1.1 Conceptualization of Individual Health-Protective Actions

According to Harris and Guten (1979), health-protective actions can be defined as, "any behavior performed by a person, regardless of his or her perceived or actual health status, in order to protect, promote, or maintain his or her health, whether or not such behavior is objectively effective toward that end" (p. 18). In the context of this study, a health-protective action is an outdoor worker taking action specifically for the benefit of their health during an air quality event. Exposure to poor air comes with a number of health implications. Long-term exposure to poor air quality increases the risk of respiratory infections, heart disease, stroke, and lung cancer. There are also short-term health implications such as irritation to the nose, throat, eyes, or skin (Rutledge et al. 2022). Some health-protective measures the EPA recommends individuals do during air quality events are: reducing time spent outdoors by shortening or rescheduling activities, choosing less strenuous activities, spending less time near busy roads, wearing properly fitting N95 respirator masks, and using HEPA air filters to reduce particles

indoors (Environmental Protection Agency, 2022a). Health communication scholarship demonstrates why HBM constructs are useful in explaining health-protective actions from environmental risks such as air quality.

2.1.2 Perceived Susceptibility

Perceived susceptibility is a key component of the HBM and is defined as how susceptible an individual thinks they are to acquiring a disease or illness (Paek & Hove, 2017). According to the HBM, perceived susceptibility is an indicator for someone to take on health-protective behaviors. An article by Wright et al. (2019) utilized the HBM to study wastewater workers using PPE in their workplace. This study collected data from 272 wastewater workers from 33 different facilities throughout the southwest region of the United States (Wright et al., 2019). According to the article, occupational hazards associated with wastewater treatment facilities, including physical hazards, chemical hazards, and biological hazards (Wright et al., 2019). For these wastewater workers, health-protective measures can be taken to mitigate these occupational hazards, such as wearing safety glasses, nitrile gloves, and face masks (Wright et al., 2019). After surveying the participants, the researchers found that perceived susceptibility of illness in the workplace was one of the best indicators of PPE compliance in the wastewater facilities (Wright et al., 2019). This indicates that perceived susceptibility is a key indicator in an individual's probability of adopting health-protective behaviors.

In the case of poor air quality, perceived susceptibility may be how susceptible one believes they are to side-effects or illness they experience when exposed to poor air quality. It is evident from research that there are a number of both short- and long-term health effects that result from being exposed to poor air quality. According to the EPA, in the short-term, individuals may experience coughing, sneezing, shortness of breath, itchy eyes, and runny nose

(2023). But exposure to poor air quality for an extended period of time can also lead to long-term health effects such as Chronic Obtrusive Pulmonary Disease (COPD) and other respiratory tract issues (Environmental Protection Agency, 2023b). In the case of outdoor workers, it is important for this study to understand how susceptible outdoor workers think they are to illness from exposure to poor air quality. This perception may be an important indicator on whether or not they take health-protective measures.

2.1.3 Perceived Severity

Perceived severity is another aspect of the HBM that relates to behavior change. Perceived severity is the belief of consequence (Rosenstock, 1974). In the Wright et al. (2019) study that looked at wastewater workers in the southeast United States, perceived severity - such as contracting a serious disease while working at a wastewater treatment facility - was another factor that contributed significantly to adoption of PPE. This in part led to wastewater workers' adoption of protective equipment to mitigate the possibility of severe disease (Wright et al., 2019).

For outdoor workers, they may take into consideration the severity of both short- and long-term health effects. Their perceived susceptibility to these irritants and illnesses might influence their decision to take preventative measures during periods of poor air quality. In this study, perceived severity is important to take into account because it will help indicate how severe individuals perceive the effects of poor air quality to be and if they are interested in taking preventative measures to mitigate or lessen these negative outcomes from poor air quality.

2.1.4 Perceived Benefits

Aside from the more negative factors such as perceived susceptibility and perceived severity, the HBM also takes into consideration the potential benefits of an action. Perceived

benefits can be defined as what an individual might gain from adopting the health-protective behavior (Rosenstock, 1974). A study by Panakobit et al. (2019) examined sugar cane workers in Thailand. These sugar cane workers are at high risk for inhaling bagasse dust, the dust that comes from the sugar cane during production (Panakobit et al., 2019). Inhaling this dust can lead to short-term irritation of the eyes, nose, and throat, but long-term exposure can lead to worsened asthma and respiratory diseases (Panakobit, 2019). In this study, the researchers utilized the HBM to encourage the usage of Respiratory Protective Equipment (RPE) to protect the workers against the health effects of bagasse dust. According to the study, 50% of participants were already using RPE regularly during their workday. Because of this, those who had high levels of perceived benefits from using RPE were 2.67 times more likely to continue to use RPE equipment (Panakobit et al., 2019). This study makes it evident that perceived benefits of taking health-protective measures can also have a larger influence on the intention to adopt health-protective measures.

For outdoor workers, it is important to understand what their perceived benefits of taking health-protective measures are. Specifically, it is important to understand if the outdoor workers would be interested in utilizing health-protective measures if it means it would mitigate their short-term and long-term health effects. It is also necessary to understand the outdoor worker's perception of the effectiveness of health-protective actions to reduce the threat of illness or disease caused by poor air quality. Furthermore, what remains to be studied is how these perceived benefits influence their behavior. In this study, if outdoor workers perceive there to be benefits surrounding the usage of health-protective equipment, this may influence their usage of that equipment and taking health-protective action.

2.1.5 Cues to Action

When discussing health-protective behaviors and the HBM, cues to action is another important concept. According to Rosenstock (1974), cues to action are exposure to factors that prompt action of behavior. In the context of air quality, there can be multiple cues to action. A cue to action can range from visible smoke in the air, to observing others taking health-protective measures, to information displayed on the AQI. All of these examples are potential cues to action for someone to take health-protective measures during a period of poor air quality. They are also generated from different sources: the natural environment, the social environment, and the mediated communication environment. The visual cue of smoke in the air from a wildfire may cue outdoor workers to take health-protective behaviors. But some particulate matter in the air is very small and can even be invisible to the naked eye (Environmental Protection Agency, 2021). Another cue to action for someone to take health-protective measures during poor air quality is seeing others taking preventative measures. One study by Li (2021) studied individuals taking health-protective measures during the COVID-19 pandemic. In this study, cues to action were one of the strongest influences on behavior. These cues to action ranged from people washing hands, to social distancing, to wearing face masks (Li, 2021). In the case of outdoor workers, similar cues to action such as coworkers wearing facemasks or taking other health-protective measures might influence one's adoption of the health-protective measure. Another cue to action is information on the AQI dial. A study by Tomcyzk (2021) looked at the effectiveness of app-based weather warnings in a virtual city. The study found that there was an affective (i.e., fear) response to the weather warning and encouraged participants to take the appropriate safety measures (2021). The AQI dial might have a similar response from participants and also encourage the adoption of health-protective measures.

2.1.6 Efficacy

Defined by Skinner and Champion (2008), individual efficacy is the belief of "personal ability to perform behaviors that bring desired outcomes" (171). For outdoor workers in this context, efficacy is how much they believe they can take the health-protective measures that would protect their health from exposure to poor air quality (ref). A study by Wagner et al. (2013) looked at the relationship between PPE, self-efficacy, and job satisfaction for women in the construction industry. This study collected data from 75 women in the construction industry (Wagner et al., 2013). While women make up only 3 percent of the construction workforce, they are still required to use PPE on the job (Wagner et al., 2013). Since there is a small demographic of women in the industry, there is limited access to PPE equipment designed for women and the PPE they are provided is usually ill fitting (Wagner et al., 2013). The survey of the participants found that 95 percent of participants used PPE at work. The results of the study indicated that greater access to PPE designed for women would result in higher usage of PPE, higher self-efficacy of work, and greater job satisfaction from women in the industry (Wagner et al., 2013). This demonstrates that self-efficacy of employees is an important indicator in the adoption or continued use of a protective measure. As identified previously, there are a number of health-protective measures outdoor workers can take during periods of poor air quality. What remains to be studied is how the individual efficacy of workers motivates them to take health-protective measures during periods of poor air quality.

2.1.7 Barriers

Barriers are the "perception of cost associated with adhering to a recommended health behavior" (Kagee & Freeman, 2017). There are a number of barriers that outdoor workers might face, including personal, structural, and organizational barriers. Each of these barriers is

important to take into consideration because these might impact an individual's ability to perform a behavior.

2.1.7.1 Personal Barriers

Personal barriers are the barriers from an individual that limit the adoption of a behavior (Kagee & Freeman, 2017). In the case of outdoor workers, this might involve health problems that prohibit the use of PPE, personal preference of PPE, and the limitations of PPE. An article by Abdollahzadeh and Sharifzadeh (2021) looked at how farmers could use PPE to limit their exposure to dangerous chemicals in the largest rice producing region in Iran: the Mazandaran Province. In the study, Abdollahzadeh and Sharifzadeh (2021) found that the main limitation to the adoption of the PPE were personal barriers of the workers. They found that the masks were uncomfortable to wear for long periods of time and significantly reduced the farmer's likelihood of adopting the health-protective measure (Abdollahzadeh & Sharifzadeh, 2021).

According to an article by Akbar-Khanzadeh et al. (1995), 62 percent of people found PPE to be uncomfortable to use for an entire work shift. Limitations of the equipment is how effective it is to protect outdoor workers during periods of poor air quality. An article by Zhou et al. (2015) found that the usage of filtering face mask respirators "limit the harmful effects of air pollution" (146). But while face masks help to improve the quality of air, they are not the perfect solution. According to an article from Multnomah County (n.d.), not all face masks are the same. In the case for fine particulate matter, such as smoke from wildfires, there is a need for specialized masks such as N95 or P100 respirators, but other, more widely available masks do not offer the same kind of protection (Multnomah County, n.d.).

2.1.7.2 Structural Barriers

In addition to personal barriers, there are also structural barriers that might limit an individual to perform a behavior. Structural barriers are factors that are outside of an individual's control but limit the ability to perform a behavior (Kagee & Freeman, 2017). A study by Lin et al. (2022) looked at race disparities during the COVID-19 pandemic. This study found that different races were impacted differently by the COVID-19 pandemic in the United States (Lin et al., 2022). Structural barriers such as access to the internet, work needs, and access to healthcare were important variables that contributed to one's health during the pandemic. In the case of outdoor workers, there are similar structural barriers. Outdoor workers do not have the ability to stay home during periods of poor air quality. In addition, there might be additional economic factors that limit outdoor workers from taking preventative measures or access to information. Structural barriers were outside the scope of this study because the sociocultural context is not a part of the HBM.

2.1.7.3 Organizational Barriers

Organizational barriers are barriers in an organization that limit a behavior (Kagee & Freeman, 2017). In the case of outdoor workers, there are a number of organizational barriers that can prevent outdoor workers from taking health-protective measures. Barriers in the workplace might be access to personal protective equipment, supervisors prioritizing work over employee health, and relationships with coworkers. Only in 2020 were the first air quality health mandates for outdoor workers implemented in California (State of California Department of Industrial Relations, 2021). This means that access for health-protective measures and supervisor support for protecting employees might be limited with no protocols for air quality events in

place. It will be important to find out what organizational barriers exist for outdoor workers and how this impacts their ability to take health-protective measures.

2.2 Concluding Summary

The HBM is a widely used theoretical framework that can be used for health communication. The six components of the HBM are individually important to consider because they each contribute to an individual decision of taking health-protective measures. This theoretical framework will be beneficial for this study because this study aims to find what motivates outdoor workers to take health-protective measures during periods of poor air quality. Now that the concepts have been defined utilizing the literature, the following sections will describe the methods, results, discussion, and conclusion.

CHAPTER 3. METHODS

In order to gain a better understanding of what motivates outdoor workers to take health-protective measures during periods of poor air quality, it is important to speak with the workers themselves to gain their insight. By discussing concepts related to the HBM such as perceived susceptibility, perceived severity, perceived benefits, cues to action, self-efficacy, barriers, and health-protective actions, this study will be able to find out what the contributing factors are for outdoor workers to take health-protective measures during periods of poor air quality.

3.1 Research Objectives

1. To identify what motivates outdoor workers to take health-protective measures during poor air quality utilizing the constructs of the HBM.

3.2 Theoretical Framework of the Method

In this study, I am researching what motivates outdoor workers to take health-protective measures during periods of poor air quality. In order to accomplish this study successfully, a theoretical framework is necessary. Based on the nature of the study, the most logical and natural theoretical framework to utilize is the HBM. Utilizing the HBM, this study will also have a qualitative approach with the use of focus groups. The purpose of the qualitative approach is to understand some of the reasons why outdoor workers make the health decisions they do. A focus group setting would allow for rich conversations with outdoor workers about air quality and what motivates them to take protective measures. The purpose of the focus groups is to delve into HBM concepts further and determine which factors motivate outdoor workers to take health-protective measures.

3.3 Stimulus Materials

In the focus groups, we had a number of stimulus materials we presented to the participants. In the focus group protocol, the last section of the study was designed to get feedback from outdoor workers on a few different displays of air quality information. During this time, we showed the participants the stimulus materials. The purpose of this was to get direct feedback from outdoor workers about what they liked about the information displayed and what they did not like. The purpose of this would be to ultimately improve the way air quality information is displayed on the City of Fort Collins website. This area of the focus groups is not directly relevant for studying what motivates outdoor workers to take preventative measures during periods of poor air quality but is relevant for future projects and studies.

3.4 Themes and Concepts

There are six factors that contribute to the HBM: perceived susceptibility, perceived severity, perceived benefits, cues to action, self-efficacy, and perceived barriers. In addition, another important concept of this study is health-protective actions. It is important to discuss each of these concepts and how they will be analyzed in the data. The design of the focus group protocol asks questions about each of these factors in order to find what might motivate outdoor workers to take health-protective behaviors. These questions were asked in a specific order so that the responses from the focus group participants were not influenced by the facilitators. This is evident in the protocol (Appendix F) where the questions about air quality and the participant's experiences with it are more generalized, then get more specific throughout the protocol.

3.4.1 Perceived Susceptibility

Perceived susceptibility is how susceptible one believes they are to poor air quality. This includes how susceptible one believes they are to both the short- and long-term health effects of poor air quality. In the focus groups, there are specific questions that are designed to elicit responses that look into how susceptible participants feel they are to poor air quality. Questions associated to gain responses for this concept are:

1. Have you ever experienced any irritations or problems that you thought could be due to poor outdoor air quality?

2. How concerned are you about poor air quality affecting you?

3.4.2 Perceived Severity

Perceived severity differs from perceived susceptibility because it gauges intense, negative outcomes. In the case of outdoor workers, this might be the perception of how severe the experience of any of the symptoms associated with exposure to poor air quality are. This might mean the perceived severity of both short- and long-term outcomes. During the focus groups, we had two questions that were designed to gauge how severe outdoor workers perceive exposure to poor air quality to be.

1. What do you know or think the risks to you are from poor outdoor air quality?

2. How concerned are you about poor air quality affecting you?

   a. *The research team informed participants after the initial responses some of the health issues associated with exposure to poor air quality saying:* Here are some health issues associated with exposure to poor air quality: it increases the risk of respiratory infections, heart disease, stroke, and lung cancer, and more severely affects people who are already ill. Health risks increase for people with asthma,

respiratory illness, heart disease, and those who are pregnant or over the age of

65.

3.4.3 Perceived Benefits

Perceived benefits are what the individuals believe they will gain from adopting the health-protective behavior. As outlined in the literature review, there are a number of different benefits from taking health-protective behaviors. This includes both personal and social. In the focus group protocol, there are questions we ask to determine what the perceived benefits are for outdoor workers to adopt the health-protective measure. These questions tie into both the individual benefits of taking preventative measures and the social benefits of taking preventative measures.

1. Have you ever experienced any irritations or problems that you thought could be due to poor outdoor air quality?

2. Who are the people that are most in favor of you taking actions to protect yourself from poor outdoor air quality at work?

The first question for perceived benefits was asked to explore dimensions of multiple constructs, including perceived susceptibility. The complexity of this question and the responses regarding experiences with poor air quality can also inform other constructs such as perceived benefits.

3.4.4 Cues to Action

Cues to action are outside factors that prompt a behavior. In the context of this study, this might be what prompts outdoor workers to take health-protective measures. In the focus groups, we have a number of questions that gather information on how outdoor workers know air quality is poor and what resources they use to get air quality information.

1. How do you know or find out when outdoor air quality is poor?

2. Does anyone use an app that tells you the air quality? Do you recall which one?

3.4.5 Efficacy

Efficacy is how well the individual believes they can perform a behavior. For outdoor workers in this study, this is looking at how well an outdoor worker thinks they can adopt a health-protective measure in order to limit the effects of poor air quality to their health. In the focus groups, we have a number of questions that tap into these concepts:

1. Here are some things that public health organizations recommend people do during poor air quality days: reduce time spent outdoors by shortening or rescheduling activities, choose less strenuous activities, spend less time near busy roads, wear properly fitting n95 respirator masks, and use HEPA air filters to reduce particles indoors.

   a. Have you done any of these things at work? When and why?

   b. What would make it easier to take up some of these actions at work?

2. When air quality is concerning or poor, what workplace procedures or policies come to mind?

3.4.6 Perceived Barriers

Perceived barriers are what prevents an individual from performing a behavior. In the case of outdoor workers, this can be personal or organizational barriers. In the focus group protocols, we have two questions that specifically tie into these barriers.

Personal:

1. What habits do you have that might either get in the way of taking protective actions or would be helpful toward doing so?

Organizational:

    1. Who are the people that make it seem less important for you to take actions to protect yourself from poor air quality at work?

3.4.7 Health-Protective Measures

Health-protective measures are actions and individual takes to further protect or maintain their health. In the context of this study, this is an outdoor worker taking action specifically for the benefit of their health during an air quality event. In the focus group protocols, we had two questions that were designed to gain data about health-protective actions outdoor workers are taking. These questions are also relevant for other concepts given the commonalities between the anticipated responses and uses in the results:

1. Here are some things that public health organizations recommend people do during poor air quality days: reduce time spent outdoors by shortening or rescheduling activities, choose less strenuous activities, spend less time near busy roads, wear properly fitting n95 respirator masks, and use HEPA air filters to reduce particles indoors.

    a. Have you done any of these things at work? When and why?

    b. What would make it easier to take up some of these actions at work?

2. When air quality is concerning or poor, what workplace procedures or policies come to mind?

3.5 Data Collection

For this study, we conducted 90-minute focus group discussions with outdoor workers at the City of Fort Collins. In this section, I will discuss my sampling methods, data collection, and data analysis procedures.

3.5.1 Sample and Recruitment

This project specifically studied outdoor workers in the City of Fort Collins. Because of the connections between Colorado State University and the City of Fort Collins, the type of sampling was purposive sampling. This means the participants held a characteristic of relevance to the research objective. In this case, that characteristic was the employment that took place in an outdoor setting in a geographical location that is impacted by air quality issues. The City of Fort Collins outdoor worker focus group participants were recruited through their supervisors. For another part of a larger study, a member of the research team interviewed supervisors of outdoor workers in one-on-one interviews. The idea behind these interviews with supervisors was to learn about their own air quality awareness and how this was translated to their workers. Following these 90-minute interviews, we asked the supervisors if their workers might be interested in participating in a 90-minute focus group. Our team then sent information to agreeing supervisors for how their workers could participate in the focus groups.

3.5.2 Data Collection Procedures

Once we had recruited individuals to participate in the focus groups, the research team organized a time to meet. All three focus groups took place at a City of Fort Collins facility and our group met with the outdoor workers. Each focus group had a facilitator and an assistant. Throughout the three focus groups, there were three different facilitating teams. When the outdoor workers came in, the research team provided them our consent form to read over so that they could give verbal consent that they wanted to participate. In the verbal consent document, we were clear that the focus groups would be recorded and if they were interested, they could fill out an optional anonymous demographic survey. The verbal consent form and anonymous demographic survey can be found in Appendix A and B respectively. Once individuals had the

opportunity to read over the document, we then started recording. At the beginning of the recording, we asked the participants if they had any questions about the consent and then to also consent verbally. Once we received consent from all of the participants, we began asking questions from the focus group protocol. The first half of the protocol is heavily focused on gathering information about outdoor worker's experience with air quality and is the main area of the data that will be analyzed for the purposes of this study. Once we asked all of the questions in the first half of the protocol, we took a five-minute break. Following the break, we began the second half of the protocol, which involved looking at various examples of air quality information and discussed as a group how they could be improved. This section of the protocol was designed specifically to develop a communication campaign about air quality. For the purposes of this study, this section of the protocol was used to develop the constructs of cues to action and further understand how AQI materials could be used by the outdoor workers. Before ending the focus groups, we asked if participants had any final thoughts they wanted to include. Once the focus group concluded, we stopped the recording and saved the file for data analysis. Participants were compensated for their time with $20 Amazon gift cards as well as a complimentary lunch.

3.5.3 Data Analysis

Our team sent the recording of the focus groups to a transcription service. Once our team received the transcriptions, we uploaded them into MAXQDA, a qualitative data analysis software. As a group, we developed questions of interest to use as a baseline for coding the data. The questions of interest document can be found in Appendix C. Once we developed questions of interest, we created a concepts and definitions table. In this table, we defined concepts from the questions of interest based on literature. Concepts and definitions can be found in Appendix

D. Using the concepts and definitions developed by our team and informed by literature, we coded the data. After analyzing the data, we developed a top line report outlining the main findings of the focus groups in each of the categories. The top line report can be found in Appendix E. Next steps in terms of data analysis for this study will be looking at the data through the lens of the HBM.

3.6 Trustworthiness of the Proposed Study

Since qualitative data is subjective in nature, it is important to analyze the trustworthiness of the study. An article by Korstjens and Moser (2018) discusses various concepts related to trustworthiness in qualitative research studies. The concepts are credibility, transferability, dependability, confirmability, and reflexivity. In this section, I will define and discuss each of these concepts in the context of this study.

Credibility is "The confidence that can be placed in the truth of the research findings" (Korstjens & Moser, 2018, p. 121). In this study, the information we are gathering from the outdoor workers is credible because these individuals have experience working in conditions with poor air quality and can offer relevant and accurate information about their experience.

Transferability is how much the information gathered in this study can be applied to other studies (Korstjens and Moser, 2018). The information gathered in this study has a large potential of being applied to other areas of research. As cited in the literature review, 4.3 percent of the American workforce works outside (Bureau of Labor Statistics, 2021). Because of this, the research in this study could be applied to other areas of the workforce besides outdoor workers in Colorado including agriculture, construction, and recreation.

Dependability is "the stability of findings over time" (Korstjens & Moser, 2018, p. 121). As outlined in the introduction, air quality is something that has been an issue for a long time.

With the world's changing environment, it is evident that air quality will continue to be an issue. Because of this, the information found in this study will continue to be relevant for time to come.

Confirmability is "the degree to which the findings of the research study could be confirmed by other researchers" (Korstjens & Moser, 2018, p. 121). As mentioned in the literature review, the HBM is a widely used theory for health research (Christopher et al., 2010). This study is utilizing the concepts of the HBM to better understand what motivates outdoor workers to take health-protective measures during periods of poor air quality. This study defines concepts using definitions from other peer-reviewed articles that also utilize the HBM. Because of this, the findings from this study would be confirmed by other researchers.

Reflexivity is how much the researcher takes into account their own biases, preferences, and preconceptions (Korstjens & Moser, 2018). As the researcher, I have taken into account the various biases, preferences, and preconceptions I have about this issue. As someone who grew up where the study took place, I have first-hand knowledge of the air quality in this region. These preconceptions were limited because data collection and analysis were done in a team-setting. The focus groups had two moderators which ensured that there was no bias coming from the facilitator. In addition, concepts that would be analyzed were developed in a team meeting. Because of these precautions, I believe that my own biases and preconceptions do not impact my study and findings.

3.7 Concluding Summary

The purpose of this study is to find out what motivates outdoor workers to take preventative measures during periods of poor air quality using constructs of the HBM. In order to successfully study this, it was decided that the best method for data collection was focus groups. This qualitative method allowed me as the researcher to ask specific questions related to

concepts of the HBM. As outlined in this section, it is evident that there are a number of questions related to each of the concepts that are specifically designed to collect data. Participants for this study were recruited through purposeful sampling and brought in for a 90-minute focus group discussion. The data from the focus groups was recorded and transcribed. The data was analyzed using MAXQDA based on a number of criteria developed by the group.

4.1 Results

The HBM is a widely used health model for studying health communication campaigns (Rosenstock, 1974). This study sought to use the HBM as a theoretical framework to study what motivates the health-protective behavioral intentions of outdoor workers during periods of poor air quality. Through purposeful sampling, the research team recruited 18 participants from the City of Fort Collins to participate in the study. The research team conducted three 90-minute focus groups and also asked the participants to fill out an optional demographic survey. In the focus groups, different questions were asked to elicit responses from participants to encourage discussion. Throughout the focus group protocol, there were questions that were intentionally asked to probe responses about each of the six factors that are included in the HBM: perceived susceptibility, perceived severity, perceived benefits, cues to action, self-efficacy, and perceived barriers. In this chapter, I will explain the results from the data for each of the six components of the HBM using direct quotations from the focus group discussion as well as in-depth analysis. Throughout the results, I will discuss how each of the HBM six concepts connect with health-protective actions with a brief discussion about health-protective actions at the conclusion of the results section. Following the results, I will have a brief discussion about the data collected including implications and opportunities for future research and extension.

4.1.1 Perceived Susceptibility

In the literature review, perceived susceptibility was defined as how susceptible an individual thinks they are to acquiring symptoms or a disease or illness (Paek & Hove, 2017). In the case for exposure to poor air quality, this perceived susceptibility might mean how susceptible they think they are to both short-term effects, such as symptoms from irritation of the eyes, nose, and throat, and long-term effects, such as decreased lung function, COPD, lung

disease, and death (Environmental Protection Agency, 2023b). In the data, it was clear that participants were concerned about their health and understand that there are health implications that come from exposure to poor air quality, but there was limited urgency when it came to taking health-protective actions. It was also interesting to note that there was not a lot of mentioning of these short- and long-term health effects during the focus group discussions. In one of the focus groups, one individual mentioned, "I always just think, I know maybe I don't feel it, but just knowing that you breathe it in every day is just not helping you at all." This comment from the participant indicates that they are aware of air quality being an issue to their health and that air quality is something they need to consider every day even in the absence of an immediate impact, such as a symptom. Notably, this participant mentioned how they are aware that breathing it in every day is not good for them but did not discuss any health-protective measures that they took in order to reduce the impact of breathing in low quality air every day. Another participant mentioned, "I feel like I should be more concerned because I know I work outside in it all day. And it's one of those things where if it's not affecting you every day, I feel like I put it in the back of my brain, but I should probably be more aware and concerned with it." This comment from another participant is similar to the first: they are aware that they work in an environment where air quality can be bad nearly every day. But similar to the first participant, they are not mentioning any type of health-protective behavior. This person also mentioned how they are almost in denial of the health effects from bad air quality by not considering it at the forefront of their mind. From these responses, it is clear that the participants have an awareness of and know that they are susceptible to the health implications. During the focus groups, there was not any discussion from the participants about the long-term health implications.

The limited urgency from the outdoor workers to take health-protective measures during air quality events does not mean that the participants are unfamiliar with air quality events. In fact, the participants all seemed relatively familiar with air quality events and the impacts these events can have on health. The participants all could point to a number of air quality events that they had experienced while living in Colorado. But it was interesting that these air quality events were primarily referencing wildfires and wildfire smoke. Throughout the focus group discussions, a key air quality event that the participants kept referencing was the Cameron Peak Fire. Many participants would make statements reflecting on the Cameron Peak Fire as a time when they considered air quality as a greater threat. One participant discussed their understanding of air quality and their concerns about experiencing health implications,

> "I think about wildfire smoke a lot more than I think about like ozone illness or anything like that. I don't even think about those at all when we have those in town, but wildfire smoke, I definitely get concerned about being out too much in it. Just because of the particulates for my lungs, but then it goes away. But yeah. I don't think at all about other types of air quality issues."

This comment from the participant indicates that the participants view poor air quality due to wildfire smoke as a greater threat to their health than other types of air quality events such as ozone. When asked what participants think of when they hear air quality, many responded, "smoke from wildfires." It is evident that wildfire smoke is the most top-of-mind example of a contributor to poor air quality the participants could recall and by extension what they might consider to be the greatest threat to their health.

Another takeaway from perceived susceptibility comes with a psychological distance where the participants indicate that the health effects they are feeling now are a problem for the future. This comment from the participant means that they understand that there are health implications involved with exposure to poor air quality, but this is not necessarily an issue they need to face now. When discussing the health implications of poor air quality, another participant mentioned, "Yeah. I don't think about the long-term effect." This comment demonstrated how the outdoor workers are mainly taking the short-term effects of poor air quality into consideration, but long-term perceived susceptibility was not prevalent in the data.

4.1.2 Perceived Severity

In the literature review, perceived severity was defined as the belief of consequence (Rosenstock, 1974). This differs from perceived susceptibility in that the perceived severity is looking at more intense, negative outcomes. In this study, perceived severity is important to take into account because it will help indicate how severe individuals perceive the effects of poor air quality to be and if they are interested in taking preventative measures to mitigate or lessen these negative outcomes from poor air quality. In the data analysis, perceived severity was an interesting concept to code for because of the laid-back nature of the responses from the participants. It was clear that the most severe health implications the participants were concerned about were short-term health effects such as pain in lungs/chest, fatigue, runny nose, irritated eyes, worsened allergies, and bad mood. Participants indicated that they were concerned about how these short-term health effects can impact them in the long run, but there was not an explicit, immediate concern for the long-term health effects. In the data, there was little to no mentioning of participants being concerned with these long-term health effects even though there is a general awareness of it mentioned by the participants in the discussions.

4.1.3 Perceived Benefits

      Perceived benefits can be defined as what an individual might gain from adopting the health-protective behavior (Rosenstock, 1974). In the context of this study and using the HBM, if outdoor workers perceive there to be benefits surrounding the usage of health-protective measures, this may influence their intention of using those strategies. When looking at the data, a main motivation for participants to take action was influenced by people the participants knew. This could be people that worked with them as outdoor workers or close family and friends. With these social influences, the participants discussed how these relationships encouraged them to take health-protective measures. There were participants that noted that they took health-protective measures because their partner didn't want them to get sick and have to take them to the doctor or their family would ask why their allergies were acting up. This benefit of staying healthy and not needing to go to the doctor's office was a benefit for the outdoor workers that was sometimes influential enough to encourage them to take health-protective measures. One participant, who disclosed to the focus group that they experienced asthma, talked about this when reflecting on what they think their partner would say, "Oh, my partner's talking in the back of my head. Like I don't want to take you to the doctor." This comment from the participant shows that the outdoor workers are heavily influenced by others close to them to take health-protective measures.

      Besides these social takeaways, there was also individual benefits of taking health-protective measures such as mitigating the impacts of short-term health effects. At the organization where the focus group participants worked, there is a heavy emphasis on safety. Because of this, there are situations where PPE such as masks and respirators are already being used to protect the worker's health. For example, the outdoor workers mentioned that they would

use respirators when doing curb lines or spraying pesticides because, "I would rather be uncomfortable and prevent my reactions to like either the chipper dust or the pesticide dust then be affected by it." This quote demonstrates how there is already an action that the outdoor workers are taking that could be easily transferred to a health-protective measure when there is poor air quality. In this instance when the outdoor worker was talking about wearing a respirator while spraying pesticides or trying to avoid chipper dust, the outdoor worker viewed the pesticides and chipper dust as being bad for their health or at least irritating or threatening enough in the short-term for them to take action to limit the symptoms they might experience. This could be translated to mask wearing during periods of poor air quality, but it is clear that the outdoor workers need to view the air quality as being similarly or equally impactful to their health as the chipper dust or the pesticides. Since the outdoor workers work with dangerous equipment, they are already trained on best practices for keeping themselves safe in different contexts. It is evident that there is a possibility of some of these safety habits to transfer over to the air quality context and taking health-protective measures as a safety precaution.

4.1.4 Cues to Action

Cues to action are exposure to factors that prompt action of behavior (Rosenstock, 1974). In the case of outdoor workers, these cues to action might be any outside exposure that prompts the outdoor workers to take health-protective measures. During the focus group discussions, main cues to action that were mentioned by the outdoor workers were physical sensory cues to action. These physical cues to action included visibility, smell, and symptoms. Visibility as a cue to action was one that a number of outdoor workers mentioned. During the discussion, a few participants indicated that they use the mountains as a "gauge" for visibility. If the visibility of the mountains was not as good, this indicated to the outdoor workers whether the air quality was

good or bad. "I think about the mountains and just... I almost use them as a gauge, how well I can see them if it's really nice and clear, then like, oh, this is a good air quality day, but some days it's like man, you can barely see them." Other physical cues to actions mentioned by the participants were being able to smell smoke in the air, having to use headlights in the middle of the day because of thick smoke, and experiencing dramatic red sunrises and sunsets. These comments from the participants about the physical cues to action were interesting because they are another example of the outdoor workers mainly taking only smoke from wildfires into consideration when thinking of poor air quality. It is true that the visibility of the mountains is worsened when there is particulate matter in the air from a nearby fire, but there are other types of air quality events such as ozone that sometimes cannot be seen with a naked eye. But even when the participants noted that the air quality looked poor, and even if they were only mentioning physical cues from wildfire smoke, they did not explicitly link this to the health-protective measures they were taking. It is clear that there is a connection between physical cues to action and awareness of air quality, but not any specific actions related to air quality.

Information-based cues to action such as weather apps are another potential source for someone to take health-protective measures. One participant said, "I look at my weather app every day and the weather channel app will have air quality alerts, so that's how I usually find out." This comment from the participant was encouraging and showed that the participants already have habits and behaviors in their routines. Throughout the discussions, there were over 15 different weather apps and tools mentioned that participants said they used when looking for weather information. While a few participants mentioned that they used these apps for air quality information specifically, a number of other participants mentioned how they regularly use these apps for other types of weather information such as the temperature forecast. It was interesting

that for a few participants, they were already utilizing weather apps for air quality information. For the other participants, it is evident that there is already a routine in place for checking weather information, so outdoor workers, who were not already using weather apps for air quality information, could easily transfer checking the AQI to this routine as well.

When prompting participants with the AQI dial and getting their feedback on it as a tool, participants responded that it was an easy-to-understand model for getting air quality information. There was some discussion from the participants asking our team to clarify what the different "levels" of the AQI meant and identifying the need for specific messaging for outdoor workers. One participant mentioned, "Would it be possible put language in there about jobs? … Where if you specifically have a language, someone could be, 'hey, it says, working outside today, that's not a good idea.' Whereas this reads is very like recreative or commuting." This comment indicates how that outdoor worker thought that the recommended actions could benefit from specific messaging for outdoor workers rather than just having messaging for other groups, such as people recreating. In addition, there was evidence that outdoor workers wanted to have more clarification between the different levels of the AQI. For example, the difference between green and yellow on the AQI dial. One participant mentioned, "How green is it?" indicating that even if the AQI is still considered green, but starting to get close to the yellow section, is it still safe and what would be the recommended actions then. But the overall concept of the AQI dial made sense to the participants and could be used as a tool for better understanding air quality.

4.1.5 Efficacy

Efficacy is the individual's belief that they can perform behaviors with desired outcomes (Champion & Skinner, 2008). In the context of this study, it was how well the outdoor workers felt that they could adopt a health-protective measure to achieve the desired outcome of lessened

effects due to exposure to poor air quality. A main part of the efficacy piece in the data is the emphasis on the organizational support of the outdoor workers. One participant mentioned that at work if they did not feel comfortable being outside, "There would be absolutely no pushback. At least in my area, it would be 100%. How can we help get inside?" Another participant expanded on this organizational support explaining,

> "Our risk management department is pretty obviously concerned about employee well-being and long-term health and everything else for a variety of reasons. Like one genuinely they want their employees to be safe, but also they have the increased responsibility of liability on all kind of stuff. So, I'd say our risk management team is genuinely concerned about well-being, which is a citywide team."

These quotes demonstrate that if an outdoor worker was in a situation where they no longer felt comfortable working because of the air quality, that they would not feel any repercussions from that. As mentioned in perceived benefits, there is an emphasis on safety at the City of Fort Collins. This is shown through the city's Risk Management team as well as other practices taken by individual departments to keep outdoor workers safe. This sector of the City of Fort Collins is responsible for the safety of employees and residents of Fort Collins. During the focus group discussion, it was clear that the risk management team keeps employees safe in a number of ways: sending out monthly safety newsletters, texting employees about events or issues that they need to be aware of, and providing trainings. One of the participants in our focus groups was the Safety Coordinator for their department and explained how she coordinates rotating safety discussions each week. While air quality was not a topic that had been discussed in one of those safety discussions yet, it was clear that following the focus group discussion about air quality, there was a need for it and the ability for it to be easily folded into their existing safety content.

4.1.6 Barriers

Barriers are the perception of costs associated with adhering to a recommended health behavior (Kagee & Freeman, 2017). In the literature review, there were two barriers that were identified for the context of this study: personal barriers and organizational barriers. Personal barriers are the barriers from an individual that limit the adoption of a behavior. For this study, it is important to take into account these personal barriers outdoor workers have for adopting the health-protective measures. The outdoor workers mentioned a number of personal barriers such as PPE being uncomfortable to wear for an entire shift.

> "It would be challenging if they said, oh, when air quality is above a certain thing, you have to wear a mask outside or something. I think it's hot out. You're sweating. You're not going to. Not unless you're directly working in some dust cloud or something. I think mostly I wouldn't want to wear a mask, even if it was kind of elevated air quality problem or whatever."

This quote from a participant shows that personal comfort matters to them more than the health effects they might feel even after being exposed to poor air quality for an extended period of time. Another individual barrier was influences of members of the community in which the focus group participants worked. A few outdoor workers mentioned they would see members of the public out not taking health-protective measures and wonder why they were out taking health-protective measures. The outdoor worker explained, "Probably the people who are out there, hair blowing in the breeze and I'm just like, 'That looks so nice. They're probably so comfortable. They're probably just so cool right now and happy.'" Another outdoor worker expanded on this:

> "See them out and about doing, especially when we're out working in poor quality days, they're out and about. We're masked up or trying to avoid as much physical work as we

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can to kind keep our intake of poor air down, when they out just wandering around doing their thing. Having a good day and going about their business and we're suffering with the smoke. It's like, 'okay, you guys do what you got to do but we're going to be over here suffering.'"

These quotes show how the outdoor workers notice when there are members of the public not taking health-protective measures, but then are asking themselves why they have to be uncomfortable.

In addition to personal barriers, organizational barriers are barriers in the workplace that limit one's ability to perform a behavior. This might be access to personal protective equipment, supervisors prioritizing work over employee health, and relationships with coworkers. While there is an emphasis on safety at the City of Fort Collins, the outdoor workers did mention that there were times when access to PPE (masks and respirators) were not available. In addition, the outdoor workers mentioned that during air quality events such as the Cameron Peak Fire, every day for months, the air quality was bad. During this extreme event, there was adoption of health-protective measures such as wearing masks, staying indoors, shifting work schedules, and slowing down the pace of work. But at a certain point, the outdoor workers needed to go out and do their jobs. One participant said, "I still have to go out to work. You can only have so many shop days." This comment was integral to the focus group discussions because it demonstrated how the organization functioned in an air quality event that lasted for longer than anticipated. This forces the organization to lessen their commitment to safety because the work needed to get done.

4.1.7 Health-Protective Actions

Health-protective actions are measures an individual takes to further protect their health. In the context of this study, this is taking action to limit both the short- and long-term effects of poor air quality for outdoor workers. During the focus groups, participants mentioned a number of health-protective measures they took during periods of poor air quality such as wearing masks, shifting work schedules, and limiting high-intensity work. Table 1 summarizes how each construct of the HBM supports the adoption of health-protective measures and also highlights how each construct lacks support for the adoption of health-protective measures.

Table 1. HBM constructs in relation to support for heath-protective action

Construct	Support for Adoption of Health-Protective Action	Lack of Support for Adoption of Health-Protective Action
Perceived susceptibility	Experiencing short-term effects	Limited urgency over preventing any long-term effects
Perceived severity	Does not support adoption of health-protective measures	Little concern over experiencing long-term effects
Perceived benefits	Commitment to social network Lessened effects of short-term exposure to poor air quality	Absence of usage of health-protective measures during air quality events
Cues to Action	Sensory experiences: smelling smoke, seeing smoke Information-based cues: weather apps, AQI	Not all participants used weather apps for air quality information. AQI lacks targeted information and suggestions.
Efficacy (Organizational)	Existing safety culture	Recognition that air quality is a safety concern Ability to overcome personal and organizational barriers
Barriers	N/A	PPE is uncomfortable to wear for long periods of time Members of the public not wearing PPE while outdoors Reliable access to PPE provided by the workplace City of Fort Collins prioritizing work over worker safety

CHAPTER 5. CONCLUSION

5.1 Summary of Key Findings

This project utilized focus groups to study the behavioral intention of outdoor workers to take health-protective measures during periods of poor air quality. Guided by the six components of the HBM, the focus groups were organized by a specific protocol developed by the research team to have an engaged dialogue about air quality events and outdoor workers' experiences. In the literature review, the six components of the HBM were individually discussed with examples from the literature. It has been theorized that the six components of the HBM (perceived susceptibility, perceived severity, perceived benefits, cues to action, efficacy, and barriers) each contribute to an individual's behavioral intention of taking health-protective measures. As discussed in the results section, there was evidence of each of these six components throughout the focus groups, although the relationships between the different components and adoption of health-protective measures were mixed. Mentions of health-protective actions was limited. The rest of this chapter will discuss in greater detail key findings from the results looking at each of the components of the HBM. It will also discuss implications for health communication scholarship and practice, as well as provide organization-specific recommendations for future health communication campaigns.

As discussed in the literature review, perceived susceptibility is an important concept in the HBM because it gauges how likely one thinks they are to contract a disease or illness. In the focus groups, it was clear that individuals knew about their own susceptibility to the effects of exposure to poor air quality, but even with this knowledge, the outdoor workers still mentioned how they would deal with these effects rather than taking specific health-protective measures. In contrast to the example in the literature review about the wastewater workers where perceived susceptibility was a major indicator of taking health-protective measures (Wright et al., 2018), it

is clear that the outdoor workers in this study consider exposure to poor air quality a threat, but not a major threat to the point where they feel like they need to constantly take health-protective measures.

In addition to perceived susceptibility, perceived severity was discussed in the literature review. As another key component of the HBM, perceived severity is a major indicator of taking health-protective measures because it is dealing with severe consequences. In the wastewater worker example, those individuals took health-protective measures because of their perceptions of the intense outcomes that could come from them not taking the health-protective measures (Wright et al., 2018). In the case of the outdoor workers, these severe consequences might be short-term irritations to long-term lung illness or death. But similar to perceived susceptibility, outdoor workers were aware of these severe outcomes, but not concerned enough with them to take the health-protective measures. More training and information about the health implications of exposure to poor air quality might encourage higher levels of threats to their health.

In the literature review, perceived benefits were identified as potential benefits of taking the health-protective actions. The example about the sugar cane workers in Thailand from Panakobit et al. (2021) discussed how their benefit of taking health-protective measures was that they did not experience the short-term effects of inhaling the bagasse dust. While there was mention of this type of benefit from the focus group discussion, it was interesting that the benefit that was mentioned the most was social benefits. Outdoor workers would explain how they would take health-protective measures so they did not get questioned by their partner or family about why they were experiencing symptoms related to exposure to poor air quality. In addition to the social benefits, it was interesting that the outdoor workers mentioned using PPE and other health-protective measures during their work, but not necessarily in the context of poor air

quality. It is clear that health-protective measures are beneficial to outdoor workers in other aspects of their work, so the transfer of these health-protective measures to include taking health-protective measures during air quality events would be another opportunity for the outdoor workers to further protect their health.

As discussed in the literature review, cues to action are important to the HBM because they indicate to outdoor workers when they need to take health-protective measures. In the literature review, some cues to action that were identified were seeing smoke in the air or seeing another person take health-protective measures. In the focus groups, a major cue to action was physical cues: seeing smoke in the air, using the mountains as a gauge, or smelling smoke. But even through this discussion, mentioning of taking health-protective measures when experiencing these physical cues to action were limited. Other cues to action discussed in the focus groups were using weather apps or the AQI as a signal to take health-protective measures. It was beneficial to see that participants had an existing behavior of regularly using weather apps to check the weather. Some participants even used the weather apps at times to check the AQI. When asked specifically about the AQI dial and messaging, there were a few areas that the participants mentioned there was missing information. Specifically, participants thought that there could be more information included about recommended actions for each "level" of the AQI. For example, the participants felt like there could be specific recommended actions for the "green" level as well as the "yellow" level and so on specifically for the outdoor workers. Current recommendations could be beneficial for members of the public, but recommendations specifically for outdoor workers are lacking. As seen in Figure 2, there are a number of recommended actions from the EPA in periods of poor air quality. For example, when the AQI is green, the messaging from the EPA is "It is a great day to be active outside". While this is a good

recommendation, there is the opportunity for the messaging to be more tailored to outdoor workers. In a higher level of AQI where health-protective actions are taken, such as the orange section of the AQI, it is evident that some of the messaging needs to be tailored. In the orange section of the AQI, or when PM is between 101-150, recommended actions from the EPA are "Sensitive groups: reduce prolonged or heavy exertion. It's OK to be active outside but take more breaks and do less intense activities. Watch for symptoms such as coughing or shortness of breath" (Environmental Protection Agency, 2022a). While these are good recommendations, there is the opportunity for the message to be more directed to outdoor workers and also provide additional health-protective actions outdoor workers could be taking. In addition to the AQI being limited in the targeted recommendations for each level of the AQI, participants felt that they did not have a good understanding of the differences between the AQI levels. Participants specifically mentioned that it was sometimes unclear what the differences between the levels were.

Efficacy was also discussed thoroughly in the literature review as how much control an individual has in their environment to take the health-protective measure. In the literature review, the example about PPE being offered to female construction workers identified that when individuals have more access to properly fitting PPE, the more usage there is by those individuals. In the focus group discussions, efficacy was discussed extensively especially in the context of the safety culture at the City of Fort Collins. It is clear that the City cares deeply about the safety of their workers and will do whatever possible to make sure workers feel safe at their jobs. Because of this, the outdoor workers discussed in detail how they feel like they have the ability to make decisions about their work related to their health with no pushback from the organization. But it was interesting to discuss efficacy with the outdoor workers when discussing

more extreme situations such as the Cameron Peak Fire. This air quality event faced the City and outdoor workers with a dilemma: should they get their work done or choose the safety of workers? It was evident that in extreme cases, outdoor workers felt pressure from their workplace to get their work done over choosing what might be best for their health.

As discussed in the literature review, barriers are what keep an individual from performing a specific behavior. An example of barriers in the literature review there were discussions of personal and organizational barriers. Personal barriers are barriers by the own individual that keep the individual from performing a behavior. In the context of this study, a main personal barrier that was discussed was uncomfortable PPE. This was consistent with the literature review and sheds light on how the comfort of employees might lead to better usage of PPE. Organizational barriers are barriers within the organization that keep the individual from performing a behavior. In the context of this study, this was what organizational structures kept the outdoor workers from taking health-protective measures. While there is a big emphasis on safety at the City of Fort Collins, and the organization protected its outdoor workers as much as possible, there were evidence that when there is a significant air quality event, such as the Cameron Peak Fire, some of the focus on safety needs to be adjusted so that the work can get done. This is a unique dilemma faced by the outdoor workers. In the future, it will be important to take into consideration future air quality events and organizations developing plans and mitigation strategies to maximize worker safety and efficiency.

5.2 Implications

This work contributes to the literature by providing a qualitative perspective to the HBM. The qualitative approach allowed the research team to gain a deeper understanding of some of the more intricate aspects behind health-protective decision making from the outdoor workers.

This perspective could be valuable in the future for understanding more about health communication and finding the most effective strategies for communicating health behavior. Additionally, this work focused on outdoor workers in the City of Fort Collins, but could be extended to other areas of the workforce that have a large number of outdoor workers such as agriculture, construction, or engineering.

The HBM was a useful theoretical framework to utilize in this study in a number of ways. First, the HBM was useful for capturing the significant barriers faced by individuals. These barriers might be individual barriers such as uncomfortable PPE. But they could also be organizational barriers such as the workplace needing to choose work productivity over employee safety during air quality events. In addition to barriers, the HBM was useful in describing how individuals use a number of different cues to action in making health decisions. As seen in the focus groups, participants utilized both physical cues to action as well as informational cues to action indicating to them when the air quality is poor.

While the HBM was useful for this study, there were some aspects of the model that were lacking. First, in the context of this study and air quality, it was clear that there are immediate, short-term, effects individuals experience. This was accounted for with perceived susceptibility, but perceived severity did not come through. It was evident that individuals perceived themselves to be susceptible to the short-term health effects of exposure to poor air quality, but there was not an immediate concern about the long-term health effects. This complemented perceived severity because individuals mentioned how they had experienced the short-term health effects of exposure to poor air quality, but found that they could manage these effects. In addition, the participants were not concerned about the long-term health effects. With limited perceived severity, this makes it difficult to encourage outdoor workers to take health-protective

actions to protect themselves from the long-term health effects. In addition, this study looked at individual efficacy, but also took into account the existing safety culture at the City of Fort Collins and how this organizational support contributed to an individual's ability to take health-protective action. While individual efficacy is a construct of the HBM, the HBM itself does not account for the efficacy an individual develops because of the culture of an organization.

Finally, an area of this study that was not captured by the HBM was social norms. Social norms can be thought of as informal rules that guide behavior in groups (Bicchieri et al., 2018). Different types of social norms and social support can affect individual perceptions of threat and efficacy in response to wildfire smoke. A study by Santana et al. (2021) found that individuals might be more likely to take health-protective action if there are social norms that support that behavior. This study acknowledged that there are some social aspects captured by the HBM, but these social constructs are not "deeply examined in these models" (Santana et al., 2021, p. 2). The researchers found that, "different types of social norms and social support can affect individual perceptions of threat and efficacy in response to wildfire smoke" (Santana et al., 2021, p. 8). Some of these social norms include interpreting information together, protecting vulnerable others, and questioning protective actions (Santana et al., 2021). To account for these social processes, the researchers developed a framework, the wildfire smoke protective behavior framework, informed by the HBM. This model indicates how it is possible to account for the constructs of the HBM while also considering social processes. In the case of this study, further research into social norms and social support and utilizing a theoretical framework such as the wildfire smoke protective behavior framework could be beneficial for further understanding what motivates outdoor workers to take health-protective action during periods of poor air quality. There are a number of social norms including, but not limited to: subjective norms,

descriptive norms, and injunctive norms. Subjective norms can be thought of as norms that are motivated by what the individual thinks others will approve of (Shulman et al., 2017). Descriptive norms are what people are doing (Shulman et al., 2017). Injunctive norms are what people might think they should be doing (Shulman et al., 2017). In the context of this study, looking at all three of these types of norms could be beneficial. Looking at the subjective norms might shed light on why an individual takes health-protective measures during periods of poor air quality. This might be motivated by their organization or even close relatives or friends. By looking at the descriptive norms, this might uncover what outdoor workers are witnessing by the individuals around them and why these actions taken by others motivate them to take health-protective action. Finally, injunctive norms are also an important consideration because these might account for what outdoor workers think they should be doing. This might account for policies and regulations imposed by the workplace to encourage worker compliance.

5.3 Recommendations for Practice

After reviewing the results of the study and comparing the findings to the literature, there are some recommendations for practice that have been developed. These recommendations are specifically directed at the City of Fort Collins, but could be modified to include other organizations and contexts.

It is evident from the data that there is a need for improved communication and awareness among outdoor workers regarding various air quality events beyond wildfires, such as additional knowledge about particle pollution and ozone. If outdoor workers developed an enhanced understanding of the short and long-term health effects of the exposure to poor air quality, this will contribute to a heightened perception of susceptibility and severity. With greater risk perceptions, it is possible that outdoor workers might have greater adoption of health-

protective measures during air quality events. This could make air quality events to be perceived as greater health threats where outdoor workers will want to take action like they did when spraying for pesticides and trying to avoid chipper dust.

To address these challenges, it is important to build upon the existing safety cultures at the City of Fort Collins and extend their scope to include air quality. This can be achieved through training programs, creation of materials, and targeted communication campaigns. Providing outdoor workers with the necessary resources to recognize and respond to threats posed by poor air quality is important. Furthermore, it is critical for the City of Fort Collins to frame exposure to poor air quality as a safety issue, not a health issue. This will heighten the focus on air quality from the managerial side as well as utilize the existing culture of safety to train and educate workers about the safety hazards of exposure to poor air quality in both the short- and the long-term. There are other contexts where health communication about long-term health effects support adoption of health-protective actions. An article by Damalas and Koutroubas (2017) studied agricultural workers and their use of PPE to reduce the effects of pesticides. The authors wanted to study how poisoning associated with exposure to pesticides could be limited. In their study, they recruited agricultural workers from Greece to participate in the study. They interviewed a group of participants some had been trained on pesticide safety and some had not. The results of the study found that for the participants who received the training had a greater belief about the hazards from pesticides. This translated to higher amounts of safety behaviors and lower exposure to pesticides at their work (Damalas & Koutroubas, 2017). In the case of outdoor workers at the City of Fort Collins, a similar training about the health risks associated with exposure to poor air quality could that lead to greater risk perceptions and possibly greater adoption of health-protective actions during periods of poor air

quality. Additionally, maintaining support from the organization for outdoor workers to take health-protective measures is critical. It is evident that the City of Fort Collins already has an existing safety culture. When making necessary changes to the organization in order to account for both the health and safety of outdoor workers during air quality events, the City must also stay consistent with what they have done in the past: allowing outdoor workers to take health-protective action during air quality events. It was evident that during extreme air quality events, such as the Cameron Peak Fire, the organization was faced with the dilemma of supporting worker safety or productivity. The City of Fort Collins must develop protocols for how productivity will be addressed in future extreme air quality events to both maximize health and safety of workers, but also maximize productivity. In a book about risk communication, the authors discuss various organizational constraints to risk communication (Lundgren et al., 2018). Specifically, the authors point to conflicting organizational requirements as one of the main constraints. This constraint being that organizations usually have existing organizational requirements, and risk communication might conflict with the goals of that organization (Lundgren et al., 2018). In the case of the City of Fort Collins, they have an organizational mandate to get work done and provide services to the community, but the City also needs to recognize worker safety.

The Air Quality Index (AQI) dial is a valuable tool that can be further integrated into training and resource development. But further development of the AQI dial, such as making targeted recommendations for people, is required. This means developing health-protective recommendations that are specifically written with outdoor workers in mind. Additionally, by incorporating the AQI into daily habits and making it accessible through various platforms, such

as mobile apps, outdoor workers can make informed health decisions during extreme air quality events.

Finally, it is essential to minimize barriers of individuals taking health-protective measures. By removing some of the personal and organizational barriers faced by the outdoor workers, we can ensure the well-being of the outdoor workers while also maintaining their productivity and efficiency even during extreme air quality events.

5.4 Limitations and Future Research

Some limitations of this research were the small number of responses gathered from the outdoor workers. In the future, a greater number of responses could be beneficial for gathering more data. Additionally, another limitation was the use of different facilitators. Different facilitation styled led to different follow-up questions being asked and limited alignment between focus group responses. Future research into some of the most effective communication strategies for communicating with outdoor workers during air quality events would be valuable to find the most effective methods of reaching people to make health-protective decisions. Utilizing this research alongside the findings of this study could result in a successful communication campaign educating outdoor workers about air quality and health-protective actions.

5.5 Conclusion

This study sought to find what motivates outdoor workers to take health-protective measures during air quality events. Guided by the HBM, this study utilized qualitative methods to answer this research question. This study found that outdoor workers at the City of Fort Collins have experienced air quality events and have the knowledge of what health-protective measures they can take to limit their exposure. The HBM was a useful theory for this particular research question with significant findings stemming from barriers and cues to action. Other

areas such as social norms were not a concept captured with the HBM, but could be useful in future research for furthering understanding the behavioral intention of outdoor workers taking health-protective action. There are a number of ways that current functions of the City of Fort Collins can be improved to further support and protect the outdoor workers. These include better education programs to inform outdoor workers of the short and long-term health effects of exposure to poor air quality, building upon the existing safety culture that exists at the City of Fort Collins, recognizing exposure to poor air quality as a safety issue as well as a health issue, and minimizing barriers experienced by the outdoor workers.

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APPENDICES

Appendix A

Informed Consent

ADULT PARTICIPANT INFORMED CONSENT
Department of Atmospheric Sciences

Participant Study Title:

Smoke-ready Communities

Formal Study Title:

Smoke-ready Communities: Creating and Sustaining Air Quality Information Using Targeted Communication Interventions

PRINCIPAL INVESTIGATOR: Emily V. Fischer, PhD, Associate Professor

CO-INVESTIGATOR(S):

Ashley Anderson, PhD, Associate Professor, Department of Journalism and Media Communication

Katie Abrams, PhD, Associate Professor, Department of Journalism and Media Communication

Jeffrey Pierce, PhD, Professor, Department of Atmospheric Sciences

Sheryl Magzamen, PhD, Associate Professor, Environmental and Radiological Health Sciences

Bonne Ford, PhD, Research Scientist, Department of Atmospheric Sciences

STUDENT INVESTIGATOR(S):

Kimberli Conro, PhD student, Department of Journalism and Media Communication

Erica Giesenhagen, MS student, Department of Journalism and Media Communication

SPONSOR: Environmental Protection Agency

WHAT IF I HAVE QUESTIONS?
For questions or concerns about the study, you may contact **Emily Fischer** at ▉▉▉▉▉▉

For questions regarding the rights of research subjects, any complaints or comments regarding the   manner in which the study is being conducted, contact the CSU Institutional Review Board at: RICRO_IRB@mail.colostate.edu; 970-491-1553.

CONCISE STATEMENT OF STUDY
This research study is aimed to understand how to better communicate about air quality issues in Colorado. You may be interested because you are a City of Fort Collins employee. This research study will take approximately an hour of your time. There are minimal risks to participating in this study, like psychological impacts related to increase in concern about air quality. We hope that this research will benefit our understanding of how we communicate about air quality problems related to public health.

WHAT IS THE PURPOSE OF THIS STUDY?
The purpose of this research study is to create smoke-ready resilient communities via effective local communication about air quality that provides clear and accessible information about air quality issues. From this research we hope to learn how to effectively communicate when and where the presence of wildfire smoke poses a health risk. We would like to motivate individuals to take actions that protect their health to reduce smoke exposure.

WHY AM I BEING INVITED TO TAKE PART IN THIS RESEARCH?
You are being asked to participate in the study because you fit these criteria: employee of the City of Fort Collins.

WHERE IS THE STUDY GOING TO TAKE PLACE AND HOW LONG WILL IT

LAST?

You will be asked to participate in a one- to two-hour focus group held via video

teleconferencing software.

WHAT WILL I BE ASKED TO DO?

If you volunteer to participate in this study, you will be asked to do the following: participate in a one- to two-hour focus group with other employees of the City of Fort Collins.

ARE THERE ANY BENEFITS FROM TAKING PART IN THIS STUDY?

There may be no direct benefit to you as a participant in this study. However, your awareness

and understanding of air quality problems may be increased.

WHAT ARE THE POSSIBLE RISKS AND DISCOMFORTS?

While the level of risk is minimal, you may become uncomfortable with some questions related
to long-term health outcomes of air quality exposure.

As with all research, there is a chance that confidentiality could be compromised; however, we
are taking precautions to minimize this risk. We will take the following measures to ensure your
confidentiality. First, we will transcribe the audio recordings as soon as possible after the
interview, and then destroy the tapes. Second, we will not transcribe your name or the names of
any other people (e.g., colleagues); the transcription will be free of any identifying information.
Third, when we report and share data from this study with others, we will not identify you by
name.

WILL I RECEIVE ANY COMPENSATION FOR TAKING PART IN THIS STUDY?

You will receive a $20 gift card for participating in this research.

WHO WILL SEE THE INFORMATION THAT I GIVE?

All information gathered in this study will be kept as confidential as possible. Your privacy is
very   important to us and the researchers will take every measure to protect it. Your information
may be given out if required by law; however, the researchers will do their best to make sure that
any information that is released will not identify you. No reference will be made in written or
oral materials that could link you to this study. For this study, we will assign a code to your data
so that the only place your name will appear in our records is on the consent and in our data
spreadsheet which links you to your code. Only the research team will have access to the link
between you, your code, and your data. All records will be stored in a restricted access folder at
CSU for three years after completion of the study. After the storage time, the information
gathered will be destroyed.

There are organizations that may inspect research records that may include yours. These
organizations are required to make sure your information is kept private, unless required by law
to provide information. Some of these organizations are:

- Environmental Protection Agency, the study sponsor.

- For funded studies, the CSU financial management team may request an audit of research expenditure, in which only your participating in the research may be shared, but not your research data.

- The Institutional Review Board, IRB, is a group of people who review the research with the goal of protecting the people who take part in the study.

- Department of Health and Human Services and similar ones if other countries are involved in the study.

Your identity/record of receiving compensation (NOT your data) may be made available to CSU officials for financial audits. Your identity/record of receiving compensation (NOT your data) may be made available to CSU officials for financial audits.

Participation in a focus group involves some loss of privacy. The researchers will make every effort to ensure that information about you remains confidential, but cannot guarantee total confidentiality. Your identity will not be revealed in any publications, presentations, or reports resulting from this research study. While we will ask all group members to keep the information they hear in this group confidential, we cannot guarantee that everyone will do so.

If you choose to take part in this study your private information collected for this study will not be used or distributed for future studies, even if we remove all identifiers linking you to your information.

<u>DO I HAVE TO TAKE PART IN THE STUDY?</u>
Your participation in this study is voluntary. You may refuse to participate in this study or in any part of this study. You may withdraw at any time without prejudice to your relations with CSU. You are encouraged to ask questions about this study at the beginning or any time during the research study.

Participant Consent:

Your consent acknowledges that you have read the information stated and voluntarily wish to participate in this research. Your consent also acknowledges that you have received, on this date, a copy of this document containing 4 pages.

Would you like to participate?

If yes: Proceed.

If no: Thank you for your time.

Appendix B

Anonymous Demographic Survey

Optional, Anonymous Demographic Survey

To have a better idea about the demographics of our groups please provide us with the information below. *This data is anonymous, confidential and will not be connected to your responses in the focus group.*

1. What is the name of your division?
    1. Facilities and Operations
    2. Historic Structures
    3. Planning and Special Projects
    4. Public Engagement
    5. Rangers
    6. Resource Management
    7. Trails and Visitor Amenities
    8. Land Conservation Planning
    9. Other

2. Approximately how long have you worked for this division?
    _____ year(s)   _____ month(s)

3. Are you a seasonal or year-round employee in this position?
    1. Seasonal
    2. Year-round

4. Are you a contractor or directly employed by the [name of entity]?
    1. Contractual Employee
    2. Hourly Employee
    3. Classified Employee of [name of entity]
    4. Unclassified Management Employee

5. What is your job title?

6. How do you usually commute to this job between May 1 to September 30?
    1. Drive

2. Bike, electric bike, scooter
3. Walk
4. Public transit
5. Someone else drives me

7. What is your current living situation?
   1. Home owner
   2. Renter
   3. Residing in temporary housing
   4. Residing with a parent or guardian and do not pay rent
   5. Homeless
   6. Other
   7. Prefer not to say

8. Is there anyone else who covers more than half of your living expenses?
   1. Yes
   2. No

9. What is your age?
   1. 18-25 years old
   2. 26-35 years old
   3. 36-45 years old
   4. 46-55 years old
   5. 56-65 years old
   6. Over 65 years old
   7. Prefer not to say

10. What is your gender identity? Leave blank if you prefer not to say.

    _____

11. What is your race?
    1. American Indian or Alaska Native
    2. Asian
    3. Black or African American
    4. Native Hawaiian or Other Pacific Islander
    5. White
    6. Prefer not to say

12. Are you of Hispanic or Latino or Spanish Origin?
    1. Yes

2. No
3. Prefer not to say

13. About how long have you lived in Colorado?
    1. Less than 1 year
    2. 1-5 years
    3. 6-12 years
    4. 13-20 years
    5. More than 20 years

14. What city do you currently reside in? Leave blank if you prefer not to say.

    _____

15. What is your approximate annual household income?
    1. Less than $25,000
    2. $26,000-$35,000
    3. $36,000-$55,000
    4. $56,000-$75,000
    5. $76,000-$96,000
    6. $97,000 or more
    7. Prefer not to say

16. Do you have a history of any of the following health conditions?
    1. Lung disease such as asthma, chronic obstructive pulmonary disease, or chronic bronchitis?
    2. Heart disease such as high blood pressure, coronary artery disease, or heart failure
    3. Seasonal Allergies
    4. Diabetes
    5. Prefer not to say

Appendix C
Questions of Interest

Focus Groups Theme Development

What are levels of a) issue familiarity, b) issue experience and c) concern over the risks related to air quality among outdoor workers?

How do outdoor workers perceive susceptibility to the risk of air quality for personal health? Others' health?

What are information seeking habits of outdoor workers related to air quality? What are information preferences of outdoor workers?

What are outdoor worker perceptions on:
a.   who holds responsibility for communicating about air quality?
b.   Perceived importance for workplace routines around air quality?
c.   Perceived efficacy for actions related to air quality?

What are outdoor worker past behaviors related to air quality?

What shapes behavioral intentions to adopt behaviors related to air quality?
- How do social norms shape behavioral intentions related to air quality?
- What are motivations to adopt behavioral intentions?
- What are barriers to adopting health-protective behaviors?

More for internal purposes: What is the perceived usefulness around the following sources of information: AQI index, City of Fort Collins Air Quality Website, Air Resources Data website, and health messages? What are anticipated information needs from these sources? Areas for improvement?

Where are there opportunities to expand. Especially when they are discussing the sources of information.

Category	**Themes to Develop**	**Questions for Group Consideration**
Issue Familiarity	Cameron Peak fire recency	Nuances of ozone familiarity?
	Pollutant differences	
	Information insufficiency	Represents curiosity and need for filling information uncertainty. Which threats are these connected to (e.g., invisible threats like

		radon)? How does this relate to health experiences, built environment, outdoor air environment?
Issue Experience	Firsthand experience with smoke	
	Health experiences	
Issue concern	Pessimism about the future	How to best develop the themes that represent range of levels of concern?
	Burden of compounded/multiple risks	
	Place/geographical comparisons (e.g., "worst place in the US")	
	Information source references	News media, other?
Perceived susceptibility - risk perceptions	Short- and long-term effect differences	
	Susceptible groups	
Information-seeking habits	Source mentions	How to develop sub-themes around mediated (formalized vs. crowdsourced?)/interpersonal sources? What are the relationships between these sources and information type (e.g., weather, AQI) sought?
	Frequency of encounters with AQI information	Do we need to differentiate seeking from incidental encounters?
	Associated routines that support AQI information encounters (e.g., weather)	
Information preferences	Notification type	
	Notification frequency	
	Source of information	

Perceived responsibility (to share information about air quality)		
Perceived importance - workplace air quality routines and protocols	Relationship to immediate health experiences	
Perceived efficacy for workplace-level action on air quality	Agents (e.g., who can take action?)	
	Protocol type (e.g., examples of things done to respond to air quality)	
	Conditions that enable	Are public expectations and supervisor expectations a sub-theme under conditions?
	Role of public expectations	Do we need to develop the theme of trade-offs here?
	Supervisor expectations	
Past individual behaviors	Motivations for taking action (e.g., role model for public behavioral responses)	
	Behavior type (e.g., scheduling work intensity accordingly, staying inside)	
Individual behavioral intentions	Motivations for adopting behaviors	
	Social Norms	

	Barriers	
Information Source Responses - Messages, FoCo website, ARS website [make separate sections for each information source]	Destination for all relevant information for outdoor work (e.g., lightning, weather, wind)	
	Desire for specific actions or behaviors	
	Positive reactions	
	Negative reactions	
	Anticipated information needs	
	Areas for improvement	

Appendix D

Concepts and Definitions

Variable: <u>Definition of variable backed by literature.</u>
    Themes of the Variable
- Examples from the Data
- Examples from the Data
- Examples from the Data

    Themes of the Variable
- Examples from the Data
- Examples from the Data
- Examples from the Data

Issue Familiarity: <u>Knowledge of air quality.</u>
    Pollutant Differences: <u>How familiar participants were with different contributors of poor air quality.</u>

- "I think about the mountains and just... I almost use them as a gauge, how well I can see them if it's really nice and clear, then like, oh, this is a good air quality day, but some days it's like man, you can barely see them."
- "Wild fires. Smoke."
- "Pollution"
- "Vehicles"
- "Yeah. I heard that if you go out in a smokey area after it rains, all the smog you see is the worst because it made it through the rain filter."

Issue Experience: <u>Personal observation of air quality events</u>
Physical impacts with smoke: <u>The ways that poor air quality has impacted participants.</u>
- I would feel like it right here, deep in my throat or before it would go to my lungs, it would just be like sharp.
- I don't know if it's physically, but probably mentally. I don't want to be in this anymore.
- I always just think, I know maybe I don't feel it, but just knowing that you breathe it in every day is just not helping you at all.
- During the fires, I felt it in my lungs for sure.

Cameron Peak Fire Recency:
- I remember during Cameron peak fire, we would come in on days we were in the field working. If it was like high smoke in town, we would come back and just do shop work or work from the office.
- I know during Cameron Peak fire, we would like a new every morning. Yeah, we'd gather in the morning and check the weather, talk about what we're going to do that day. And one of the things we look at every day was the air quality index. Just to see how bad it was that day. If it was really bad, we'd kind of work around it. If it was moderate, we'd go out and do our job typically. But that's one thing we would do as a crew.
- That was like the biggest time we ever looked at air quality index.

Place/geographical comparisons
- It is, it is. And I know it didn't use to be this bad and it used to be worse. I remember down in Denver, when I first moved down there, decade ago, people talking about how much worse it used to be, smog wise, and it's cleaned up a little bit, but it seems like it crept back up. I don't know what that is.

Greater Concerns: <u>Concerns with climate issues regarding air quality and other factors</u>
Pessimism about the future:
- Yeah. It's a problem for the future.
- And that's nice that we do have a lot more battery operated equipment to help supplement afterwards as well. And I know it is helpful and I'm glad we are doing our part, but it just feels like a drop in the bucket compared to everything else out there that is contributing. So I don't know how broad, if the county does it, if, what other agencies also were doing things like this. I know it is helpful to reduce, but still there's so much huge industry pollution and factories and all this stuff. It's discouraging to me that there is just so much else that is happening. That it feels like, what are we even doing? How much does it actually reduce?

- And this might be my own bias, but that feeling of its personal actions only has so much effect. So when I see here's options for you to do, it's okay, cool. But you know, I'm not impacting the major polluters, and the major issues. But that's just my gut reaction when I see suggestions like that.

Perceived Susceptibility - Risk Perceptions: <u>Susceptibility to the threats of poor air quality.</u>
Short- and long-term effect comparisons
- Yeah. I don't think about the long term effect.
- I'm sure it causes issues with respiratory system. Like asthma, or I don't know, maybe even cancer in the long long-term if it gets too bad.
- I don't think I'm worried about long term, but short term of feeling bad.
- I worry about my crew probably more than I worry about myself. Because I don't have any respiratory issues, underlying, already. And so I know that I usually am fine in those situations, but my crew, I usually kind of send inside, get out of it for a while. Because I don't know, I'm not going to delve into their health histories, so it's kind of up to them, but...
- I would say in the immediate sense, I don't feel an effect, but I know that I've had my lung capacity tested and have decreased lung capacity from wildfire smoke. Yeah, this probably will be more of an issue 20 years, 30 years [inaudible].
- I always wonder how many of these things are, maybe, stacking up to the long-term health problems, particularly in the lungs.

Susceptible groups
- I don't know what that means, but I know what the repercussions are that this is not a cautionary statement. You know, children, older adults, active people with heart lung disease should avoid prolong heavy exertion outdoors.
- Just even thinking about wildfires and summer outdoor activities for me has changed in the past several years. Just reevaluating and considering alternatives, which with urban smog we had done before, but now we'll be doing based on air quality because I work mainly with kids.
- Sometimes for the stuff we would do, we can move it indoors or we would cancel because it's activity based outside. Especially working with young kids, we let them know that this is what the air quality is and ask them if they want to continue based on what their threshold is.
- If you're a person that experiences asthma or seasonal allergies, you might want to look at the fair. you're might need to figure out your own threshold or know what that is beforehand.

Burden of compound/multiple risks
- I feel like I would play the "do I have COVID or is it smoke and shit?"
- I don't think about it unless it's the spring, from an allergy standpoint, or summer when that heat and ozone and fire, smog all combines.

Normative beliefs
- I feel like I should be more concerned because I know I work outside in it all day. And it's one of those things where if it's not affecting you every day, I feel like I put it in the back of my brain, but I should probably be more aware and concerned with it.
- I think about wildfire smoke a lot more than I think about like ozone illness or anything like that. I don't even think about those at all when we have those in town, but wildfire

smoke, I definitely get concerned about being out too much in it. Just because of the particulates for my lungs, but then it goes away. But yeah. I don't think at all about other types of air quality issues.

Information seeking habits: Ways of understanding air quality experiences

Associated Routines That Support AQI Information Encounters
- I think about the mountains and just... I almost use them as a gauge, how well I can see them if it's really nice and clear, then like, oh, this is a good air quality day, but some days it's like man, you can barely see them.
- I look at my weather app every day and the weather channel app will have air quality alerts, so that's how I usually find out.
- I usually get notifications through my weather app. I use AccuWeather. I usually get notifications all the time about red flag warnings, or anything that should be of concern, I usually get a notification for.
- Honestly, my wife usually tells me. I imagine she uses one of those. During the fires, you can look outside and tell what kind of day it's going to be.

Frequency of Encounters
- I usually get notifications through my weather app.

Source Mentions
- I use the PurpleAir website, which I think is the independent air quality monitors and people set them up throughout town businesses.
- Weather Underground and I just looked and it does have air quality index on here.
- I use AccuWeather.
- Ozone Front Range.
- you get it through NIF-C. So the national inter agency fire control and then through the local geographic area coordinating centers.
- The Healthy Homes project
- Ozone.frontrange.lister.com.
- I know a few years ago, like pre COVID, our old parks manager wanted to implement co-meet up, it's a lead to 911. It's just a cell phone thing where you can send out an alert to everybody's cell phone.
- My entire crew never reads their emails. It's like, I don't know why, like check your emails, everybody check your emails. They don't do it and so it's up to me to like pass on to them.
- Yeah, usually somebody would send it out to the senior supervisors and then our [crosstalk]. Head facilities guy who is usually our head communicator would send that out to us.

Information Preferences: Preferred method of contact for air quality information

Source of Information
- I don't have alerts on my phone for emails that I get through the city because it would just be pinging all the time. It's really crazy, I literally just that I check it throughout the day.
- You could send out an air quality text message to everybody. It might be a good idea though.
- If I didn't have the alerts, I would never check it.

- Yeah, usually somebody would send it out to the senior supervisors and then our [crosstalk]. Head facilities guy who is usually our head communicator would send that out to us.

Notification Frequency
- I don't have alerts on my phone for emails that I get through the city because it would just be pinging all the time. It's really crazy, I literally just that I check it throughout the day.
- We have our weekly or I guess going to have monthly safety meetings, but yeah, those are once a month at best to which we pass on information like that

Notification Type
- we get severe weather alerts
- We get those ozone alerts.
- So we get emails. We're not allowed to use two stroke stuff after a certain time of day to try to help cut down on it.
- I think the emails help. I look at that my own one to decide whether to pass it along to our partner organizations, just so they know so they can decide. But I don't know.
- Yeah. It comes to my phone so I see it.
- Okay. Yeah. Cause that was my question is the emails are pretty helpful for me. But I check my every day when I was a seasonal many years ago. I doubt if I checked my email every morning so we might miss quite a few people. So I don't know if-

Perceived Responsibility: Burden of taking care of others
Employer responsibility
- Yeah. But we hear it from our supervisor who maybe he hears from somebody higher up kind of thing. And maybe it trickles down like that, but he's very much so, active in our safety and that kind of thing.
- I would say that I feel that my overhead, whatever I told them is how my comfort level to be like, okay, sounds good.
- And our risk management department is pretty obviously concerned about employee wellbeing and long term health and everything else for a variety of reasons. Like one genuinely they want their employees to be safe, but also they have the increased responsibility of liability on all kind of stuff. So I'd say our risk management team is genuinely concerned about wellbeing, which is a citywide team.

Individual responsibility
- everyone has their individual thresholds as to what safety is. So you could be out and I guess like not actual peer pressure, but you think there's peer pressure. Hey, I don't like... Like I should wear a mask right now. Not saying that there is that, but like it can be a mental battle.

Perceived Importance - Workplace air quality routines/protocols: Safety procedures of the workplace regarding air quality
Relationship to immediate health experiences
- sometimes our work will tell us when it's going to be a really bad day. They will encourage people to work indoors but that was basically only a thing during the Cameron Peak Fire, which I would say is pretty rare. A little more common these days, but hopefully not a regular thing anymore.

Perceived Efficacy for Workplace-Level Action on Air Quality: <u>Amount of control</u>

Coworker expectations

- We all watch each other.
- I'd say if there's a whole group thing think sometimes. If everybody walked in with a mask except for one person, I feel like that person would be inclined to put on a mask as opposed to, there's one person with the mask and the rest of us aren't wearing masks. I think it's leading by example in a lot of situations and just educating others as to the risks of crew communicating. This is really dangerous so make sure you wear PPE or whatever it might be.
- I'm pretty much just base everything off just what everybody else is doing around me.

Agents

- I mean, I guess on our end, like public engagement. So I do public programming and I have a lot of autonomy if I feel like it's not safe to be outside, I can just cancel the program and be inside for the day, which is not always an option for field staff.
- No one's going to get in trouble if it's a bad air quality day and you go inside and not get a job done. So I think that's a really good policy that I like from our department.
- Like not comfortable being outside? There would be absolutely no pushback.
- I feel like everybody's real supportive as far as management. I've never heard anybody be like, I don't care. You got to go do it. There's maybe like a, we got to figure out how to get it done. It's not like in a way you're being penalized for being, for wanting to be safe.

Past individual behaviors: <u>Definition of variable backed by literature.</u>

Behavior type

- We tried to... When we were spraying weeds up at Soapstone, we needed to obviously do our job. We couldn't just work in the shop all day. So we did try to wear masks and we wore N95s for a little bit, but then it was so hot and stuff that we ended up... And the air quality was just terrible, so we did end up having to call up early anyway, but that's something that we did as a crew every once in a while was, well, and like individually was if you preferred to wear a mask because it helped with... I mean, it was also COVID, right? Was the Cameron Peak fire. So we already had them on us. And so I personally would wear them on those really, really bad days
- Stay indoors.
- Wear a mask.
- I would much rather go a lot slower to reduce my drift from the desk than go at a normal pace than wear a mask.

Motivations for taking action

- My parents are like that. We heard that there is a wildfire. Are you okay? Yeah, I'm fine. But yeah. I feel like on the office stuff side too, our supervisors are always really supportive. As I said before of if we feel like, hey, we can't safely do public programming and invite 20 people to stand outside in this or go for a five mile hike. So we're going to cancel. They're always really supportive. They don't quite... It's left up to our discretion. They don't question those decisions. So yeah.
- Yeah. Because you kind of like get complacent and stuff. They do it every day. So an outside person sees something that looks off, like it might not be off to you because we're so used to it.

- When I think I'm like, "Oh, my partner's talking to the back of my head. Like I don't want to take you to the doctor." So then I'm like, "Okay, I should go."
- Yeah. They get uncomfortable because I'm sweating an insane amount. But for me, I would rather be uncomfortable and prevent my reactions to like either the chipper dust or the pesticide dust then be affected by it. And for them, I mean, maybe they aren't affected as much by it. And so maybe it doesn't bother them as much, so they'd rather be more comfortable.
- That's for sure when I mask up, if It's, yeah. Curb lines and stuff like that. Super nasty.
- Personal wellbeing for the most part

Barriers: <u>Barriers to complying to air quality suggestions</u>

Other barriers
- The heat.

Individual barriers
- It's also hard to limit exposure. Not only for employment, but I don't have air conditioning.
- Probably like the general public as well. See them out and about doing, especially when we're out working in poor quality days, they're out and about. We're masked up or trying to avoid as much physical work as we can to kind keep our intake of poor air down, when they out just wandering around doing their thing. Having a good day and going about their business and we're suffering with the smoke. It's like, okay, you guys do what you got to do but we're going to be over here suffering.

Work barriers
- The only thing I can see is if we're out of supply or something and we can't get to our PPE.
- Staffing. I don't have enough people and I just have to get a job done. That absolutely stop me from following any of those.
- And so you get a week or two or even three bad air quality days in a row, they're starting to lose their ability to do their job. And they probably have to be out in some of that to a degree, but it might be pushing those more strenuous jobs to another month or to the spring or to the fall and maybe outside of a wildfire season or otherwise just finding less strenuous jobs to maybe make it less of an effect being out on those days. I think we can do that.
- I'd say communication as well. If we're wearing masks or respirators, talking on radios or just communicating with people we're also working with machines. So add that on top of it. You can't hear each other and if you have to take the mask on and off the talk, you are kind of defeating the purpose of it. So that's one that I can probably think of.

Appendix E

Top Line Report

Executive Summary

Our research group conducted focus groups with 18 outdoor workers in the City of Fort Collins. The main goal of these focus groups was to hear from their perspective how the City of Fort Collins is addressing air quality and how some of the procedures, policies, and communication can be improved. From the focus groups, it was clear that outdoor workers' knowledge of poor air quality originates from experiences with poor air quality and knowledge of contributors to poor air quality. Respondents would assess air quality on a daily basis and used the visibility of the mountains as a gauge. It was clear from the discussions that outdoor workers experience physical reactions to poor outdoor air quality. For the outdoor workers, the primary concern was the discomfort that arose with these short-term effects of air quality. Participants had the knowledge of long-term health effects but were not necessarily concerned about them. In addition, participants were generally more concerned with other people's health than their own. This was especially relevant for crew chiefs, who makes decisions for other workers and public engagement specialists who run public-facing programs. The outdoor workers did not perceive themselves as a sensitive group, but identified how individuals with respiratory issues, elderly, children were particularly at risk to the effects of poor air quality.

Air quality information seeking ranges on a continuum of information engagement from checking AQI during the worst possible conditions, such as a wildfire smoke event, to regularly checking AQI as part of a daily routine. Outdoor workers have notification overload in their environment. In the case for air quality information, they want a single notification that would come early in the day to be relevant for decision making about their work day. Current ozone action notifications come too late in the day for them to do anything about it.

When considering whose responsibility it is to communicate air quality information, there is a perception of shared responsibility. On one hand, the City holds responsibility for communicating when there is poor air quality. But on the other hand, the individual is also responsible for determining what is their own level of exposure according to their own personal safety and health. Workers' safety at the City of Fort Collins is important in the organization, but there is a perceived tension between prioritizing worker safety and health and work completion. This tension was exacerbated during the extreme event of Cameron Peak that went on for months. Pressure to get the job done in the face of public expectations builds over a long period of time.

At the City of Fort Collins, there is no set protocol to follow in the case of an air quality event. The Cameron Peak Fire was a precedent. During this extreme event, there was adoption of health-protective measures such as wearing masks, staying indoors, shifting work schedules, and slowing down the pace of work.

Within the workplace, there are social norms that are important for adoption of behavioral intentions: There is a safety culture within the organization that supports behavioral intentions; the workers think and feel positively toward taking health-protective actions; and the workers feel they should take health-protective actions because of family members. But there are also some significant barriers to the behavioral intention. These are the pressure to get work done, reliable access to PPE, and personal discomfort from using PPE.

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Issue Familiarity

An integral portion of this studying was gauging the participants' familiarity with the issue of air quality. In terms of issue familiarity, or knowledge of air quality, the participants were familiar with the term "air quality". When asked about what came to mind when they heard "air quality", participants were able to point to specific experiences with poor air quality such as smoke from wildfires, pollution, and vehicle emissions. It was evident from these responses that air quality had negative connotations with it. Participants only mentioned contributors to poor air quality, not what air quality is like when it is good. There were not any participants that asked for clarification of what air quality was. Some other, more specific, details such as the different types/sizes of particulate matter and ozone were not mentioned by the participants. Cognitively, it was easy for participants to recount specific experiences with poor air quality due to their direct experiences with poor air quality caused by wildfires. It was not surprising that respondents in Colorado mentioned smoke from wildfires as one of the main contributors to poor air quality (this might have looked different if we lived in a heavily populated area where the top concern might be vehicle emissions).

Issue Experience

The focus groups were made up of a range of individuals. We had some participants who had only lived in Colorado for a few years, and others who had lived here their entire lives. No matter how long the participants had been here, all had experienced some sort of air quality event. It was evident that there was a relationship between familiarity of air quality and personal experiences. When asked about air quality, the top of mind answer most of the participants gave was wildfire smoke. For the participants, the experience they referred to the most was the Cameron Peak Fire. Some other participants could draw from other air quality events that had happened in the past, or were even able to speak to how different air quality is today compared to even a decade ago. But during the conversation, it was the Cameron Peak Fire that was referred to the most. There were three main themes that developed in the conversation about experiences with poor air quality: physical impacts from smoke, the Cameron Peak Fire Recency, and geographical comparisons. Participants discussed their physical experiences with confronting smoke and other pollutants such as having pain in their throats, lungs, eyes, and noses. Four of the participants in the focus groups disclosed that they had asthma or other respiratory issues. From the respondents, the more sensitive individuals did not express more than other participants that they had difficulty with poor air quality. Among the group, there was consensus that poor air quality caused general irritation for their eyes, nose, throat, and lungs. In addition to these physical experiences, participants were able to compare air quality to other geographical places/locations. For example, they mentioned how the air quality in Fort Collins is better than Denver. It seemed like the participants who had lived in Colorado for an extended period of time often thought that Fort Collins' air quality was always better than Denver's. Participants mention how there is a "smog" that hangs over Denver that Fort Collins does not necessarily have. But another participant pointed to how in recent years, the air quality in Fort Collins is beginning to become similar to Denver's:

> "Before maybe the last five or 10 years, [I] probably would have associated it with more just urban smog that used to be over the Denver Metro area and it's just creeping up the front range in both directions now as well."

Participants have noticed air quality events and how they are more poor air quality days in recent times. In terms of their greater concerns, participants signaled that this will be an issue for the

future. Some pessimism also came with this because some participants felt that their actions to improve air quality could only do so much, or were a drop in the bucket in the greater scheme of things. One participant mentioned, "This might be my own bias, but that feeling of personal actions only have so much effect… you know, I'm not impacting the major polluters, and the major issues."

Participants also spoke about other experiences they had with air quality specifically referring to their jobs as outdoor workers. When discussing the Cameron Peak Fire, the outdoor workers mentioned how they needed to shift their work indoors especially when the air quality was considered dangerous. Typically it was up to the supervisors to make the decision whether or not they would stay indoors for the day or not. Other times, they would adjust their work schedules by only going out in the morning and staying indoors later in the day.

Health Implications

The participants of the focus group were namely concerned with the immediate, or short term effects of poor air quality. Short term effect being it would impact them for some time and then go away unlike a long term effect where there are more long-lasting health implications such as lung disease. Pointing to some of their experiences they discussed earlier such as pain and irritation in their throat, lungs, eyes, and noses. Top of mind, the participants pointed to the Cameron Peak Fire and how the continued, multi-day exposure to poor air quality impacted them. One participant mentioned how they would blow their nose, and it would be black. When this comment was made, there was agreement among the other participants signaling that they had experienced this too. Some outdoor workers mentioned specifically that they knew about the difference between short and long term, but the short term was what concerned them the most.

While participants were mainly focused on the short term effects, it was clear that participants also knew about long term health effects. A small number of participants throughout the focus groups (around four) could really point to some specific long-term health effects such as lung disease. But this was mainly an awareness of the long-term effects of exposure to poor air quality. The participants did not necessarily have concern about these potential effects at the time. One participant stated, "I don't think I'm worried about long term, but short term of feeling bad."

Others' Health

It was clear that participants cared more about the health of others than their own health. In the focus groups, we had crew members, public engagement specialists, and crew chiefs. One participant who was a crew chief and supervised those within his group (five to six individuals), said, "I worry about my crew probably more than I worry about myself. Because I don't have any respiratory issues, underlying, already. And so I know that I usually am fine in those situations, but my crew, I usually kind of send inside". Another supervisor mentioned that it was not his job to make people disclose health information to him, but always tried to create an environment where someone could approach and tell him if they felt uncomfortable being outside on a given day.

Participants when asked about who was more at risk with poor air quality were able to point to a general population of susceptible groups. Though they were not specifically named, people mentioned their loved ones who had asthma, or the elderly at people who are more at risk than the general population. Other participants who worked in more public facing roles, such as public engagement, pointed to children being particularly at risk. One participant who worked in

public engagement explained, ""Sometimes for the stuff we would do, we can move it indoors or we would cancel because it's activity based outside. Especially working with young kids." In addition with the children, participants who were public engagement specialists seemed to consider the general population as more vulnerable. This was evident because one participant mentioned that if there was ever any kind of air quality event or reason for there to be concern, outdoor public engagement events would be canceled to make sure they did not put anyone in harm's way. An interesting finding from the focus groups was that outdoor workers did not consider themselves to be more vulnerable than the general population, even though their work requires them to be outdoors more than the general public.

Information Preferences

Before the group were provided specific examples of resources to find out more about air quality, the participants shared what their primary ways of finding out air quality information were. The question that prompted this was, "How do you know when air quality is poor?" At first, some participants disclosed that they did not actively seek out air quality information. But as the discussion continued, and we asked specifically what apps they used to find out air quality information, some people mentioned specific sources such as using the weather apps on their smartphones. This seemed to be a type of information seeking that was part of their daily routine and preparing for the work day. One participant specifically mentioned that he checked his smartphone for the weather everyday, and knew that there was AQ information there, but did not actively engage with it unless it was visible that there was poor air quality (being able to see smoke outside). Other participants mentioned using Purple Air or Weather Underground. One participant was very familiar with Purple Air and checked it regularly. Other participants mentioned that they would only check these resources (active information seeking) during a period of poor air quality, like the Cameron Peak Fire. Participants also mentioned that during extreme air quality events, like the Cameron Peak Fire, they got their information from their supervisors.

When discussing the ideal ways the participants would want to receive air quality information, it was clear there was no silver bullet to information preferences of outdoor workers. Some people liked getting emails, others said their inboxes were always inundated with emails from the City. One method of communication that seemed to track well with all participants was phone notifications (texting) that went out once a day in the early morning. The participants mentioned that they specifically wanted it in the morning because Ozone Action Day Alerts are announced in the late afternoon, and by then, they have already been outside for the majority of their day. "I don't have alerts on my phone for emails that I get through the city because it would just be pinging all the time. It's really crazy, I literally just check it throughout the day." Additionally, the outdoor workers begin their day very early in the morning, so having air quality information early in the day would be a more relevant time for them to decide how they will adjust their work accordingly.

Perceived Responsibility

When asked who held responsibility for communication about air quality, there were a mix of responses. There were two themes that emerged here: responsibility of the City and personal responsibility. On one hand, people thought their employer and the City as a whole held the responsibility to communicate air quality information to workers when necessary. Necessary being when the air quality would be unhealthy for them to go outside. "We hear it from our

supervisor who maybe he hears from somebody higher up kind of thing. And maybe it trickles down like that, but he's very much so active in our safety and that kind of thing." But on the other hand the participants made it clear that it comes down to the individual whether they want to go outside and work that day or not. One participant said, "Everyone has their individual thresholds as to what safety is."

Attitude Toward Safety

From the focus groups, it was made clear by the participants that The City of Fort Collins has a big emphasis on safety. The first demonstration of this was when a participant explained that any individual, no matter their ranking, can call "stop work" if something is unsafe. This stems from outdoor workers typically using dangerous equipment such as chainsaws, lawn mowers, and blowers. But this could apply to poor air quality as well. If an individual decided they wanted to call stop work because they felt unsafe, there would be no push back. It was evident that all of the participants were very respectful of the "stop work" rule and abide by it. In addition to being able to call "stop work", additional safety measures that are taken by the City are weekly safety meetings where they discuss different aspects of safety (using equipment, PPE, etc). One participant who was in the focus group was actually the Safety Coordinator and organized the talking points for each meeting across the department. During the Cameron Peak Fire, air quality was something that was discussed weekly during these meetings. But it was evident from the discussions with the outdoor workers that there is no specific protocol/procedures they follow regularly regarding air quality.

Efficacy

In terms of worker efficacy, the outdoor workers were faced with a unique dilemma during extended periods of time of poor air quality: should they go outside and work (while risking their health) or stay inside and not complete their job? As mentioned earlier, there is a well-established Safety Culture at the City of Fort Collins. This system gives workers a significant amount of efficacy when it comes to making safety decisions. For example, if there was another event like the Cameron Peak Fire, and a worker felt uncomfortable going outside, if they told their supervisor that they felt uncomfortable, it was evident that there would be no pushback or ramifications for that. But the workers said this is a difficult issue to navigate because at a certain point, the work needs to get done. During the Cameron Peak Fire, there was an extended period of time where the outdoor workers were inside. Because of this, there were situations where they needed to go outside and work in poor air quality conditions. During one focus groups, the participants discussed the pressure they felt from the City to get their work done. "When we were spraying weeds up at Soapstone, we needed to obviously do our job. We couldn't just work in the shop all day. So we did try to wear masks and we wore N95s for a little bit, but then it was so hot and the air quality was just terrible, so we did end up having to call up early anyway". In addition, one participant said that outdoor workers can all be fitted for respirators to use when they are spraying weeds. There were a small number of outdoor workers who worked in the natural areas (4-5) who all had these, but other workers who were in parks did not have these.

Past Behaviors

When reflecting on past behaviors, the participants recollected what they did during the Cameron Peak Fire. During this time, some behaviors they took were staying indoors, shifting

work schedules, wearing a mask, and slowing down their pace of work. What encouraged them to take these measures was their knowledge of the poor air quality (communicated by their supervisors) and own personal experience with smoke (ash falling from the sky, physical irritation from smoke). Once again, the participants mentioned again the dilemma of working vs. not getting work done and their general discontent with wearing masks because they are hot, uncomfortable, and stuffy. It seemed like the workers and the supervisors could make the decision to stay inside. But with the added pressure from the City to get work done, it seemed like when the supervisor recommended they come inside, that was the final decision. One participant from the focus group summarized this by saying, "We seem to have some sort of threshold where we were directed to work inside."

Social Norms

When considering social norms, there are a few types of norms to consider: descriptive, prescriptive, and subjective norms. According to Baumeister and Vohs (2007), descriptive norms are what most people in a group think, feel, or do. In the case of the outdoor workers, they think and feel positively toward taking health-protective actions. Prescriptive norms are moral values and societal standards about behaviors. In terms of norms for the City workers, it was evident that outdoor workers approved of any safety decision an individual made. This was reinforced by the strong Safety Culture that is a part of the workplace at the City. It was clear that during an air quality event, when the smoke is visible, there are immediate physical impacts, and clear communication from supervisors, the act of taking preventative measures is important to outdoor workers. But during another day when there is an Ozone Action Day, but the mountain look "clear", the social norms surrounding preventative measures fade away. It seems to be based on the "extremeness" of the event for social norms for taking preventative measures to combat poor air quality to really take hold. Additionally, there were some subjective norms, the belief that an important person or group of people will approve and support a particular behavior, that arose during the focus group. Participants discussed wanting to take preventative measures because of important others such as family members or partners. On the other hand, the social motivations were because of the actions their coworkers were taking. One participant mentioned that if there was a group and only one person was not wearing a mask, more than likely they would end up putting on a mask like the rest of the group. In addition, if some people in the group mentioned that they felt uncomfortable working outside, that crew might decide to do indoor work that day.

Barriers

During discussion, it was evident that there were a number of barriers to workers for adopting health-protective behaviors. There were three types of barriers that arose: work barriers, personal barriers, and limitations of PPE. For work barriers, it was clear that participants felt a certain pressure from the City to get their work done. This meant that they could not stay indoors all the time and at a certain point, they would need to go outside and get their work done even in poor air quality. Additionally, during the discussion it was evident that sometimes there is limited access to PPE. Usually the equipment is provided by the department, but it can be hard to find. On a personal level, participants made it clear that it is uncomfortable to wear a mask for 8-hours in the summer heat. In addition to that, another barrier for the outdoor workers was questioning the effectiveness of the PPE equipment they used. One participant mentioned seeing members of the general public out and about not taking any kind of preventative measure which

brought up the question for him of how important wearing PPE or taking other preventative measures was.

Conclusion

Air quality is an issue that directly impacts outdoor workers. During the focus group discussion with 18 City of Fort Collins outdoor workers, our team was able to gain a better understanding of their experiences and attitudes about air quality and taking protective measures during air quality events. When discussing extreme air quality events such as the Cameron Peak Fire, it was clear that the event physically impacted the outdoor workers and also impacted their work. While the City of Fort Collins does not have a set protocol for these air quality events, it is clear that the safety of workers is paramount. But when faced with an air quality event that span for days, weeks, or even months, there is pressure from the City for workers to get their work done, potentially putting themselves at risk. The outdoor workers found that there is a shared responsibility for communicating health information between the City and the individual worker. The outdoor workers were interested in having more air quality information shared with them such as cell phone notifications. But the outdoor workers specified that this information must come at an opportune time. In the case of outdoor workers, they need their notifications to come early in the day, before their work begins, so that they can make appropriate adjustments for their daily work. Between the safety culture of the workplace and other social norms, it is clear that there is an environment at the City of Fort Collins that supports the workers in taking preventative measures during air quality events. But some barriers such as pressure to get work done, access to PPE, and uncomfortable PPE can stand in the way of the behavioral intention.

Usefulness of AQI Resources

Resource	Information Needs	Positive	Negative	Areas for Improvement
AQI Index	Want to know, "What is the air quality right now?" Location-based information Ways to protect themselves. Need information early in the day.	Liked the color gradient. Found it easy to understand. Thought it seemed "real time" Thought City of Fort Collins seemed like a trustworthy source.	The information on the dial was generic. Just in one location of the City.	Need to include information for rural places and places not just in the City.
City of Fort Collins		Liked the cameras and the different locations.	Did not like that they needed to click to another page to get to AQI.	Could be one page. Could have AQI information for all

AQ Website	Quick information	Important to the OW because they work in different locations.	Did not like how you needed to click between Ozone, 2.5 PM, and 10 PM Concern over where the information was actually coming from.	of the locations where there are cameras (Difficult to tell sometimes if it is clouds, smog, or smoke).
Health Messages			Colors are not great for individuals who might be color blind. Information/definitions seemed outdated (cooling centers, respite) Language did not seem urgent enough. Confusion around who is considered a "sensitive group" and how this impacts what they can and can't do.	Recommend to wear a mask when it reaches certain levels.

AQI Index: Almost all of the participants reacted positively to the AQI dial. They had either seen it before, or thought it was a good representation of the AQ data. The color gradient was useful for participants because it shows the range. One participant mentioned, "Everybody knows how the dial works. Green is good, red is bad." From the AQI dial, the outdoor workers wanted to know what the difference between green, orange, red, and purple was in terms of how it would "look" outside. They thought it might be nice to have reference photos. The dial could be improved because it only shows the air quality in one location. For outdoor workers who go to multiple locations in the City, the generic information does not help them. It could be improved if there was AQI for multiple areas in the City.

City of Fort Collins Air Quality Website: In terms of navigation, the respondents did not like that you have to click to the AQI page from the other City of Fort Collins landing page. One participant mentioned that he would not have known to click the link because it did not look very interactive. There were also some questions and lack of knowledge that arose from the page. For example, one main concern was not knowing what PM was. In addition to that, the participants noted that they did not know the difference between 2.5 and 10 PM. Participants were able to navigate to some areas of the site to find more information on some of these terms, but mentioned that these were still difficult to find. One part of the website that participants responded well to (nearly everyone, if not all participants, liked it) was the webcam images showing the live feed of different areas in Fort Collins. One outdoor worker mentioned they

liked this because they work up at Soapstone. Since it is far away, the AQ from Fort Collins might not be accurate, so this was more meaningful to them. Some participants were wondering where the data that was in the dial was from. Because if it is from the city, and they are working out at Soapstone, the AQ information does not help them.

Health messages: The participants liked the health messages that were given to them. They were able to understand that the green portion of the chart was what you do when air quality is good, and as you go down, what you should do when air quality is bad. One participant wanted the chart to be more directed at people with jobs, not necessarily people recreating outside. Another participant suggested adding potential symptoms one would experience in an X day. There were also some language suggestions the participants had. One person mentioned that "high intensity" is a broad term and varies from person to person, so it should be more specific. Two participants specifically said urgency in the messages needs to increase as it becomes more serious and it was not alarming enough. Another person had the question of what a cooling center was an how they could find resources about that.

- Issue Familiarity - Originates from experiences with poor air quality (e.g., wildfires) and knowledge of contributors to poor air quality
  - There is a baseline level of air quality discussion and engagement within the organization.
  - No set protocols or knowledge/familiarity with specific protocols.
  - Assessment of air quality on a daily basis - visibility of mountains is a gauge; positive attitude toward webcam that shows this.
- Issue Experience
  - Outdoor workers experience physical reactions to poor outdoor air quality
  - Geographical position in the Front Range relates to Issue Experience and Familiarity
- Issue Concern
  - General pessimism around the trends of air quality in our geographical area
  - Knowledge of long-term health effects but not necessarily concerned about them
  - Primary concern is the discomfort that arises with short-term effects of air quality
  - Other people's health is more important than my health when making health-protective action decisions (crew chief, who makes decisions for other workers, public engagement specialist, who run public-facing programs)
  - They perceive the following groups are more at risk for air quality issues: respiratory issues, elderly, children. They don't identify themselves as outdoor workers as being more at risk than the general public.
- Air quality information seeking
  - Continuum of information engagement: Ranges from checking AQI during the worst possible conditions during a wildfire smoke event up through regularly checking AQI as part of a daily routine
- Air quality information preferences
  - They have notification overload in their environment.

- They want a single notification that would come early in the day to be relevant for decision making about their work day (e.g., Ozone action notifications come too late in the day for them to do anything about it.)
  - Perceived Responsibility
    - Perception of shared responsibility: The City holds responsibility for communicating when there is poor air quality, but the individual is responsible for determining what is their own level of exposure according to their own personal safety and health.
  - Attitudes Toward Safety
    - Perception that workers' safety is important in the organization.
    - Perceived tension between prioritizing worker safety and health and work completion.
      - This tension was exacerbated during the extreme event of Cameron Peak that went on for months. Pressure to get the job done in the face of public expectations builds over a long period of time.
  - Past Behaviors
    - Cameron Peak Fire as precedent: There was adoption of health-protective measures during this extreme event. Wearing masks, staying indoors, shifting work schedules, slowing down the pace of work.
  - Social Norms are important for adoption of behavioral Intentions
    - Prescriptive: There is a safety culture within the organization that supports behavioral intentions.
    - Descriptive: They think and feel positively toward taking health-protective actions.
    - Subjective: They feel they should take health-protective actions because of family members.
  - Barriers to behavioral intentions
    - Work: Pressure to get work done. Reliable, consistent access to PPE. Is available, but not uniformly. Perceived responsibility of the organization to provide PPE
    - Personal: Discomfort is the primary personal barrier. Using PPE (e.g., respirator) is uncomfortable in summer heat. This leads to risk-benefit calculations between immediate discomfort and long-term benefit.
- For the personal motivations, these applied to someone who had asthma themselves and didn't want it to flare up.