UNIVERSITY OF CALIFORNIA MERCED

An Examination of the Existing Patterns of Healthcare Utilization, Barriers to Health System Integration, and the Role of Digital Health Interventions in creating an integrated healthcare system for Agricultural Workers in California

A dissertation submitted in partial satisfaction to meet the requirements for the Doctor of Philosophy degree in Public Health

By

Nimrat Kaur Sandhu

Committee Members:

Dr. Paul Brown

Dr. Asa Bradman

Dr. Ricardo Cisneros

Degree year: 2024

The dissertation submitted by Nimrat Kaur Sandhu is approved, and it is acceptable in quality and form for publication on microfilm and electronically.

Dr. Paul Brown

Committee chair Signature

Dr. Asa Bradman

Committee member Signature

Dr. Ricardo Cisneros

Committee member Signature

Acknowledgments

This dissertation is dedicated to my husband, Pushpinderdeep, for his consistent support of my kids Gurfateh Singh and Guradeeb Singh, for their cute smiles that kept me motivated, my parents, Gursharan Singh and Bhupinder Jit Kaur, for their constant encouragement and my in-laws Gurmit Kaur and Hardeep Singh for being solid pillars of support throughout my arduous PhD journey.

The creation of this manuscript would have been impossible without the exceptional mentorship provided by my adviser, Dr. Paul Brown, the support of my committee members, Dr. Asa Bradman, and Dr. Ricardo Cisneros, and the encouragement from my colleagues in the department of public health.

It is also important to acknowledge the contribution of the University of California, Merced Center for Geographic Information Studies, for providing invaluable assistance in calculating the distance and travel time required for this study, the Farmworker Health Study group, for providing the dataset and sharing their expertise as well as the employers, farmworker-serving healthcare providers, and advocates who participated in the interviews.

Table of contents

List of Tables

List of Figures

CURRICULUM VITAE

EDUCATION

08/2020-12/2024	Ph.D. in Public Health, University of California, Merced (expected)
08/2017-04/2019	Masters in Public Health (M.P.H.), Wayne State University School of Medicine and Public Health Sciences, Detroit, Michigan, U.S.A.
08/2007-04/2013	Bachelor of Medicine and Bachelor of Surgery (M.B.B.S.) Sri Guru Ramdas Institute of Medical Sciences and Research, Amritsar, India

RESEARCH INTERESTS

Health services research, healthcare access and utilization among medically underserved populations, creating integrated and coordinated healthcare systems for vulnerable communities such as farm workers, and examining the role of digital health interventions to develop innovative healthcare service delivery models.

FELLOWSHIPS AND AWARDS

2023	Academy Health: Student Abstract Award: State Health Policy Interest Group
2021	American Public Health Association (A.P.H.A.) Student Paper Award winner: Medical Care section
2020	Recipient of Earl. C Anthony fellowship at the University of California Merced

UNITED STATES MEDICAL LICENSING EXAMS (U.S.M.L.E.)

Completed U.S.M.L.E. Step 1, Step 2 C.K., Step 2 C.S., and Step 3

CONFERENCE PRESENTATIONS

Poster presentations

Sandhu N.K., Mendoza A.L., Pokhrel P., Brown P. **"**Examining the Priorities of Local Health Departments in California: A Mixed Methods Study." Academy Health Annual Conference, Baltimore, June 2024.

Sandhu N.K., Brown P. **"**Farmworker Information and Care-Seeking Patterns for Occupational Illnesses: A Cross-Sectional Study of Farmworkers in California.**"** Academy Health Annual Conference**,** Baltimore, June 2024.

Sandhu N.K., Brown P**. "**Improving Healthcare Access and Integration of Care for Farm Workers in California: Opportunities for Using Digital Health.**"** Academy Health Annual Conference, Baltimore, June 2024.

Sandhu N.K., Brown P., Diringer J. Paramo N. "An Examination of the Existing Health Insurance Framework for Agricultural Workers in California and Proposing Policy Options to Improve Coverage Rates: A Mixed Methods Study." Academy Health Annual Conference, Seattle, June 2023.

Sandhu N.K., Brown P., Perea-Ryan M., Diringer J. "Identifying the Predictors for the Utilization of Healthcare Services Among Agricultural Workers in California Using the Anderson Model of Healthcare Utilization: Findings from the University of California Merced Farmworker Health Study (UCM FWHS.)" Academy Health Conference, Seattle, June 2023.

Muniz L., *Sandhu N.K.,* Brown P. "An examination of barriers related to accessing interpretation services in health care facilities among farmworkers in California." U.R.O.C. Symposium, Merced, August 2022.

Sandhu N.K., Brown P., Strochlic R., Getz C., Diringer J. "Examining the Relationship between Digital Access, Access to Health Insurance Coverage and Utilization of Telehealth Services Among Agriculture Workers: A Mixed Methods Study." Academy Health Annual Conference, Washington D.C. June 2022.

Sandhu N.K., Brown P., Diringer J. "Identifying Barriers to Healthcare Access and Utilization and Proposing Innovative Models of Healthcare Delivery to Agriculture Workers from the Perspective of Healthcare Providers." Academy Health Annual Conference June 2021.

Oral presentations

Sandhu N.K., Brown P., Diringer J. Paramo N. "An Examination of the Existing Health Insurance Framework for Agricultural Workers in California and Proposing Policy Options to Improve Coverage Rates: A Mixed Methods Study." Academy Health Conference Seattle, June 2023.

Traboco L., Zamora-Abrahan G., Reyes Sheila M., Ovseiko Pavel V., *Sandhu N.K.,* Gupta L. "Gender Parity in Rheumatology Conference speakership: Is the Philippines leading the way ahead?" Japan College of Rheumatology Conference Tokyo, April 2023

Sandhu N.K, Brown P., Diringer J. "Identifying barriers and facilitators for healthcare access and utilization among agriculture workers: Impact of the Affordable Care Act (A.C.A.)." A.P.H.A. Annual Conference, Denver, Colorado, U.S.A., October 2021.

Sandhu N.K., Brown P., Diringer J. "Impact of the A.C.A. on agriculture worker access to and utilization of healthcare services: Evidence from the N.A.W.S." Health and special topics panel presentation, UC Merced Farmworker Health Conference, Merced, U.S.A., April 2021.

PUBLICATIONS

Journal articles

Sandhu N.K., Strochlic R., Getz, C., Diringer J., Brown P. (2023) Health Insurance Coverage for Farmworkers in California After the Introduction of the Affordable Care Act: A Mixed-methods Study. *Medical Care*

Mora A.M., Kogut K., *Sandhu N.K.,* Ridgway D., Patty C.M., Renteria M., Morga N., Rodriguez M.T., Romero M., Valdovinos J.M, Torres-Nguyen A., Guzman O., Martinez M., Doty R.L., Padilla A., Flores E., Brown P.M., Eskenazi B. (2023) SARS-CoV-2 infection and long COVID among California farmworkers. *Journal of Rural Health*

Sandhu N.K., Wright G., Fajardo K., Gupta L. (2023) Health equity in Rheumatology: A Global Health Perspective. *Touch REVIEWS in R.M.D.*

Sandhu N.K., Peixoto M., Figliuolo M., Gupta L. (2023) Gender Equity in Academic Medicine. *Journal of Korean Medical Sciences (J.K.M.S.)*

Sandhu N.K., Ravichandran N., Nune A., Day J., Sen P., Nikiphorou E., Tan A.L., Joshi M., Saha S., Katsuyuki S. S., Jagtap K., Agarwal V., Ziade N., Velikova T., Milchert M., Kuwana M., Makol A., Chinoy H., Agarwal V., Aggarwal R., Gupta L.(2023) Flares of Autoimmune Rheumatic Disease following COVID-19 Infection: Observations from the C.O.V.A.D. study. *International Journal of Rheumatic Diseases*

Sandhu N.K., Wason R., Goel A.(2022) Scientific peer review in the modern era: a comprehensive guide. *Indian Journal of Rheumatology*

Rodrigues F., Newell R., Babu G.R., Chatterjee T., *Sandhu N.K.,* Gupta L. (2024) The social media Infodemic of health-related misinformation and technical solutions. *Health Policy and Technology*

Rodriguez F., Gupta P., Khan A.P., Chatterjee T., *Sandhu N.K.,* Gupta L. (2023) The Cultural Context of Plagiarism and Research Misconduct in the Asian Region. *Journal of Korean Medical Sciences (J.K.M.S.)*

Traboco L.S., Zamora -Abrahan G., Reyes S.M., Ovseiko P.V., *Sandhu N.K.,* Gupta L. Gender Parity in Rheumatology Conference speakership: Is the Philippines leading the way ahead?(2023) Rheumatology International

Gaur P.S., Saha S., Goel A., Ovseiko P., Aggarwal S., Agarwal V., Haq A. U., Danda D., Hartle A., *Sandhu N.K.,* and Gupta L.(2023) Mental Healthcare for Young and Adolescent LGBTQ+ Individuals in the Indian Subcontinent. *Frontiers in Psychology*

Kahlon P., *Sandhu N.K.,* Kuriakose P., Peres E. (2017) Lenalidomide Maintenance Therapy after Autologous Peripheral Blood Stem Cell Transplant (P.B.S.C.T.) in Multiple Myeloma Patients: Factors That Impact Treatment. *Blood*

Kahlon P., Mishra A., Williams T., *Sandhu N.K.,* Donthireddy V., Dobrostoskaya I. (2017) Diagnosing Primary Squamous Cell Cancer of the Rectum in a Patient With H.I.V.: A Case Report. *Journal of Oncology Practice*

Reports

Farmworker Health in California: Health in a Time of Contagion, Drought and Climate Change, sponsored by the California Department of Public Health (C.D.P.H.)

Economic and Health Burden of Chronic Diseases in the Farmworker Community of California sponsored by the California Department of Public Health (C.D.P.H.)

DISSEMINATION

Policy Briefs

Sandhu N.K., Mendoza A.L., Pokhrel M., Brown P.(2024) Examining the priorities of Local Health Departments in California: A mixed methods study: U.C.M. Public Health Decision Intelligence Unit.

Diringer J., Montano M., Galvez I., Paramo N., *Sandhu N.K.,* Brown P. (2023) Making Medi-Cal Work for California Farmworkers: Collaboration between Insure the Uninsured Project (I.T.U.P.), U.C.M., and Diringer and Associates

Diringer J., Montano M., Galvez I., Paramo N., *Sandhu N.K.,* Brown P. (2023) Expanding Health Coverage for California Farmworkers: Collaboration between Insure the Uninsured Project (I.T.U.P.), U.C.M., and Diringer and Associates

Sandhu N.K. (2020) Role of Vitamin E Oil in Causing Vaping Related Severe Lung Illness. Merced: UC Merced Nicotine and Cannabis Policy Center.

Hurd T., *Sandhu N.K.* (2020) Access to healthcare and health insurance in California: U.C.M. Translational Research Center

Sandhu N.K. (2020) Overview of the methodology used in Previous Agriculture Worker Health Studies: U.C.M. Translational Research Center

Manzo R., *Sandhu N.K.* (2020) Agriculture worker health and health disparities: U.C.M. Translational Research Center

Joel Diringer J., *Sandhu N.K.* (2020) Agriculture worker Policy review: U.C.M. Translational Research Center

Information Briefs

Sandhu N.K., Nunez A., Mantoan G., Brown P., Ridgway D. (2021) COVID-19 treatment strategies other than Chloroquine and Hydroxychloroquine: U.C.M. Translational Research Center

Sandhu N.K., Nunez A., Mantoan G., Brown P., Ridgway D. (2021) COVID-19 Solidarity trial: U.C.M. Translational Research Center

Sandhu N.K., Nunez A., Mantoan G., Brown P., Ridgway D. (2021) COVID-19 Chloroquine and Hydroxychloroquine: U.C.M. Translational Research Center

Sandhu N.K., Nunez A., Mantoan G., Brown P., Ridgway D. (2021) COVID-19 Serological tests: U.C.M. Translational Research Center

Newspaper articles

Sandhu N.K., Jaddou N. (2017) Answers to common questions about Seasonal Allergies article, Somerset Gazette

WORK EXPERIENCE

06/2023-6/2024	Graduate student researcher for California Department of Public Health (Behavioral Economics and Health Economics in Public Health grant)
04/2024-06/2024	Teaching Assistant for Behavioral Economics for Public Health course for public health officials sponsored by the California Department of Public Health

01/2023-06/2023	Intern at California Health Benefits Review Panel (C.H.B.R.P.)
06/2022- 06/2023	Graduate student researcher for Robert Wood Johnson Foundation project (Transforming Healthcare Systems grant)
01/2022-05/2022	Teaching Assistant for Research Methods at UC Merced
08/2021-12/2021	Teaching Assistant for Introduction to U.S. Healthcare at U.C.M.
05/2021-08/2021	Graduate student researcher UC Merced Farmworker Health study (funded by California Department of Public Health grant)
08/2020-05/2021	Teaching Assistant for Health Communication at UC Merced
03/2020-08/2020	Assistant Research Specialist, Nicotine and Cannabis Policy Center, University of California, Merced
08/2019-02/2020	Research Assistant, Health Sciences Research Institute, UC Merced
08/2018-06/2019	Public health intern at Wayne State University Campus Health Center
01/2019-05/2019	Teaching Assistant for Epidemiology at Wayne State University
09/2018-01/2019	Wellness Warriors program paid student volunteer
08/2018-05/2019	Developed an H.I.V. Pre-Exposure Prophylaxis (PrEP) project at the Wayne State University Campus Health Center
05/2013-01/2014	General physician at Fortis Hospital Ludhiana, Punjab, India

CERTIFICATIONS

C.I.T.I. training certification

Educational Commission for Foreign Medical Graduates (E.C.F.M.G.) certified 3/10/2016

Punjab Medical Council certified on 4/10/2013

CERTIFICATE COURSES COMPLETED

John Hopkins University	Foundations of Telehealth
John Hopkins University	Foundations of Healthcare Systems Engineering
University of Minnesota	Interprofessional Healthcare Informatics
UC Davis	Telehealth best practices and uses
University of Sydney	eHealth: More than just an electronic record
John Hopkins University	COVID-19 Contact tracing certificate
John Hopkins University	Measuring and Maximizing the Impact of Contact Tracing
John Hopkins University	Infectious Disease Transmission Models for Decision-Makers

TEACHING CERTIFICATE COURSES

University of California Merced Center for Engaged Teaching and Learning -Evidence-based teaching practices

The University of California Merced: Center for Engaged Teaching and Learning- Advanced Pedagogy

The University of California Merced: Center for Engaged Teaching and Learning- Preparing to teach in the online environment

The University of California Merced: Center for Engaged Teaching and Learning- Faculty Institute Seminar on Designing Resilient Online Instruction

The University of California Merced: Public Health Department- Introduction to Systematic Review: Methods & Tools for Public Health Research

PROFESSIONAL MEMBERSHIPS

Academy Health

Academy Health State Health Research and Policy Interest Group

Academy Health Public Health Systems Research Interest Group

American Public Health Association

Health Sciences Research Association of Australia and New Zealand (H.S.R.A.A.N.Z.)

UCM FWHS Medical Advisory Board

UCM FWHS Research Group

Health Sciences Research Institute UC Merced (H.S.R.I.)

Nicotine and Cannabis Policy Center UC Merced

American Medical Association

American Red Cross

COVID-19 Consulting Group UC Merced

Punjab Medical Council

UC Merced Public Health Graduate Student Executive Group

Wayne State University Alumni Association

COMMUNITY SERVICE ACTIVITIES

2022-2023: President, UC Merced Public Health Graduate Student Executive Group

2021-2022: Treasurer, UC Merced Public Health Graduate Student Executive Group

10/2021: Panelist UC Merced Public Health Graduate Experiences Panel

02/2019: UC Merced Farmworker Health Study Advisory Panel

2014-2019: Langar Seva (Free food kitchen) at Sikh temple in Sterling Heights, Michigan

2010-2011: Breast Cancer Awareness Campaign Amritsar, India

2011-2012: Medical professional volunteer at Primary care clinic Mallu Nangal village, Punjab, India

01/2010-02/2010: Immunization officer, National Pulse Polio Campaign, Amritsar, India

LANGUAGES

English, Punjabi, Hindi and Urdu

Abstract

Introduction: Previous studies on healthcare utilization among California agricultural workers California report low usage despite high vulnerability. Many studies are outdated with limited scope, and do not reflect the impact of recent policy changes. This study examines the effects of distance, socioeconomic, structural, and cultural factors on healthcare access with the actual and intended healthcare utilization patterns under the current policy framework. Digital health interventions rapidly expanded during the COVID-19 pandemic and can help overcome many obstacles. This study further examines digital access and utilization patterns among workers, the perspectives of providers and advocates on their usage, and proposes delivery models that might enhance care integration.

Methods: UCM FWHS was used to examine the patterns and predictors of delay in seeking services, actual and intended healthcare utilization through Chi-square tests, linear and logistic regressions. Additionally, NAWS 2018 digital access supplement and CHIS 2021-22 surveys were used to study digital access and utilization. Thirty-eight semi-structured interviews were also conducted with healthcare providers, employers, and advocates to understand their perspectives on the barriers to access and utilization. Subsequently, 20 semi-structured interviews were conducted with providers and advocates to seek their views on digital health utilization and recommendations for health integration for state agricultural workers.

Results: Cost, transportation, distrust, inconvenience, and lack of culturally competent care had a more significant impact on healthcare utilization than distance. Workers without health insurance and lower health literacy were less likely to use healthcare services. They had high digital inclusion, but lower health-related utilization, compared with the general population of California. Models for digital health integration include a hybrid model engaging Promotoras through home visits or telehealth access points, creating a separate healthcare system, or binational plans with digitally integrated services.

Conclusions: A multimodal approach is needed to address healthcare needs among agricultural workers in California that incorporates the provision of affordable, convenient, high-quality, culturally competent services.

Policy implications: Expanding health insurance coverage, using culturally competent health education programs, including digital outreach, and implementing pilot projects using hybrid models of digital health integration incorporating financial incentives for providers and trained Promotoras can improve healthcare utilization among workers.

Introduction

Brief overview of agricultural worker health in the U.S. and the state of California

Agriculture and its affiliated industries represent a crucial part of the U.S. economy, contributing up to 10.3% of the total employment in the country, with direct on-farm employment accounting for approximately 2.6 million jobs in 2020.[1] According to the United States Department of Agriculture Economic Research Service (USDA ERS), agriculture and its related industries contributed $1.5 trillion to the GDP in 2023, with $203.5 billion was being directly contributed by U.S. farms in 2023 and the value of U.S. agricultural exports being $196 billion in 2022.[2] The industry is of particular significance in the state of California which had the highest rank in terms of income related to farm-based cash receipts among all states in the U.S. in 2022.[2]

However, despite being labeled as "Essential workers" during the COVID-19 pandemic due to their critical contribution to the U.S. economy and food supply, agricultural workers in the country remain a vulnerable and marginalized population.[3,4] They are engaged in hard manual labor outdoors in the fields, often at elevated temperatures while exposed to toxic chemicals and wildfire smoke, and operate heavy machinery without appropriate training and necessary access to Personal Protective Equipment, making them vulnerable to both non-fatal and fatal injuries.[5–9] Studies have shown that they have the highest rates and among the costliest for worker compensation claims among workers employed in any industry across the U.S.[10,11]

According to the 2022 report of the National Census of Fatal Occupational Injuries, these workers had the highest rate of work-related fatalities at 18.6 per 100,000 FTE workers compared with an overall average rate of 3.7 per 100,000 FTE across all occupations in the U.S.[12] A recent study using National Electronic Injury Surveillance System data from 2015-19 conducted by Gorucu et al. and found that there were 62,079 ER visits for non-fatal injuries reported among agricultural workers in the U.S.[13] A recent Bureau of Labor report document revealed that 21,020 injuries were disclosed by workers engaged in the production of agricultural goods between 2021and 2022.[12]

California, despite being ranked first in terms of agricultural production and revenue, does not fare much better. According to the Fatal Occupational Injuries report by the Department of Industrial Relations between 2013-2022, workers engaged in industries related to agriculture and natural resources had a fatality rate of 11.4 per 100,000 workers compared with an overall average rate of 2.4 per 100,000 workers across all industries in the state.[14] Similar findings were revealed by the BLS 2021 Survey of Injuries, Illnesses, and Fatalities, which showed that the non-fatal injury rate for these workers in California was 4.6 per 100,000 FTE compared with 3.6 across all industries in the state.[12]

In this era of rising ambient temperatures related to climate change in this rapidly warming world, they work outdoors all day, often without adequate rest breaks and access to safe drinking water, making them vulnerable to a variety of heat-related illnesses.[9,15,16] According to a recent report using Occupational Safety and Health Administration (OSHA) data, agricultural workers had the third highest rate of heat-related fatalities, accounting for one-fifth of all heat-related fatalities between 2015 and 2021 in the U.S.[17] Approximately

32% of the 502 fatal and catastrophic heat cases in California were among workers in the Agriculture, Forestry, Fishing, and Hunting industries, and of these cases, 94% were farm workers.[18,19]

Recent studies in California and Washington examining worker compensation claims data for workers across various industries revealed that agricultural workers in these states had the among the highest rates of heat-related illness claims compared with other workers..[8,20] Although Cal/OSHA regulators have been actively trying to enforce regulations related to educating workers and employers about these illnesses and their management, knowledge and implementation remains questionable.[15,19,21] Furthermore, a recent study evaluating the role of state regulations in protecting workers from heat-related illnesses demonstrated that the regulations are not enough to protect workers, as even workers on farms complying with the set regulatory limits for heat exposure remained just as vulnerable to heat-related illnesses as those on non-compliant farms, indicating the need for urgent attention from policymakers.[22]

They are exposed to potentially dangerous toxicants such as pesticides at a much higher rate than other occupations, increasing their vulnerability to a range of illnesses, including skin rash and arrhythmia, myocardial infarction, and cancer.[5,23–25] Pesticide exposure can also lead to adverse maternal and child health outcomes in the form of miscarriages, stillbirths, preterm births, and intellectual defects in children of mothers who were exposed during pregnancy.[26,27] A study using CalEnviro screen data on environmental exposures found a significantly higher burden of pesticide exposure in rural low-income communities in agrarian regions compared with more urban and wealthier areas of the state.[28] These illnesses are not limited to farm workers alone but extend to their families through para-occupational take-home exposures from their clothing and shoes, which can cause health problems through cumulative exposure.[26,27] Although state safety regulations exist to protect them from such hazards, they often fail to recognize the symptoms of such illnesses or are hesitant to report them due to language barriers, lack of familiarity with the system and fears of termination or retaliation due to their immigration status.[23,24]

Agricultural workers in our state are often required to work under hazardous conditions, including during wildfire smoke events, leading to respiratory illnesses such as asthma.[29] Moreover, the nature of their occupation requires them to work in close proximity to each other, making them vulnerable to communicable diseases such as tuberculosis and COVID-19.[30–32] A recent study conducted by Lusk et al. found that a one percent increase in the number of hired agricultural workers in a county was associated with a 0.04 percent increase in COVID-19 cases and a 0.07 percent increase in the number of deaths per person in the county.[33] A significant proportion of these workers are immigrants from countries where T.B. is endemic, and according to the CDC, agricultural workers are at six times higher risk of T.B. than other workers.[30] The Central Valley, which represents the state's largest agricultural region, is endemic for Coccidioidomycosis, the causative organism for Valley Fever.[34] Agricultural workers are at heightened risk for developing this otherwise rare disease by inhaling dust infested with these spores while working outside in the fields.[4,35,3637]

Moreover, they have very high rates of chronic diseases and mental illnesses; but despite their vulnerabilities, they are less likely to utilize healthcare services compared with workers in other industries and often suffer from worse health outcomes.[35,38–41] Agricultural workers are also known to suffer from high levels of work-related stress, being particularly among female farmworkers who are often exposed to wage theft and workplace harassment.[42,43] Depression is a common mental disorder reported among farmworkers, with some previous studies reporting that between 20 to 50% of migrant farmworkers interviewed reported suffering from poor mental health.[42,44–46]

Previous studies have also reported that these workers have high rates of hypertension and diabetes, which may remain undiagnosed or poorly treated.[47,48] A recent study combining clinical measurements and survey data from 3 previous studies on Latino farmworker communities in California (MICASA, PASOS pilot, and PASOS RCT) found a high obesity prevalence of 29.2 to 54.5 percent, elevated waist circumference was reported in 29.4–54.0 percent of participants with high blood pressure reported in 42.0–45.5 percent and high cholesterol in 23.7–25.8 percent of participants in the three studies.[49] However, several studies have shown that despite high susceptibility to occupational injury and illness as well as high prevalence of chronic and infectious diseases among individuals employed as agricultural workers, they are less likely to seek or utilize healthcare services.[36,50,51] According to the findings from the California Heat Illness Prevention Study (CHIPS), approximately 40% of participants with elevated HbA1c consistent with diabetes were not diagnosed with the disease.[47] These findings indicate the urgent need to improve the usage of healthcare services among agricultural workers in the state.

Brief overview of the existing health system framework for agricultural workers in California

Agricultural workers in the state can seek healthcare services from various providers, including those who operate in Federally Qualified Community Health Centers (FQHCs), private medical offices, free services delivered by clinics affiliated with local public health departments, emergency departments, urgent care centers, hospitals, and traditional healers. The Migrant Health Act of 1962 led to the establishment of Migrant Health Centers, which provide culturally competent primary care services to migrant and seasonal workers in the U. S. [52–54]. According to the HRSA, there were 175 Migrant Health Centers across the U.S. that provided services to approximately one-third of the migrant worker population in the country in 2019, with many of these centers receiving funding under section 330 (g) of the Public Health Service Act.[55,56]

Agricultural workers can pay for these healthcare services in four different ways: under the provisions of the Affordable Care Act, as a benefit of their employment, which can be limited to the worker or include their family members, MediCal coverage or government-sponsored health insurance if their income is below the prescribed limit (138 percent of the defined Federal Poverty Level or FPL), buy health insurance coverage through state health exchanges if their income is above the set limit on FPL and meet eligibility criteria or they can pay for their medical expenses out of pocket[57–59] However, undocumented workers were previously not eligible for coverage under Medicaid which

although has now been extended to all workers regardless of immigration status will continue to exclude a large proportion of workers who do not meet the income eligibility limits.[51]

Seasonal workers employed fewer than 120 days are not eligible to receive coverage from their employers, and small-scale farmers with less than 50 workers are not mandated to offer coverage to their workers.[51,60] Furthermore, the recently rescinded "Public Charge" rule introduced under the Trump administration, which penalized immigrants upon seeking government benefits, significantly reduced health insurance among these workers.[51,61] According to a study by Touw et al., this contentious regulation presumably led 2.1 million immigrant essential workers to forgo Medicaid benefits for which they were otherwise eligible.[62]

According to a recent NAWS survey report focused on workers in California, most agricultural workers in the state live in rural areas, typically within 25 miles of the farm where they are employed and most such regions and suffer from an ongoing shortage of critical healthcare resources.[35,36,63,64] A majority of rural agricultural counties in the state have been formally designated as Medically Underserved Areas (MUAs), which are regions with a shortage of primary healthcare providers and Health Professional Shortage Areas (HPSAs), which are regions with an acute shortage of medical, dental, and mental health providers.[65] Moreover, this scarcity is not just restricted to having few brick-and-mortar healthcare institutions with limited services and providers, these regions also lack access to ancillary services such as laboratories and rehabilitation centers.[55,66,67]

Most of these areas are served by Critical Access hospitals, some of which have been shuttered in recent years due to financial insolvency.[68,69] A study examining primary care provider density in the U.S. reported that between 2009 and 2017, although there was an overall increase in the number of providers, it was more notable in urban areas, indicating widening health disparity.[70] The patients receiving services at these rural facilities often suffer from multiple comorbidities requiring sophisticated management, which is difficult to provide with limited resources, leading to conditions of burnout and professional dissatisfaction among providers who practice in these regions, contributing to increased turnover and the delivery of poor quality of services.[63,66,71,72]

The scarcity of services in rural areas forces agricultural workers in the state to travel long distances to seek healthcare services or, in some scenarios, forgo seeking necessary services promptly.[73,74] According to the NAWS 2019-2020 report, nearly 27% of workers in the U.S. relied on ridesharing, with the situation being even worse for workers in California, where up to 35% of the workers were dependent on sharing rides or public transportation.[35,75 75]. Rural areas have limited means of reliable public transportation, and they may not always be available during times of need.[73,76] Migrant workers are specifically affected by this obstacle due to their dependence on employer-provided transit and housing. [77]

Moreover, being able to attend these appointments requires workers to seek time off from their employers since most healthcare facilities operate during traditional working hours when most of them are working in the fields. Many farmworkers lose wages if they

seek time off or leave for medical reasons or to access appointments with healthcare providers. Previous studies have shown that they are low-wage workers, and a large proportion of them either lack health insurance or have restricted coverage, forcing them to carefully balance competing needs for healthcare services and meeting household expenses.[57,58] This situation is further worsened by fears of being fired or facing retaliation from their employers for requesting paid time off, which may lead to avoidance of seeking healthcare services.[52,62,78,79]

These challenges are further complicated by the fragmented nature of the rural healthcare system, wherein providers and institutions work in isolation without coordinating their services and sharing care plans with other providers who may be involved in their patient's care.[67,72,80,81] The providers lack access to a vast referral network and refrain from sharing patient health information with other providers due to confidentiality concerns and a lack of financial incentives [66,67] Despite recent efforts at the federal level to promote the use of electronic medical records to facilitate collaboration through digital health information exchange, different providers use different software and servers that do not communicate with each other which combined with the lack of necessary technological infrastructure and trained staff result in this status quo.[80,82,83]

Lack of collaboration among providers creates uncertainty among both patients and providers with preventable delays in care, the creation of inconsistent and often controversial treatment plans, and the repetition of medical tests as patients traverse the care continuum.[84,85] Patients are left to fend for themselves to seek referrals, schedule appointments, and follow-up services in a convoluted healthcare system.[86,87] This leads to enhanced health-related expenditures in an already overburdened system with long waiting times, delivery of poor quality healthcare services, and worse patient health outcomes. [81,88] Agricultural workers face multiple challenges accessing and utilizing healthcare services in this convoluted system.

Most agricultural workers have not completed formal education beyond the eighth grade and have limited health literacy. Previous studies have shown that many them do not understand the benefits of having health insurance coverage or the need for preventive screening and follow-up on a regular basis [22,56,89] Many are immigrants unfamiliar with the U.S. healthcare system whose preferred language of communication is not English adding to the complexity of navigating the healthcare system.[78,90] A large number of them are undocumented workers who harbor feelings of distrust not only due to being unaccustomed to seeking services in this system but also due to a lack of understanding of the consequences of such actions within the constantly changing immigration framework.[62,79,91]

Some workers harbor alternative health beliefs that may not align with the U.S. healthcare system, which gives preference to Western medicine.[92] Healthcare providers in rural areas often lack cultural competence training, due to which they may ignore their deeply held values and cultural beliefs.[93–97] Their low levels of educational attainment, lack of English proficiency, and inability to understand medical jargon create feelings of distrust, potentially alienating them from the healthcare system by making them feel invisible and unwelcome.[54,98] It exacerbates the problems faced by agricultural workers in

California in not only scheduling appointments but also adhering to treatment regimens and seeking follow-up services, calling for an urgent re-examination of the system to improve this precarious situation.[54,95,96]

Brief overview of health system integration

The overall framework of the healthcare system in the U.S. is a complex maze of public and private healthcare providers and payers with wide variations in the nature and quality of services available by type of health insurance coverage, income, region, and immigration status.[66,67,69,99] While the U.S. has the highest reported health-related expenditures among countries in the Organization for Economic Cooperation and Development (approximately 20% of its Gross Domestic Product (GDP) compared with 8% for other countries, its healthcare system was ranked last by the Commonwealth Fund in a list of 11 comparable high-income countries. [100,101] The state of California ranks fourth in terms of health-related expenditures, spending approximately one-third of its GDP, but ranks 14th in the quality of its healthcare system compared with other states in the U.S. [102,103]

While this arduous labyrinth is challenging to navigate for most patients, low-income individuals with low levels of health literacy, linguistic and cultural barriers, such as agricultural workers, face a significant uphill battle trying to seek healthcare services, particularly in rural medically underserved regions.[56,81,104] The current configuration of the delivery of healthcare service in such areas of the state is highly disorganized, with patients, payers, and providers operating in isolation without sharing necessary patient health information or resources, leading to duplication of services misdiagnosis and creation of erroneous treatment regimens, resulting in poor patient-provider interaction, and lack of appropriate follow-up by patients. [84,86,105,106]

Health system integration refers to the process by which the different parts of the healthcare apparatus, such as clinics, hospitals, radio-diagnostic facilities, ancillary care providers, social services, nutritionists, and others, organize themselves in multidisciplinary teams aimed at delivering high-quality, consistent and comprehensive services for all patients across the care continuum from health promotion to prevention, treatment, and rehabilitation, at different levels and sites within and outside the healthcare sector throughout their lives. [107–109] Integration was introduced as a concept to mitigate the rising costs of healthcare services associated with increased life expectancy due to modern scientific advancements as well as to fix the declining quality of these services due to the increasing complexity of the healthcare system [86,105,107]

This reorganization can occur at the *organizational level* through mergers, at the *functional level* through enhanced staff coordination, at the *service level* through multidisciplinary teams, and at the *clinical level* through consistent treatment plans [110,111]. *Real integration* occurs through sharing physical assets between institutions, while *Virtual integration* can occur through contractual agreements alone. [108,112] It can involve fostering collaborations among providers delivering services at the same level of care *(Horizontal integration)*, different levels of care *(Vertical integration)* across a particular sector *(Sectoral integration)*, placing the patient and their caregivers at the center of the healthcare

delivery system *(Person-Centered integration*), and even involve building bridges between the medical and public health infrastructure *(Whole system integration)*. [106,111,113]

Such cooperative agreements can be based on shared vision and financial incentives across organizations *(Normative integration)* or coherent rules and policies *(Systemic integration)* across an institution.[84,114] Previous studies have shown that such integration of the healthcare system helps to not only improve the health of the patients at a lower cost as well as promote both patient and provider satisfaction through better collaboration but also results in a reduction in wastage of resources and an overall improvement in the efficiency of the system. [115–117]

Three main types of integrated care models have been frequently described in previous studies: 1) Individual-focused models (Patient-Centered Medical Homes, Accountable Care Organizations Case Management model, and Personal Health Budgets), 2) Population-focused models (Kaiser Health System and Veteran Affairs Model), and 3) Disease-focused models (Chronic Care Model, Improving Chronic Illness Care model, Innovative Care for Chronic conditions model, and Transitional Care model).[105,108,111,118] The following paragraphs briefly explain each model along with the benefits and drawbacks of utilizing the model for agricultural workers in California.

The *Patient-Centered Medical Home (PCMH) model* is focused on a primary care provider serving as the custodian of services for a designated group of patients and works with a interdisciplinary team to buy services on their behalf.[119] Although this model utilizes evidence-based guidelines, provides linkage to community resources, promotes shared decision-making, and can provide affordable healthcare services using alternative payment models, most managed care organizations in the state, specifically in rural underserved areas, are not based on this mode, and it is not focused on providing whole-person care through culturally competent healthcare interventions for marginalized populations such as agricultural workers [114,119,120]

The *Accountable Care Organization (ACO) model* involves the creation of a consortium of physicians, hospitals, and other providers to deliver integrated health services for a defined population who receive financial incentives for their collaboration through shared savings and losses.[111] Although it offers affordable services according to evidence-based guidelines, promotes self-management, and provides linkage to community resources, the current regulatory environment, lack of necessary infrastructure, and professional expertise make setting up an ACO in rural areas a big challenge. [121–123].

The *Case Management model* focuses on reducing healthcare costs associated with managing patients with multiple comorbidities who utilize healthcare services more frequently by designating a case manager who creates individualized care plans to coordinate services on their behalf.[124–126] This model facilitates shared decision-making according to evidence-based guidelines and linkage to various community resources, but the role of the case manager is not clearly defined, and it lacks emphasis on the provision of culturally sensitive care or the utilization of digital health interventions for providing whole-person care to vulnerable populations in MUAs [114,124]

The *Personal Health Budget model* empowers patients to act as budget holders and buy services to achieve outcomes meaningful to them.[107,114] Although this model promotes self-management of illnesses according to the patient's personal beliefs, it requires a high level of health literacy as patients must know which services are clinically appropriate, how to access them, and at what cost, making it unsuitable for individuals with low levels of educational attainment such as agricultural workers who are unfamiliar with the U.S. healthcare system, lack knowledge of the type of services they need and face difficulties in traversing the healthcare system. [107,114]

The *Chronic Care Model (CCM) model* is a disease-focused model for managing a single illness or group of diseases that involves using a multisite integrated healthcare system and clinical information systems to promote the self-management of diseases according to clinical recommendations and encourages the use of innovative approaches to service delivery.[107,127] Although it is beneficial in lowering readmissions and costs associated with chronic conditions such as diabetes or hypertension, it does not emphasize providing whole-person care, there is a lack of clearly defined roles in the multidisciplinary team, and it does not focus on delivering comprehensive or affordable healthcare services in a culturally competent manner. [107,128]

The *Improving Chronic Illness Care (ICIC) model* is another disease-focused model that utilizes a proactive approach, focused on prevention through active case management, clearly defined roles in multidisciplinary teams, and the delivery of culturally competent care.[114,129] Although it helps improve health outcomes and reduces costs associated with high-utilizer patients, it does not focus on providing affordable services, creating new facilities and mobile clinics, or expanding digital health initiatives for low-income populations in underserved regions.[107,111,114]

The *Innovative Care for Chronic Conditions Model (ICC) model* is another disease-focused model that incorporates the critical elements of the CCM model, promotes shared financial incentives, provides culturally competent services, and creates a conducive political environment for health system integration. [130] However, it is challenging to create a favorable political climate to foster the provision of easily accessible and affordable whole-person care for traditionally disenfranchised populations such as agricultural workers via conventional or modern techniques.[107,108,111,130]

The *Transitional Care (TCM) model* is a nurse-led model focused on improving the continuity of care for elderly high-utilizer patients by creating individualized care plans to facilitate their seamless transition across the healthcare system.[131] This model is not focused on a specific disease or target population but does not prioritize disease prevention, improve healthcare access for underserved communities, promote the delivery of culturally competent services, or ensure the availability of whole-person care for low-income populations at affordable prices.[132]

The *Kaiser Health System* is a population-focused model of integration that combines systemic and normative forms of integration by including a nonprofit health plan (Kaiser Foundation plan), nonprofit hospitals (Kaiser Foundation hospitals), and a for-profit physician group (Permanente Medical Group).[133] The Kaiser Fund pyramid refers to

a risk stratification approach focused on providing high-quality services according to evidence-based guidelines and shared decision-making emphasizing health promotion for the general population, self-management for patients with chronic conditions, disease management for high-risk patients, and case management for patients with severe illnesses.[133] However, this expensive private health insurance plan does not improve access or continuity of care in medically underserved farmworker communities as it does not cover low-income populations such as agricultural workers. [111,114]

The *Veteran Affairs (VA) model* is a fully integrated healthcare network representing another example of a population-focused health system integration model, including government-sponsored health plans, hospitals, and healthcare providers that deliver services to U.S. Armed Forces veterans.[134] It also emphasizes shared decision-making under a risk stratification approach per evidence-based guidelines but does not cover low-income populations such as agricultural workers and is not directed toward improving healthcare access for vulnerable populations. [111]

While no model alone can overcome all the problems faced by state agricultural workers while accessing and utilizing healthcare services, different models have certain features that, in combination, can help to overcome some of these obstacles. Health system integration can be achieved by various methods or techniques including payment incentives, integrated care pathways, health information exchange systems, and innovative methods of service delivery and the following paragraphs briefly explain these methods and the benefits and drawbacks of using them to improve the healthcare experience for agricultural workers.

Payment incentives are alternative payment methods that include bundled payments for all services used to manage an episode of care, Value-Based Purchasing (VBP), or financial incentives for healthcare providers if their services meet specific performance standards and gain sharing or financial arrangements between payers and providers that reward delivering clinically appropriate healthcare services at lower costs by providers.[64,135,136] While this method attempts to coerce healthcare providers to work together to ensure profitability, they may not significantly impact agricultural workers because most of the workforce either lacks or has limited health insurance coverage, and rural providers are often exempt due to the lack of infrastructure, expertise, and referral network needed for collaborative functioning under such initiatives.[57,75]

Integrated Care Pathways are clinical frameworks with well-defined roles across multidisciplinary teams in various departments and institutions to provide evidence-based treatment for a designated patient population for a limited period to improve the quality of services and the transition of care between providers and facilities. [84] Although it can help improve healthcare access and utilization for agricultural workers in medically underserved areas, rural providers lack adequate support staff, infrastructure, technical expertise, and referral networks and develop collaborative systems without viable monetary benefits to create such pathways. [87,137]

Some innovative methods of service delivery have been utilized in recent years, including *Mobile clinics*, which refer to customized vehicles fitted with medical equipment,

and *Worksite clinics* or brick-and-mortar healthcare facilities situated on or near the farms often run by employers to enable workers to access healthcare services onsite without taking time off in resource-strained communities.[138] Other methods include using *Peer educators or Promotoras,* who are Spanish-speaking community health workers serving as educators, advocates, interpreters, and recruiters for clinical trials in agricultural communities.[139,140] Although these methods can help improve accessibility by reducing transportation barriers and the need for paid time off, they provide limited services, they do not share information with other providers, and there is a lack of appropriate follow-up care due to the absence of a robust referral network in rural communities. [141,142]Although Promotoras have helped agricultural workers receive culturally competent services and navigate the healthcare system, they possess limited knowledge and ability to deliver services in areas with modest resources and cannot overcome the problems associated with the lack of healthcare providers and specialty services in their communities.[143,144]

Role of Digital Health Interventions in Health System Integration for Agricultural Workers

Digital health interventions have dynamically changed how individuals including agricultural workers can access and utilize healthcare services in the modern era. The recent COVID-19 pandemic led to the swift expansion of telemedicine services in underserved farmworker communities, due to which many agricultural workers and rural providers engaged with these digital tools to fulfill the social distancing requirements imposed by public health authorities, reducing initial skepticism and making these services accessible at an unprecedented scale. The paragraphs below briefly discuss the different types of digital tools and how they can facilitate health system integration for agricultural workers.

Telemedicine refers to digital technologies that deliver healthcare services virtually via smart devices, including cell phones, tablets, laptops, or desktop computers, which were introduced to improve the accessibility of care in rural and remote areas.[145,146] They involve using audio or video modalities to facilitate interaction and collaboration between patients and their healthcare providers as well as among providers operating at different levels and sites, either through asynchronous sharing of records or messages or synchronous audio or video visits. [147,148] Although they had been previously deployed as small-scale projects to deliver services in some underserved areas before the pandemic, the safety restrictions and shortage of hospital beds during the pandemic led to the large-scale expansion of these services across all fields of medicine such that they were used to deliver most types of services that did not require a physical examination.[145,149,150]

Health Information Systems are digital modalities designed to improve health system integration by allowing healthcare institutions to virtually store, process, and exchange health-related information among their patients as well as providers both within and outside their network to foster collaboration and better communication .[151] They include *Electronic Health Records (EHRs),* which are digital versions of a patient's medical history and treatment regimen, *Computerized Clinical Decision Support Systems (CDSS)*, or software tools developed to help clinicians make quick evaluations and develop

evidence-based treatment-related plans, and *Computerized Provider Order Entry (CPOE)* or programs used to order medications and diagnostic tests which create digital logs for providers.[151–153] These digital systems develop mechanisms to share information electronically, allowing rural providers to communicate with each other as well as specialists in urban centers, preventing duplication of services, reducing the occurrence of adverse reactions, and facilitating the implementation of consistent treatment plans according to clinical guidelines. [154,155]

Remote Patient Monitoring Systems (RPMS) are digital tools to monitor patients virtually in remote locations via smart devices such as surveillance cameras, glucometers, oximeters, and blood pressure monitors, which can transmit their information to healthcare providers using Bluetooth or broadband internet services and are used to make treatment-related decisions.[156–158] They include wearable sensors to detect falls in older adults and activity trackers that promote a healthy lifestyle by counting calories and steps.[156,159] Other examples include the ACTIVATE project, which used RPMS to successfully lower blood pressure and blood sugar levels in underserved Latino communities in the Central Valley, and the AmritaJeevanam system, which not only shares various health parameters with local healthcare providers but also counsels patients on managing their medical conditions in rural areas in India[158,160]

Mobile Health applications are digital tools delivered via applications installed on smartphones and tablets. Some applications aimed at agricultural workers include the OSHA Heat safety tool, which measures the worksite heat index and offers advice related to regulatory compliance, and the NIOSH Ladder app, which uses audio-visual signals to promote the safety of workers using extension ladders.[161] They have been used during home visits by community health workers to educate mothers as well as to correctly classify and manage childhood illnesses in developing countries such as Malawi and India. [162,163] They have also been utilized for nutrition education for pastoral workers in Ethiopia, local and national level surveillance of mother-to-child transmission of HIV in South Africa, and management of stroke patients in rural regions of China [157,164–166]

Artificial intelligence refers to new digital systems that can autonomously perform tasks previously performed by humans using machine learning, big data, robotics, natural language processing, and computer vision based on clustering, classification, and prediction techniques.[167,168] They are being deployed to help clinicians read images, analyze test results, aid clinical decision-making, and analyze facility data for quality improvement through supervised and unsupervised learning techniques.[167,169] However, there have been concerns about bias in the data used to base treatment decisions, lack of skilled workers who can use them effectively, and skepticism from clinicians about the accuracy and reliability of these modalities.[169–171]

Digital health interventions help to overcome transportation barriers by delivering services within the communities where these workers live such that they do not need to seek paid time off and can access these services via their smartphones at a convenient time and location.[172–174] They can help to improve access to culturally competent providers in rural areas without requiring the creation of expensive brick-and-mortar facilities or relocating providers by offering financial incentives.[175–177] The electronic sharing of patient

health information across providers can facilitate effortless care transition and prevent duplication of services.[80] The recent surge in digital health service usage among all groups, including agricultural workers, has also lowered apprehensions and facilitated the creation of more user-friendly formats.[172,174,178,179]

Digital Health integration for state agricultural workers within the existing health policy framework

Despite being termed as "Essential workers" and lauded as the custodians of our food supply during the recent COVID-19 pandemic, agricultural workers faced an uphill battle in keeping themselves safe while working in the fields, including the lack of PPE, living in overcrowded housing, lack of knowledge of how to protect themselves, limited test and treatment availability.[3,4] Previous studies based on the results of NAWS surveys have shown that agricultural workers are less likely to utilize healthcare services in the U.S. when compared with the rest of the population.[35,36,95] Some studies conducted during the recent pandemic also reported that healthcare access remained restricted despite their heightened susceptibility due to the occupational requirement of working in person and in close proximity.[3,91,180] Their ability to access and use healthcare services is constrained by the lack of time off, lack of health insurance coverage, lack of transportation, and their inability to navigate the healthcare system easily.[35,57,75,95]

While no model or method can exclusively resolve all the unique problems faced by agricultural workers in the state, different models and methods offer specific solutions that can be combined to develop innovative solutions to improve healthcare access and utilization for this medically underserved population. Digital health services played a key role in providing access to indispensable services in underserved communities during the pandemic, and most patients in these vulnerable communities expressed their satisfaction with these services.[181,182] According to the California HealthCare Foundation Health Policy Survey 2022, more than half of Californians reported receiving healthcare services via telemedicine in the past 12 months (55 % via telephone and 44 % via videoconferencing), of whom nearly 80% overall and 76% of low-income respondents including those from non-English speaking communities reported being satisfied, with roughly one-third being equally satisfied with in-person and virtual visits.[183] Similarly, the Connected Care Accelerator Program (CCA), initiated to deliver telehealth services to low-income communities in the state, revealed that nearly 90% of FQHC providers felt confident conducting tele visits and reported that it improved access to services for marginalized communities. [184]

Moreover, changes in healthcare policy in recent years favor using these digital tools to integrate healthcare services for agricultural workers. The federal government has announced several measures to promote the expansion of high-speed, reliable broadband internet networks and access to smart devices in rural areas, such as the Affordable Connectivity Program (ACP).[185,186] The disjointed response of public health agencies to the recent pandemic led to the creation of the federal-level Data Modernization Initiative by the CDC in 2021 to develop a national-level health information exchange platform

through technological upgrades and staff training to permit quick and easy sharing of information collected from local healthcare facilities between different public health departments across the country.[187]

Moreover, the state-funded health insurance plans in California have decided to continue reimbursing providers for tele visits at the same rate as in-person visits at FQHCs and Rural health centers, although they have placed restrictions on the originating site, provider type, and type of services being delivered after the pandemic, making these solutions financially attractive for healthcare providers.[149,188] The California Health and Human Services Data Exchange Program will create a statewide health information exchange through mandated data-sharing agreements between healthcare providers, public health agencies, and social service programs beginning in 2024 to enable seamless electronic exchange of patient health information across secure digital platforms.[189]

The California Department of Health and Human Services (DHCS) recently launched the California Advancing and Innovating Medi-Cal (Cal Aim) program to provide high-quality, integrated, and coordinated healthcare services for people experiencing homelessness, aging populations, patients with complex medical needs, individuals with serious behavioral disorders, children with disabilities and other populations that are underserved but high utilizers of healthcare services in California.[190] Although it aims to provide enhanced care management for vulnerable communities, there is no clarity on the role and extent of utilization of digital health interventions, and currently, it does not include farm workers as a target population.

Most studies on agricultural workers in the state were conducted several years before the pandemic and do not consider the impact of recent policy changes on their access and utilization of the healthcare system. Very few studies have quantified the effect of distance from different types of healthcare facilities on delays in access to healthcare services, ER visits, and hospitalizations among agricultural workers under the current health policy landscape. Although there have been reports of high levels of patient satisfaction with telehealth services, very little research has been conducted to assess their impact on agricultural workers. Similarly, not many studies have explored the impact of digital access on healthcare utilization among agricultural workers, the sources of health information they utilize, and their willingness to use digital tools to seek healthcare services, particularly during and after the COVID-19 pandemic.

Moreover, current research is based on the experiences of agricultural workers alone and does not consider the perspectives of healthcare providers, employers, and advocates delivering these services and the challenges they face in providing affordable, easily accessible, high-quality services in an integrated framework. The dissertation aims to answer these critical questions using a mixed-methods approach by examining current patterns of use, barriers, and facilitators to healthcare access and utilization under the current political climate. The aims and objectives of the dissertation are provided in the next section, followed by gaps in the literature, the theoretical frameworks and the datasets used, and a brief overview of each study discussed in this manuscript.

Overall aims and objectives

Aim: Examination of the patterns of healthcare utilization, barriers and facilitators for health system integration, and the role of digital modalities in the provision of high-quality integrated healthcare services for agricultural workers in California

Objectives*:* The dissertation intends to achieve the following objectives:

1. To examine the role of socioeconomic, structural, and cultural factors on healthcare utilization among agricultural workers in California.
2. To examine the barriers and facilitators for healthcare access and utilization among agricultural workers in the state from the perspective of employers, healthcare providers, and farm worker advocates.
3. To examine actual and intended patterns of health service utilization among agricultural workers in the states using the Anderson Model of healthcare utilization.
4. To identify the predictors of preventive healthcare utilization among agricultural workers using the Anderson Model of healthcare utilization.
5. To identify the predictors of emergency healthcare utilization among agricultural workers using the Anderson Model of healthcare utilization.
6. To examine the extent of occupational health literacy and its role in healthcare utilization among agricultural workers
7. To examine the levels of digital access and the patterns of its utilization among agricultural workers in California compared with the rest of the U.S.
8. To examine the predictors for the utilization of digital health services for health-related reasons among agricultural workers.
9. To examine the barriers and facilitators for the delivery of integrated healthcare services using digital health modalities and propose models that present creative solutions from the perspective of healthcare providers, health policy researchers, and farm worker advocates.

Gaps in literature

The following section examines the gaps in existing literature related to healthcare access and utilization among agricultural workers in California. It explores the need for information to create an integrated and coordinated healthcare system for agricultural workers by examining the barriers and facilitators within the existing healthcare framework to identify opportunities for improvement. It also identifies the need to explore patterns of digital health access and utilization among agricultural workers to propose innovative models to provide high-quality integrated healthcare services to agricultural workers in the

state. The gaps in the literature reviewed in each study and its underlying rationale to improve healthcare access and utilization in this vulnerable population are discussed below.

Study 1

Title: Examination of the Role of Distance, Socioeconomic determinants, Structural, and Cultural factors on Delay in seeking Healthcare Services among Agricultural Workers in California: A Mixed Methods Study

Underlying rationale:

- Few studies have examined the role of distance on delays in seeking access to healthcare services in rural areas, with even fewer examining these barriers among agricultural workers
- Most such studies were either conducted in other states, were over ten years old, or had a limited scope.
- There are no studies that have examined the impact of distance from FQHCs, hospitals, and rehabilitation centers on delays in seeking healthcare access among agricultural workers.
- The health policy landscape in California has changed rapidly in recent years, but not many studies have examined the barriers to healthcare access and utilization for agricultural workers in the current healthcare framework.
- Most such studies were conducted before the pandemic using NAWS data with limited currently employed agricultural workers from California and a restricted scope of work.
- Most studies examined these barriers by interviewing agricultural workers and did not include the perspectives of healthcare providers, employers, and farmworker advocates who deliver these services in challenging work environments.
- This study will add to the literature by exploring the intertwined impact of socioeconomic, structural, and cultural factors on health system integration for agricultural workers in California from the perspective of employers, healthcare providers, and advocates within the current health policy framework using a mixed methods approach.

Study 2

Title: Examination of the actual and intended patterns of healthcare utilization among agricultural workers in California

Underlying rationale:

- There are very few studies that have examined the actual and intended patterns of healthcare utilization among agricultural workers in California, particularly during the COVID-19 pandemic.
- Most studies examining such patterns in agricultural workers were conducted in other states or used NAWS data, which had a limited number of respondents workers from California.
- Previous studies on this topic used data that was collected over a decade ago, being outdated or very old, were limited in their scope, examining either healthcare access or utilization without trying to understand the complex relationship between these concepts and do not reflect the impact of current health-related policies in the state of California.
- Very few studies have examined care-seeking patterns among agricultural workers when exposed to the typical symptoms of common occupational illnesses.
- Most such studies were conducted before the pandemic, were focused on only one type of illness, were conducted in other states, and involved workers who had been exposed to such symptoms.
- Very few studies have examined the role of online sources of information among agricultural workers in the context of care-seeking for occupational illnesses and their potential use for community outreach.
- This study is novel because it examined healthcare usage patterns, levels of occupational health literacy, and the use of digital sources of information among state agricultural workers when exposed to symptoms of occupational illnesses to better understand how to create an integrated healthcare system within the current political climate.

Study 3

Title: Examination of Patterns of Digital Health Access, its Utilization, and Role in the creation of an Integrated and Coordinated Healthcare system for Agricultural Workers in California: A mixed methods study

Underlying rationale:

- There are very few studies that have examined the levels of digital access and its utilization among these workers before, during, and after the COVID-19 pandemic.
- Most such studies were conducted in other states, were conducted several years ago under a different health policy framework or had a restricted scope.

- Most of these studies examined the barriers to digital health usage by interviewing agricultural workers alone without incorporating the perspectives of healthcare providers who were entrusted with delivering these services.
- At the time of this review, there were no studies exploring the role of digital health interventions in managing occupational illnesses among agricultural workers.
- At the time of this review, there were no studies on how healthcare providers can effectively utilize digital health interventions to deliver high-quality integrated services for agricultural workers.
- This study tried to answer these questions by examining levels of digital access its usage patterns and seeking recommendations from healthcare providers and advocates on the role of digital modalities in health system integration for agricultural workers in California.

Theoretical frameworks

The theoretical frameworks used in the studies which constitute this dissertation are briefly described below.

The Anderson Model of Healthcare Utilization

This model was selected to inform quantitative studies related to healthcare usage among agricultural workers in California. It was developed by a U.S. health services researcher named Ronald M. Andersen in 1968 and was subsequently modified over time to understand the patterns of healthcare utilization. It is one of the most widely used and acknowledged behavioral models to examine the utilization of healthcare services among vulnerable populations such as farmworkers.[191,192] This model has frequently been used in studies conducted in Western countries and more developed regions and recently in some developing countries worldwide to study healthcare systems.

The Anderson model is a multilevel model that considers both individual and circumstantial determinants of health service usage. The model determinants include predisposing factors such as demographic characteristics (age, gender, sexual identity), social factors (educational attainment, occupation, ethnicity), social relationships, and mental factors (attitudes, values, and knowledge), enabling factors such as financial circumstances (income, employment, and health insurance coverage) and organizational factors (having a usual place of care, access to transportation, travel time, waiting time, provider density, linkage to community resources, and community outreach) and needs factors which include the perceived need for health services (based on self-perception) and evaluated need for healthcare services (based on professional assessments by healthcare providers).[191]. The expanded version of his model for vulnerable populations also incorporates social determinants that influence healthcare decisions in marginalized populations such as agricultural workers, making it an appropriate choice for this study. [192]

Constructivist grounded theory

This theory informs the qualitative sections of this dissertation. Very little research has been conducted on delivering healthcare services to agricultural workers in an integrated framework. Most of this research is not focused on digital health interventions to facilitate interaction between patients and providers and help patients move seamlessly through the healthcare system. Consequently, the grounded theory method of data collection and analysis was selected to inductively examine this relatively unexplored area to generate a conceptual framework for the provision of integrated, coordinated, high-quality healthcare services for farmworkers as was proposed by Glaser and Strauss.[193–195]

This approach provides a standardized method for the concurrent collection and analysis of data collected through in-depth interviews with healthcare providers, employers, and farm worker advocates to look for emerging themes. These themes were analyzed to form conceptual codes further examined via subthemes. The constructivist approach was used wherein the researchers do not consider themselves to be neutral observers and attempt to co-construct the knowledge with their participants to propose creative solutions for the challenges faced in the delivery of high-quality integrated healthcare services to agriculture workers with the realization that neither data nor theory exist in a vacuum but are constructed by our interactions with study participants.[194–197] The study participants include highly qualified individuals with in-depth knowledge of their field, which helps us examine the issues of healthcare access and utilization using the "studying up" approach to explore the problem from the point of view of those who are in a position of power and privilege as proposed by Laura Nader thereby developing an all-inclusive understanding of this complex issue.[198,199]

Datasets

This section briefly describes the different datasets analyzed in the quantitative sections of the studies included in this dissertation.

The University of California Merced Farm Worker Health Survey (UCM FWHS)

The FWHS, funded by the California Department of Public Health (CDPH), surveyed 1453 agricultural workers from the major agrarian regions of the state (San Joaquin Valley, Upper Central Coast, Lower Central Coast, Napa, Sonoma, Imperial, and Coachella Valley). The FWHS study was conducted using a community-based participatory research approach in multiple languages to ensure equitable participation in 2021-22. The FWHS is the most extensive state-based study on farmworker health and follows up on the previous California Agriculture Worker Health Survey (CAWHS) conducted in 1999. This dataset was chosen because it collected extensive information on occupational health, healthcare access, and utilization among agricultural workers in California. The FWHS also specific questions about hypothetical scenarios presenting workers with typical symptoms of common occupational illnesses and asking them about their intended healthcare utilization patterns.

National Agricultural Worker Survey (NAWS) 2018 Digital Access supplement

The NAWS is an ongoing nationally representative survey of hired agricultural workers funded by the U.S. Department of Labor.[38,75] NAWS provides information on participant demographic characteristics, working conditions, health status, healthcare access, and utilization. The surveyors interviewed currently employed workers at their work sites, excluding H2A workers.[36,38,75] The NAWS participants were randomly sampled and can provide weighted estimates for agricultural workers in California compared with other major agricultural regions in the U.S. The Digital access supplement included in 2018 asked detailed questions about digital access among agricultural workers, the type of devices used, and the purposes for which the workers used these services. The NAWS survey also collected information about the use of these devices for health-related purposes and their relationship with healthcare utilization due to which it was used to study digital health utilization among agricultural workers in California.

California Health Interview Survey (CHIS)

CHIS is the largest state-sponsored health survey in the nation, which provides detailed health-related information on the non-institutionalized residents in all 58 counties in California. It is an online and telephone-based survey that interviews over 20,000 Californians (adults, teenagers, and children) conducted by the UCLA Center for Health Policy Research every year on a continuous basis.[200,201] The survey uses a random sampling technique such that the survey sample statistically represents the diverse population of the state and provides detailed information on various health-related topics, including healthcare access, health status, health insurance coverage, and healthcare utilization (including telemedicine).[200,201] This data can be requested stratified by age, gender, region, occupation, and income. This dataset was chosen because it collects extensive information about the health of California's low-income Latino residents, which was used to compare healthcare utilization patterns with agricultural workers. Several questions related to the utilization of telehealth services among state residents were recently incorporated in this survey. These questions include whether the survey respondents had utilized any telehealth service in the past year, the type of visit including audio and video visits and the level of satisfaction with these services which were used to examine telemedicine utilization in this population.

Brief overview of the proposed studies

This section of the manuscript provides a brief description of the three studies, the results of which are presented in this dissertation with each section presenting the aims and objectives, datasets used, the theoretical framework, statistical tests, and software employed to carry out the study.

Study 1

Aim: Examination of the role of Distance, Socioeconomic Determinants, Structural and Cultural factors on Delay in seeking Healthcare Services among Agricultural Workers in California

Objectives:

- To examine the role of distance and travel time from healthcare facilities (FQHC, hospital, and rehabilitation center) on delay in seeking services
- To examine the self-reported barriers to delay in seeking healthcare services
- To examine the socioeconomic, structural, and cultural barriers to healthcare utilization from the perspective of healthcare providers and farm worker advocates

Quantitative analysis dataset: The UCM FWHS, a survey of 1453 farmworkers from the major agricultural regions in California, was completed in 2021-22. The location of the farm workers was recorded using cross-street addresses and geocoded to determine their approximate locations. The experts at the UCM SPARC Center for G.I.S. studies used these geocoded locations to determine the driving distance and travel times from the nearest FQHC/ MHC, Rehabilitation centers, and hospitals.

Qualitative analysis dataset: Thirty-eight semi-structured, in-depth interviews were conducted with growers, farm worker advocates, and healthcare providers via the secure institutional version of the Zoom video conferencing application between February 2021 and October 2021 using the snowball sampling approach. The Institutional Review Board at UC Merced approved the study protocol as exempt. The interviewees were asked to express their views on barriers and facilitators for healthcare access and utilization for agricultural workers in California. Each interview was recorded, transcribed verbatim, and cross-checked for accuracy.

Theoretical framework: Anderson's model of healthcare utilization and the Constructivist Grounded theory framework.

Statistical tests: Cross-tabulations, chi-square tests, and logistic regression analysis (significance $p<0.05$) using STATA (version 18.0).

Qualitative coding: Focused and axial coding techniques using Dedoose software version 9.2

Study 2

Aim: Examination of the self-reported actual and intended patterns of healthcare utilization among agricultural workers in California

Objectives:

- To examine the usage levels, patterns and predictors for use of healthcare services under routine and emergency settings among state agricultural workers in the current political climate
- To examine the patterns and predictors of care-seeking in different occupational health scenarios
- To examine predictors for using online sources when faced with occupational illnesses

Dataset: The University of California Merced-led Farm Worker Health Study (UCM FWHS), a survey of 1453 farmworkers from the major agricultural regions in the state, completed in 2021-22. California Health Interview Survey (CHIS), an ongoing representative survey of non-institutionalized California residents in 2021, was used to compare health utilization patterns. The first part of the study examines the self-reported patterns of routine preventive healthcare services and emergency services split by health insurance status. The UCM FWHS has a section that presents survey respondents with the typical symptoms of three different occupational illnesses (HRI, Valley Fever, and PRI) and asks them to identify the disorder and where they will go to seek information and care. This section was scrutinized to explore occupational health literacy and intended care-seeking patterns among the respondents.

Theoretical framework: Anderson's model of healthcare utilization

Statistical tests: Cross-tabulations, chi-square tests, two-sample test of proportions, Principal Component Analysis (PCA), logistic regression analysis, and linear regression analysis ($p<0.05$) using STATA (version 18.0).

Study 3

Aim: Examination of the levels of digital access, digital health utilization, and its role in the creation of an integrated healthcare system for agricultural workers in California

Objectives:

- To examine the levels of digital access and predictors for its utilization for health-related reasons

- To examine the patterns of usage, barriers, and facilitators to digital health utilization
- To propose innovative models for the delivery of integrated healthcare services using digital health modalities from the perspective of healthcare providers and advocates

Quantitative analysis dataset: The National Agricultural Worker Survey (NAWS 2018 Digital Access Supplement), a survey of 1347 farmworkers from the major agricultural regions in the U.S., was completed in 2018. California Health Interview Survey (CHIS), an ongoing representative survey of non-institutionalized California residents in 2021 and 22, was used to study digital health utilization patterns.

Qualitative analysis dataset: We conducted 20 semi-structured, in-depth interviews with healthcare providers and farm worker advocates using a snowball sampling approach via the secure institutional version of the Zoom video conferencing application between November 2023 and April 2024. The Institutional Review Board at UC Merced approved the study protocol as exempt. The interviewees were asked to share their experiences delivering digital health services to agricultural workers, their patterns of utilization, barriers, and facilitators for digital health access and utilization among agricultural workers in the state. They were also asked to propose ideas to develop innovative models to facilitate the creation of an integrated healthcare system for agricultural workers in the state using digital modalities.

Theoretical framework: Anderson's model of healthcare utilization and Grounded theory

Statistical tests: Cross-tabulations, chi-square tests, and logistic regression analysis ($p<0.05$) using STATA (version 18.0).

Qualitative coding: Focused and axial coding techniques using Dedoose software version 9.2

Chapter One

Study 1: Examination of the role of Distance, Socioeconomic Determinants, Structural and Cultural factors on Delay in seeking Healthcare Services among Agricultural Workers in California: A Mixed Methods Study

Introduction: Agrarian workers in the U.S. are reported to have among the highest rates of fatal and nonfatal occupation-related injuries and illnesses reported across all other industries in the country. [11,13,202,203] They are engaged in hard manual labor outdoors, often at elevated temperatures and wildfire smoke, which in the wake of rising ambient temperatures makes them vulnerable to various heat-related and respiratory illnesses.[6,20,22–24] They are constantly exposed to varying levels of dangerous chemicals such as pesticides, often without adequate access to necessary Personal Protective Equipment (PPE). [5–9] Studies have shown that they have the highest rates for worker compensation claims among workers employed in any industry across the U.S.[20,204]

Moreover, they have very high rates of chronic diseases and mental illnesses, but despite their vulnerabilities, they are less likely to utilize healthcare services compared with workers in other industries and often suffer from worse health outcomes.[35,38–41] Despite being termed as "Essential workers" and custodians of our food supply during the recent COVID-19 pandemic, they faced several barriers in keeping themselves safe while working in person in our fields, including the lack of PPE, living in overcrowded housing, lack of knowledge of how to protect themselves, limited test and treatment availability.[3,4]

Among these workers, the most widely reported barriers to healthcare access and utilization are the high cost of services and the lack of health insurance coverage.[3,39,77] Some recent policy changes have attempted to address these issues. The state lawmakers have voted to enact the expansion of MediCal for undocumented workers to improve health insurance coverage for these workers.[51]However, another major hurdle includes the availability of and access to healthcare providers is distance as most workers live in medically underserved rural areas close to the farms where they are employed as reported in various publications.[35,38] These MUAs have sparse and restricted healthcare services, forcing workers to travel long distances and lack reliable means of transportation to access these services promptly.[54,73,77]

Another policy change includes the expansion of the network of farmworker-serving Federally Qualified Healthcare Centers (FQHCs) and Migrant Health Clinics (MHCs) with the provision of cheaper services on a sliding fee scale to reduce some of these challenges [39,51,205,206] Distance from healthcare facilities has often been reported as a significant obstacle to healthcare access and utilization in rural areas.[76,207,208] However, in recent years, due to the expansion of medical services, some studies have shown that the role of distance has become controversial, such that distance alone may either not be a determinant or not the most important determinant of healthcare utilization, and other factors such as the cost of healthcare services, health insurance coverage, financial security,

transportation, cultural and linguistic barriers, access to culturally responsive services may play a more notable role.[74,207–209]

Despite being well-known obstacles to healthcare access and utilization in rural communities, very few studies have examined the impact of these barriers on healthcare usage patterns among agricultural workers.[32,36,95,97,210]Most of these studies were conducted over a decade ago when the healthcare policy landscape and the spread of healthcare services were considerably different from those that exist today.[72,95] Moreover, most of these studies either did not focus on agricultural workers in California or were conducted in other states, which may have a substantially different policy framework compared with this state[22,25,37]. Additionally, they do not quantify the impact of these challenges by examining the relationship between distance from different types of healthcare facilities on healthcare utilization and delays in seeking healthcare services among agricultural workers.[57,210,211]. Most of these studies do not consider the impact of the expansion of MHCs and FQHCs in conjunction with the closure of many Critical Access hospitals in rural areas.[69,205] They also do not take into account the significant impacts of policy measures that facilitate the use of innovative healthcare delivery methods such as mobile clinics, the recent introduction and expansion of telehealth services during the COVID-19 pandemic on healthcare access and utilization among agricultural workers in California.[68,69,71,138,206,212]

This study aims to examine these issues using the University of California Merced-led Farm Worker Health Study (UCM FWHS) dataset, the largest state-based survey of agricultural workers in California in 2021-22, funded by the California Department of Public Health (CDPH).[59] The geocoded locations from the cross-street addresses provided by survey respondents were used to calculate distances and travel times from the nearest FQHC, hospital, and rehabilitation facility. We also examined the need for an appointment, approximate waiting times, and self-reported reasons for delay in seeking needed services. Anderson's model of healthcare utilization was used as the theoretical framework as it accounts for the individual and social determinants of healthcare utilization in vulnerable populations by incorporating them as predisposing, enabling, and need factors.[191,192]

Previous studies also had a limited focus, choosing to explore only one or more factors, including distance from healthcare facilities, availability of transportation, health insurance coverage, or distrust of the healthcare system due to fear of deportation or employer retaliation.[36,51,213] They do not simultaneously consider the impact of various factors beyond cost and availability, both structural and cultural, which impair their ability to navigate the U.S. healthcare system. These factors often interact with each other and critically impact their decision to seek healthcare services. Moreover, these issues are explored only from the vantage point of the agricultural worker, who has limited information about local healthcare policy or the existing framework within which healthcare services are delivered.

In order to examine this issue in greater detail, 38 semi-structured interviews were conducted with farmworker-serving healthcare providers, growers, farm worker advocates, and other key stakeholders to take a deeper look at the deficiencies in the current system not only from the outside but also from within. The grounded theory framework, which

allows the simultaneous collection and analysis of data related to less explored topics of interest, was used to understand the perspectives of the interviewees on the challenges agricultural workers face while trying to access and utilize healthcare services in the current health policy landscape.[195,196,214] The study aims to fill the gaps in our understanding related to the current state of healthcare access for state agricultural workers and the obstacles they need to overcome to utilize the services available to them. The purpose of this study is to examine the impact of distance from healthcare facilities, availability of transportation, and the amplifying effect of lack of paid time off, low income, fear of deportation, and lack of availability of culturally competent healthcare services on healthcare access and utilization among agricultural workers in California.

Methods: The UCM FWHS dataset, a survey of 1453 farmworkers from the major agricultural regions of the state funded by the California Department of Public Health (CDPH) and completed in 2021-22, was used in this study.[59] It is the most extensive state-based study on farmworker health, following the previous California Agriculture Worker Health Survey (CAWHS) conducted in 1999.[215] This survey was selected because the collected comprehensive information on healthcare access and utilization among agricultural workers in California while the National Agricultural Worker Survey (NAWS) includes a limited number of currently employed hired agricultural workers from California, and the NAWS 2019-20 survey did not collect detailed information on healthcare utilization among agricultural workers.[75]

The self-reported location of the interviewed farm workers was recorded using cross-street addresses which were geocoded to determine their approximate locations and were later used to determine the drive time distance and travel times from different types of healthcare facilities the nearest FQHC/MHC using data from the Department of Healthcare Access and Information (HCAI) website (https://funding.hcai.ca.gov/fqhc-site-search/), the nearest Rehabilitation centers using data from the website (https://hcai.ca.gov/visualizations/top-five-major-diagnostic-categories-mdcs-for-california-hospitals/), and the nearest hospital using data from the American Hospital Directory website (https://www.ahd.com/states/hospital_CA.html), using the ArcGIS software package with the help of experts at the UCM SPARC center for GIS studies. The Anderson model of healthcare utilization described earlier was used as the theoretical framework informing study. The variables selected under this framework are listed below.

Predisposing variables: Gender, age, fear of deportation, number of years in the U.S

Enabling variables: Financial security, health insurance coverage, educational status, distance from nearest FQHC, distance from the nearest hospital, distance from nearest rehabilitation facility, travel time from nearest FQHC, travel time from the nearest hospital, travel time from nearest rehabilitation facility.

Need variables: History of chronic disease and the need for appointment.

Dependent variables included delay in seeking healthcare services in the past 12 months, delay in seeking prescription drugs in the past 12 months, having an E.R. visit in the past 12 months, and having been hospitalized in the past 12 months.

Data was analyzed using STATA software version 18.0; significance was defined as $p<0.05$ was used in all statistical tests. The summary statistics of appropriate variables are reported as percentages for categorical, mean, and standard deviation for continuous variables. The relationship between healthcare utilization variables and other categorical variables was examined by Chi-square tests. The relationship between distance and travel time from different healthcare facilities and delay in seeking healthcare services was examined using Logistic regression. The assumptions for logistic regression: binary outcome, independent observations, large sample size, and linearity in log odds were also tested during the analysis. The model fit was examined based on Lfit, AIC, and BIC criteria, examining the area under the logistic regression curve, and the best-fitting model was chosen to ensure parsimony and avoid overfitting. The role of confounders and effect modifiers was examined through mediation and moderation analyses.

Qualitative study methods*:* We conducted 38 semi-structured, in-depth interviews with growers, farm worker advocates, healthcare providers, and other key stakeholders between February 2021 and October 2021. The interviewees were asked to express their views on barriers and facilitators for healthcare access and utilization for agricultural workers in California. We used the Zoom video-conferencing application to conduct the interviews. We used the snowball sampling approach to recruit participants because of the small number of healthcare providers, employers, and advocates who work with this population. The Institutional Review Board at the University of California in Merced reviewed and approved the study protocol as exempt.

Table 1.1 presents the important demographic characteristics of the interviewees. We conducted interviews until we achieved theoretical saturation; in other words, no new themes emerged from successive interviews.[216] Each interview was recorded, transcribed verbatim, and cross-checked for accuracy. The grounded theory framework was used to code the interviews. It allows for simultaneous collection and analysis of data, allowing a thick description of the issue from the diverse perspectives of the stakeholders.[193,195,214,216] Detailed field notes and memos were written to capture any additional information not mentioned in the interviews. The relevant themes and subthemes were identified using the focused and axial coding techniques by two team members, who met regularly to discuss any differences in opinion, which were resolved through reconciliation meetings and recorded in memos.[193]

Table 1.1 Demographic characteristics of interviewees

Interviewee characteristics	**N= 38 (Percentage)**
Gender	
Male	27 (71.1)
Female	11 (28.9)
Type of organization	
Grower	13 (34.2)
Contractor	3 (7.9)
Advocacy groups	8 (21.0)
Healthcare provider	9 (23.7)
Health insurance provider	5 (13.2)
Ethnicity	
Hispanic	22 (57.9)
Non-Hispanic	11 (28.9)
Other	5 (13.2)

Results: Thirty-eight interviewees participated in the qualitative study, the demographic characteristics of whom are presented in Table 1.1 Among these participants, 71.1% were male and 28.9% were female with approximately 34% of the interviewees being growers, nearly 24% being healthcare providers, 21% being farmworker advocates, and 13.2% being health insurance providers. Approximately 58% were of Hispanic ethnicity, while nearly 29% were Caucasian and due to the small number of stakeholders working with agricultural workers in California, information about age, educational qualification, and location was not collected to maintain confidentiality.

Demographic characteristics of participants in the UCM FWHS used for quantitative analysis have been presented in Table 1.2. and show that the study oversampled female farm workers and some under-represented groups to enable future researchers to examine the health characteristics in greater detail.[59] As shown in Table 1.2 below, the sample had 55.4% females, 42.9% males, and 1.7% who reported their gender as other, approximately 24.2% of the sample had not attended regular school, while only 6.5% had attended some college, approximately 46% of the survey respondents did not have health insurance coverage at some time in the last 12 months, and nearly 26.2% did not consider themselves to be financially secure enough to cover emergency expenses of $400.

The average age of the survey respondents was 41.36 (SD: 12.25) years with approximately 20% being employed by growers, and contractors employed 62%. Nearly 21% were migrants, with 82.5% reporting that Spanish was their preferred language of communication with approximately 9.1% of survey respondents showing some level of

dependence on employer-provided transportation. Over 97% of survey respondents self-identified themselves as of Hispanic ethnicity.

Table 1.2 Demographic characteristics of the UCM FWHS participants

Characteristics (N=1453)	**Mean (standard deviation) or percentages**
Gender	
Female	55.4%
Male	42.9%
Other	1.7%
Educational status	
No regular school	24.2%
Regular school	47.4%
Some college	6.5%
No response	21.9%
Financial security	
Not financially secure	26.2%
Financially secure	73.8%
Health insurance coverage	
No health insurance	45.6%
Had health insurance	54.4%
Age	41.36 (12.25)
Type of employer	
Grower	20.2%
Contractor	62.0%
Other	17.8%
Migrant status	
Not migrant	79.2%
Migrant	20.7%
Preferred language of communication	
English	2.3%
Spanish	82.5%
Other	15.2%
Dependence on employer-provided transportation	

Needs transportation	9.1%
Has transportation	90.9%
Ethnicity	
Hispanic	97.2%
Not Hispanic	2.8%

Table 1.3, shown below, provides the drive times and distances from the geocoded locations supplied by survey respondents as calculated by the UCM GIS center based on the techniques specified earlier in the methods section of the manuscript. The average distance from the nearest FQHC, nearest hospital, and nearest rehabilitation facility was 3.46 miles (SD: 5.35), 6.59 miles (SD: 7.19), and 10.51 miles (SD: 11.22), respectively. The average travel time from the nearest FQHC, hospital, and rehabilitation facility was 6.12 minutes (SD: 7.52), 10.45 minutes (SD: 8.91), and 14.62 minutes (SD: 12.84), respectively.

Table 1.3 Distance from or travel time to various healthcare facilities

Distance or travel time	**Mean (standard deviation)**
Distance from nearest FQHC (miles)	3.46 (5.35)
Distance from nearest hospital (miles)	6.59 (7.19)
Distance from nearest rehabilitation facility (miles)	10.51 (11.22)
Travel time from nearest FQHC (minutes)	6.12 (7.52)
Travel time from nearest hospital (minutes)	10.45 (8.91)
Travel time from nearest rehabilitation facility (minutes)	14.62 (12.84)

The survey respondents were asked if they had delayed seeking healthcare services or prescription drugs in the past 12 months if the cost was a key factor, and to select other factors besides cost that influenced their access to healthcare services. Approximately 21% of workers had delayed seeking healthcare services; nearly 66 % reported that the cost of healthcare services was a key factor. They were asked about other factors apart from cost that affected their decision, which are listed in Table 1.4. The most common cause for delays in seeking healthcare services were inconvenient hours of operation at the clinic (44.6%), followed by lack of availability of transportation services (13.4%), language barriers (12.0%), and loss of referral documents (11.4%).

Similarly, approximately 14% of workers had delayed seeking prescription drugs, and among them, nearly 66 % reported that the cost of healthcare services was a key factor. They were further asked about other factors apart from cost that affected their decision, which are listed in Table 1.4. The most common cause for delay in seeking prescription drugs aside from cost was inconvenient hours of operation at the clinic (58.7%), followed by lack of availability of transportation services (21.0%), language barriers (12.8%), and loss of documents (19.2%).

Table 1.4 Reasons for delay in seeking healthcare services

Potential reasons for delay aside from cost of services	**Delay in seeking care (n=184)**	**Delay in seeking prescription drugs (n=109)**
Language	12.0%	12.8%
Transportation	13.4%	21.1%
Inconvenient hours	44.6%	58.7%
No childcare	5.9%	4.6%
Lost referral	11.4%	19.2%
Didn’t have time	8.6%	7.3%
Other	33.7%	25.6%
Don’t know	10.9%	2.8%

The survey respondents were also asked about whether they needed to see their Primary Care Provider (PCP) or a specialist provider for any reason in the past 12 months and the waiting times they experienced when trying to access these services. Table 1.5, shown below, presents the self-reported waiting times among survey respondents who stated that they needed to see a Primary Care Provider PCP (n=303) or a specialist (n=149) or needed an urgent appointment within two days to manage an injury or illness (n=247). As can be seen, approximately 37% of workers reported waiting for over seven days to see their PCP, while over 55% of workers reported waiting for over three weeks to see a specialist provider. Approximately 17% of workers reported needing an appointment within two days to manage an injury or illness, but over 68% reported either never or only sometimes getting an appointment within that time frame, indicating the difficulty in seeking healthcare services in a timely fashion.

Table 1.5 Waiting times among those who needed to seek healthcare services

Characteristic	**%**	**Characteristic**	**%**	**Characteristic**	**%**
Among those who needed to seek care for any reason				Need for appointment in 2 days due to illness or injury	17.4%
PCP wait time (n= 303)		Specialist wait time (n=149)		Among those who needed an appointment, those who got the appointment in 2 days (n=247)	%
Same day	1.3%	Same day	2.0%	Never	33.2%
1-2 days	40.9%	1-2 days	12.8%	Sometimes	35.6%
3-7 days	20.5%	3-7 days	11.4%	Usually	12.2%
8-21 days	15.2%	8-21 days	18.1%	Always	17.8%
Over 3 weeks	22.1%	Over 3 weeks	55.7%	Don’t know	1.2%

Table 1.6 presents the percentages of individuals who delayed seeking healthcare services, delayed seeking prescription drugs, took antibiotics without a prescription, or reported having had a doctor visit, blood test, ER visit, or hospital stay in the last 12 months split by distance from the nearest FQHC, hospital, and rehabilitation facility. Chi-square tests were conducted to look for statistical significance and were found to be non-significant.

Table 1.6 Relationship between delay in seeking services by distances from healthcare facilities

Characteristic	FQHC distance= < 20 miles (n=1296)	FQHC distance> 20 miles (n=76)	Hospital distance= <20 miles (n=1250	Hospital distance> 20 miles (n=122)	Rehab distance =<20 miles (n=1062)	Rehab distance >20 miles (n=310)
Delay in seeking healthcare services	20.9%	21.2%	20.5%	23.3%	20.2%	22.8%
Delay in seeking prescription drugs	14.3%	12.8%	14.2%	13.9%	14.3%	13.7%
Using antibiotics without a prescription	15.1%	12.7%	15.0%	13.8%	15.6%	13.0%
Doctor visits in the last 12 months	43.3%	43.6%	43.3%	43.4%	42.6%	45.4%
Blood test in last 12 months	40.1%	42.4%	40.0%	42.1%	40.0%	41.0%
E.R. visits in the previous 12 months	21.9%	22.3%	22.4%	19.4%	22.3%	21.3%
Hospital stays in the last 12 months	11.2%	14.2%	11.3%	12.9%	11.1%	12.7%

Table 1.7 presents the logistic regression analysis results. The relationship between delay in seeking healthcare services and distance from the nearest hospital, distance from the nearest rehabilitation facility, travel time from the nearest hospital, and travel time from the nearest rehabilitation facility was statistically significant. A one unit increase in distance from the nearest hospital was associated with a 1.04 (95%CI:1.01,1.07) times increase in the odds of delay in seeking healthcare services. A one unit increase in distance from the nearest rehabilitation facility was associated with a 1.03 (95%CI:1.01,1.05) times increase in the odds of delay in seeking healthcare services. Agricultural workers with financial security had 0.41 (95% CI: 0.25,0.68) times and 0.63 (95 % CI: 0.41,0.65) times the odds having delayed seeking healthcare services in the last year compared with those who were not secure in the first and second model. Similar results were observed when analyzing travel times from the hospital and rehabilitation facility.

There was no statistically significant relationship between delay in seeking healthcare services and distance from the nearest FQHC or travel time from the nearest FQHC. There was no statistically significant relationship between delay in seeking prescription drugs and distance from any healthcare facility. No statistically significant relationship existed between using antibiotics without a prescription and distance from any healthcare facility. There was no statistically significant relationship between having visited the Emergency Room for any reason in the past 12 months and distance from any type of healthcare facility. There was no statistically significant relationship between being hospitalized for any reason in the past 12 months and distance from any healthcare facility.

There were no statistically significant mediation and moderation effects upon testing these relationships using health insurance coverage, financial security, and the use of employer-provided transportation as mediators and moderators.

Table 1.7 Results of logistic regressions

Delay in seeking healthcare services	**Odds Ratio (95%C.I.)**	**Delay in seeking healthcare services**	**Coefficient (95%CI)**
Distance from the nearest hospital	1.04 (1.01,1.07)*	Distance from nearest rehabilitation facility	1.03 (1.01,1.05)**
Gender Female Male/Other	 Ref group 0.80 (0.51,1.26)	Gender Female Male/ Other	 Ref group 0.80 (0.51,1.25)
Age	0.98 (0.97,1.004)	Age	0.98 (0.96,1.0)
Number of years in U.S.	1.0 (0.99,1.02)	Number of years in U.S.	1.0 (0.97,1.03)
Fear of deportation	0.135 (0.107)	Fear of deportation	1.13 (0.92,1.39)
Financial security Not secure Secure	 Ref group 0.41 (0.25,0.68)***	Financial security Not secure Secure	 Ref group 0.63 (0.41,0.65)***
Health insurance coverage No insurance Had insurance	 Ref group 0.64 (0.42,0.0.99)*	Health insurance coverage No insurance Had insurance	 Ref group 0.63 (0.41,0.68)*
Number of chronic diseases	2.21 (1.38,3.55)***	Number of chronic diseases	2.28 (1.42,3.68)***

Need for an appointment. No Yes	 Ref group 4.0 (2.45,6.51)***	Need for appointment No Yes	 Ref group 4.17(2.55,6.81)***
Educational status Some college Regular school No regular school	 Ref group 0.69 (0.30,1.57) 0.53 (0.22,1.30)	Educational status Some college Regular school No regular school	 Ref group 0.73 (0.32,1.68) 0.51 (0.21,1.27)
Self-rated health Excellent Very good Good Fair Poor	 Ref group 0.81 (0.31,2.10) 0.37 (0.17,0.84)* 1.08 (0.48,2.42) 0.40 (0.12,1.29)	Self-rated health Excellent Very good Good Fair Poor	 Ref group 0.87 (0.33,2.27) 0.39 (0.17,0.88)* 1.12 (0.50,2.53) 0.42 (0.13,1.38)
Dependence on employer transportation Needs transport Has transport	 Ref group 0.75 (0.30,1.86)	Dependence on employer transportation Needs transport Has transport	 Ref group 0.71 (0.29,1.77)
Constant	1.02 (0.20,5.19)	Constant	0.94 (0.18,4.83)

*p value<0.05, **p-value <0.01, and ***p value <0.001

Qualitative study findings: The interviews were analyzed using the constructivist grounded theory approach. This approach recognizes that the researcher may hold certain pre-existing biases based on prior knowledge or lived experiences and may not serve as a neutral observer.[193,195] We hold an insider-outsider position in the context of the project as public health researchers who have previously engaged with agricultural workers, employers, and healthcare providers during the planning, data collection, and dissemination of the UCM FWHS.[217,218] We are insiders because our professional expertise allows us to understand medical jargon.[6,51217] We have an outsider position, not being agricultural workers or directly providing healthcare services to these workers, and therefore, we may not fully comprehend their struggles.[217,218].

According to the stakeholders, agricultural workers face multiple and complex challenges when attempting to access healthcare services during times of need. A list of the common themes and codes is provided in Table 1.8 on the next page. They have been split into four main categories: Socioeconomic barriers to health system integration, structural barriers to health system integration, cultural barriers to health system integration, and innovative methods of service delivery. Some of the relevant themes and associated quotes from the interviews that shed light on these issues are presented in the next section.

Table 1.8 List of commonly appearing themes with codes

Socioeconomic barriers to health system integration	**Structural barriers to health system integration**	**Cultural barriers to health system integration**	**Innovative methods for service delivery**
Difficulty in juggling competing household and healthcare expenses	Availability of few rural clinics	Low levels of health literacy	Use of mobile clinics
Lack of health insurance coverage	Shortage of primary care providers	Fear or mistrust of the healthcare system	Grower-run clinics
Limited health insurance coverage	Long waiting times at appointments	Avoidance of the healthcare system due to fear of deportation	Use of telemedicine services to improve access
High cost of healthcare services	Shortage of specialist providers	Lack of familiarity with the healthcare system	Employers facilitate healthcare utilization

Lack of paid time off	Long waiting times for referrals	Language barrier and lack of appropriate interpretation services	Use of Grower-run clinics as telehealth access points
Avoidance due to fear of wage loss	Absence of economic incentives for providers and healthcare institutions	Alternative health beliefs	Creation of programs that incorporate traditional medicine
Avoidance due to fear of employer retaliation	Burnt-out providers with heavy patient loads deliver poor-quality services	Poor follow-up with post-visit instructions	Training Promotoras to help patients navigate healthcare services
Lack of reliable access to transportation	Lack of seamless electronic health information exchange	Lack of culturally competent services	Sliding fee scale at FQHCs
Limited access to timely public transportation	Regional managed care programs	Avoid treatment for minor injuries and illnesses	Healthcare providers perform home visits for very sick patients
Lack of knowledge about health insurance	Difficulty in obtaining health insurance	Younger workers avoid getting health insurance	
Lack of knowledge of worker compensation	Difficulty in navigating the healthcare system		

Socioeconomic barriers to health system integration: The stakeholders spoke about several obstacles to healthcare access and utilization among agricultural workers. Some economic barriers and social conditions that impede care-seeking are briefly discussed below.

High cost of healthcare services: The interviewees shared that agricultural workers face financial difficulties paying for healthcare services. They are low-wage workers and face economic challenges in paying for healthcare services even when they are allowed to pay on a sliding fee scale at FQHC, leading to avoidance of the healthcare system.

"I think cost is definitely one. Even sometimes, in nonprofit clinics, a visit can be $35, and then the medication can add up to maybe $50 or $60, which will make somebody go when they absolutely have to. It's not like oh, I don't feel well, let me go into the clinic; it's more. Oh my God, I can't stand this pain, so let me go in. So, it really does not help with preventative care. Medications are another challenge because maybe you did go to the visit, but if the medication costs again a lot of money, especially like diabetes medications which can cost a lot of money, you may or may not go get it, and if you do, maybe you get the first dose, but then you don't go back for refills." (Grower)

Lack of access to health insurance coverage*:* The interviewees discussed that despite ongoing efforts by the state to enhance health insurance coverage particularly for undocumented workers through Medi-Cal expansion, many continue to either have no or have restricted access to adequate insurance coverage, affecting their ability to take care of themselves.

"When I asked farmworkers how many of you guys are insured, 60% of all our farmworkers are uninsured, so we know there's a gap right there, and the ones that are insured are typically insured through the local safety net health insurance, right? So whether it's in Kern county current family health care or health net or whatever insurance for low-income folks, that's where our farmworkers get their resources and get their services from. Now we do have a large population that just doesn't have any insurance and, depending on the gender, will probably never end up in the hospital or clinic unless they are really dying or unless they really have a severe problem." (Healthcare provider)

Avoidance of taking time off due to loss of wage: The stakeholders revealed that farm workers are low-income workers without the privilege of seeking paid time off. Consequently, they are limited in balancing taking time off with wage loss and spending money on transportation and treatment over competing household expenses.

"If you don't work, you don't get paid, and so you can't literally afford to take time off for medical attention. In fact, this was one of the huge barriers. I remember, in the very early days of the pandemic, talking with workers about some of the symptoms of COVID-19 and highly dismissing it. Just like basically looking at me as a white man of privilege and saying

well, of course, you can take time off when you get a headache or a cough. We don't have that luxury, so we're absolutely not going to do that." (Farmworker advocate)

Fear of employer retaliation: The stakeholder revealed that while some employers wanted their workers to seek healthcare services, they did not want to be reported to Worker compensation, while, workers specifically undocumented workers, believed that accessing healthcare services or notifying their employers may lead to retaliation or job loss, leading to delays in care.

"There's a conflict. Often, they would like to send an employee in for something. However, they don't want us to write a first report because it's their workman's compensation. Even on the farm worker side, we have a little resistance because they don't want to be out. They don't want that to be a ding against them, or they can't go back to work, especially if they're working, obviously undocumented, so that we've tried to see if we can move into more of that occupational health, and we haven't been successful on our side." (Healthcare provider)

Access to limited means of transportation: They revealed that some of these workers do not have a vehicle to reach their doctor's appointments, and they are dependent on public transit or employer-provided transportation

"Well, the main barrier in this area, and I think what I've seen in most places, is transportation because a lot of them were a minority; they live on the farms. They are not in town. They are by the farms, and so the transportation is the number one issue." (Healthcare provider)

Lack of timely access to reliable means of transportation: The stakeholders shared that even if the clinic was located close to where the farm worker resides, the lack of easily accessible transportation services hinders their ability to utilize healthcare services in their area.

"I think a lot of nonprofit clinics, or even county clinics, are located in areas where a lot of farmworkers live. But if there's no public transportation, then that definitely is a barrier. But I think, at least from what I see, most either nonprofit or county clinics are located in areas that are accessible." (Grower)

Limited levels of vehicle ownership: They shared that although vehicle ownership was a challenge for agricultural workers, even those with a vehicle may be unable to effectively utilize it to access healthcare services due to competing needs and responsibilities.

"Well, they do. They do have the vehicle, but they only have one vehicle; it's the one that the household uses for work. If they need to go to the hospital or to the clinic or take the kids and this and that, then they don't have transportation. Now that's the problem." (Healthcare provider)

Structural barriers to health system integration: The stakeholders spoke about structural barriers within the existing healthcare system, which make it difficult for workers to seek healthcare services in a timely and convenient manner. Some of the structural conditions that impede care-seeking are briefly discussed below.

Availability of a few rural clinics: The stakeholders revealed that most workers live in less populated Medically Underserved Areas (MUAs) where building large clinics and hospitals may not be economically feasible.

"Usually, to make a clinic tensile, you need about most people would say you need about 20,000 people within a reasonable geographic area and make a standalone brick and mortar clinic run very well, so there are some of those, and some of the growers are doing themselves... For us, it's pretty tough to do because I just don't have a large enough number of people in an area to make it feasible, and the people who build those things and run those usually want to be in a more concentrated population." (Health insurance provider)

Availability of limited primary care providers and services: They shared that many of these facilities are not very profitable and are often manned by limited providers and personnel, which constrains their abilities to provide high-quality, integrated, and coordinated services to agricultural workers.

"FQHCs don't have the providers, workers do not have access and take into consideration transportation in rural areas. I think that's a growing need in farmworker communities." (Healthcare provider)

Shortage of specialist providers: The stakeholders shared that farmworker-serving FQHCs offer limited services due to a shortage of providers, specifically specialist providers, which can lead to problems with referrals and delay healthcare utilization among workers in their service areas.

"I think it's a complicated process. You know, FQHCs, in general, are designated as primary care hubs, right by HRSA, by the Bureau of Primary Health Care, so we don't have specialty services or referral services in-house, and this falls across for everything, so not only physical health but dental, primary care and mental health, primary care. Right. So then, unlike a Kaisers Sutter or whatever, we don't have a secondary and tertiary care facility to ramp up care like that." (Healthcare provider)

Long waiting times: The limited number of providers in rural clinics leads to huge patient volumes. The stakeholders revealed that many workers complained of long appointment waiting times, which disincentivized them from seeking care unless absolutely necessary.

"They would go into clinics, where they probably had to wait two hours to be seen, they would still have to pay a copay, and it was just we would always get complaints about either the wait times or the availability of where they could go to get the service and the copay." (Grower)

Inability to access appointments due to inconvenient hours of operation: The stakeholders shared that the traditional 8 am to 5 pm working hours at most clinics tend to make them inaccessible to most workers due to their long working hours

"Just part of the work, you know, the long hours lots of times, health, you know health care facilities or your normal clinic if they're eight to five and they're working till 9 pm or something, then you know how are they going to do that or weekends things like that, just a lot of things related to the nature of the work I think also contribute to them, not accessing healthcare many times." (Farmworker advocate)

Lack of financial incentives for healthcare providers for integration*:* The interviewees revealed that the prevailing reimbursement levels under Medi-Cal are deficient due to which few providers, particularly specialists, are willing to provide services to farm workers without appropriate financial incentives.

"So these specific initiatives for people who were at the income level of farmworkers it was open to people without documents or with documents, and, ideally, the primary targets were Farmworkers. The main issue, though, is that if you don't do outreach, people don't come in, and you also need providers to enroll to be providers of that specific insurance benefit, and CMS didn't really fund a fair reimbursement level. I mean, the reimbursement was like $10 per visit, so there were only like two providers that wanted to play."(Farmworker advocate)

Cultural barriers to health system integration: The stakeholders spoke about cultural barriers that complicate care-seeking within the current health policy framework. Some of these challenges are briefly discussed below.

Low Health literacy: They shared that farm workers have low levels of health literacy, limited ability to recognize their symptoms, and the need to manage their illnesses appropriately leading to avoidance or delays in seeking healthcare services to prevent the loss of wages.

"They don't feel like they needed right to miss an afternoon off from work just to get a checkup to tell them that they're fine, right yeah, that's their sugar run, and yeah. Um, now if it was after hours and they didn't have to go someplace, they would do it, but some of them some would say, oh, I'm healthy, you know, right." (Farmworker advocate)

Avoidance of the healthcare system due to fears of deportation: They stated that a significant percentage of farm workers are undocumented and feared deportation upon using any service due to adversarial changes in immigration policies and the lack of familiarity with the U.S. system

"Trust is a big factor between any patient and healthcare provider, you know, especially for immigrant populations who might not necessarily be familiar with the healthcare system understand or know how to navigate it and so then being able to trust the provider, the person that they're working for the health care is critical to the success of them accessing services along with an understanding of again the culture and the practices that the indigenous patient might have. For providers to truly understand it so that they can connect with them, and maybe offer treatment and services that align with those beliefs." (Farmworker advocate)

Unfamiliarity with the U.S. healthcare system: The interviews revealed that many workers were born abroad and did not understand the nuances of the U.S. healthcare system. They discussed how it creates obstacles in seeking care for foreign-born workers like those in the H2A program.

"The H2A when they come, they come to work, and they try to save, save, save, and send, send, send home, you know, they keep very little for themselves here which, you know, sometimes comes into play when there's an emergency, you know, bad toothache, or just a stomach ache, you know, anything, anything, you know, like a little cold. They're so used to being able to go to the pharmacy over there and getting whatever they need, you know, but when it comes here, you need to go to a doctor, you need to get a prescription. You know it's a process here. It's not like going to the pharmacy and getting antibiotics just because you can. It's very different, so it's a cultural shock over here, and it's just education and learning about it. But access, yes, it's difficult." (Farmworker advocate)

Distrust of the healthcare system: The stakeholders revealed that while some healthcare providers did not understand their occupational risks, language, and culture, while others seemed to be working for the employer or regulatory agency, making them feel alienated and uncomfortable, leading to avoidance or delays.

"Having access to doctors who are culturally appropriate, that are not in bed with the employer, that are aware of the litany of occupational risks that farmworkers face, and

rather than treating symptoms, as we see frequently with pesticides and pesticide poisoning, actually inquire as to the true nature of a symptom and getting to the root cause, lack of health insurance, and just very poorly designed workplaces that are inherently, again by design, dangerous and then you layer on top of that inadequate regulatory system and report enforcement and then a very healthy dose of racism, just kind of greases the wheels of everything I just mentioned." (Farmworker advocate)

Lack of adequate translation of interpretation services: The interviewees revealed that many workers, especially those belonging to the indigenous communities, face obstacles in receiving culturally sensitive care, which often leads to avoidance of the healthcare system due to the feeling of helplessness, not being heard and validated.

"Many indigenous workers speak languages that are not Spanish and maybe limited Spanish proficient, and certainly limited English proficient, not all health centers especially have the resources to provide care to indigenous speakers and so you know, especially for languages that are not as common, so I'm thinking outside of Mixteco and those major indigenous languages, there are lots of other indigenous languages, and so it's much harder to ensure that workers have the access they need in terms of someone who is both linguistically and culturally accessible for them." (Farmworker advocate)

Alternative beliefs and cultural practices: Some stakeholders shared that some workers favored seeking healthcare services more closely aligned to their cultural beliefs, even if it meant traveling farther or across the border.

"The thing is that some people go all the way to Fresno to see somebody, for instance. So they know where they are, they go" (Farmworker advocate)

"There's a certain amount of, you know, the witch doctor still exists in some of this culture, and if there's a problem, they're going to go back to Mexico. They're sending, you know, 35% out of every check home, so those folks are very much different, and this is a regional issue for us, right? I don't think you'll find this in other places. Those folks are very much still transitory workers." (Grower)

Expansion of innovative methods of healthcare delivery: The social distancing restrictions during the COVID-19 pandemic led to the widespread proliferation of new approaches to delivering services to vulnerable populations and some of the relevant techniques are briefly discussed here.

Use of mobile clinics: The stakeholders revealed that mobile clinics play an essential role in helping deliver services to these workers conveniently at work sites.

"Mobile clinics are great. Migrant health centers have been doing mobile clinics for decades and it's a really important tool, especially for workers who live in remote areas. There are plenty of them here in California, where there are no clinics nearby because of limited transportation. So, I think mobile clinics are fantastic, and I think with COVID, it's been shown as a great way to get vaccinations out to farmworker communities." (Farmworker advocate)

Grower-run worksite clinics: The interviews shared that some large agricultural companies had developed their health insurance plans and a network of clinics to serve their employees. It helped them take care of occupational injuries and illnesses as well as create a culture of wellness.

"Reiter-affiliated companies have had clinics for a number of years. Western Growers has its series of clinics, and I think they're called Pinnacle. Then the company you know, the Resnick's and POM Wonderful, own a lot of Kern County. They also have their own clinic or a couple of their own clinics, like in Lost Hills; I think there's one.. Most of it is primary care. I mean, they're really nice clinics, and they probably have some referrals." (Farmworker advocate)

Use of telemedicine services: They shared that the pandemic allowed many workers to utilize telemedicine services and realize the benefits of accessing their provider at a convenient time from any location. It helped to reduce the impact of barriers related to distance and transportation.

"We've had some employees use the online if they're in the middle of the night, and their kid is sick or they're sick, and they don't want to go to urgent care and, they have that benefit of just creating a profile with their app and having an online doctor visit, and I know some of our employees have used that it's nice for them to know that if something happens over the weekend, or if they're out of town or just the middle of the night and they don't really want to go to the hospital, they can just you know open their phone up and it's right there and they have access to a doctor." (Grower)

Use of telemedicine services at grower-run worksite clinics: Another innovative approach was the delivery of services via audio and video visits at worksite clinics. The stakeholders shared that although this method had been tested before, it was deployed at scale during the pandemic and helped make services more accessible to farm workers.

"Telemedicine has been one of the really bright spots that come out of COVID because most programs had a telemedicine component, but it was not highly utilized, but with COVID, when you couldn't go see your doctor, suddenly people turn, and they realized how easy and convenient it is. It's a huge cost saver for the medical system, and I think the

doctors really like it, too. They can see more patients, they can write scripts, they're not they're not personally exposed to germs. So, telemedicine really got its time in the sun through COVID-19, and I think it's going to continue to be a good form of care. Our W G's program uses a vendor called Doctor On Demand, and the other popular one out there is Teladoc." (Grower-run clinic)

Use of Promotoras for community outreach: The interviewees discussed the benefits of building trust through peer educators such as Promotoras. However, in most cases, their role was restricted to enrollment in health insurance programs.

"We have community outreach here where we have a Promotora program with five Promotoras. We've had 5 Promotoras since 2008. We started the program. We had a head of outreach, and they were enrollment officers when COVID hit hard. So that's how we were doing outreach. We were doing outreach through Promotoras, I would say directly to farms. We were doing that for enrollment for things, or they were doing things for screenings. They would go to the farmworker camps here in Davis."(Healthcare provider)

Incorporation of traditional methods with Western medicine: Some interviewees spoke about the need to collaborate with local community-based organizations to incorporate traditional medical practices in existing healthcare systems to build trust and promote follow-up and continuity of care in these communities.

"I won't call it training, but like coordination building with community members, and I go back to, you know, giving birth, a lot of my health stuff is also rooted in giving birth, but like, how different it is here versus back home. Like here, they give the women ice chips, and then back home, you're only supposed to drink hot teas and soups. The cultural things like that, not seeing your doctor necessarily until you're about to give birth. One of the programs that we offer is, it's more so mental health, but it's looking at connecting, like teas and the baths of certain herbs, to wellness, and there's a big interest from the community in that and bringing those practices in." (Farmworker advocate)

Discussion: This study examined the intricate and overarching challenges faced by agricultural workers navigating the complex health system in California. The first part of this study examined the role of distance from various healthcare facilities, waiting times, transportation, cost of services, and inconvenient hours on delays in care seeking. The second part used data from qualitative interviews to examine the socioeconomic, structural, and cultural challenges along with the ramifications of newer service delivery techniques on their care-seeking patterns.

While distance from healthcare facilities has often been mentioned as a significant factor impacting care-seeking among agricultural workers, few studies have examined its role in delays in seeking necessary services.[36] Studies exploring the role of distance from healthcare facilities on healthcare usage among vulnerable populations have shown mixed

results in recent years. A systematic literature review focused on residents of countries in the global north found that out of 108 examined studies, 83 supported a "distance decay effect," or reduced utilization with an increase in distance, 19 found no effect, and 6 found a "distance bias effect" or better health outcomes in patients who lived farther away due to greater utilization of local resources.[219]

Older studies on this topic have found an association between healthcare utilization and distance from the nearest healthcare facility, while some newer studies have documented a reduction or lack of statistical significance in such effects due to the expansion of medical services in previously underserved areas.[50,208,220,221] A recently conducted international study mapping distances and travel times from the nearest healthcare facilities around the world revealed that less than 9% of the population worldwide live over 1 hour away from a healthcare facility.[222] Similar results were presented in a study conducted by the Pew Research Center, which showed that only 18 % of Americans lived more than 10 miles away from the nearest hospital in 2018.[222,223]

The previous national-level study examining the role of distance from healthcare facilities on healthcare utilization among agricultural workers was published in 2011.[95] It calculated distance only from the nearest FQHC, using data from the NAWS 2005-06 dataset. There have been several changes in the state of healthcare services in the past 20 years with the opening of new FQHCs as well as the closure of some rural "Critical Access Hospitals," due to which there is a need to understand the current state of service availability and its impact on agricultural workers while developing policies to improve healthcare access.

This study calculated the distance from three types of healthcare facilities (nearest FQHC, nearest hospital, and nearest rehabilitation facility) from the self-reported cross-street addresses of survey respondents in the UCM FWHS conducted in 2021-22. While some findings are similar to that of the previous NAWS study, which found no significant association between delay in care-seeking care and distance from the nearest FQHC, we found an increase in the likelihood of delay in care-seeking with an increase in distance from the nearest hospital or rehabilitation facility, which were not examined in that study and also highlighted the role of poor financial security and lack of health insurance coverage on delays in healthcare utilization, similar to the conclusions of the NAWS-based study.[95]

Previous studies on this contentious subject also shared that distance related considerations may have a more influential role studies in urban areas .[66,74,209,219] Other studies have demonstrated that rural residents were more affected by the affordability of healthcare services and the availability of reliable public transportation than by distance from healthcare facilities [74,209,221,224]Similar results were observed in a recent study using population registry data for farm workers in Iowa, which found that delays in care for injuries were related to travel times to hospitals or other healthcare facilities only within the first hour and did not demonstrate a direct relationship with residing in a rural area and distance from a healthcare facility.[220] Another study conducted in Colorado revealed that fewer than 8% of the migrant farm workers in the state lived more than 30 minutes from the nearest FQHC or migrant clinic.[50]

A recent study examining barriers to healthcare utilization among agricultural workers found the cost of services and distance from healthcare facilities to be critical factors associated with delay in seeking healthcare services among California agricultural workers, but it used data from NAWS 2013-16 datasets and relied on answers to the question asking for the reasons for not seeking healthcare services and does not calculate distance from healthcare facilities to examine this relationship.[36] Other studies on barriers to healthcare utilization citing distance as a barrier among agricultural workers are either literature reviews, use data from NAWS with limited information on California workers, do not calculate the distances, or are based on qualitative data collection from farm workers. [52,54,57,77]

Similar to the barriers discussed by the interviewees, some studies have also revealed that residents in medically underserved areas who are not satisfied with their care may exhibit a "healthcare bypass effect" or avoidance of local healthcare facilities and preference to travel longer to avail of better services at larger healthcare centers.[74,219,225,226] This phenomenon has been responsible for the financial insolvency and closure of some Critical Access Hospitals in rural areas.[69]

Another factor that needs to be considered is that data collection for this study was conducted in 2021-22 when California Agricultural workers faced the COVID-19 pandemic with limited in-person healthcare services and a significant percentage of the care being delivered via telemedicine.[182,227,228] During this time, several rural FQHCs in California, including regions from where the sample was collected, worked in collaboration with the RAND corporation and state health agencies under the Connected Care Accelerator (CCA) program to expand the availability of digital health resources to medically underserved populations such as agricultural workers.[184] Moreover, state public health agencies, local hospitals, and other healthcare facilities also ran mobile clinics to provide healthcare services to these workers at their worksites or community locations.[138,229] These concurrent changes in the delivery of healthcare services may have contributed to the results and lessened the impact of distance on delays in seeking care.

Agricultural workers in California face multiple barriers to healthcare access and utilization, which have been examined in the interviews using the "Studying up approach" to capture the perspectives of the healthcare providers and advocates who serve them.[198,199] They help to highlight the system-level factors which impede the utilization of healthcare services among these workers. As mentioned in the results section, they can be split into socioeconomic factors (cost of services, lack of or limited health insurance coverage, lack of paid time off, and fear of wage loss or employer retaliation), structural factors (few rural clinics, shortage of providers, inconvenient hours, long waiting times and lack of transportation) and cultural factors (low health literacy, alternative health beliefs, distrust of the healthcare system and lack of culturally sensitive providers)

These problems can be examined through the lens of the intersectional theory, which states that inequities faced by vulnerable groups are not the result of a singular factor but several interacting factors associated with socioeconomic factors and power relations.[230,231] They face multiple barriers, including financial difficulties related to being low-wage workers, many of whom lack health insurance or have limited insurance coverage.[59,62] They face systemic challenges as many of them are undocumented immigrants who fear deportation, do not speak English fluently and lack familiarity with

the healthcare system in the U.S.[52,95] They also face racial barriers as the majority of them are of Hispanic ethnicity with different health beliefs which may alienate them from the western medicine-based healthcare system.[93,94] All these factors interact to shape their decision to seek or delay using healthcare services in the U.S.

The Anderson model for healthcare utilization was selected to explore the impact of distance on delays in seeking healthcare service, controlling for the socioeconomic determinants of healthcare usage among agricultural workers by considering them in terms of predisposing, enabling, and need factors as explained in the methods and results.[191,192] Despite being widely used to explain utilization patterns in vulnerable populations, a recent study evaluating the theoretical frameworks for healthcare utilization among foreign-born individuals argued that the existing model does not fully capture the concepts of social justice and health equity but maintains that it is the most dynamic model to examine the existing health policy framework.[232]

These findings also align with a recently proposed framework for the conceptualization of healthcare access developed by Levesque et al. in 2013, which defines access as a multilevel construct with five dimensions: approachability, availability acceptability, and accommodation, affordability, and appropriateness.[232,233]They face barriers to "approachability" as they lack timely access to reliable means of transportation.[35,95] They face obstacles of "availability" as they live in medically underserved areas with few providers and a limited array of services.[234] They face barriers to "acceptability" due to low health literacy and often hold alternative health beliefs.[93] They face barriers to "accommodation" due to inconvenient hours and long waiting times.

They face challenges related to "affordability" as they earn low wages and remain uninsured despite recent attempts to expand coverage regardless of immigration status. Many providers serving in these areas do not understand their language, culture, and beliefs, creating treatment regimens that may not align with their beliefs and real-world realities, creating barriers to "appropriateness." The NAWS-based study mentioned in the above paragraph attributed the low levels of utilization of these facilities to the lack of high-quality, culturally competent services near their areas of residence or work.[95]

A multifaceted approach that considers these complex constructs and how they interact in real-world scenarios is needed to provide affordable, easily accessible, high-quality, and culturally competent healthcare services to agricultural workers in the state. Policymakers should examine more intricate and overarching approaches, such as improving the availability of public transit in rural areas, deploying trained culturally sensitive healthcare providers and advocates, as well as offering services with short waiting times during non-traditional office hours or on weekends through the novel and more convenient methods such as telemedicine or mobile clinics.[235–238]

Limitations: Firstly, UCM FWHS was conducted in 2021-22 during the COVID-19 pandemic and recruited participants using a convenience sampling technique with the help of farmworker-serving community-based organizations and clinics due to the social distancing requirements during data c[59] It is not a representative sample of agricultural workers in California.[59] Secondly, due to the undocumented status of a significant percentage of the participants, they were asked to provide addresses of the cross street near

their homes and not their exact home addresses to maintain confidentiality. These cross streets may be far away from their actual addresses and closer to the nearby cities for some workers living in rural areas. However, most workers tend to live close to the cross streets, and the distances were calculated and verified by the UCM GIS center for GIS studies to ensure accuracy in the distance and travel time calculations.

The qualitative data from the interviews reflects only the opinion of the interviewees and cannot be generalized to all relevant stakeholders.[193,194,196] The stakeholders who did not participate in the study may hold different perspectives than those shared in this manuscript. However, the research team ensured adequate participation of farm worker advocates, employers, and healthcare providers until theoretical saturation was achieved to ensure the inclusion of a diverse spectrum of opinions on this crucial issue.[216]

Conclusions: Workers who live far away from hospitals and rehabilitation facilities are more likely to delay seeking needed services than those who live near these facilities. Although most workers who participated in the survey lived close to healthcare facilities, they may not utilize them due to various limitations such as long wait times for appointments, lack of paid time off, high cost of services, lack of access to reliable means of transportation, limited access to culturally competent providers and a general lack of confidence in the system.

There is an urgent need to understand the multidimensional and overlapping barriers agricultural workers face when utilizing the state healthcare apparatus. New methods of care delivery such as worksite clinics, telehealth, mobile clinics, the use of Promotoras, and the incorporation of traditional medical techniques with modern Western medicine can help overcome some of these barriers.

Policy implications: Policymakers need to consider multiple barriers to healthcare access and utilization among state agricultural workers as well as their interactions with each other to develop viable policy solutions. They should expand access to high-quality but low-cost services tailored to their competing life and work responsibilities. These services should ideally be provided by culturally sensitive providers at a convenient time and location outside traditional working hours with a seamless exchange of information across providers. New techniques such as using mobile clinics, telemedicine services, setting up worksite clinics, making home visits by healthcare providers, and including traditional medicines in treatment regimens should be incorporated within the existing healthcare system to facilitate health system integration.

Chapter Two

Study 2: Examination of actual and intended patterns of healthcare utilization among Agricultural Workers in California: Findings from UCM FWHS Study

Introduction: The preceding study has shown that agricultural workers in California, despite having the highest rates of occupational fatalities, injuries, and illnesses compared with other workers in the state, continue to experience multiple complex challenges in accessing healthcare services.[13,202,203] Prior studies based on the results of NAWS surveys have shown that despite their heightened susceptibility to various occupational illnesses, agricultural workers are less likely to utilize healthcare services in the U.S. when compared with the rest of the population.[35,36,95] Recent studies during the COVID-19 pandemic have also revealed restricted access to healthcare services among agricultural workers in the state[3,91,180] and although previous studies have reported healthcare utilization patterns among agricultural workers, most of these studies are outdated, with many dating over ten years old. [60,98,173] Some studies are reviews of older literature and do not add new information. [56,60] Still, other studies on this topic either use older data or contain limited health-related information and do not reflect the impact of the recent changes in the health policy landscape on agricultural worker health.[1]

Very few of these studies are focused on the state of California, which differs in its worker demographic characteristics and health policies compared with the other agrarian states. [24,35,97,215,239] A deeper understanding of their healthcare utilization patterns within the current policy framework is needed to fully understand this problem to develop comprehensive and viable solutions. The study adds to the literature by using data from the University of California Merced-led Farm Worker Health Study (UCM FWHS), which is the largest state-sponsored agricultural worker health survey conducted in California since the last such study in 1999.[59,215] It provides detailed information on self-reported healthcare utilization patterns by survey respondents in 2021-22 and covers topics such as the use of routine preventive services, immunization patterns, emergency service utilization, and patterns of delays in seeking healthcare services and prescription drugs that are not included in the National Agricultural Worker Survey (NAWS) 2019-20 survey.[59,75]

Moreover, NAWS only includes a limited number of currently employed agricultural workers from California who are interviewed at their worksites and does not include H2A workers or those who may have previously been engaged in agriculture and asks limited questions about healthcare access and utilization; most of which were not included in the NAWS 2019-20 survey.[35,38,75] The UCM FWHS includes workers employed in agriculture in the past year who were sampled using Community-based organizations and could answer the survey in 6 languages to ensure equitable participation.[59] This study will, therefore, help to bridge the gap in our understanding by presenting self-reported healthcare utilization patterns among agricultural workers in the state accounting for recent policy changes such as the sequential expansion of Medi-Cal for undocumented workers, expansion of telemedicine, shuttering or downsizing of critical access hospitals in rural areas, expansion of FQHCs and use of mobile clinics using the Anderson model of

healthcare utilization as a theoretical framework as it considers both individual and contextual health determinants among vulnerable populations.[51,68,191,240,241]

This study will also examine intended patterns of healthcare utilization among agricultural workers when faced with hypothetical scenarios representing typical symptoms of common occupational illnesses such as pesticide-related illness (PRI), heat-related illness (HRI), and Valley Fever. Although agricultural workers are exposed to potentially dangerous toxicants such as pesticides in acute and chronic settings at a much higher rate than workers in other occupations, they often fail to recognize these symptoms or are hesitant to report them due to fear of retribution from their employers.[5,23–25] They work outdoors for long hours in the summer heat, making them vulnerable to Heat-related illnesses, some of which may even be fatal.[8,9] Moreover, agricultural workers in the Central Valley, which is endemic for Coccidioidomycosis, are at heightened risk for developing Valley Fever.[34] Although the state has numerous regulations to protect workers against such hazards, compliance with these rules and reporting of adverse events remains low.[22,23,242,243]

Although translated versions of occupational health education documents have been provided in Spanish for workers whose preferred language of communication is not English, some studies found that these versions are not culturally competent, with many being written at an educational level or in a language difficult for them to comprehend.[56,244,245] State regulators and employers have made several efforts in recent years to improve health literacy and promote occupational safety for these workers, including using peer educators, digital resources, and mobile clinics.[32,246,247] However, most of the studies related to occupational health among these workers were conducted before the COVID-19 pandemic and, therefore, do not consider the impact of these changes. Previous studies have examined only one of these illnesses at a time, mostly among workers who either experienced symptoms or had reported being exposed to these illnesses.[242,243,248]. This study is unique because it tests the ability to recognize and manage the symptoms of 3 different occupational diseases among workers who are not currently experiencing them. It also helps to understand their intentions to use available healthcare resources when faced with occupational health symptoms, assisting policymakers in developing novel and innovative solutions.

There have also been several changes in digital access and digital healthcare utilization, including broadband service expansion, digital community outreach, and increased availability of telemedicine services for these workers in recent years due to the COVID-19 pandemic.[32,33,188,249] Very few studies have examined the impact of using online sources of information on healthcare utilization among agricultural workers.[174,250,251]Most studies exploring this relationship were conducted in other states with different policy frameworks, such as North Carolina and Michigan.[3,4,174]Data from the UCM FWHS was collected in 2021-22 and captured the impact of these new policy changes, allowing investigators to explore their ramifications on the information and care-seeking behavior among state agricultural workers. It also helps to determine the underlying characteristics of agricultural workers who choose to use online sources of information when faced with symptoms of occupational illnesses and can potentially benefit from digital community outreach and further expansion of telemedicine services.

Methods: Information for this study is from the University of California Merced Farmworker Health Survey (UCM FWHS), a survey of 1453 agricultural workers from California, was conducted between 2021 and 2022 under the oversight of the California Department of Public Health.[59]This survey collected in-depth information about occupational health, physical environment, access to healthcare services, current health status, and utilization patterns related to the use of routine preventive as well as emergency healthcare services among agricultural workers in the state. It also collected extensive information on barriers and facilitators for access, utilization, and the sources of information these workers utilized when exposed to different occupational illnesses.[59]

The participants were asked to respond to three hypothetical scenarios where they were presented with symptoms of common illnesses to which they are exposed due to their occupation (Valley Fever, Heat-Related Illness, and Pesticide-Related Illness) and then asked to select the sources of information they would use to help them determine their further course of action.[59]They were asked about the use of online sources, waiting, consulting friends, use of at-home or over-the-counter medications, Promotoras, union members, going to the E.R., health clinic, public health, and their primary care provider. Due to the long length of the survey, these questions were not asked in surveys for participants who were asked to answer additional questions before being subjected to medical tests or required lengthy translations for Indigenous workers.

The self-reported healthcare utilization questions from the survey (doctor visit, dentist visit, E.R. visit, hospitalization, delay in seeking care, or prescription drugs in the last 12 months) were used to examine the actual healthcare utilization among agricultural workers under the existing health policy framework in California. Cross-tabulations compared healthcare utilization among survey respondents and low-income (250% of Federal Poverty Level) working-age (18-65 years) Latino residents, as reported in the California Health Interview Survey (CHIS). CHIS was chosen for comparison because it is the largest state-sponsored ongoing health survey in California, conducted by the UCLA Health Policy Center, which provides detailed information on healthcare access and utilization among the state residents, which can be further examined by various demographic characteristics, including age, gender, income, race, and occupation.[200,201]

Two sample tests of proportions were used to examine differences between the samples. The utilization of different healthcare services split by health insurance status between the comparison groups was further examined using Cross-tabulations and Chi-square tests, with significance defined as $p<0.05$ using STATA (version 18.0). The predictors of having a doctor's visit, dentist visit, blood tests, E.R. visit, hospitalization in the past year, and having a usual place of care among agricultural workers in California were examined utilizing logistic regression models.

The Anderson model of healthcare utilization was utilized to select predictors for each regression model, which are listed below.[191,192]

Age, gender, educational status, marital status (Predisposing),

Financial security, health insurance, fear of deportation, type of employer, health literacy, and preferred language of communication (Enabling)

Need for an appointment, having a usual place of care, history of work injury (Need)

Health literacy was measured on a scale (-8 to +8) by combining the values obtained from questions "How often do you need help in understanding instructions from your doctor or pharmacy" (1: never to 5: always), "How confident are you in filling forms by yourself?" (1: not at all confident to 5: very confident), "how often do you feel confused when you read descriptions of medications" (1: never to 5: always) and "how confident are you in helping others understand instructions?" (1: not at all confident to 5: very confident). The average health literacy in the sample was 0.30 (SD:4.5), 0.7 (SD: 4.5), and -1.1 (SD:4.3), calculated based on the formula below.

> *Health literacy*=confident filling forms for self + confident helping others - need help understanding instructions – feel confused reading descriptions of medications.

The predictors for utilization of routine preventive services (having a routine doctor visit, dentist visit, and blood tests) were examined using the Anderson model of healthcare utilization as a theoretical framework.

The various options for information and care seeking in the three occupational illness scenarios in the survey were classified into distinct categories using the Principal Component Analysis (PCA) technique. The components were selected based on eigen values>1(Kaiser criterion), KMO>0.6, and models that explain at least 60% variance as recommended in various scientific publications.[252–254] Subsequently, three categories were established based on the results of the PCA analysis: use of self-management techniques, use of healthcare services, and use of community resources. New variables were created by combining the options identified under each category. The predictors of using self-management techniques, healthcare services, and community management when exposed to various occupational illness-type symptoms were examined using Linear regression analyses while the predictors for using online information sources when exposed to different occupational illness-type symptoms among California agricultural workers were analyzed using separate logistic regression analyses for each hypothetical scenario.

Results*:* The demographic characteristics of survey respondents in the UCM FWHS dataset are presented in Table 2.1. The study sample had 55.4% female and 43.0% male farm workers. Among those insured, there were 55.7% females and 43.3% males, while among those who were not insured, there were 55.9% females and 42.3% males. Females and some minority groups were oversampled by design to enable an in-depth examination of their employment and health-related characteristics.[59] The average self-reported age of the surveyed agricultural workers was 41.4 years (SD: 12.3), overall, 41.3 years (SD:12.9) in the insured and 41.4 years (SD: 11.4) in the uninsured group.

Approximately 48% were married, 19.8% were divorced or separated overall, with 50.5% being married, 19.0% being divorced or separated in the insured group, 46.7% being married, and 17.3% being divorced or separated in the uninsured group. Nearly 47.0% reported having attended regular school, with only 6.5% having attended some college in the overall group, 49.9% reported having attended regular school and 6.8% having attended some college in the insured group, 52.1% reported having attended regular school, and 7.8% having attended some college in the uninsured group. Approximately 74.0% considered themselves financially secure enough to cover expenses of $400 if faced with

an emergency, with 82.0% in the insured and 65.6% in the uninsured group reporting financial security with approximately 62.0% were employed by farm labor contractors, with 61.5% in the insured group and 67.3% of the uninsured group reporting such employment.

Only 21% were self-identified migrant workers, with 19.9% in the insured and 21.9% in the uninsured group. Approximately 9.1% showed dependence on employer-provided transportation, with 9.7% in the insured and 5.9% in the uninsured group reporting such dependence. Nearly 97.0% were of Latino or Hispanic ethnicity overall, with 98.6% in the insured and 98.4% in the uninsured group. Approximately 84.0% reported Spanish was their preferred language of communication overall, with 85.9% in the insured and 79.6% in the uninsured group reporting such preference and nearly 19.6% of workers reported having a history of work-related injury in the past two years, with 14.6% in the insured group and 29.1% of the workers in the uninsured group reporting such history.

Table 2.1 Demographic characteristics of UCM FWHS participants by insurance status

	Overall	**With insurance**	**Without insurance**
Gender			
Female	56.0%	55.7%	55.9%
Male	42.9%	43.3%	42.3%
Other	1.7%	1.0%	1.8%
Age	41.4 (12.3)	41.3 (12.9)	41.4 (11.4) *
Marital status			
Married	47.9%	50.5%	46.7%
Living with partner	21.8%	19.2%	25.4%
Divorced/ separated/ widowed	19.8%	19.0%	17.3%
Never married/ other	10.5%	11.3%	10.6%
Educational status			**
No regular school	24.2%	19.2%	32.7%
Regular school	47.4%	49.9%	52.1%
Some college	6.5%	6.8%	7.8%
No response	21.9%	24.1%	7.4%
Financial security			***
Not financially secure	26.2%	18.0%	34.4%
Financially secure	73.8.%	82.0%	65.6%
Type of employer			
Grower	20.2%	21.3%	18.7%
Contractor	62.0%	61.5%	67.3%

Other	17.8%	17.3%	14.0%
Migrant status			
Not migrant	79.2%	80.1%	78.1%
Migrant	20.7%	19.9%	21.9%
Preferred language of communication			**
English	2.3%	2.8%	2.0%
Spanish	82.5%	85.9%	79.6%
Other	15.2%	11.3%	18.3%
History of work injury			***
Yes	19.6%	14.6%	29.1%
No	80.4%	85.4%	70.9%
Dependence on employer-provided transportation			*
Needs transportation	9.1%	9.7%	5.9%
Has transportation	90.9%	90.3%	94.1%
Health Literacy (scale: -8 to +8)	0.30 (4.5)	0.7 (4.5)***	-1.1 (4.3)
Ethnicity			
Hispanic	97.2%	98.6%	98.4%
Not Hispanic	2.8%	1.4%	1.6%
N	1453	790	501

*p value<0.05, **p-value <0.01, and ***p value <0.001 according to Chi square tests

Table 2.2 presents self-reported healthcare utilization patterns among survey respondents in the UCM FWHS in comparison with the general low-income (income up to 250% of the Federal Poverty Level) working age (18-65 years) Latino population of California as reported in the CHIS survey 2021 results. These groups were further compared based on health insurance coverage, and two sample tests of proportion and Chi-square tests were used to examine whether there were statistically significant differences between these groups.

Overall, 43.4% of the agricultural workers in the UCM FWHS sample had visited the doctor for a routine visit in the last 12 months, compared with 55.5% in the low-income Latino group. Among those with insurance, 54.8% of the workers in the UCM FWHS had a routine doctor visit compared with 60.7% in the low-income Latino group. Among those who did not have insurance, 28.3% of the workers in the UCM FWHS had a routine doctor visit compared with 32.7% in the low-income Latino working-age population. Overall, 35.0% of the agricultural workers in the UCM FWHS sample had visited the dentist in the last 12 months, compared with 55.2% in the low-income Latino working-age population.

Among those with insurance, 45.5% of the workers in the UCM FWHS had a dentist visit compared with 57.5% in the low-income Latino working-age population. Among those who did not have insurance, 22.0% of the workers in the UCM FWHS had a dentist visit compared with 44.9% in the low-income Latino group, according to CHIS.

Overall, 20.9% of the agricultural workers in the UCM FWHS sample had delayed seeking healthcare services in the last 12 months compared with 18.9% in the Latino working-age population. Among those with insurance, 16.3% of the workers in the UCM FWHS delayed seeking care compared with 19.1% in the low-income Latino group. Among those who did not have insurance, 28.8% of the workers in the UCM FWHS delayed seeking care compared with 17.6% in the low-income Latino working-age population. Overall, 14.3% of the agricultural workers in the UCM FWHS sample had delayed seeking prescription drugs in the last 12 months compared with 11.1% among the low-income Latino working-age population in California. Among those with health insurance coverage, there were no statistically significant differences between these groups. Among those who did not have insurance, 21.4% of the workers in the UCM FWHS delayed seeking care compared with 12.0% in the low-income Latino working-age population.

Overall, 76.7% of the agricultural workers in the UCM FWHS sample had a usual place of care, compared with 74.5% in the low-income Latino group. Among those with insurance, 80.0% of the workers in the UCM FWHS had a usual place compared with 80.5% in the low-income Latino group. Among those who did not have insurance, 73.9% of the workers in the UCM FWHS had a usual place of care compared with 48.5% in the low-income Latino working-age population. Overall, 22.0% of the agricultural workers in the UCM FWHS sample had visited the E.R. in the last 12 months, compared with 17.7% in the low-income Latino group. Among those with insurance, 21.6% of the workers in the UCM FWHS had an E.R. visit, compared with 19.5% in the low-income Latino group. Among those who did not have insurance, 22.0% of the workers in the UCM FWHS had an E.R. visit compared with 9.8% in the low-income Latino working-age population.

The type of places where these workers usually went to seek care is presented in Table 2. The most common locations were Community health centers (42.6%), followed by Private medical or doctor's offices (29.6%) and Migrant Health Clinics (14.3%), with only 7.9% choosing to go to the hospital or the E.R. Among the workers with insurance the most common places were the Community health center (38.8%) followed by Private medical or doctor's office (37.9%) and Migrant health clinic (11.1%) with only 7.1% choosing to go to the hospital or the E.R. Among the workers who do not have insurance the most common places were Community health center (49.7%), Private medical or doctor's office (19.9%) and Migrant Health Clinic (15.2%) and with 8.4% choosing to go to the hospital or the E.R.

Table 2.2 Patterns of Routine Healthcare Service Utilization

	Farmworkers Health Study			**California Health Interview Survey (CHIS 2021)**		
	Overall	**With insurance**	**Without insurance**	**Overall**	**With insurance**	**Without insurance**
Doctor visit in the last 12 months	43.4%	54.8%	28.3%###	55.5%***	60.7%**	32.7%
Dental visit in last 12 months	35.0%	45.5%	22.0%###	55.2%***	57.5%***	44.9%***
Delay in seeking care	20.9%	16.3%	28.8%###	18.9%	19.1%*	17.6%***
Delay in seeking prescription drugs	14.3%	9.8%	21.4%###	11.1%***	10.9%	12.0%***
Usual place of care	76.7%	80.0%	73.9%#	74.5%	80.5%	48.5%***
Visited the E.R. in last year	22.0%	21.6%	22.0%	17.7%***	19.5%	9.8%***
N	1426	788	498	5,287,000	4,306,000	981,000
If they have a usual place of care						
Type of place	**Overall**		**With insurance**		**Without insurance**	
Community Health Center	42.6%		38.8%		49.7%	
Private medical/doctor's office	29.6%		37.9%		19.9%	
Traditional healer	0.7%		0.3%		1.6%	
Hospital/ER	7.9%		7.1%		8.4%	
Migrant Health Clinic	14.3%		11.1%		15.2%	

Other	4.9%	4.8%	5.2%
N	1092	629	368

*p value<0.05, **p-value <0.01, and ***p value <0.001 according to the two-sample test of proportions between UCM FWHS and CHIS values, #p value<0.05, ##p-value <0.01, and ###p value <0.001 according to Chi-square tests in the UCM FWHS

The patterns of screening and hospitalization are presented in Table 2.3. Overall, 48.4% of the agricultural workers in the UCM FWHS sample had received a flu shot in the last 12 months, with 51.2% of workers with insurance and 47.8% without health insurance coverage reporting that they received a flu shot in the past year. Overall, 11.4% of the agricultural workers in the UCM FWHS sample had ever received skin cancer screening, with 11.4% of workers with insurance and 11.6% without health insurance coverage reporting that they had ever been screened for skin cancer. Overall, 11.5% of the agricultural workers in the UCM FWHS sample had been hospitalized in the past year, with 11.2% of workers with insurance and 12.5% without health insurance coverage reporting being hospitalized in the past year.

Forty percent of the agricultural workers in the UCM FWHS sample had received blood tests in the past year, with 49.9% of workers with insurance and 27.2% without health insurance coverage reporting having blood tests in the past year. Overall, 14.9% of the agricultural workers in the UCM FWHS sample had used antibiotics without prescription in the past year, with 10.5% of workers with insurance and 23.9% without health insurance coverage reporting such usage.

Table 2.3 Patterns of preventive or emergency healthcare utilization

	Overall	**With insurance**	**Without insurance**
Flu vaccination in the last 12 months	48.8%	51.2%	47.8%
Skin cancer screening	11.4%	11.4%	11.6%
Whether hospitalized in the past year	11.5%	11.2%	12.5%
Blood tests in the last 12 months	40.3%	49.9%	27.2%***
Using antibiotics without a prescription	14.9%	10.5%	23.9%***
N	1416	785	494

*p value<0.05, **p-value <0.01, and ***p value <0.001 according to Chi square tests

The results examining predictors of routine preventative services are shown in Table 2.4. Females had 2.0 times (95%CI: 1.41,2.84) the odds of going to the doctor for a routine visit compared with males. A one unit increase in fear of deportation was associated with a 1.26 (95%CI:1.09,1.47) times increase in the odds of having a routine doctor visit in the last 12 months. Workers with health insurance coverage had 2.91 times (95%CI: 2.05,4.15) the odds of going to the doctor for a routine visit compared with those who do not have coverage. A one unit increase in health literacy was associated with 1.07 times (95%CI:1.02,1.12) increase in the odds of having a routine doctor visit in the last 12 months. Workers who needed an appointment had 1.58 times (95%CI: 1.0,2.5) the odds of going to the doctor for a routine visit compared with those who did not. Workers who do not have a usual place of care had 0.23 times (95%CI: 0.15,0.37) the odds of going to the doctor for a routine visit compared with those who do not.

Females had 2.3 times (95%CI: 1.64,3.33) the odds of having been to the dentist in the past 12 months compared with males. A one unit increase in fear of deportation was associated with a 1.31 (95%CI:1.12,1.53) times increase in the odds of having a dentist visit in the last 12 months. Workers with financial security had 1.75 times (95%CI: 1.12,2.74) the odds of going to the dentist compared with those without. Workers with health insurance coverage had 2.38 times (95%CI: 1.66,3.42) the odds of going to the dentist compared with those who do not have coverage. A one unit increase in health literacy was associated with a 1.06 times (95%CI:1.01,1.11) increase in the odds of having a dentist visit. Being a migrant was associated with 1.64 times (95% CI:1.11,2.43) the odds of having been to the dentist compared with non-migrants. Workers who attended regular school had 0.5 times (95% CI: 0.27,0.90) the odds of having been to the dentist compared with those who attended some college. Workers who did not have a usual place of care had 0.59 times (95%CI: 0.39,0.90) the odds of seeing the dentist than those who do not.

Females had 2.0 times (95%CI: 1.41,2.82) the odds of having had blood tests in the past 12 months compared with males. A one unit increase in age was associated with 1.03 times (95%CI:1.01,1.04) increase in the odds of having blood tests. A one unit increase in fear of deportation was associated with 1.18 (95%CI:1.02,1.37) times increase in the odds of having blood tests. Workers with financial security had 1.56 times (95%CI: 1.02,2.40) the odds of having blood tests compared with those without. Workers with health insurance coverage had 2.35 times (95%CI: 1.66,3.45) the odds of having blood tests compared with those who do not have coverage. A one unit increase in health literacy was associated with 1.07 times (95%CI:1.02,1.12) increase in the odds of having blood tests. Workers who needed an appointment had 1.74 times (95%CI: 1.11,2.71) the odds of having blood tests compared with those without. Workers who do not have a usual place of care had 0.33 times (95%CI: 0.21,0.52) the odds of having blood tests compared with those without.

Table 2.4 Results of Regression analysis examining predictors of routine preventive care services

	Doctor **Odds ratio (95% CI)**	**Dentist** **Odds ratio (95%CI)**	**Blood tests** **Odds ratio (S.E.)**
Gender Male/Other Female	 Ref group 2.0(1.41,2.84)***	 Ref group 2.33(1.64,3.33) ***	 Ref group 2.0(1.41,2.82)***
Age	1.01 (0.99 1.02)	0.99 (0.98,1.01)	1.03(1.01,1.04)***
Fear of deportation	1.26(1.09,1.47)**	1.31(1.12,1.53)**	1.18(1.02,1.37)*
Financial security Not secure Financially secure	 Ref group 1.47 (0.96,2.26)	 Ref group 1.75(1.12,2.74)*	 Ref group 1.56(1.02,2.40)*
Health insurance No insurance Had insurance	 Ref group 2.91(2.1,4.15)***	 Ref group 2.38 (1.66,3.4)***	 Ref group 2.35(1.66,3.5)***
Type of employer Grower Contractor/Other	 Ref group 0.706 (0.46,1.07)	 Ref group 0.95 (0.62,1.47)	 Ref group 0.87 (0.57,1.31)
Health literacy	1.07(1.02,1.12)**	1.06 (1.01,1.11)*	1.07 (1.02,1.12)**
Migrant status Not migrant Migrant	 Ref group 1.19 (0.79,1.77)	 Ref group 1.64 (1.11,2.43)*	 Ref group 1.17 (0.78,1.73)
Educational status Some college Regular school No regular school	 Ref group 0.80 (0.44, 1.45) 0.69 (0.34, 1.38)	 Ref group 0.50 (0.27,0.90)* 0.74 (0.37,1.51)	 Ref group 0.70 (0.39,1.26) 1.09 (0.55,2.17)
Language English Spanish Other	 Ref group 0.53 (0.15,1.90) 0.59 (0.15, 2.26)	 Ref group 0.90 (0.26,3.12) 0.62 (0.17,2.34)	 Ref group 1.71 (0.46,6.26) 1.79 (0.45,7.07)
Need for an appointment. No Yes	 Ref group 1.58 (1.0,2.5)*	 Ref group 1.29 (0.81,2.05)	 Ref group 1.74 (1.11,2.71)*
History of work injury No Yes	 Ref group 0.79 (0.51, 1.22)	 Ref group 0.99 (0.64,1.54)	 Ref group 0.78 (0.50,1.20)
Having a usual place of care Yes No	 Ref group 0.23 (0.2,0.4) ***	 Ref group 0.59 (0.4,0.9)*	 Ref group 0.33(0.2,0.5)***
Marital status Married Not married	 Ref group 1.09 (0.78,1.53)	 Ref group 1.14 (0.81,1.60)	 Ref group 0.89 (0.64,1.25)

Dependence on employer transport Uses employer transportation Has transportation	Ref group 0.62 (0.30,1.25)	Ref group 1.06 (0.52,2.16)	Ref group 1.11 (0.55,2.23)
Constant	0.25 (0.04,1.50)	0.10 (0.02,0.60)*	0.02(0.003,0.15)***

*p value<0.05, **p-value <0.01, and ***p value <0.001

The predictors for utilization of emergency services (E.R. visit or hospitalization in the past 12 months) and having a usual place of care were examined using the Anderson model of healthcare utilization as a theoretical framework. Table 2.5 displays the regression results, which are discussed below. Females had 1.63 times (95%CI: 1.06,2.48) the odds of having an E.R. visit in the past 12 months compared with males. Being a migrant was associated with 2.18 times (95% CI:1.40,3.38) the odds of having been to the E.R. compared with non-migrants. Workers who needed an appointment had 2.41 times (95%CI: 1.48,3.39) the odds of having an E.R. visit compared with those who did not. Workers with a history of work-related injury had 2.66 times (95%CI: 1.66,4.25) the odds of having an E.R. visit compared with those without. Not being married had 0.61 times (95%CI: 0.40,0.91) the odds of having an E.R. visit compared with being married.

Females had 2.04 times (95%CI: 1.20,3.47) the odds of having a hospital stay in the past 12 months compared with males. Workers not dependent on employer-provided transportation had 0.23 times (95%CI: 0.01,0.52) the odds of having a hospital stay compared with those who did. A one unit increase in age was associated with a 1.03 (95%CI:1.01,1.04) times increase in the odds of having a usual place of care. A one unit increase in health literacy was associated with a 1.05 times (95%CI:1.003,1.1) increase in the odds of having a usual place of care. Workers who attended regular school had 0.3 times (95% CI: 0.12,0.80) the odds, and those who did not attend regular school had 0.17 times (95%CI:0.06,0.47) times the odds of having a usual place of care compared with those who attended some college. Workers who need an appointment had 1.87 times (95%CI: 1.09,3.22) the odds of having a usual place of care compared with those who do not have one.

Table 2.5 Results of regression analysis examining predictors of using emergency services

	E.R. visit **Odds ratio (95%CI)**	**Hospital stay** **Odds ratio (95%CI)**	**Having a usual place of care Odds ratio (95%CI)**
Gender Male/Other Female	Ref group 1.63(1.06,2.48)*	Ref group 2.04(1.20,3.47)**	Ref group 1.21 (0.83,1.76)
Age	1.01 (0.98,1.01)	1.01 (0.99,1.03)	1.03(1.01,1.04)**
Fear of deportation	1.12 (0.93,1.35)	1.06 (0.85,1.32)	1.01 (0.86,1.18)

Financial security			
Not secure	Ref group	Ref group	Ref group
Financially secure	0.79 (0.48,1.29)	0.76 (0.42,1.35)	0.96 (0.62,1.49)
Health insurance			
No insurance	Ref group	Ref group	Ref group
Had insurance	1.11 (0.72,1.70)	1.136 (0.67,1.92)	1.17 (0.81,1.70)
Employer type			
Grower	Ref group	Ref group	Ref group
Contractor/Other	1.19 (0.70,2.01)	0.81 (0.44,1.47)	1.18 (0.77,1.82)
Health literacy	1.03 (0.97,1.09)	1.01 (0.94,1.08)	1.05 (1.003,1.1)*
Migrant status			
Not migrant	Ref group	Ref group	Ref group
Migrant	2.18(1.40,3.38)**	1.542 (0.89,2.67)	1.23 (0.79,1.92)
Educational status			
Some college	Ref group	Ref group	Ref group
Regular school	1.24 (0.57,2.69)	1.66 (0.55,4.98)	0.30 (0.12,0.80)*
No regular school	1.44 (0.59,3.33)	2.33 (0.70,7.78)	0.17(0.06,0.47)**
Language			
English	Ref group	Ref group	Ref group
Spanish	0.53 (0.347)	1.23 (0.15,10.2)	0.41 (0.05,3.23)
Other	0.26 (0.188)	0.10 (0.11.9.18)	0.20 (0.02,1.67)
Need for an appointment			
No	Ref group	Ref group	Ref group
Yes	2.41(1.48,3.39)***	1.78 (0.99,3.18)	1.87 (1.09,3.22)*
History of work injury			
No	Ref group	Ref group	Ref group
Yes	2.66(1.66,4.25)***	1.76 (0.99,3.13)	1.63 (0.99,2.68)
Having a usual place of care			
Yes	Ref group	Ref group	
No	1.24 (0.76,2.02)	0.68 (0.35,1.32)	
Marital status			
Married	Ref group	Ref group	Ref group
Not married	0.61 (0.40,0.91)*	0.82 (0.50,1.34)	0.96 (0.67,1.39)
Dependence on employer transport			
Uses employer transportation	Ref group	Ref group	Ref group
Has transportation	0.52 (0.23,1.13)	0.23 (0.01,0.52)***	0.97 (0.45,2.09)
Constant	0.19 (0.03,1.38)	0.10 (0.01,1.72)	6.93 (0.54,89.7)

*p value<0.05, **p-value <0.01, and ***p value <0.001

The type of health insurance coverage among workers is shown in Table 2.6. Approximately 46% of the survey respondents did not have health insurance coverage at some time in the last 12 months. Among workers without health insurance coverage, 46.7% were offered health insurance through an employer plan. Ineligibility due to work or immigration status and high cost were the main barriers to obtaining coverage among uninsured workers. Approximately 37.3% of workers were offered health insurance coverage through their employer plan, of whom 39.3% took up the employer-offered health insurance coverage. Approximately 46.9% of workers had coverage through MediCal.

Table 2.6 Types of Health Insurance Coverage

Characteristic	**Percentage**
Health insurance coverage in the last 12 months Yes No	 54.4% 45.6%
N	1291
If NO HEALTH INSURANCE	
Does the employer offer health insurance? Yes No	 46.7% 53.3%
N	604
Barriers to health insurance • Not eligible (work/immigration status) • Too expensive • Other	 44.6% 30.2% 25.2%
N	271
IF HEALTH INSURANCE	
Health insurance through MediCal	46.9%
N	1170
Health insurance offered through the employer	37.3%
N	1075
Employer coverage (among those who were offered health insurance through an employer plan)	39.3%
N	407

The predictors for having health insurance coverage are presented in Table 2.7. A one-unit increase in age was associated with a 1.02 (95% CI:1.005, 1.03) time increase in the odds of having insurance . Workers with financial security had 1.81 (95% CI:1.34,2.45) times the odds of having health insurance coverage than those without. A one-unit increase in health literacy was associated with a 1.1 (95% CI:1.06, 1.13) times increase in the odds of having health insurance coverage. Workers with a history of work-related injury had 0.44 (95% CI:0.32,0.61) times the odds of having health insurance coverage compared with uninsured. Moderation was tested through interaction terms to examine the moderating effect of migrant status on health literacy, financial security, and type of employer, and it was found to be statistically non-significant.

Table 2.7 Predictors of health insurance coverage (with and without interaction terms)

Health insurance	**Odds ratio (95% CI)**	**Odds ratio (95% CI) (Interaction term 1)**	**Odds ratio (95% CI) (Interaction term 2)**	**Odds ratio (95% CI) (Interaction term 3)**
Gender Male/Other Female	 Ref group 0.99 (0.75, 1.29)	 Ref group 0.98 (0.75, 1.29)	 Ref group 0.99 (0.75, 1.29)	 Ref group 0.99 (0.75, 1.29)
Age	1.02 (1.005,1.03)**	1.02 (1.005,1.03)**	1.02 (1.005,1.03)**	1.02 (1.005,1.03)**
Financial security Not secure Secure	 Ref group 1.81 (1.34, 2.5)***	 Ref group 1.82 (1.35, 2.46)***	 Ref group 1.85 (1.32, 2.59)***	 Ref group 1.82 (1.35, 2.5)***
Employer Grower Contractor/ Other	 Ref group 0.88 (0.63,1.22)	 Ref group 0.88 (0.63,1.22)	 Ref group 0.88 (0.63, 1.22)	 Ref group 0.83 (0.57,1.19)
Health literacy	1.1 (1.06,1.13)***	1.09 (1.03,1.15)**	1.09 (1.06, 1.1)***	1.09 (1.05,1.1)***
Migrant status Not migrant migrant	 Ref group 1.08 (0.78,1.48)	 Ref group 1.12 (0.75,1.68)	 Ref group 1.14 (0.62, 2.09)	 Ref group 0.84 (0.40,1.79)
History of work-related injury No Yes	 Ref group 0.44 (0.32,0.6)***	 Ref group 0.44 (0.32,0.61)***	 Ref group 0.44 (0.32,0.61)***	 Ref group 0.44 (0.32,0.6)***
Marital status Married Not married	 Ref group 1.07 (0.82,1.40)	 Ref group 1.07 (0.82,1.40)	 Ref group 1.07 (0.82,1.40)	 Ref group 1.07 (0.82,1.40)
Migrant##health literacy		0.89 (0.46, 1.08)		

Migrant## financial security			0.92 (0.45, 1.88)	
Migrant## employer				1.34 (0.59, 3.08)
Constant	0.54 (0.27,1.06)	0.53 (0.26, 1.08)	0.53 (0.27, 1.06)	0.57 (0.28, 1.14)

*p value<0.05, **p-value <0.01, and ***p value <0.001

The demographic characteristics of the surveyed agricultural workers who answered questions related to information seeking when exposed to symptoms of various occupational illnesses are presented in Table 2.8. The study sample had 56.3% female and 43.3% male farm workers. Among those insured, there were 56.5% females and 43.3% males, while among those who were not insured, there were 56.6% females and 43.2% males. The average self-reported age of the surveyed agricultural workers was 41.6 years (SD: 12.2) overall, 41.6 years (SD:12.8) in the insured, and 41.4 years (SD: 11.5) in the uninsured group.

Approximately 47% of participants were married, with 49.1% being married in the insured group, 45.7% being married, and 17.3% being divorced or separated in the uninsured group. Nearly 58.3% reported having attended regular school, with only 7.2% having attended some college in the overall group, 63.0% reported having attended regular school and 7.5% having attended some college in the insured group, 53.9% reported having attended regular school, and 7.3% having attended some college in the uninsured group. Approximately 71.1% considered themselves financially secure enough to cover expenses of $400 if faced with an emergency, with 78.5% in the insured and 63.3% in the uninsured group reporting financial security.

Approximately 64.3% were employed by contractors overall, with 63.0% in the insured group and 66.9% of the uninsured group reporting such employment and only 22.0% were self-identified migrant workers, with 23.1% being insured and 21.2% uninsured. Approximately 7.8% showed dependence on employer-provided transportation, with 8.1% in the insured and 5.4% in the uninsured group reporting such reliance. Nearly 98.2% were of Latino or Hispanic ethnicity overall, with 98.5% insured and 98.2% uninsured. Approximately 82.2% reported Spanish as their preferred language of communication overall, with 85.1% in the insured and 79.7% in the uninsured group reporting such preference. Nearly 20.9% of workers reported having a history of work-related injury in the past two years, with 14.4% in the insured group and 29.8% of the workers in the uninsured group reporting such history. The average health literacy in the sample was -0.4 (SD:4.4), with 0.4 (SD: 4.5) and -1.3 (SD:4.3) calculated based on the formula described earlier.

Table 2.8 Demographic characteristics of UCM FWHS participants (occupational health scenarios)

Characteristics	Overall	With insurance	Without insurance
Gender			
Female	56.3%	56.5%	56.6%
Male	43.3%	43.3%	43.2%
Other	0.4%	0.2%	0.2%
Age	41.6 (12.2)	41.6 (12.8)	41.4 (11.5)
Marital status			
Married	47.3%	49.1%	45.7%
Living with partner	22.9%	21.1%	25.4%
Divorced/Separated/widowed/other	19.6%	19.5%	18.5%
Never married	10.2%	10.3%	10.4%
Educational status			**
No regular school	29.5%	24.0%	33.8%
Regular school	58.3%	63.0%	53.9%
Some college	7.2%	7.5%	7.3%
No response	5.0%	5.5%	5.1%
Financial security			***
Not financially secure	28.9%	21.5%	36.7%
Financially secure	71.1%	78.5%	63.3%
Type of employer			
Grower	20.7%	21.9%	19.4%
Contractor	64.3%	63.0%	66.9%
Other	15.0%	15.1%	13.7%
Migrant status			
Not migrant	78.1%	76.9%	78.8%
Migrant	21.9%	23.1%	21.2%
Preferred language of communication			*
English	2.1%	2.4%	2.0%
Spanish	82.2%	85.1%	79.7%
Other	15.7%	12.5%	18.3%
History of work injury			***
Yes	20.9%	14.4%	29.8%
No	79.1%	85.6%	70.2%

Dependence on employer-provided transportation			
Needs transportation	7.8%	8.1%	5.4%
Has transportation	92.2%	91.9%	94.6%
Health Literacy (scale between -8 to +8)	-0.4 (4.4)	0.4 (4.5)	-1.3 (4.3) ***
Ethnicity			
Hispanic	98.2%	98.5%	98.2%
Not Hispanic	1.8%	1.5%	1.8%
N	1103	600	453

*p value<0.05, **p-value <0.01, and ***p value <0.001 according to Chi square tests

The information and care-seeking patterns among agricultural workers when exposed to symptoms of different occupational illnesses are presented in Table 2.9 and discussed below. The survey respondents were presented with three hypothetical scenarios where they were asked how they would respond if they had symptoms typically associated with heat-related illness, Valley Fever, and pesticide-related illness. These patterns have further been examined by splitting them into categories based on the health insurance status of the workers.

The use of online sources was seen in 22.5% (HRI scenario), 26.7% (Valley Fever scenario), and 24.5% (PRI scenario), but the usage was higher among workers with health insurance coverage compared with those without (HRI: 24.3% and 21.5%, VF:28.3% and 24.9%, PRI:26.2% and 23.5%). Consulting with family and friends was seen in 47.1% (HRI scenario), 53.1% (Valley Fever scenario), and 46.0% (PRI scenario), but such consultation was lower among workers with health insurance coverage compared with those without coverage (HRI: 44.0% and 54.3%, VF:52.2% and 56.8%, PRI:41.5% and 53.8%). Waiting to see if symptoms disappear was seen in 50.8% (HRI scenario), 60.1% (Valley Fever scenario), and 51.5% (PRI scenario), but the levels were lower among workers with health insurance coverage compared with those without coverage (HRI: 47.8% and 57.7%, VF:59.3% and 62.8%, PRI:48.2% and 58.6%).

Consulting with community health workers was seen in 25.1% (HRI scenario), 27.5% (Valley Fever scenario), and 27.3% (PRI scenario), but such consultation was higher among workers with health insurance coverage compared with those without coverage (HRI: 26.7% and 24.2%, VF:31.7% and 23.7%, PRI:29.8% and 26.7%). Consulting with the union was seen in 7.9% (HRI scenario), 7.5% (Valley Fever scenario), and 8.5% (PRI scenario), but such consultation was variable among workers with health insurance coverage compared with those without coverage (HRI:7.9% and 8.9%, VF:8.7% and 6.8%, PRI:9.2% and 8.3%). Consulting with the public health department was seen in 47.8% (HRI scenario), 50.6% (Valley Fever scenario), and 48.7% (PRI scenario), but such consultation was higher among workers with health insurance coverage compared with those without coverage (HRI: 53.5% and 43.7%, VF:58.2% and 43.3%, PRI:56.3% and 42.1%).

Choosing to consume at-home medication was seen in 50.9% (HRI scenario), 63.0% (Valley Fever scenario), and 51.8% (PRI scenario), but such choices were lower among workers with health insurance coverage compared with those without coverage (HRI: 49.8% and 56.1%, VF:62.8% and 63.8%, PRI:49.1% and 59.4%). Choosing to consume over-the-counter medication was seen in 51.6% (HRI scenario), 60.4% (Valley Fever scenario), and 52.2% (PRI scenario), but such consultation was lower among workers with health insurance coverage compared with those without coverage (HRI: 51.9% and 54.1%, VF:60.6% and 62.4%, PRI:50.4% and 59.1%). Consulting with the family doctor was seen in 39.6% (HRI scenario), 38.8% (Valley Fever scenario), and 40.0% (PRI scenario), but such consultation was higher among workers with health insurance coverage compared with those without coverage (HRI: 48.7% and 32.2%, VF:46.7% and 30.9%, PRI:50.3% and 31.1%).

Fewer than 10% of workers chose to use traditional medicine in all three scenarios, but such consultation was lower among workers with health insurance coverage compared with those without coverage (HRI:4.9% and 9.8%, VF:8.3% and 11.8%, PRI:5.6% and 11.5%). Consulting with a health clinic was seen in 54.4% (HRI scenario), 58.2% (Valley Fever scenario), and 48.4% (PRI scenario), but such consultation was higher among workers with health insurance coverage compared with those without coverage (HRI: 60.7% and 49.8%, VF:67.6% and 48.6%, PRI:54.1% and 44.6%). Going to the E.R. was seen in 55.3% (HRI scenario), 41.9% (Valley Fever scenario), and 50.8% (PRI scenario), but such consultation was higher among workers with health insurance coverage compared with those without coverage (HRI:62.0% and 48.6%, VF:47.6% and 37.9%, PRI:58.3% and 44.0%).

Table 2.9. Information-seeking behavior in different occupational health scenarios

	Heat-Related Illness scenario			**Valley Fever scenario**			**Pesticide Related Illness scenario**		
	Total	Insured	Not insured	Total	Insured	Not insured	Total	Insured	Not insured
Go online	22.5%	24.3%	21.5%	26.7%	28.3%	24.9%	24.5%	26.2%	23.5%
Consult with family or friends	47.1%	44.0%**	54.3%	53.1%	52.2%	56.8%	46.0%	41.5%**	53.8%
Wait till symptoms go away	50.8%	47.8%**	57.7%	60.1%	59.3%	62.8%	51.5%	48.2%**	58.6%
Consult with Promotora	25.1%	26.7%	24.2%	27.5%	31.7%**	23.7%	27.3%	29.8%	26.7%

Go to union	7.9%	7.9%	8.9%	7.5%	8.7%	6.8%	8.5%	9.2%	8.3%
Public Health Dept.	47.8%	53.5%**	43.7%	50.6%	58.2%***	43.3%	48.7%	56.3%***	42.1%
Take at-home medicine	50.9%	49.8%	56.1%	63.0%	62.8%	63.8%	51.8%	49.1%**	59.4%
Get OTC medicine	51.6%	51.9%	55.1%	60.4%	60.6%	62.4%	52.2%	50.4%**	59.1%
Go to the Family Doctor	39.6%	48.7%***	32.2%	38.8%	46.7%***	30.9%	40.0%	50.3%***	31.1%
Go to receive traditional medicine	6.8%	4.9%**	9.8%	9.7%	8.3%	11.8%	7.9%	5.6%**	11.5%
Go to a health clinic	54.4%	60.7%**	49.8%	58.2%	67.6%***	48.6%	48.4%	54.1%**	44.6%
Go to ER	55.3%	62.0%***	48.6%	41.9%	47.6%**	37.9%	50.8%	58.3%***	44.0%
N	1077	589	438	1103	600	453	1090	595	446

*p value<0.05, **p-value <0.01, and ***p value <0.001 according to Chi square tests

The PCA technique was used to classify the options for information seeking for the scenario that presents agricultural workers with symptoms resembling the typical presentation of heat-related illness (hot, dry skin, fever, fast heartbeat, exhaustion, nausea, and vomiting), and the results are presented in Table 2.10. Three components were selected based on the Kaiser criterion (eigen values>1), scree plot findings, and explained variance of at least 60%[252,254,255] Subsequently, three categories were created by grouping the options. The self-management category includes asking friends, waiting for symptoms to disappear, use of over the counter or at-home medications. The healthcare utilization category includes consulting with the family doctor, health clinic, public health department, and the use of the Emergency Room. The community management category includes consulting with community health workers or Promotoras or seeking guidance from union members. The use of traditional medicine was selected by very few respondents and removed from the model. The use of online sources did not fit into any of the three categories at the criteria of factor loading> 0.3, did not add to the explained variance, and was excluded from the model.[253–255]

The PCA technique was then used to classify the options for information seeking for the scenario that presents agricultural workers with symptoms resembling the typical presentation of Valley fever (fever, shortness of breath, cough, loss of appetite, muscle aches, fatigue, and loss of sleep) and the results are presented in Table 2.10. Three components were selected based on the Kaiser criterion (eigen values>1), scree plot findings, and explained at least 60% variance.[252,254,255]

Subsequently, three categories were created by grouping the options. The self-management category includes the use of at-home or over-the-counter medications, consulting friends, and waiting for the symptoms to disappear.

The healthcare utilization category includes consulting with the family doctor using the emergency room, health clinic, and public health department. The community management category includes consulting with union members, community health workers, or Promotoras. The use of traditional medicine was selected by very few respondents and removed from the model. The use of online sources did not fit into any of the three categories at the criteria of factor loading> 0.3, did not add to the explained variance, and was excluded from the model.[253–255]

The PCA technique was also used to classify the options for information seeking for the scenario that presents workers with symptoms resembling the typical presentation of Pesticide-Related-Illness (fever, vomiting, muscle twitching, slow heart rate, small pupils, incontinence, weakness, and disorientation while working in the fields), and the results are presented in Table 10. Three components were selected based on the Kaiser criterion (eigen values>1), scree plot findings, and explained variance of at least 60%.[252,254,255] Subsequently, three categories were created by grouping the options. The self-management category includes waiting for the symptoms to disappear, consulting friends, and the use of over-the-counter and at-home medications.

The healthcare utilization category includes consulting with the family doctor, the health clinic using the emergency room, and the public health department. The community management category includes consulting with union members and using traditional medicine. The use of Promotoras was selected by a few respondents and removed from the model. The use of online sources did not fit into any of the three categories at the criteria of factor loading> 0.3, did not add to the explained variance, and was excluded from the model.[253–255] The predictors of using online sources for guidance when faced with symptoms of PRI have been examined in Table 2.16.

Table 2.10 Results of PCA analysis

HRI Scenario				**Valley Fever**			**PRI scenario**		
Options	Self-care	Health usage	Peer group	Self-care	Health usage	Peer group	Self-care	Health usage	Peer group
Asking friends	0.3941			0.4181		0.3220	0.5137		
Waiting	0.4930			0.5068			0.4568		
Use of Promotoras*			0.6471			0.5722			0.8367
Consult with union			0.6879			0.7073			0.5207
Use of Public health		0.4770			0.4888			0.4871	
Use of OTC medication	0.5490			0.5392			0.5084		
Use of prescription medication	0.5263			0.5199			0.4909		
Family doctor		0.4718			0.4817			0.4843	
Use of clinic		0.5308			0.5589			0.4857	
Use of ER		0.4645			0.4022			0.4513	
Variance explained	25.7%	23.4%	15.8%	23.5%	22.1%	14.4%	32.2%	18.2%	10.1%

*traditional medicine in PRI scenario

The predictors for selecting options in each category under these three scenarios were examined through linear regressions. The results examining these categories for the Heat-related Illness Scenario are presented in Table 2.11 below. A one unit increase in fear of deportation was associated with a 0.17 unit (S.E. 0.05) increase in the likelihood of using self-management-type resources. Being financially secure was associated with a 0.32 unit (S.E.:0.15) increase in the likelihood of using self-management-type resources compared with not being financially secure. A one unit increase in health literacy was associated with a 0.07 unit (S.E. 0.01) decrease in the likelihood of using self-management-type resources. Attending regular school was associated with a 0.54 unit (S.E.:0.22) increase in the likelihood of using self-management-type resources compared with attending college. Using Spanish as a preferred language of communication was associated with a 0.9 unit (S.E.:0.45) decrease in the likelihood of using self-management-type resources compared with those using English.

Needing an appointment was associated with a 0.51 unit (S.E.:0.16) increase in the likelihood of using self-management-type resources compared with those who did not need one. Having a history of work-related injury was associated with a 0.32 unit (S.E.:0.15) increase in the likelihood of using self-management-type resources compared with those who did not have such a history. A one unit increase in fear of deportation was associated with a 0.28 unit (S.E. 0.01) increase in the likelihood of using healthcare resources. Being financially secure was associated with a 0.58 unit (S.E.:0.14) increase in the likelihood of using healthcare resources compared with not being financially secure. Health insurance coverage was associated with a 0.47 unit (S.E.:0.12) increase in the likelihood of using healthcare resources compared with those who did not have health insurance. Not having a usual place of care was associated with a 0.32 unit (S.E.:0.13) decrease in the likelihood of using healthcare resources compared with having a usual place of care. A one unit increase in fear of deportation was associated with a 0.04 unit (S.E. 0.02) increase in the likelihood of using community-management-type resources.

Table 2.11 Results of Regression analysis (HRI scenario)

HRI (Self-management)	**Coefficient (S.E.)**	**HRI (Use of healthcare services)**	**Coefficient (S.E.)**	**HRI (Use of community resources)**	**Coefficient (S.E.)**
Gender/Female	0.082 (0.123)	Gender/Female	0.110 (0.115)	Gender/Female	-0.004(0.05)
Age	-0.006 (0.005)	Age	0.001 (0.005)	Age	0.0005 (0.002)
Fear of deportation	0.171 (0.053)**	Fear of deportation	0.280 (0.050)***	Fear of deportation	0.044 (0.022)*
Financial security/ Secure	0.323 (0.152)*	Financial security/Secure	0.583 (0.142)***	Financial security/Secure	0.107 (0.061)
Insurance status/ had insurance	-0.106 (0.126)	Insurance status/ had insurance	0.471 (0.118)***	Insurance status/had insurance	0.022 (0.051)

Employer/contractor or other	0.214 (0.149)	Employer/ contractor or other	0.067 (0.139)	Employer/ contractor or other	0.066 (0.060)
Health literacy	-0.075 (0.016)***	Health literacy	-0.006 (0.015)	Health literacy	-0.0006 (0.007)
Migrant status/ migrant	-0.201 (0.142)	Migrant status/ migrant	-0.020 (0.134)	Migrant status/migrant	0.003 (0.057)
Educational status Regular school No regular school	 0.547 (0.22)* 0.217(0.26)	Educational status Regular school No regular school	 0.307 (0.209) 0.256 (0.242)	Educational status Regular school No regular school	 0.097 (0.09) 0.0782 (0.11)
Language Spanish Other	 -0.91 (0.46)* -0.66(0.49)	Language Spanish Other	 -0.358 (0.42) -0.485 (0.45)	Language Spanish Other	 -0.060 (0.19) -0.087 (0.20)
Need for appointment/ Yes	0.505 (0.158)**	Need for appointment/ Yes	0.199 (0.149)	Need for appointment/ Yes	0.143 (0.064)
History of work-related injury/ Yes	0.320 (0.150)*	History of work-related injury/ Yes	-0.246 (0.141)	History of work-related injury/ Yes	-0.097 (0.060)
Having a usual place of care/ No	0.159 (0.143)	Having a usual place of care/ No	-0.318 (0.134)*	Having a usual place of care/ No	-0.026 (0.057)
Marital status/ Not married	-0.062 (0.120)	Marital status/ Not married	-0.159 (0.112)	Marital status/ Not married	0.005 (0.048)
Dependence of employer-provided transportation/ Yes	-0.439 (0.236)	Dependence on employer-provided transportation/ Yes	-0.219 (0.219)	Dependence on employer-provided transportation/ Yes	-0.016 (0.094)
Constant	1.479 (0.605)*	Constant	0.298 (0.563)	Constant	-0.053 (0.244)

*p value<0.05, **p-value <0.01, and ***p value <0.001

Table 2.12 presents the linear regression analysis results for the predictors of utilization of these categories in the Valley Fever scenario. A one unit increase in age was associated with a 0.017 unit (S.E. 0.01) decrease in the likelihood of using self-management-type resources when controlling for other covariates. A one unit increase in fear of deportation was associated with a 0.19 unit (S.E. 0.05) increase in the likelihood of using self-management-type resources. A one unit increase in health literacy was associated

with a 0.06 unit (S.E. 0.02) decrease in the likelihood of using self-management-type resources. Having attended regular school was associated with a 0.51 unit (S.E.:0.22) increase in the likelihood of using self-management-type resources compared with having attended college. Not having a usual place of care was associated with a 0.31 unit (S.E.:0.13) increase in the likelihood of using self-management-type resources compared with those with a usual place of care.

Having a history of work-related injury was associated with a 0.37 unit (S.E.:0.15) increase in the likelihood of using self-management-type resources compared with those who did not have such a history. Having dependence on employer-provided transportation was associated with a 0.52 unit (S.E.:0.22) increase in the likelihood of using self-management-type resources compared with those who did not have such a history. Being a female was associated with a 0.25 unit (S.E.:0.11) increase in the likelihood of using healthcare services compared with being male. A one unit increase in fear of deportation was associated with a 0.24 (S.E. 0.05) increase in the likelihood of using healthcare resources. Being financially secure was associated with a 0.41 unit (S.E.:0.13) increase in the likelihood of using healthcare services compared with not being secure.

Health insurance coverage was associated with a 0.55 unit (S.E.:0.11) increase in the likelihood of using healthcare resources compared with those who did not have health insurance. Not having a usual place of care was associated with a 0.62 unit (S.E.:0.12) decrease in the likelihood of using healthcare resources compared with having a usual place of care. A one unit increase in fear of deportation was associated with a 0.06 unit (S.E. 0.02) increase in the likelihood of using community-management-type resources. Health insurance coverage was associated with a 0.13 unit (S.E.:0.05) increase in the likelihood of using community-based resources compared with those who did not have health insurance. A one unit increase in health literacy was associated with a 0.01 unit (S.E. 0.01) decrease in the likelihood of using community-management-type resources.

Table 2.12 Results of regression analysis (Valley Fever scenario)

V.F. (Self-management)	**Coefficient (S.E.)**	**V.F. (Use of healthcare services)**	**Coefficient (S.E.)**	**V.F. (Use of community resources)**	**Coefficient (S.E.)**
Gender/ Female	0.062 (0.116)	Gender/ Female	0.252 (0.107)*	Gender/ Female	0.022 (0.047)
Age	-0.012 (0.005)*	Age	0.0006 (0.005)	Age	-0.001 (0.002)
Fear of deportation	0.185 (0.051)***	Fear of deportation	0.244 (0.046)***	Fear of deportation	0.062 (0.020)**
Financial security/ secure	0.260 (0.139)	Financial security/ secure	0.405 (0.128)**	Financial security/ secure	0.105 (0.056)
Insurance status/ had insurance	0.104 (0.117)	Insurance status/ had insurance	0.547 (0.108)***	Insurance status/ had insurance	0.134 (0.047)**

Employer/ Contractor/Other	0.224 (0.138)	Employer/ Contractor/Other	0.219 (0.127)	Employer/ Contractor/Other	0.072 (0.056)
Health literacy	-0.063 (0.015)***	Health literacy	-0.011 (0.014)	Health literacy	-0.013 (0.006)*
Migrant status/ migrant	-0.256 (0.134)	Migrant status/ migrant	0.137 (0.124)	Migrant status/ migrant	0.014 (0.054)
Educational status Regular school No regular school	 0.51(0.23)* 0.21(0.26)	Educational status Regular school No regular school	 -0.01 (0.21) 0.087 (0.24)	Educational status Regular school No regular school	 0.001 (0.09) -0.01 (0.10)
Language Spanish Other	 -0.29 (0.437) -0.171 (0.46)	Language Spanish Other	 -0.30 (0.398) -0.4 (0.424)	Language Spanish Other	 0.09(0.18) 0.07 (0.19)
Need for appointment/ Yes	0.243 (0.151)	Need for appointment/ Yes	0.132 (0.138)	Need for appointment/ Yes	0.076 (0.062)
History of work-related injury/ Yes	0.369 (0.145)*	History of work-related injury/ Yes	-0.221 (0.133)	History of work-related injury/ Yes	-0.034 (0.059)
Having a usual place of care/ No	0.316 (0.133)*	Having a usual place of care/ No	-0.616 (0.122)***	Having a usual place of care/ No	-0.085 (0.054)
Marital status/ Not married	-0.118 (0.113)	Marital status/ Not married	-0.114 (0.104)	Marital status/ Not married	-0.004 (0.046)
Dependence on employer-provided transportation/ Yes	-0.519 (0.218)*	Dependence on employer-provided transportation/ Yes	-0.163 (0.200)	Dependence on employer-provided transportation/ Yes	-0.015 (0.088)
Constant	1.363 (0.577)*	Constant	0.436 (0.527)	Constant	-0.158 (0.234)

*p value<0.05, **p-value <0.01, and ***p value <0.001

Table 2.13 below presents the results of the linear regression analysis. A one unit increase in fear of deportation was associated with a 0.17 unit (S.E. 0.05) increase in the likelihood of using self-management-type resources when controlling for other covariates. Being financially secure was associated with a 0.31 unit (S.E.:0.15) increase in the likelihood of using self-management-type resources compared with not being secure. A one unit increase in health literacy was associated with a 0.07 unit (S.E. 0.02) decrease in the likelihood of using self-management-type resources. Having attended regular school was associated with a 0.52 unit (S.E.:0.23) increase in the likelihood of using self-management-type resources compared with having attended college.

Having a history of work-related injury was associated with a 0.33 unit (S.E.:0.15) increase in the likelihood of using self-management-type resources compared with those who did not have such a history. A one unit increase in fear of deportation was associated with a 0.28 (S.E. 0.05) increase in the likelihood of using healthcare resources. Being financially secure was associated with a 0.50 unit (S.E.:0.13) increase in the likelihood of using healthcare resources compared with not being secure. Health insurance coverage was associated with a 0.52 unit (S.E.:0.11) increase in the likelihood of using healthcare resources compared with those who did not have health insurance. Not having a usual place of care was associated with a 0.31 unit (S.E.:0.13) decrease in the likelihood of using healthcare resources compared with having a usual place of care.

Table 2.13 Results of regression analysis (PRI scenario)

PRI (Self-management)	**Coefficient (S.E.)**	**PRI (Use of healthcare service)**	**Coefficient (S.E.)**	**PRI (Use of community resources)**	**Coefficient (S.E.)**
Gender/ Female	0.143 (0.120)	Gender/ Female	0.178 (0.110)	Gender/ Female	-0.034 (0.035)
Age	-0.008 (0.005)	Age	-0.0004 (0.005)	Age	-0.0002 (0.002)
Fear of deportation	0.169 (0.052)**	Fear of deportation	0.278 (0.048)***	Fear of deportation	0.022 (0.0154)
Financial security/ secure	0.314 (0.146)*	Financial security/ secure	0.496 (0.133)***	Financial security/ secure	0.062 (0.043)
Insurance status/ had insurance	-0.189 (0.122)	Insurance status/ had insurance	0.516 (0.112)***	Insurance status/ had insurance	-0.019 (0.036)
Employer/ contractor or other	0.231 (0.144)	Employer/ contractor or other	0.080 (0.132)	Employer/contractor or other	0.038 (0.043)
Health literacy	-0.072 (0.015)***	Health literacy	-0.018 (0.014)	Health literacy	-0.009 (0.005)
Migrant status/ Migrant	-0.163 (0.138)	Migrant status Migrant	0.052 (0.127)	Migrant status/ Migrant	-0.025 (0.041)
Educational status		Educational status		Educational status	
Regular school	0.52 (0.23)*	Regular school	0.13 (0.205)	Regular school	0.017 (0.07)
No regular school	0.135 (0.26)	No regular school	0.168 (0.237)	No regular school	0.024 (0.08)
Language		Language		Language	
Spanish	-0.54 (0.45)	Spanish	-0.33 (0.43)	Spanish	-0.26 (0.13)
Other	-0.33 (0.48)	Other	-0.59 (0.45)	Other	-0.20 (0.14)

Need for appointment/ Yes	0.284 (0.155)	Need for appointment/ Yes	0.032 (0.143)	Need for appointment/ Yes	0.0345 (0.046)
History of work-related injury/ Yes	0.330 (0.147)*	History of work-related injury/ Yes	-0.206 (0.136)	History of work-related injury/ Yes	0.031 (0.043)
Having a usual place of care/ No	0.229 (0.140)	Having a usual place of care/ No	-0.305 (0.127)*	Having a usual place of care/ No	0.040 (0.041)
Marital status/ not married	-0.052 (0.118)	Marital status/ not married	-0.163 (0.108)	Marital status/ not married	-0.020 (0.034)
Dependence on employer-provided transportation/ Yes	-0.605 (0.225)**	Dependence on employer-provided transportation/ Yes	-0.126 (0.211)	Dependence on employer-provided transportation/ Yes	0.057 (0.067)
Constant	1.291 (0.592)*	Constant	0.377 (0.554)	Constant	0.245 (0.174)

*p value<0.05, **p-value <0.01, and ***p value <0.001

The information and care-seeking patterns among the workers by categories are presented below. As shown in Table 2.14, In the HRI scenario, 74.2% of workers preferred using one or more resources in healthcare management, 68.4% in self-management, and 25.26% in the community management category. Among those with insurance,81.5% preferred using one or more sources in healthcare management, 65.9% in the self-management category, and 25.8% in the community management category. Among those without insurance,66.9% preferred using one or more sources in healthcare management, 65.9% in self-management, and 24.2% in the community management category.

In the Valley fever scenario, 79.0% of workers preferred using one or more resources in self-management, 71.8% in healthcare management, and 28.6% in the community management category. Among those with insurance,79.2% preferred using one or more sources in healthcare management, 79.0% in the self-management category, and 32.5% in the community management category, while among those without insurance,64.7% preferred using one or more sources in healthcare management, 80.2% in self-management, and 24.3% in the community management category.

In the PRI scenario, 72.4% of workers preferred using one or more resources in healthcare management, 68.6% in self-management, and 14.3% in the community management category. Among those with insurance,80.2% preferred using one or more sources in healthcare management, 66.9% in the self-management category, and 12.3% in the community management category, while among those without insurance,65.5% preferred using one or more sources in healthcare management, 72.0% in self-management, and 16.6% in the community management category.

The percentage of workers choosing none of these options was 7.7%, 6.5%, and 8.3% in the HRI, Valley Fever, and Pesticide-related illness scenarios. Among those with insurance, the percentage of workers choosing none was 6.5%, 3.8%, and 5.7% in the HRI,

Valley Fever, and Pesticide-related illness scenarios, while among those without insurance, the percentage of workers choosing none of these options was 7.5%, 7.3%, and 9.2% in the HRI, Valley Fever, and Pesticide-related illness scenarios.

Table 2.14. Information and care-seeking options by categories

		Heat-Related Illness scenario			**Valley Fever scenario**			**Pesticide Related Illness scenario**		
		Overall	Insured	Not insured	Overall	Insured	Not insured	Overall	Insured	Not insured
Self-care	One or more	68.4%	65.9%	73.5% **	79.0%	79.0%	80.2%	68.6%	66.9%	72.0% *
	None	31.6%	34.1%	26.5%	21.0%	21.0%	19.8%	31.4%	33.1%	28.0%
Care use	One or more	74.2%	81.5%	66.9% ***	71.8%	79.2%	64.7% ***	72.4%	80.2%	65.5% ***
	None	25.8%	18.5%	33.1%	28.2%	20.8%	35.3%	27.6%	19.8%	34.5%
Community use	One or more	25.3%	25.8%	24.2%	28.6%	32.5%	24.3% **	14.3%	12.3%	16.6% *
	None	74.7%	74.2%	75.8%	71.4%	67.5%	75.7%	85.7%	87.7%	83.4%
None of the categories		7.7%	6.5%	7.5%	6.5%	3.8%*	7.3%	8.3%	5.7%	9.2%*
N#		1077	589	438	1103	600	453	1090	595	446

*p value<0.05, **p-value <0.01, and ***p value <0.001 according to Chi-square tests

#There are a small number of missing values (<5.0%) for the insurance variable among survey respondents who answered questions related to their care-seeking patterns

The agricultural workers were asked about their interpretation of the symptoms in each occupational health scenario; their answers are displayed in Table 2.15 below. In the Heat-Related Illness Scenario, 30.0% of workers attributed their symptoms to heat, with 28.0% of workers stating that they did not know the cause, 12.0% stated other, 7.0%

attributed it to respiratory illness, 3.6% to cardiovascular disease and 3.5% to fatigue. In the Valley Fever Scenario, 46.7% of workers attributed their symptoms to respiratory conditions, with 27.0% of workers stating that they did not know the cause, 8.0% indicated fatigue, 3.4% attributed it to mental illness, 2.7% to other and 0.8% to Valley fever. In the Pesticide-Related Illness Scenario, 31.1% of workers did not know the cause, with 18.3% of workers attributing their symptoms to heat, 10.9% stated other, 10.0% attributed it to respiratory illness, 5.6% to cardiovascular disease and 2.5% to pesticide poisoning. These findings indicate that the workers could not correctly identify the causes of commonly presenting occupational symptoms.

Table 2.15: Most commonly attributed causes of symptoms in each occupational health scenario

Heat-Related Illness scenario		**Valley Fever scenario**		**Pesticide Related Illness scenario**	
Attributed cause	*%*	*Attributed cause*	*%*	*Attributed cause*	*%*
Heat-related illness	30.0%	Respiratory condition	46.7%	Don't know	31.1%
Don't know	28.0%	Don't know	27.1%	Heat-related illness	18.3%
Other	12.0%	Fatigue	8.0%	Other	10.9%
Respiratory condition	7.0%	Mental health condition	3.4%	Respiratory condition	10.0%
Cardiovascular disease	3.6%	Other	2.7%	Cardiovascular disease	5.6%
Fatigue	3.5%	Valley Fever	0.8%	Pesticide/ poisoning	2.5%
N	1238		1286		1262

The predictors of using online sources of information were examined using the Anderson model of healthcare utilization; the results are presented in Table 2.16. In the HRI scenario, A one unit increase in age was associated with 0.97 times (95%CI:0.95,0.98) increase in the odds of using online sources. A one unit increase in fear of deportation was associated with a 1.4 (95%CI:1.13,1.72) times increase in the odds of using online sources. Workers with financial security had 2.9 times (95%CI: 1.48,2.67) the odds of using online sources compared with those who do not, while workers without a usual place of care had 2.55 times (95%CI: 1.62,4.01) the odds of using online sources compared with those who do. Workers who are not married had 1.53 times (95% CI:1.0, 2.33) the odds compared with those who are married.

In the Valley Fever scenario, female workers had 1.61 times (95%CI: 1.09,2.39) the odds of using online sources compared with males. A one unit increase in age was associated with a 0.97 times (95%CI:0.95,0.99) increase in the odds of using online sources. A one unit increase in fear of deportation was associated with a 1.48 (95%CI:1.22,1.79) times increase in the odds of using online sources. Workers with financial security had 2.9 times (95%CI: 1.48,2.67) the odds of using online sources compared with those who do not. Workers without a usual place of care had 2.4 times (95%CI: 1.56,3.69) the odds of using online sources compared with those who do. Workers dependent on employer-provided transportation had 0.36 times (95% CI:0.14, 0.90) the odds of using online sources compared with those who were not. In the PRI scenario, female workers had 1.55 times (95%CI: 1.04,2.31) the odds of using online sources compared with males. A one unit increase in age was associated with 0.97 times (95%CI:0.96,0.99) increase in the odds of using online sources. A one unit increase in fear of deportation was associated with a 1.48 (95%CI:1.22,1.81) times increase in the odds of using online sources. Workers with financial security had 2.0 times (95%CI: 1.15,3.48) the odds of using online sources compared with those who do not. Workers without a usual place of care had 2.23 times (95%CI: 1.44,3.43) the odds of using online sources compared with those who do.

Table 2.16 Predictors of using online sources

	HRI (Use of online sources)	**V.F. (Use of online sources)**	**PRI (Use of online sources)**
	Odds ratio (95%CI)	**Odds ratio (95%CI)**	**Odds ratio (95%CI)**
Gender			
Male/Other	Ref group	Ref group	Ref group
Female	1.36 (0.89,2.07)	1.61 (1.09,2.39)*	1.55 (1.04,2.31)*
Age	0.97 (0.95,0.98)***	0.97 (0.95,0.99)***	0.97 (0.96,0.99)**
Fear of deportation	1.40 (1.13,1.72)**	1.48 (1.22,1.79)***	1.48 (1.22,1.81)***
Financial security			
Not secure	Ref group	Ref group	Ref group
Financially secure	2.90 (1.48,5.67)**	1.63 (0.97,2.76)	2.00 (1.15,3.48)*
Insurance status			
No insurance	Ref group	Ref group	Ref group
Had insurance	1.20 (0.79,1.84)	1.15 (0.78,1.71)	1.13 (0.76,1.68)
Type of employer			
Grower	Ref group	Ref group	Ref group
Contractor/ Other	1.32 (0.78,2.23)	1.16 (0.72,1.87)	1.19 (0.73,1.94)
Health literacy	1.018 (0.95,1.08)	1.04 (0.99,1.09)	1.01 (0.96,1.07)
Migrant status			
Not migrant	Ref group	Ref group	Ref group
Migrant	1.04 (0.65,1.66)	1.09 (0.70,1.70)	0.99 (0.64,1.56)

Educational status			
Some college	Ref group	Ref group	Ref group
Regular school	1.09 (0.53,2.27)	0.91 (0.44,1.85)	1.07 (0.52,2.18)
No regular school	0.78 (0.32,1.89)	0.67 (0.29,1.54)	0.80 (0.34,1.85)
Language			
English	Ref group	Ref group	Ref group
Spanish	0.51 (0.13,1.95)	0.38 (0.10,1.42)	0.44 (0.12, 1.6)
Other	0.59 (0.14,2.49)	0.35 (0.09,1.44)	0.41 (0.1,1.65)
Need for appointment			
No	Ref group	Ref group	Ref group
Yes	1.61 (0.93,2.76)	1.24 (0.74,2.1)	1.34 (0.8,2.25)
History of work-related injury			
No	Ref group	Ref group	Ref group
Yes	1.01 (0.60,1.71)	1.03 (0.62,1.70)	1.06 (0.65,1.74)
Having a usual place of care			
Yes	Ref group	Ref group	Ref group
No	2.55 (1.62,4.01)***	2.4 (1.56,3.7)***	2.23(1.44,3.4)***
Marital status			
Married	Ref group	Ref group	Ref group
Not married	1.53 (1.0,2.33) *	1.28 (0.87,1.88)	1.47 (0.99,2.17)
Dependence on employer transport			
No	Ref group	Ref group	Ref group
Yes	0.56 (0.22,1.46)	0.36 (0.14,0.90)*	0.47 (0.18,1.17)
Constant	0.07 (0.01,0.56)*	0.21 (0.03,1.39)	0.09 (0.01,0.61)*

*p value<0.05, **p-value <0.01, and ***p value <0.001

Discussion: The findings of the study indicate that the surveyed agricultural workers in the UCM FWHS had lower rates of utilization for routine preventive services, such as having routine doctor visits and dental visits in the last year, compared with the low-income Latino population of California represented in CHIS. They had higher levels of E.R. utilization and were more likely to delay seeking healthcare services compared with working-age low-income Latinos in CHIS. Agricultural workers with health insurance coverage were more likely to use routine preventive services and less likely to delay seeking healthcare services. However, they had similar rates of Emergency Room utilization compared with workers who did not have health insurance coverage.

According to the NAWS 2017-18 survey (the last version that reported the healthcare utilization patterns among agricultural workers), approximately 71% of workers had reported seeing a healthcare provider in the U.S. in the last two years.[75] Another NAWS report focused on California workers using data from 2015-19 revealed that only 65% of workers in California had reported having seen a healthcare provider in the U.S. in the last two years.[35] According to the NAWS 2017-18 survey, approximately 44 % of the workers

reported having visited a private medical office, and only 15 % had seen a dentist in the last two years.[38] In the aggregated NAWS-based data report on California, nearly 38% of workers reported having visited a private medical office, and only 15% reported having seen the dentist.[35] The study reveals that nearly 44% of workers had a routine preventive doctor's visit, and 35% had a dental visit last year. However, the utilization patterns remain lower than those of other low-income working-age Latinos in California, with insured workers reporting higher rates than uninsured workers. Similarly, approximately 40% of the workers reported having routine blood tests in the past year, with insured workers reporting higher rates than uninsured workers.

These findings stand in sharp contrast to 84.9% of the non-institutionalized U.S. adults who reported having seen a healthcare provider in the last 12 months, and 65.3% reported having been to the dentist in the last 12 months, according to the National Center for Health Statistics in 2019.[256] According to the findings of the National Health Interview Survey 2022, 87.6% of the non-incarcerated adult population of the U.S. had a usual place of care, and only 6.1% had delayed seeking care due to cost.[257,258] The study reveals that only 76.7% of the surveyed workers had a usual place of care, with similar patterns observed in insured and uninsured groups. Approximately 21% of the surveyed workers had delayed seeking care, with higher rates among uninsured workers than insured workers, with over two-thirds reporting cost as the main reason for the delay. These findings reveal significant disparities in access to and utilization of healthcare services among agricultural workers compared with other low-income working-age Latino adults in California and the non-institutionalized adult population of the U.S.

The study also examined predictors for using various healthcare services among agricultural workers in the state. The survey respondents with health insurance coverage and financial security had higher levels of routine or preventive services usage and a lower likelihood of delays compared with those who did not. Previous studies have shown similar findings, which reveal that health insurance coverage rates are associated with higher health service utilization, continuity of care, and better health status across various population groups in the country.[3,259–262] Similar studies on agricultural workers have demonstrated an association between having health insurance coverage and utilization of healthcare services.[57,58,95] Financial security, age, and health literacy were found to be the crucial predictors of having health insurance among agricultural workers in the study.

The study also highlights the barriers to utilization posed by the lack of financial security among low-wage agricultural workers juggling between competing needs such as paying for household expenses and seeking healthcare services. These results are also in agreement with those of similar studies revealing that the cost of healthcare services remains a major barrier to healthcare utilization despite the continued expansion of coverage under the Affordable Care Act (ACA)[36,58,211] Despite policy changes in California, such as the sequential expansion of Medi-Cal for undocumented workers and attempts to improve uptake of coverage by involving local community-based organizations, coverage rates continue to remain low. Due to current income-based eligibility limits, a significant proportion of workers will remain ineligible for insurance coverage in the state.[51] Recently

proposed policy initiative to allow undocumented workers to seek insurance under Covered California can enhance coverage rates in this vulnerable group.[263]

The study also highlights the impact of health literacy on intention and ability to utilize the U.S. healthcare system. The surveyed workers with higher levels of health literacy, as calculated in the formula described earlier in the manuscript, were found to be more likely to use routine preventive services such as having a usual place of care, visiting the doctor for a routine visit, having a dentist visit and blood tests in the past year. These findings are in agreement with those of other studies, which indicate that higher levels of health literacy and familiarity with the healthcare system were associated with healthier lifestyle choices, higher rates of utilization of preventive healthcare services, adherence to treatment regimens, and satisfaction with the medical services received.[54,78,264,265]

The second part of the study also draws attention to the low levels of occupational health literacy in this group. Although nearly 85% of workers in the UCM FWHS reported having received heat-related illness training, only 30% could successfully identify the typical symptoms of the illness in the study.[59] This situation was even worse when the workers were asked to identify the typical symptoms of Valley Fever and Pesticide-related Illnesses. Prior studies on this topic have also shown deficiencies in the knowledge and perceived severity of the various occupational illnesses, but most such studies were either focused on one kind of illness, had a very small sample, or were based in other states with a different farmworker profile than California.[24,34,242,243]

Workers employed in the agriculture, fishing, and forestry sectors had the highest rates of heat-related illnesses based on Worker Compensation claims filed between 2000 and 2017 in California[8] and the second-highest rate of HRIs based on Worker compensation claims filed between 2006 and 2017 among all workers employed in the state of Washington. [20] Previous studies have shown varying levels of knowledge about heat-related illness among agricultural workers, with risk perception reported to be low even among more knowledgeable participants.[21,243,266] According to a recent study on Valley fever, even among those aware of the disease, the median knowledge score was 53%, and the participants held several misconceptions about the cause of the disease, its transmissibility, with approximately half the workers indicated that they preferred to consult with their friends and family, indicating poor understanding and perception of the severity of the disease.[242]

A recent study combining the examination of risk perception for pesticide exposure, protective behaviors, and perceived control with the measurement of urinary biomarkers for metabolites of common pesticides among Latino farmworkers in Idaho revealed the presence of 10 biomarkers in more than 80% of samples with inconsistencies in risk perception and protective behaviors despite nearly 73% of workers reported to having attended pesticide safety training.[267] Another study reported that in addition to the inability to recognize the symptoms of such exposures, the fear of deportation, employer retaliation, limited proficiency in the English language, and lack of recognition of symptoms by local clinicians remain major barriers to the reporting and appropriate management of acute pesticide exposures among workers.[23] Several studies have shown that many workers have deficient knowledge of these occupational illnesses, do not perceive the severity of these

symptoms, or lack the ability to manage them appropriately.[243,266] The findings of our study reveal similar patterns of inability to recognize symptoms of such illnesses and a preference for self-management due to low-risk perception as previous studies on this topic.[9,27,242,243]

The current study is unique because it provides comprehensive information about healthcare utilization in a large sample of agricultural workers in California. The survey was conducted in 2021-22 and incorporates detailed information about using routine preventive services, emergency services, and delays in seeking healthcare services, enabling the study investigators to examine the self-reported actual and intended patterns of healthcare utilization among the state agricultural workers within the current health policy framework. Other studies have certain limitations. The NAWS survey has limited participants from California and only includes currently employed hired workers interviewed at their worksites, excluding H2A workers and those who may have previously been employed in this industry.[38,75] Moreover, the NAWS survey collects limited information on healthcare access and utilization, and the questions related to these sections were not included in the last publicly available version of the NAWS 2019-2020 survey.[35,38] Although the CHIS data has several questions related to healthcare access and utilization, it includes very few participants who identify as agricultural workers yearly, and hence, the corresponding information cannot be used to make meaningful interpretations of their healthcare usage patterns.[200,201]

Some recently conducted studies have shown that California has enacted state policies supportive of improving healthcare access among undocumented immigrants, such as Medi-Cal expansion and reduced immigration enforcement encounters, which have helped to improve healthcare access and utilization among these vulnerable worker communities, similar to the findings of this study.[91,268–270] Despite recent efforts by state regulators to improve occupational health literacy to prevent injuries and illnesses among these workers, their ability to identify and manage such symptoms remains poor. Previous studies have shown that existing programs and educational materials are not written at the level and in a language that is easily understandable for these workers, indicating an urgent need to develop new programs to bridge this gap.[245]Several studies have reported that peer educators such as Promotoras help to build trust, educate farmworkers about various illnesses, enhance recruitment in health-related programs, and follow up with healthcare services. [235,236,271] However, in our study, most workers preferred consulting with family members or friends, with fewer than 30% showing a preference for consulting with these community health workers in any of the examined occupational health scenarios.

Moreover, the findings show that approximately one-fourth of the survey respondents used online sources to seek information in any of the three previously discussed occupational health scenarios. Younger workers with financial security who feared deportation and did not have a usual place of care were more likely to use online sources of information and their willingness to use online sources for health-related queries makes them potential candidates for digital outreach and delivery of healthcare services via telemedicine. Agricultural workers are known to reside in medically underserved areas, lack paid time off, and have limited access to healthcare services at a convenient time and location.[36,77] Digital health interventions such as telemedicine can be used to bridge this gap. [160,272]

The recent COVID-19 pandemic has demonstrated the ability of healthcare providers and community health workers to disseminate health education messages and deliver healthcare services effectively via digital devices.[184,249] The California HealthCare Foundation Health Policy Survey 2022 revealed that both physicians and patients, particularly individuals from low-income, non-White, and non-English speaking communities, had high levels of usage and expressed satisfaction with digital services.[183]However, this expansion did not yield similar benefits across all communities, particularly agricultural workers who often lacked access to high-speed internet, smart devices, and lacked the technical literacy needed to operate them.[174,273] They also held concerns related to privacy while using telehealth services due to often changing adversarial immigration policies.[274,275] Additionally, most of these services were focused on COVID-19, although this strategy can be implemented to improve the availability of occupational health information and management of occupational injuries and illnesses for vulnerable worker communities.[172,184]State lawmakers should explore new policy options to expand the use of these digital health services for outreach and treatment among agricultural workers to improve access and utilization in rural farmworker communities.

Limitations: The UCM FWHS is a comprehensive state-funded survey that collected crucial information about agricultural worker health in 2021-22 during the COVID-19 pandemic when farm workers were designated as "essential workers" due to their critical role in maintaining the national food supply at substantial personal risk. [4,62] Due to the social distancing requirements and lockdowns imposed by public health authorities, obtaining a random sample of the agricultural worker population in the state was very challenging.[182,276] Consequently, the study investigators used a convenience sampling technique for data collection, and the dataset was not a random or representative sample of agricultural workers in California. [59] Moreover, the survey oversampled women and Indigenous workers to enable future researchers to examine the health status and healthcare utilization patterns among these minority groups in greater depth.[59]

The reported healthcare utilization patterns are based on self-report and depend on the ability of the respondents to accurately recall past experiences [277,278]. Moreover, these patterns were also affected by the reduced availability of in-person healthcare services and the rapid expansion of telemedicine services during this period [184,276,279,280]. However, the published report compared the sampling patterns and demographic characteristics of the survey respondents with those of representative national surveys such as the American Community Survey (ACS) and the National Agricultural Worker Survey (NAWS) and found them very similar [59]. Moreover, the survey was conducted in six languages in collaboration with multiple farmworker-serving community-based organizations to ensure equitable participation conducted under the guidance of a Community Advisory Board composed of health policy researchers, healthcare providers, employers, and advocates with continuous supervision from CDPH to ensure the scientific integrity of the study.[59]

Conclusions: Agricultural workers in California reported lower levels of utilization of routine preventive healthcare services compared with other low-income Latino working-age individuals in the state. According to self-reported utilization patterns by survey respondents, agricultural workers delayed seeking healthcare services and obtaining prescription drugs more often compared with other low-income Latinos in California. Agricultural workers who had health insurance coverage reported higher levels of utilization of routine preventive services and lower levels of delay in seeking services compared with those who did not have insurance. When exposed to symptoms of occupational illness, information and care-seeking patterns among agricultural workers were classified as self-management, use of healthcare service, and community management.

Workers with lower levels of health literacy are more likely to prefer self-management resources than workers with higher health literacy. Workers with health insurance coverage and those who reported being financially secure enough to cover emergency expenses and had a usual place of care were more likely to use healthcare services. A small percentage of agricultural workers were found to use online sources of information when faced with symptoms of any occupational illness.

Previous studies have shown similar patterns of difficulties in understanding and managing the symptoms of occupational illnesses in an effective manner [78,281–283]. Workers who use online sources of information tend to be younger, have high levels of fear of deportation, and are less likely to have a usual place of care. These workers represent a vulnerable group who can benefit from expanding digital outreach and telemedicine services to improve healthcare utilization. Policymakers should explore novel solutions such as culturally competent training interventions delivered through new techniques, including digital outreach and delivery of health interventions to facilitate health system integration.

Policy implications: This study has several important implications for policymakers operating at various levels of government. The UCM FWHS is a comprehensive survey that collected detailed information about the health status, access, the actual and intended healthcare utilization patterns among agricultural workers in California. The findings of the study can help to understand the existing healthcare framework under which these agricultural workers attempt to take care of their health while working in hazardous occupational conditions. It helps to identify the gaps in care and identify improvement opportunities that can be incorporated within the current system to facilitate healthcare utilization among these workers. It helps to identify information-seeking patterns when exposed to symptoms of occupational illnesses, which can help design educational interventions to better prevent and manage occupational injuries and diseases. It also helps to identify agricultural workers who can potentially benefit from digital outreach and the availability of telemedicine services. It will help to design more effective healthcare interventions for agricultural workers using both traditional and digital means to improve access and utilization.

Chapter Three

Study 3: Examination of patterns of Digital health access, its utilization, and its role in the creation of an integrated and coordinated healthcare system for agricultural Workers in California: Mixed methods study

Introduction: Chapters 1 and 2 examined patterns of healthcare utilization, barriers, and facilitators for healthcare access and system integration for agricultural workers in the state as well as some innovative service delivery models, such as telemedicine, that can facilitate the coordination of the healthcare system. Although digital health initiatives have been explored in previous decades as potential solutions to some of these problems, the COVID-19 pandemic created a unique situation due to the social distancing requirements needed to protect patients and providers, which led to the rapid adoption of these technologies across all medical disciplines and all social groups.[182,284,285] It enabled these digital tools to be used for triage, initial assessment, follow-up, provision of primary care, specialty care, and outreach in previously disconnected rural farm working communities.[175,176,247,286,287]

This study examines the role of digital health interventions in creating an easily accessible, integrated, and coordinated healthcare system for these agricultural workers in California who are employed in one of the most hazardous industries in the state.[6,8,202] They live in medically underserved areas with few healthcare services, long waiting times, and inconvenient hours of operation.[66,74,210,234] They lack access to reliable means of transportation and fear wage loss and employer retaliation on seeking time off to take care of their health.[36,51,67,213] Undocumented workers fear deportation due to constantly changing immigration policies[57,58] and this uncertainty creates a sense of alienation and fear among these workers.[286,288,289] The rural healthcare system is fragmented, comprising few providers with a small referral network and limited sharing of patient health information across different organizations, making it hard for patients with low levels of health literacy to schedule appointments and navigate the healthcare system.[36,66,80,213]

Digital health interventions include synchronous services (audio visits, video visits, and remote patient monitors) and asynchronous services (digital messages and electronic health information exchange).[145,146] Their promise of convenience and efficiency can help to overcome some of these barriers, such as transportation, provider shortages, long waiting times, and lack of paid time off to improve access in rural communities.[79,212,290] They can make culturally sensitive specialists and ancillary services available to marginalized groups in rural areas.[291,292] Rural healthcare providers can create coherent and comprehensive treatment plans that enable better continuity of care for underserved populations through the streamlined flow of information via virtual tools.[293,294] They can also successfully carry out surveillance and community outreach to prevent and manage chronic diseases such as diabetes and hypertension using remote patient monitors connected to mobile health applications.[156,160,162]

Some studies have examined the spread of digital services during the pandemic and the widening disparities associated with the lack of reliable high-speed broadband internet services between rural and urban communities.[295–297] However, very few studies have explored the availability of digital devices among agricultural workers, their willingness to use them, and their levels of utilization for any potential use for any health or non-health-related purposes [174,251,275]

Although digital inclusion and broadband connectivity are now considered crucial social determinants of health, there is limited information on digital access and utilization among agricultural workers in California.[241,246,295,298] Most studies on digital health utilization among farmworkers were conducted either before the pandemic or in other states, such as North Carolina and Michigan, which have a different policy framework and worker demographics compared with California.[4,35,89,174]Most of the studies in rural areas conducted during the pandemic had a narrow focus and were limited to using these services to manage COVID-19 or a few other diseases.[228,284,299] Very few studies have examined the role of these interventions in delivering occupational health services in rural areas but were not focused on agricultural workers and did not provide comprehensive recommendations on how to offer these services in an integrated framework.[32,300,301]

This study examines the level of digital access and predictors of its utilization for health-related purposes among agricultural workers in California compared with those in other regions of the U.S. using the NAWS 2018 Digital Access supplement and the Anderson model for healthcare utilization among vulnerable populations as the theoretical framework.[191,192] Recognizing that there have been several changes in digital access and healthcare utilization during the pandemic, the California Health Interview Survey (CHIS) 2021-22, which is a state-level survey with a representative sample that incorporates telehealth-related questions has been used to study their telehealth utilization patterns.[200,201]

While few studies have examined the challenges faced by healthcare providers in facilitating healthcare access and utilization in rural areas, most such studies are not focused on digital health or agricultural workers. [66,67,71,74,286] No studies at the time of this review specifically focus on exploring the role of digital health interventions in delivering integrated healthcare services for California agricultural workers. This study attempts to unravel some of these questions using the "studying up" approach by presenting the perspectives of farmworker-serving healthcare providers and advocates collected through qualitative interviews.[198] They were asked to express their views on the usage patterns among these workers, barriers, and facilitators for their utilization and to seek recommendations on how these technologies can be effectively harnessed to develop innovative models to deliver high-quality integrated and coordinated healthcare services for agricultural workers in the state.

Methods: The quantitative section of this mixed methods study uses data from the National Agricultural Worker Survey (NAWS) 2018 Digital Access supplement, which examines the levels of digital access among agricultural workers in the country. NAWS is a national-level survey of hired agricultural workers in the U.S., with ongoing data collection about demographics, employment characteristics, health status, healthcare access, and utilization

among currently employed agricultural workers interviewed at their place of work.[38,75] The survey uses a random sample and publicly available weighting methodology, allowing researchers to generate weighted representative estimates for this population.[36]

This dataset was chosen because the survey had questions on the extent and type of digital access and the purpose for which the digital access was used in a representative sample of agricultural workers in different regions of the U.S. In this survey, the state of California is included as a separate region, allowing the study investigators to examine patterns of digital service utilization in the state. The statistical package used for quantitative data analysis is STATA version 18.0. The alpha value chosen for statistical analysis conducted in this study was 0.05. Categorical variables have been reported as percentages, while mean and standard deviation have been used to report continuous variables in this manuscript and the predictors for utilizing digital access for health-related purposes were examined through logistic regression analyses. The utilization of digital access for various reasons was examined among agricultural workers in California compared with the rest of the country, with regional differences further explored using Chi-square tests. The Anderson model for healthcare utilization was used as the theoretical framework to select independent variables in the study.[191,192] The factors considered in this study are presented below.

Predisposing factors: Gender, age, ethnicity, legal status, number of years in U.S., migrant status, marital status

Enabling factors: Family Poverty level, educational status, preferred language of communication, type of employer, type of work, health insurance coverage, access to a cell phone with internet, access to a cell phone with text, access to a computer, and access to a tablet

Need factors: Need for an appointment, Having a chronic condition.

The utilization of digital services for health-related purposes was selected as the dependent variable for the study. The assumptions for logistic regression were tested, including binary outcome, independent observations, large sample size, and linearity of log odds. The model fit was tested using Lfit, the area under the regression curve, AIC, and BIC criteria. Five models were examined, including the overall use of digital access for health reasons and after including access through cell phones with internet services, cell phones with text services, computer access, and tablet access as independent variables in the analysis.

The NAWS 2019-20 survey did not collect information about digital access and healthcare utilization among agricultural workers; therefore, the California Health Interview Survey (CHIS) 2021-22, which included questions on telehealth utilization, was used to examine the patterns of digital health service utilization among California agricultural workers. CHIS is an ongoing state-level survey conducted by the University of California Los Angeles, which interviews approximately 20,000 non-institutionalized residents of California using a representative sample of the population.[35,200] Although this survey has occupation-related information, it includes a very small number of agricultural workers in the same category as workers employed in forestry, fishing, and mining. However, since a significant proportion of agricultural workers in California are low-

income Latinos as per previous reports based on NAWS,[35,75] working-age (18-65years) Latinos in California with income less than or equal to 250% of the Federal Poverty level were chosen as a proxy to examine patterns of digital health utilization among agricultural workers during the period of rapid expansion of telemedicine in the COVID-19 pandemic.

Qualitative study methods: The patterns of digital health access and service utilization among agricultural workers in California were further explored through interviews with healthcare providers and farmworker advocates. The interviews aimed to understand the perspectives of the interviewees on digital health service utilization in this population and seek recommendations on how these services can be effectively used to create an integrated and coordinated healthcare system that can deliver affordable, high-quality, and convenient healthcare services for agricultural workers in the state. The interview guide was based on an in-depth literature review and data analysis from previous interviews. The Institutional Review Board at the University of California Merced reviewed and approved the study protocol as exempt.

The interview guide and study protocol were tested through a pilot interview and the findings were used to improve the conduct of the study. We conducted 20 individual in-depth interviews with farmworker-serving primary care providers, specialty service providers, telehealth resource providers, farmworker advocates from community-based organizations, and health policy researchers working on these complex issues. The inclusion criteria for the study were being a healthcare provider (M.D., D.O., N.P., or P.A.), representative of farmworker-serving FQHC or hospital, advocates from Community-based Organizations, or health policy researchers engaged in projects related to agricultural worker health in the past five years and the interviews were conducted between November 2023 to April 2024.

The study used a snowball sampling approach for recruitment due to the limited number of providers and advocates who either serve agricultural workers exclusively or have a practice where a significant proportion of their clients are agricultural workers.[10] Each interview was conducted online using a secure version of the Zoom video conferencing application provided by the university and lasted approximately an hour. The interviews were recorded after getting informed consent from the participants and transcribed verbatim using the transcription software Otter.ai. The transcripts were later reviewed and cross-checked for accuracy. The interviews were conducted till no new information emerged from successive interviews or theoretical saturation was achieved.[11,12]

The data from the transcripts was analyzed using the Dedoose qualitative data management software. The constructivist grounded theory framework was chosen as the theoretical framework used for the study as it allows the examination of this less-explored complex issue in an in-depth manner.[11,13,14] The focused and axial coding techniques were used to identify relevant themes and sub-themes from the interviews.[14,15] Detailed memos and field notes were written to capture any additional information. The codes were analyzed by two team members who met regularly to reconcile differences, which were recorded in memos and included in the analysis.[11,16]

Results: Twenty interviews were conducted in this study by the time theoretical saturation was achieved the participant demographic characteristics are shown in Table 3.1. Among the interviewees, 55% were male, while 45% were female. Approximately 55% were physicians with M.D. degrees, 15% were NP/ PA, 15% had J.D., and 10% had bachelor's or post-high school certifications. Among them, 40% were primary care providers, 30% were specialist care providers, and 30% were farmworker advocates. Among the interviewees, 35% were Caucasian, 30% were Hispanic, 30% were Asian, and 5% were African American. Limited demographic information was collected to maintain confidentiality, as few healthcare providers and advocates serve agricultural workers in California.

Table 3.1 Demographic characteristics of study participants

Interviewee characteristics	**N=20 (percentage)**
Gender	
Male	11 (55.0)
Female	9 (45.0)
Educational qualifications	
MD	11 (55.0)
NP/PA	3 (15.0)
JD	3 (15.0)
Doctorate	1 (5.0)
Bachelor's or Post high school certifications	2 (10.0)
Type of organization	
Primary care provider	8 (40.0)
Specialist provider	6 (30.0)
Farmworker advocate	6 (30.0)
Ethnicity	
Hispanic	6 (30.0)
Caucasian	7 (35.0)
Asian	6 (30.0)
African American	1 (5.0)

The demographic characteristics of the NAWS 2018 survey respondents are presented in Table 3.2. There were 1347 respondents, of whom 594 were from California. Among them, 68.4% were male, with 67.1% being male in California and 69.4% in the rest of the U.S. Among them, 35.3% were reported as undocumented, with 38.6% in California and 32.8% in the rest of the U.S. There were only 13.7% migrant workers, with 14.6% in California

and 13.0% in the rest of the U.S. Among them, 56.5% were reported as married, with 63.0% in California and 51.4% in the rest of the U.S. Among them, 78.8% identified themselves as Hispanic, with the figures being reported as 95.6% in California and 65.6% in the rest of the U.S. with approximately 59% were between 25 to 50 years of age with 67.0% of California and 52.9% of workers in the rest of the U.S. in this survey.

Nearly 90% were directly employed by growers, with 80.6% in California and 96.9% in the rest of the U.S. The most common type of work was fieldwork engaging 62.8% of workers overall, 77.9% in California, and 50.6% in the rest of the U.S. Approximately 60% reported having health insurance coverage, with the reported figures being 66.1% in California and 54.1% in the rest of the U.S. Nearly 81% were above the family poverty level with the numbers being 87.6% in California and 76.1% in the rest of the U.S. Approximately 42% reported having less than an eight grade level of education with 50.4% of California and 35.3% of workers in the rest of the U.S. reported being in this group. Nearly 66% reported Spanish as their preferred language of communication, with these figures being 85.2% for California workers and 51.7% for workers from the rest of the U.S. These findings indicate the presence of significant demographic differences between workers in California compared with those in the rest of the U.S. as examined using the results of Chi-square tests of independence.

Table 3.2 Demographic characteristics of survey respondents for the NAWS 2018 survey

Characteristic	**Overall (N=1347)**	**California (N=594)**	**Rest of U.S. (N=753)**
Gender			*
Male	68.4%	67.1%	69.4%
Female	31.6%	32.9%	30.6%
Legal status			***
Documented	64.7%	61.4%	67.2%
Undocumented	35.3%	38.6%	32.8%
Migrant status			
Not Migrant	86.3%	85.4%	87.0%
Migrant	13.7%	14.6%	13.0%
Marital status			*
Married	56.5%	63.0%	51.4%
Not married	43.5%	37.0%	48.6%
Race			***
Hispanic	78.8%	95.6%	65.6%
Not Hispanic	21.2%	4.4%	34.4%

Age			**
25 and below	15.0%	6.8%	21.5%
26 to 50 years	59.1%	67.0%	52.9%
Over 50 years	25.9%	26.2%	25.6%
Employer type			***
Grower	89.7%	80.6%	96.9%
Contractor	10.3%	19.4%	3.1%
Work type			***
Fieldwork	62.8%	77.9%	50.6%
Nursery	25.6%	11.5%	37.0%
Packing house/ other	11.6%	10.6%	12.4%
Health insurance coverage			**
Yes	59.4%	66.1%	54.1%
No	40.6%	33.9%	45.9%
Family Poverty Level			**
Above poverty level	81.2%	87.6%	76.1%
Below poverty level	18.8%	12.4%	23.9%
Educational status			***
Less than 8th grade	41.9%	50.4%	35.3%
9th to 12th grade	46.8%	44.1%	48.9%
Some college	11.3%	5.5%	15.8%
Preferred language of communication			***
English	32.7%	13.2%	47.8%
Spanish	66.3%	85.2%	51.7%
Other	10.0%	16.6%	5.5%

*p value<0.05, **p-value <0.01, and ***p value <0.001 as per Chi-square tests of independence between region and demographic variables

Digital access through various devices among agricultural workers was thereafter examined for workers in California compared with the rest of the U.S. Weighted estimates were generated using the weighting variable and STATA code provided in the NAWS codebook and supplementary materials.[35,38] The regional differences in digital access through various devices were further examined through Chi-square tests. The results of the analysis below are presented in Table 3.3 below. Digital access was reported by 92.2% of survey respondents, with 91.9% of workers in California and 92.4% of workers in the rest

of the U.S. reported having access to digital services. Approximately 46% of workers reported having access to a computer, with 33.2% of workers in California and 55.2% of workers in the rest of the U.S. reporting such access with nearly 91% of workers reported having access to a cell phone with an internet connection, with 90.1% of workers in California and 90.9% of workers in the rest of the U.S. reporting such access. Approximately 97% of workers reported having access to a cell phone with text services, with 96.4% of workers in California and 97.7% of workers in the rest of the U.S. reporting such access. Nearly 28% of workers reported having access to a tablet, with 23.4% of workers in California and 31.5% of workers in the rest of the U.S. reporting such access. There were statistically significant regional differences in digital access among agricultural workers through various devices.

Table 3.3 Access to Digital devices among farmworkers (weighted estimates)

	Overall (N=1347)	**California (N=594)**	**Rest of U.S. (N=753)**
Digital Access	92.2%	91.9%	92.4%
Access to Computer	45.5%	33.2%	55.2%***
Access to cell phone with internet	90.5%	90.1%	90.9%*
Access to cell phone with text	97.2%	96.4%	97.7%*
Access to tablet	28.0%	23.4%	31.5%***

*p value<0.05, **p-value <0.01, and ***p value <0.001 as per Chi-square tests of independence between region and digital access variables

The results are shown in Table 3.4. Only 17% of workers in the U.S. reported using these services for health-related purposes, with the reported figures being 15.9% among workers in California compared with 19.7 % among workers in the rest of the U.S. Approximately 22% of workers overall, 21.4% among those in California and 22.6% of workers in the rest of the U.S. used these services for employment reasons. Nearly 12.3% of workers overall, 9.5% among those in California, and 14.5% of workers in the rest of the U.S. used these services for education or training with approximately 3.2% of workers overall, 1.5% in California, and 4.6% in the rest of the U.S. used them to seek childcare services. Among these workers, 12% overall, 13.9% in California, and 10.6% in the rest of the U.S. used these services to seek housing. Approximately 14% overall, 17.8% in California, and 11.3% of workers in the rest of the U.S. used these services to seek benefits. Among these workers, 39.6% overall, 42.1% in California, and 37.6% in the rest of the U.S. used these services for reasons not included in these categories.

Table 3.4 Usage patterns for digital devices among farmworkers (weighted estimates)

	Overall (N=1347)	**California (N=594)**	**Rest of U.S. (N=753)**
Health	17.1%	15.9%	19.7%
Employment	22.1%	21.4%	22.6%
Education/training	12.3%	9.5%	14.5%**
Childcare	3.2%	1.5%	4.6%*
Housing	12.0%	13.9%	10.6%*
Benefits	14.1%	17.8%	11.3%
Other	39.6%	42.1%	37.6%
Overall	59.7%	59.3%	60.0%

*p value<0.05, **p-value <0.01, and ***p value <0.001 as per Chi-square tests of independence between region and digital service utilization variables

The predictors for utilizing digital access for health-related reasons among agricultural workers were examined using logistic regression. The Andersen model for healthcare utilization was used as a theoretical framework to select predictors and inform the analysis described in the methods section. Five models were examined, including predictors among workers with any digital device, among those with access to a computer, a cell phone with internet, a cell phone with text, or a tablet, and the results are presented in Table 3.5. Agricultural workers with a 9th to 12th-grade level of education had 2.52 (95%CI:1.6, 3.97) times, 2.08 (95%CI: 1.3,3.3) times, 2.2 (95% CI: 1.4,3.47) times, 2.3 (95%CI: 1.46,3.64) and 2.26 (95%CI: 1.42,3.60) times the odds of using digital services for health compared with those with less than an eighth-grade education in the overall digital access, access to a computer, access through cell phone with internet, access through cell phone with text and access to tablet groups respectively.

Agricultural workers with some college education had 4.23 (95%CI:1.83, 9.77) times, 3.33 (95%CI: 1.38,8.03) times, 3.98 (95% CI: 1.7,9.4) times, 4.34 (95%CI: 1.84,10.2) and 4.22 (95%CI: 1.8,9.99) times the odds of using digital services for health compared with those with less than an eighth-grade education in the overall digital access, access to a computer, access through cell phone with internet, access through cell phone with text and access to tablet groups respectively. Agricultural workers with income less than the Family Poverty Level had 0.49 (95%CI:0.25, 0.97) times and 0.50 (95%CI: 0.25,0.99) times the odds of using digital services for health compared with those with

income above the Family Poverty Level in the overall digital access, and access to tablet groups respectively.

Agricultural workers employed in nurseries had 2.33 (95%CI:1.4, 3.39) times, 2.29 (95%CI: 1.36,3.86) times, 2.15 (95% CI: 1.3,3.6) times, 2.2 (95%CI: 1.32,3.69) and 2.18 (95%CI: 1.3,3.66) times the odds of using digital services for health compared with those employed in fieldwork in the overall digital access, access to a computer, access through cell phone with internet, access through cell phone with text and access to tablet groups respectively. Agricultural workers who needed an appointment had 2.05 (95%CI:1.09, 3.85) times, 2.32 (95%CI: 1.21,4.44) times, 2.23 (95% CI: 1.76,4.2) times, 2.29 (95%CI: 1.21,4.36) and 2.3 (95%CI: 1.21,4.38) times the odds of using digital services for health compared with those who did not in the overall digital access, access to a computer, access through cell phone with internet, access through cell phone with text and access to tablet groups respectively.

Agricultural workers with digital access through a computer had 2.05 times (95%CI:1.3, 3.15) times the odds of using digital services for health compared with those who did not report such access. Agricultural workers with digital access through a cell phone with internet access had 3.53 times (95%CI:1.11, 11.7) times the odds of using digital services for health compared with those who did not report such access. There was no statistically significant relationship between reporting access to a cell phone with text services or a tablet and using digital services for health-related reasons. There was no statistically significant difference between residing in California or the rest of the U.S. and using digital services for health-related reasons.

Table 3.5 Predictors of utilization of digital services for health-related reasons among agricultural workers

Digital health	**Odds ratio (95%CI)**	**Access to computers Odds Ratio (95% CI)**	**Access to a cell phone with internet Odds ratio (95% CI)**	**Access to a cell phone with text Odds ratio (95% CI)**	**Access to tablets Odds ratio (95% CI)**
Gender					
Male	Ref group	Ref group	Ref group	Ref group	Ref group
Female	1.14 (0.7,1.8)	1.01 (0.6, 1.6)	1.01(0.6,1.7)	1.04 (0.6,1.7)	1.03 (0.6,1.7)
Age	0.97 (0.9,1.0)	0.98 (0.9,1.0)	0.98 (0.9,1.0)	0.98 (0.9,1.0)	0.98 (0.9,1.0)
Number of years in U.S.	1.0 (0.9,1.0)	1.0 (0.9,1.0)	1.0 (0.9,1.0)	1.0 (0.9,1.0)	1.0 (0.9,1.0)
Education					
8th or less	Ref group	Ref group	Ref group	Ref group	Ref group
9 to 12th	2.5(1.6,4.0)***	2.08(1.3,3.3)**	2.2(1.4,3.5)**	2.3(1.5,3.6)**	2.26 (1.4,3.6)**
College	4.2(1.8,9.8)**	3.3(1.4,8.0)**	3.98(1.7,9.4)**	4.3(1.8,10.2)*	4.2(1.8,10.0)**
Migrant status					
Not migrant	Ref group	Ref group	Ref group	Ref group	Ref group
Migrant	1.07 (0.6,2.0)	1.13 (0.6,2.1)	1.08 (0.6,2.0)	1.1 (0.6,2.0)	1.11 (0.6,2.0)
Legal status					
Citizen	Ref group	Ref group	Ref group	Ref group	Ref group
G.C./other	0.75 (0.4,1.5)	0.77 (0.4,1.6)	0.73 (0.4,1.5)	0.73 (0.4,1.5)	0.73 (0.4, 1.5)
Undoc	0.53 (0.3,1.1)	0.55 (0.3,1.2)	0.50 (0.2,1.1)	0.50 (0.2,1.1)	0.50 (0.2,1.1)
Preferred language					
English	Ref group	Ref group	Ref group	Ref group	Ref group
Spanish	0.92 (0.4,2.3)	1.17 (0.4,3.2)	1.09 (0.4,2.9)	1.12 (0.4,3.0)	1.14 (0.4,3.1)
Other	0.75 (0.1,4.9)	0.72 (0.1,5.1)	0.73 (0.1,4.8)	0.81 (0.1,5.4)	0.80 (0.1,5.4)
Family Poverty Level (FPL)					
Above FPL	Ref group	Ref group	Ref group	Ref group	Ref group
Below FPL	0.49 (0.2,1.0)*	0.52 (0.3,1.0)	0.52 (0.2,1.0)	0.50 (0.2,1.0)	0.50 (0.2,1.0)*
Region					
Rest of U.S.	Ref group	Ref group	Ref group	Ref group	Ref group

California	1.42 (0.9,2.2)	1.33 (0.8,2.1)	1.33 (0.8,2.1)	1.3 (0.8,2.1)	1.3 (0.8,2.1)
Employer type					
Grower	Ref group	Ref group	Ref group	Ref group	Ref group
Contractor	1.16 (0.6,2.2)	1.37 (0.7,2.6)	1.3 (0.7,2.5)	1.26 (0.7,2.4)	1.26 (0.67,2.4)
Type of work					
Fieldwork	Ref group	Ref group	Ref group	Ref group	Ref group
Nursery	2.33(1.4,3.4)**	2.29(1.4,3.9)**	2.15(1.3,3.6)**	2.2(1.3,3.7)**	2.18(1.3,3.7)**
Packing House	1.3 (0.5,3.5)	1.40 (0.5,4.1)	1.38 (0.5,4.1)	1.34 (0.5,3.9)	1.35 (0.5,3.9)
Marital status					
Not married	Ref group	Ref group	Ref group	Ref group	Ref group
Married/ living together	1.35 (0.8,2.3)	1.14 (0.67,1.9)	1.18 (0.7,2.0)	1.24 (0.7,2.1)	1.23 (0.7,2.1)
Divorced/ widowed	1.17 (0.5,2.9)	1.13 (0.4,2.9)	1.05 (0.4,2.7)	1.12 (0.4,2.8)	1.14 (0.5,2.9)
Health insurance					
Not insured	Ref group	Ref group	Ref group	Ref group	Ref group
Insured	1.08 (0.7,1.7)	0.99 (0.6,1.6)	1.06 (0.7,1.7)	1.06 (0.7,1.7)	1.05 (0.7,1,7)
Need for apt					
No	Ref group	Ref group	Ref group	Ref group	Ref group
Yes	2.05 (1.1,3.8)*	2.32 (1.2,4.4)*	2.23(1.8,4.2)*	2.3 (1.2,4.4)*	2.3 (1.2,4.4)*
Chronic condition					
No	Ref group	Ref group	Ref group	Ref group	Ref group
Yes	1.13 (0.73,1.73)	1.11 (0.72,1.73)	1.09 (0.70,1.68)	1.09 (0.70,1.7)	1.09 (0.70,1.7)
Race					
Not Hispanic	Ref group	Ref group	Ref group	Ref group	Ref group
Hispanic	0.31 (0.03,3.20)	0.26 (0.02,2.80)	0.28 (0.03,2.87)	0.28 (0.03,2.9)	0.27 (0.03,2.9)
Computer					
No		Ref group			
Yes		2.05 (1.3,3.2)**			
Cellphone with internet					
No			Ref group		
Yes			3.53 (1.1,11.7)*		

Cellphone with text No Yes				 Ref group 1.19(0.3,4.2)	
Tablet No Yes					 Ref group 1.17(0.7,2.0)
Constant	0.64 (0.05,8.84	0.55 (0.04,8.02)	0.21 (0.01,3.79)	0.6(0.03,12.2)	0.74 (0.05,10.5)

*p value<0.05, **p-value <0.01, and ***p value <0.001

Social distancing requirements during the COVID-19 pandemic led to the rapid expansion of telemedicine services in California.[184,227,302] However, the last publicly available version of NAWS (2019-20) did not capture these changes or collect any information about potential changes in healthcare utilization among agricultural workers during this period.[75] Therefore, their patterns of digital health utilization were examined using the California Health Interview Survey (CHIS), which asks specific questions related to telemedicine from non-institutionalized California residents using a large representative sample and collects information on ethnicity, income, and occupation.[200,201] However, there are few self-identified agricultural workers for the years 2021-22, and they were grouped with workers engaged in forestry, fishing, and mining.

As per previous NAWS[35,38,75] reports, most California agricultural workers are low-income Latinos; consequently, working-age Latinos (18-65 years) with income below 250% of the Federal Poverty Level were chosen as a proxy to study telehealth utilization patterns in this group. The results of the analysis over 2021 and 22 compared with the general working-age population of California have been presented in Table 3.6. Nearly 38% of low-income working-age Latinos used telemedicine in 2021, which dropped to 36.4% in 2022 compared with 45.9% usage in 2021 and 44.1% in 2022 for the working-age population of California.

Approximately 57.3% of low-income Latinos rated video visits as similar or better than in-person visits in 2021, which changed to 54.9% in 2022 compared with 63.3% in 2021 and 65.9% in 2022 for the working-age population of California. Nearly 66.7% of low-income Latinos rated audio visits as similar or better than in-person visits in 2021, which changed to 65.9% in 2022 compared with 60.3% in 2021 and 62.9% in 2022 for the working-age population of California. The use of online tools to connect with peers with mental health problems was similar, ranging from 6 to 7% across both groups in 2021 and 2022. Approximately 11.3% of low-income Latinos connected with mental health providers online in 2021, which dropped to 9.6% in 2022 compared with 10.9% in 2021 and 11.1% in 2022 for the working-age population of California. Nearly 8.6% of low-income Latinos used online tools to receive help for mental health and related disorders in 2021, which increased to 9.7% in 2022 compared with 8.8% in 2021 and 10.3% in 2022 for the working-age population of California.

Approximately 20% of low-income Latinos were connected to community resources by their Doctor's office in 2021 and 20.6% in 2022, compared with 15.7% in 2021 and 17.2% in 2022 for the working-age population of California. These findings indicate significant levels of telemedicine use in this group, although the levels remain lower than in the general population. They reported higher levels of satisfaction with audio visits compared with video visits. They had similar levels of using online tools to seek mental health-related services, while few healthcare providers connected them with community resources.

Table 3.6 Patterns of digital healthcare utilization among low-income working-age Latinos compared with the overall working-age population of California

	CHIS 2021 (low-income Latino)	**CHIS 2021 (Overall)**	**CHIS 2022 (low-income Latinos)**	**CHIS 2022 (Overall)**
Utilized telemedicine in the past year	38.3%	45.9%	36.4%	44.1%
Rating of video visit similar to or better than an in-person visit	57.3%	63.3%	54.9%	65.9%
Rating of audio visit similar to or better than an in-person visit	66.7%	60.3%	65.9%	62.9%
Connected online with people with similar mental health problems	6.2%	6.7%	7.0%	7.2%
Connected with mental health providers online	11.3%	10.9%	9.6%	11.1%
Used online tools to receive help for mental health	8.6%	8.8%	9.7%	10.3%
Doctor's office connected with community resources	19.6%	15.7%	20.6%	17.2%

Qualitative Study Findings: The interviews were analyzed using the constructivist grounded theory framework developed by Charmaz, which considers interviewees as co-creators of knowledge and accounts for the pre-existing biases among interviewees and interviewers, considering that knowledge is created within the context of lived experiences and prior knowledge.[193,195] This approach was selected because it allows the simultaneous collection and analysis of this data, enabling the researchers to develop a deeper understanding of less explored or more recent issues with limited availability of information.[193,196,214]

The snowball sampling technique, used for hard-to-reach populations and provides unique interactional information, was used for recruiting study participants due to the limited number of farmworkers serving healthcare providers and advocates in the state.[303] The research team has maintained reflexivity during the study by acknowledging that we hold an insider-outsider position as the team members despite having a background in medicine and public health, enabling them to understand healthcare delivery systems and medical jargon, do not directly deliver services to agricultural workers in California.[217,304]

The data was analyzed using the focused and axial coding techniques described by Kathy Charmaz in her book on grounded theory research using the Dedoose qualitative data management software.[193]A list of the most commonly used codes has been provided in Table 3.7 below. The codes have been split into four main categories: Facilitators for digital health, barriers to digital health, patterns of utilization, and recommendations.

Table 3.7 List of commonly used codes

Patterns of utilization	**Facilitators for digital health**	**Barriers to digital health**	**Recommendations**
Rapid expansion of telemedicine during the pandemic	Tele visits increase healthcare access in rural areas	Low levels of health literacy	Make technological resources more user-friendly
Preference for in-person visits over tele visits	High levels of satisfaction with tele visits	Low levels of technical literacy	Use of a hybrid model
Preference for audio visits over video visits	Willingness to learn and utilize digital health services	Lack of reliable broadband connectivity for patient	Insurance providers continue to reimburse tele visits at the same rate as in-person visits.
Lower wait times through tele visits	Introduction of new programs (ACP) to improve digital connectivity	Worker concerns about privacy during video visits	Creation of telehealth access points at user-friendly venues
Tele visits are used to review labs, follow-up, and simple case management.	Innovative programs (CCA and ACTIVATE) to increase utilization	Lack of reliable broadband connectivity for providers	Training Promotoras to help patients navigate digital health services
Tele visits are not suitable for complex case management	Care coordinators or Promotoras train patients to use remote patient monitors.	Lack of seamless electronic health information exchange	Use of Grower-run clinics as telehealth access points
Use of tele visits for triage of patients	Use of a hybrid model with some	Lack of culturally competent services	Creation of a separate integrated healthcare system

during and after the pandemic	in-person and tele visits		for agricultural workers
Limited knowledge of and utilization of Promotoras	Seamless electronic health information exchange	Lack of trained Promotoras to navigate digital services	Creation of binational health insurance plans and service delivery via telehealth
Limited interprofessional consultation	Improved rates of follow-up with tele visits	Lack of financial incentives for healthcare providers	Including agricultural workers under Cal A.I.M.
Limited knowledge of care integration initiatives such as Cal A.I.M.	Workers do not need to take time off	High cost of reliable internet services	Insurance providers pay for care coordinators for digital health services.
Limited utilization and benefits of Pay for performance initiatives	Use of A.I. tools for quality improvement initiatives	Lack of policies to continue telehealth after the pandemic	Need to train providers to deliver culturally competent

The prominent themes related to digital health utilization among agricultural workers in California and some illuminating quotes from the interviewed stakeholders are presented below.

Patterns of Digital Health Service Utilization: The stakeholders revealed that agricultural workers and the providers who served them showed distinct patterns of utilization of tele health services during and after the COVID-19 pandemic. Some relevant themes are presented below.

Increase in the utilization of digital services: Most stakeholders revealed that the rapid expansion of telemedicine services and digital outreach during the COVID-19 pandemic led to an increase in the availability and utilization of these services among agricultural workers in California.

"So with the pandemic, we started to do more, the telephone visit or video visits, and we started to depend more on their home monitor, home reading, whether it's blood pressure or temperature, and it's becoming more part of our practice." (Primary Care provider)

Tele visits helped to improve healthcare access in rural areas: Most interviewees stated that telemedicine helped improve access to healthcare services for agricultural workers during

and after the COVID-19 pandemic by allowing them to overcome barriers related to transportation and seeking paid time off.

"So we're in this dilemma, provider shortages, specialty care shortages for in-person visits, and transportation costs for the farm worker that are barriers. You want to create other options; pathways to access care, not in lieu of being seen. Because, you're going to need to be seen if it's an emergency or urgent illness situation or specialty care. But you need to have the portal the pathway into the system, and telehealth is one of those systems." (Farmworker advocate)

Preference for audio visits over video visits: Most stakeholders reported a preference for audio visits over video visits due to the ease of use and fewer technical skills required to access the visit among agricultural workers and healthcare providers serving them.

"So, we try to do a video call and a phone call. So, for the video call, we use teams on Microsoft Teams, and that doesn't usually go well with not-so-tech-savvy populations, like in the farmworker population, but when that doesn't work, then we defaulted to phone, just change it to a phone visit, and that seems to be working just fine." (Primary care provider)

Reduced waiting times due to tele visits: The stakeholders revealed that telemedicine allowed providers to reduce waiting times for primary and specialty care as healthcare providers were more willing to schedule these appointments for populations in medically underserved areas.

"What we have experienced is that getting these specialists through telehealth is very easy, and they have a far reach, you know, outreach to these different populations. So they should not stop it." (FQHC provider)

Preference for in-person visits over tele visits: The stakeholders stated that agricultural workers preferred to see their providers in person compared with either audio or video visits as they wanted to have a meaningful long-term relationship with their providers.

"Farmworkers feel like it's not real care because I'm not being seen. I'm just being told over camera. They would feel you want to have the one-on-one as opposed to doing that. I will say that there was a much larger preference for being able to see medical providers in person. So if that were a choice, most people would want to see their medical primary provider in person." (Specialist care provider)

Tele visits used for follow-up, management of simple cases, and review of labs: The stakeholders revealed that they used telemedicine services to manage simple cases, review uncomplicated labs, make routine follow-up visits, and triage patients during and after the pandemic. They stated that these visits helped improve follow-up rates and reduced appointment no-shows.

*"I worked in the COVID times, and I saw that there were less of no shows just because of this telehealth, in general." (*FQHC Provider)

"You know, not just medications, but lab review. So, if they get blood work, we can always do a phone visit to review their labs if they need it or if they do images, too. We can always do a phone visit to review their images, check in after consultants and things like that. (Primary care provider)

Facilitators for digital health integration: The stakeholders discussed that the COVID-19 pandemic led to the rapid expansion of telemedicine services across all health-related disciplines over a short period, enabling agricultural workers to seek healthcare services conveniently. Facilitators for digital health integration are discussed below.

Increase in the utilization of digital devices and services: The interviewees shared that that many agricultural workers have internet-enabled cell phones, and they routinely use social media tools with audio and video sharing, making it easier for them to access telehealth.

"Everyone's becoming a lot more savvy, you know, WhatsApp, as it evolves, you know, is certainly so in our local Mixteco survey, we asked, you know, and everyone, oh, like 50 or 60%, said that they prefer getting messages on WhatsApp and you know, that does video uploads, and it does Audio uploads, and it does direct text. So I think everyone's figuring out these systems a lot faster." (Farmworker advocate)

Use of innovative programs to expand telehealth: Some healthcare providers developed or participated in innovative programs such as ACTIVATE and Connected Care Accelerator (CCA), providing remote patient monitors and successfully interacting with patients virtually.

"*We tried in one of our clinics in Gustine, where we provided them those blood pressure machines, and they were interfaced with our EMR, and we were able to get data from them. I mean, the blood pressure and pulses, it was not a lot of things. Just blood pressure and pulse rate we used to get because patients who are, you know, hypertensive, diabetic. So those patients we use to get whole recordings of the repetitions at home. So we tried that in one of our clinics, and it helped us. It was a wonderful experience."* (FQHC provider)

Role of community-based organizations: The interviewees shared that many agricultural workers mistrust the healthcare system and digital health modalities due to the lack of skills needed to navigate digital health services and fears related to their documentation status. CBOs can help to overcome these barriers and build a sense of trust.

"The Farmworker communities rely on the use of cell phones, and so they're becoming more and more aware of them, and know how to operate and are more trusting of it, but it takes time, and I would also add that working with community-based organizations that know this and connecting with farmworkers can help them ease that fear of the use of technology for accessing care." (Farmworker advocate)

Seamless electronic exchange of patient health information: Some facilities developed systems that permitted seamless transmission of patient health information across providers in their system or their partners. However, these systems did not extend to outside providers, where such exchanges remained difficult across different EMR systems.

"Institutions that use EPIC are able to pull in records from outside institutions, anywhere in the state of California. I think it's really nice that that makes for better health care overall. Because there's just sharing information, even if it is a little more limited, but that doesn't tend to be the case 100% of the time, so sometimes there's situations where you're just kind of left in the dark as to what a person has been treated for." (Specialist provider)

Role of peer educators or community health workers*:* Some interviewees discussed that their organizations successfully used community health workers such as Promotoras to conduct follow-ups after tele visits. They helped to train patients on how to access these visits and helped to promote adherence to treatment regimens, increasing the effectiveness of telemedicine services.

"We utilize tele ICU and tele neuro in the hospital, where you have a physician that can offer their expertise, but also empower health promoters with the knowledge they need to go and empower patients, and I think that it increases the number of touches that that physician has, through the health promoter, because the health promoter lives in the community I think that it seems like a perfect marriage and perfect extension of the telehealth provider" (Specialist provider)

Barriers to digital health integration: The interviewed providers and advocates discussed that these workers faced multidimensional hurdles when attempting to access affordable and reliable digital services to access tele visits.

Limited access to reliable internet services: The stakeholders reported restricted and unreliable access to continuous broadband connectivity for workers residing in rural communities.

"A large portion of the population that work in agriculture kind of live on the outskirts of the city borders, and some of them live in an unincorporated area where the Internet access is splotchy and would drop calls and or make it very difficult to be able to utilize the telehealth app."(Specialist provider)

Lack of technical literacy: Most interviewed providers expressed that their patients who were agricultural workers lacked the technical proficiency to download or access links for video visits.

"Downloading an app onto your phone can be daunting, and I think also that because we don't have equity in kind of internet service, especially in these rural areas, that it makes it difficult to connect, and I think that, yes, it has made a difference." (Specialist provider)

Concerns related to privacy: Some stakeholders revealed that agricultural workers were sometimes reluctant to participate in video visits or digital outreach due to the concerns associated with the lack of privacy in their home or work settings.

"All the CBOs were trying to figure out, okay, like, how do we do digital outreach? Right, so how do we reach these people? And one of the things that was interesting and relevant was that that your housing played a role in how accessible you were. Because, as you know, many farm workers share homes. So, there might be two families or more living in a home, or they may, they may be renting rooms to, you know, like, other people. So what the CBOs found was that it was hard to communicate with and reach people because they didn't have a place to sit in, be quiet in, and focus because there was no room." (Farmworker advocate)

Tele visits not suitable for managing complex cases: The interviewees spoke about the limitations of these modalities as certain severe occupational illnesses or injuries, as well as life-threatening emergencies, require in-person management and cannot be safely managed over tele visits.

"If you are not as familiar with the patient, or if the patient is really presenting new symptoms, then you really do need to look at the patient and see what the problem is. Then, it is not beneficial to try and manage the patients through an audio-only encounter." (Specialty care provider)

Withdrawal of financial incentives for providers*:* The interviewees also discussed the lack of parity reimbursement payments for audio-only encounters, restrictions on new patient encounters following the end of the state pandemic payment regulations and they stated that the new policies would lead to financial strain and disincentivize rural providers from offering these services.

"A lot of these services are not going to be done if they are not reimbursed. So when they're reimbursed at hospitals, but they're not reimbursed at you know, the Rural Health Center, a lot of patients depend on their local health center. We're just making that divide further and further and leaving them behind." (Telehealth service provider)

Language barriers and scarcity of culturally competent care: Many stakeholders revealed that agricultural workers faced language barriers and did not receive culturally competent care.

"I think also navigating the system in terms of English language, you know, most health organizations do have interpreters. But it's, it's not an easy communication, like every time I have to call a patient using an interpreter, it's just not the same flow in the discussion. It's interrupted. Sometimes, it's not interpreted correctly. Sometimes, the interpreter and the patient will go down a path of talking to each other and I'm like, Okay, what is exactly being discussed here, and then I have to interrupt." (Specialist provider)

Limited effectiveness of Promotoras*:* Many providers were unaware of Promotoras groups to promote digital health literacy or build trust. They also reported that these groups had varying levels of training, which resulted in limited effectiveness.

"How one defines Promotora is different from agency to agency, and I think that they can provide a care coordinating function, you know, if appropriately trained and placed within a system that allows for that. So I can't say it's one or the other. Not all Promotoras are going to be case managers, and not all case managers are going to be Promotoras."(Farmworker advocate)

Recommendations: The interviewees were asked to share their recommendations on creating an integrated and coordinated healthcare system for agricultural workers using digital tools. Their ideas were then used to develop models for digital health integration.

Make technological tools more user-friendly: Most stakeholders believe that digital tools need to be tailored to meet the requirements of agricultural workers, such as being available in multiple languages with a simple interface, taking into account the small screen size of their cell phones.

"Modify the syntax so there aren't distractors. For example, one of the things that keeps on being ignored in app design for people like farmworkers is that a lot of formatting that's fairly commonplace for more educated users of interactive apps is unfamiliar to the low literate users who may or may not well have the technology they have. They have mobile phones, they're used to some kinds of interaction, you know, Facebook, or whatever, but they're not used to intensively interactive apps. So I think there's just got to be more thought to include pretty systematic piloting and testing of interface design to make it work?" (Farmworker advocate)

Use of a hybrid model with some in-person and tele-visits: Nearly all stakeholders supported a hybrid model with in-person and tele-visits to develop long-term trusting relationships with the patients, enabling the development of treatment plans grounded in real-world realities.

"I still feel like there has to be that in-person, patient-doctor and or trusted health care provider-patient relationship that is formed, and so telehealth would definitely help with follow-ups, it definitely would help with even initial consultations, but then it would have to be that in-person aspect, and it really is about going to the people because for a physician not to be able to experience what the patient environment looks like, is difficult to make reality-based management plans for those patients." (Specialist provider)

Creation of telehealth access points: Some stakeholders recommended the creation of telehealth access points with smart devices, reliable broadband access, and private spaces manned by digital navigators at user-friendly venues in medically underserved communities.

"TAPS is a telehealth access point. I am a patient; I don't have Wi-Fi at home, or I don't have a cell phone or whatever. The library has a private room with a computer that's got a camera; it's a safe, smart place for me to go where I can privately conduct my telehealth appointment. We now have a map on our website for patients who need an access point for their telemedicine visit, and it may be just a private room with Wi-Fi" (Telehealth provider)

Use of care coordinators who go to patient homes: Some stakeholders suggested that trained Promotoras armed with internet-connected smart devices should go to patient homes and help them access tele visits, clarify post-visit instructions, and schedule follow-up appointments.

"The issues about how you build a culture of actually using those resources and to build that culture, I think, requires intervention on the part of the existing Promotoras for doing

in-person outreach and contacts to build awareness and inclination to use those hubs and that can be done, and ACTIVATE was actually looking at that aspect of it. How could the existing in-person Promotora contacts leverage telehealth?" (Farmworker advocate)

The use of grower-run clinics as telehealth access points: Some interviewees voiced support for grower-run worksite clinics, which can provide preliminary care and serve as telehealth access points, while others voiced concerns about lack of confidentiality and fear of employer retaliation.

"I think the best way to potentially get people the health care that they need, and the health care that they deserve is to treat them where they spend most of their time, right outside of home. Now, even at home, you can use telemedicine to connect with people and get them healthcare services, but outside of the home, it makes the most sense to see people at work." (Specialist provider)

Creation of a separate integrated healthcare system: Some providers expressed that the existing healthcare system is siloed and very complicated to navigate for agricultural workers and suggested creating a separate integrated system of clinics, hospitals, and ancillary services using digital and traditional modalities to provide easily accessible high-quality services.

"The only way would be like some app or something, especially for these workers, or certain clinics that only see these workers, and they have, you know, maybe a lab of their own, that they have maybe like a physical therapist, and an occupational therapist of their own. You know, like, so that the communication amongst the providers isn't a barrier in addition to other barriers." (Primary Care provider)

Creation of binational plans and telehealth agreements: Some stakeholders expressed support for the creation of a binational system of healthcare providers and plans that interact via digital tools to provide comprehensive, integrated service in coordination with physicians from Mexico, although some providers expressed concerns about the quality of care and legislative complexities associated with this approach

"Binational health, why can't we have a system that's blended? Because our communities come and go, they migrate back and forth, and COVID taught us that doesn't change when you get sick. At the same time, you want both systems to work, and Mexico, for example, and here, right. You want to make sure there's enough providers in Mexico, and there's enough providers here. So, it should be part of a more comprehensive approach to the solution." (Farmworker advocate)

Creation of financial incentives for providers: These stakeholders agreed that there was a need to continue pandemic-era reimbursement policies and further expand financial incentives for healthcare providers to ensure their continuation beyond the pandemic.

"I think certainly making sure that all the providers are adequately reimbursed so we remove that as a barrier and the reimbursement may be providing health coverage for the farm workers and through the health coverage, be it Medi Cal or private systems reimburse the providers." (Farmworker advocate)

Inclusion of agricultural workers under Cal AIM: The healthcare providers expressed limited knowledge of Cal AIM, and advocates voiced their support for its extension to agricultural workers using a telehealth-based model to provide integrated services.

"Cal AIM is looking to be kind of this innovative way, and it's really, you know designed around the homeless community, and around mental health. But as what I've observed is, it hasn't risen to the level that yeah, you need to include farmworkers, so they should also be part of the conversation, and also be part of the requirements through these consortiums." (Farmworker advocate)

Discussion: Agricultural workers in California were found to have high levels of digital access, mainly through cell phones equipped with internet services, with approximately one-third of workers having access to a computer, compared with over half of the workers in the rest of the country. These findings are similar to 91.5% of households reporting access to internet-enabled devices but significantly lower than 96% of households reporting computer ownership in California according to the five-year estimates for computer and internet usage from the American Community Survey 2022.[305]

The study indicates that despite having high levels of digital access, very few workers used their digital services for health-related purposes in 2018. These findings are in stark contrast to those of a recent study examining the use of the Internet to seek health information or interact with the healthcare system among adults in the U.S. as per the findings of the National Health Interview Survey (NHIS) 2011-18 which reported that 49.2% individuals reported searching for health-related information online while 18.5% reported having at least one digital interaction (scheduling appointments, filing prescriptions or communicating with provider) with the healthcare system.[306]

The significant predictors of utilization of digital access for health-related purposes among agricultural workers included educational attainment, need for appointment, place of work, income, and having access through a computer or a cell phone with internet access. Age, gender, documentation status, health insurance, region, and preferred language of communication were not significant predictors. These findings differ from the study by Mahajan et al. described above, which showed that younger individuals who were of non-Hispanic white or Asian ethnicity, females with higher income and higher levels of

education who were citizens with health insurance coverage in the Mid-west or Western regions and had pre-existing health conditions were more likely to use digital health services.[306,307]

The deadly COVID-19 pandemic led to a substantial shift in the use of these interventions as the primary means for seeking healthcare services.[181,279] There was a rapid extension of these modalities, deployed on a war footing in clinics and hospitals across the country, touching the lives of patients and providers in communities who had never used them.[172,177,184,286] Some recent studies, such as those based on reports from the California Health Policy Survey 2022 and the Connected Care Accelerator program, examined telehealth utilization patterns during the pandemic and revealed an exponential increase in the use of these digital tools with very high levels of satisfaction among patients and providers in the states who expressed willingness to use them even after the pandemic ended.[160,183,184]

This study indicates that low-income working-age Latinos with income at 250% of the Federal Poverty Level or less in California from the CHIS 2021-22 survey, who were used as a proxy for agricultural workers, had lower levels of telehealth utilization compared with the general adult population of the state. They expressed higher levels of satisfaction with audio visits than video visits but had similar usage patterns for digital tools to seek mental health resources. These findings agree with recent studies that reported wide disparities in telehealth utilization among different communities.[273,308]

A recent study based on the COVID-19 Unequal Racial Burden Survey 2021 conducted in the U.S. revealed lower levels of telehealth access in rural areas and for low-income adults, with no racial or ethnic differences reported in the willingness to use telehealth services.[273] Similar findings were reported from the Health, Ethnicity, and Pandemic study using a nationally representative sample of adults in the U.S., which revealed that Asians had lower levels of utilization than non-Hispanic whites and individuals without health insurance with limited broadband coverage were less likely to use these services.[179] Similar disparities were noted in a study based on Medicaid reimbursement data from Alabama between 2019-21, which showed that despite an overall increase in telemedicine use, there was significantly lower utilization among black and Hispanic communities in the state.[308]

The Technology Adoption Model (TAM) postulates that individual-level factors termed “perceived ease of use” and “perceived usefulness” influence the adoption of any new technology, but it does not consider the role of social relationships and structural determinants that significantly influence these decisions among vulnerable populations.[309,310] The Unified Theory of Acceptance and Use of Technology (UTAT) model proposed by Venkatesh et al. expands on this model by proposing that facilitating conditions and social influence must also be considered key constructs to better explain such choices.[310,311] Some studies have reported that agricultural workers have positive attitudes toward mobile health and telemedicine services[251,312]. However, other studies have revealed that lack of reliable high-speed broadband access and low technical literacy remain major barriers.[212,238] Few recent studies have revealed that distrust of the healthcare

system and adversarial immigration policies have created obstacles to digital health integration. [79,274,296]

The second part of this study uses the "Studying up" approach developed by Laura Nader to examine the perspectives of healthcare providers and farmworker advocates on the impact of digital health on agricultural workers' access to and utilization of healthcare services.[198] According to this approach, it is necessary to consider not only the opinions of those who are receiving the benefit of telehealth but also those tasked with their delivery to develop a comprehensive understanding of the issues and better develop real-world solutions to improve healthcare delivery systems for these workers. [198,199] As discussed in the results section, they revealed that telehealth did help to improve access to healthcare services for agricultural workers. It helped to reduce waiting times and improve adherence to follow-up care with fewer no-shows during telehealth appointments during the pandemic. Most workers and providers showed a preference for audio visits over video visits. There were some concerns about privacy due to overcrowded housing conditions and feelings of mistrust due to fear of deportation among undocumented workers.

These findings are similar to those reported in a retrospective study using appointment-level data from 55 FQHCs in Texas, which showed that compared with in-person visits, tele visits were less likely to result in missed appointments, particularly among individuals with chronic conditions.[302] Another study examining types of visits in California FQHCs between 2019-22 revealed that most tele visits were audio-only and tele visit volumes decreased slightly after the pandemic, with audio visits replaced by in-person visits and video visits which increased following withdrawal of parity payments that were later restored for MediCal patients at FQHCs.[301,313]

The stakeholders revealed that similar to the findings of previous studies, agricultural workers had low levels of health literacy and often tended to ignore their symptoms.[95,97,243] Due to low technical literacy and unreliable high-speed internet access, they preferred audio visits, although they were willing to use and adopt digital tools.[241,314] They highlighted the lack of culturally competent care and mistrust of the healthcare system as barriers to adoption despite the benefits of improved access at a convenient time and location.[79,274] Several studies have reported that Promotoras or peer educators have been successfully used to conduct community outreach and recruit agricultural workers in health-related trials and interventions.[140,235,271]

However, healthcare providers in this study reported that they were either unaware of these peer educator/Promotora services or found them to be untrained volunteers with limited knowledge of the healthcare system. They noted that agricultural workers could benefit from having culturally competent care coordinators who could train them on using digital tools, help them adhere to post-follow-up instructions, and set up referral appointments. Although Promotoras can help to build a bridge with this community, they need to be trained as paid community health workers through structured programs and protocols to enable them to integrate healthcare services in rural areas successfully.[140,236,271,315] The interviewees also provided recommendations on how the delivery of healthcare services can be integrated using digital health interventions. Their

suggestions were used to create several innovative models, displayed in Figure 3.1 on the next page.

They suggested that Promotoras should be recruited and trained as paid community health workers affiliated with the healthcare system and serve as digital care coordinators to help agricultural workers access health and social services virtually through home visits.[139,315] Another model involves setting up telehealth access points in private rooms at community venues such as libraries or grocery stores in rural communities, with Promotoras serving as digital navigators. [174,241] They also recommended that grower-run on-site healthcare facilities use trained medical staff as first responders and digital coordinators for telehealth access points, enabling workers to seek care without needing time off. Other models recommend creating a single streamlined system meant for agricultural workers, which delivers comprehensive care for these workers, while another model recommends establishing binational health plans and healthcare systems by engaging physicians on both sides of the U.S.-Mexico border to provide high-quality, culturally competent, and convenient services. Some interviewees also recommended their inclusion under the Cal AIM initiative for vulnerable communities in the state.

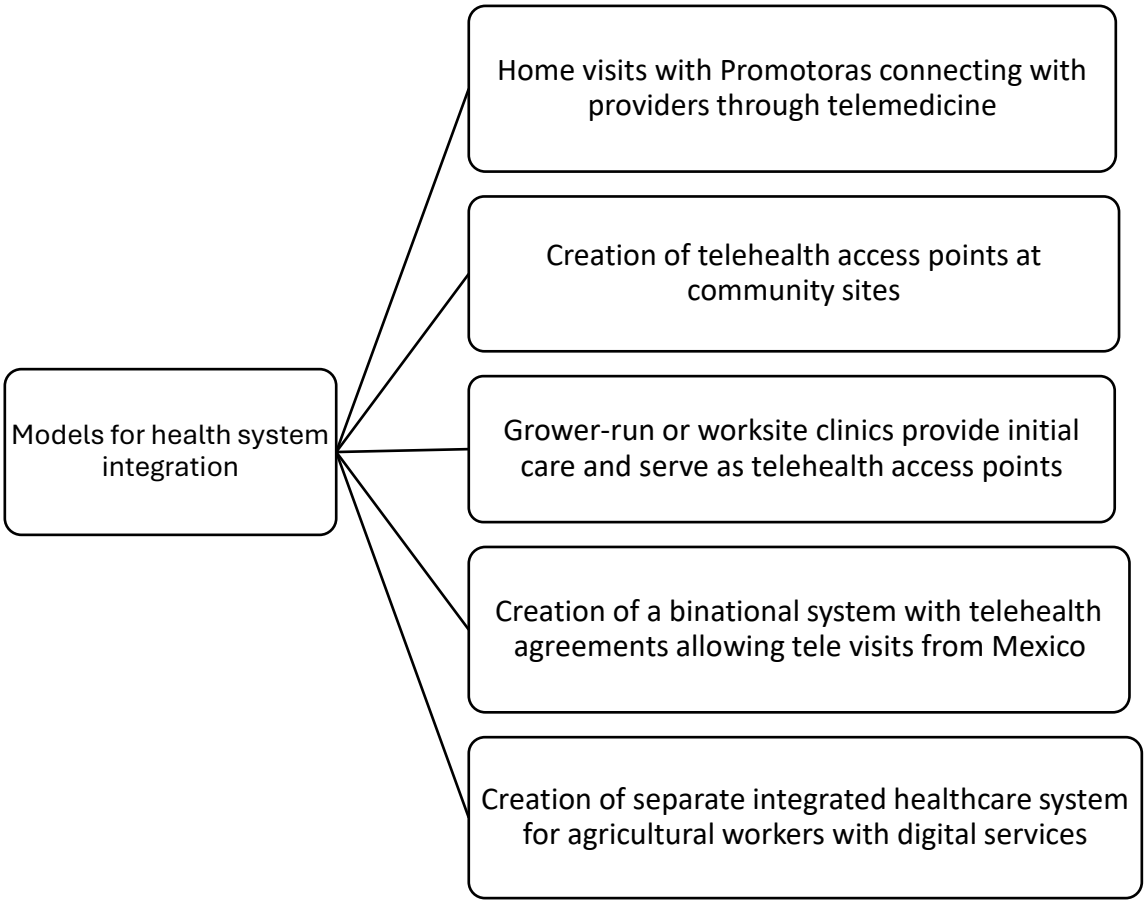

Figure 3.1. Proposed Models for Health System Integration

The interviewees, however, agreed that none of these models could singularly solve all these complex problems, and some combination of these models needs to be developed according to the local availability of resources and the preferences of the agricultural workers in the region. Furthermore, recent policy changes such as the termination of the Affordable Connectivity Program, withdrawal of parity payments for tele visits except at FQHCs and RHCs, and billing audio visits differently than video visits lower financial incentives for providers and patients to continue using these services. The current post-pandemic telehealth policies need to be reviewed in light of new evidence to facilitate the creation of a digitally integrated healthcare system for agricultural workers in the state.

Limitations: This study is subject to certain limitations. Firstly, the study uses data from the NAWS 2018 Digital Access supplement, which does not reflect the impact of the expansion of digital health services during and after the COVID-19 pandemic. Moreover, the survey excluded H2A workers and workers who were not employed in agriculture at the time of the study. However, it is a national-level ongoing survey of agricultural workers in the USA using a random sample of currently employed agricultural workers who are interviewed using a validated questionnaire.[38,75] Moreover, it shows that digital access among agricultural workers was high even before the COVID-19 pandemic.

The latest version of the NAWS survey (2019-20) includes a limited number of questions on healthcare utilization, with no information collected on telehealth access or utilization, due to which the CHIS 2021-22 survey, which included questions on telehealth utilization, was identified as a potential alternative.[200] However, it includes a limited number of self-identified agricultural workers grouped with workers engaged in forestry, fishing, and mining.[200,201] As per previous reports based on NAWS surveys and other studies, most agricultural workers in California are low-income Latinos, and this group was therefore used as a proxy for agricultural workers to examine their patterns of digital health services utilization.[35,36,38,75]

The findings from stakeholder interviews only represent the perspectives of the interviewees and are not generalizable to all farmworker-serving healthcare providers and advocates.[216,316] However, care was taken to examine diverse viewpoints by recruiting study participants operating at various levels of healthcare (primary care, specialty services, telehealth service providers, representatives of FQHCs, hospitals, CBOs, and health policy researchers). The interviews were conducted till theoretical saturation was achieved to ensure comprehensive data collection, followed by systematic coding and validation by two team members to create the models.[194,196]

Conclusions: Agricultural workers in California have high levels of digital access through various devices, including cellphones with text, internet, computers, and tablets. However, before the COVID-19 pandemic, they had minimal utilization of these devices for health-related reasons. The predictors for using digital services for health-related purposes included having higher educational attainment, need for an appointment, working in a nursery, higher levels of income, and having access to a cellphone with internet or a computer. Gender, age, preferred language of communication, immigration status, migrant status, and access to health insurance coverage were not associated with digital health service utilization.

Most agricultural workers in California are low-income Latino workers. As per the findings from the CHIS survey 2021-22, telemedicine (audio and video visits) utilization increased in this population following the rapid expansion of this modality during the pandemic. Approximately two-thirds of low-income Latinos rated audio visits as similar or better than in-person visits, while over half rated video visits as similar or better. However, their levels of utilization were lower than the working-age population of California.

Interviews with farmworker serving healthcare providers and advocates revealed that low levels of health and technical literacy, lack of reliable internet access, privacy concerns, lack of culturally competent services, lack of financial incentives for providers, and distrust of the healthcare system remain barriers to utilization. However, most stakeholders reported that tele visits increased access for agricultural workers, reduced waiting times, and improved follow-up rates. They stated that trained Promotoras acting as culturally competent care coordinators will be crucial in improving health literacy and digital health utilization. They recommended the creation of telehealth access points at community venues or farms or creating a separate system, including binational plans and services to improve access and utilization of digital health services.

Policy implications: Firstly, it helps the readers and policymakers to understand the existing levels of digital access and digital health utilization patterns among agricultural workers in California. Secondly, it highlights the barriers to and facilitators for the adoption of these digital tools in this group. Thirdly, it helps to identify the challenges to digital health integration within the current policy framework. Fourthly, it provides recommendations on how digital tools can help to integrate healthcare services by proposing models of care that can be tested as pilot projects in medically underserved agricultural regions.

Conclusions

Agricultural workers in California constitute a marginalized population who are engaged in a hazardous occupation with very high rates of injuries and illnesses compared with workers involved in other industries in the state.[202,203,317] They suffer from high rates of infectious disease due to their immigration status and the need to work in close proximity to each other.[30–32] They have high rates of undiagnosed chronic diseases due to their lifestyle choices with low levels of health literacy and healthcare utilization compared with other low-income Latino groups and the general population of the state and U.S.[49,318,319]

This dissertation attempted to examine the barriers to access and utilization of healthcare services and their patterns for utilizing routine and emergency healthcare services under the current political climate. It ventured to study their comprehension of classic symptoms of frequently encountered occupational illness and their ability to seek appropriate care in such scenarios. It also attempted to examine the impact of large-scale expansion of digital health services during the COVID-19 pandemic on their healthcare usage, examine their levels of digital access, its utilization for various purposes, and propose new creative models for health system integration for agricultural workers in the state. Each study gathered critical information about their healthcare usage patterns and barriers to health system integration while proposing novel potential solutions to achieve the ultimate objective of improving the overall health and healthcare utilization among agricultural workers in the state.

Major conclusions from Study 1

The findings from the first study revealed that healthcare access and utilization among agricultural workers, who were celebrated as "Essential workers" during the COVID-19 pandemic in California is a convoluted and often ignored issue that nevertheless requires urgent attention from state lawmakers.[3,4] Most agricultural workers live in medically underserved areas, with distance from healthcare facilities frequently touted as a significant barrier to healthcare access.[36,95]The first study examined the impact of distance, socioeconomic, structural, and cultural factors on healthcare access and utilization among this vulnerable population using a mixed methods approach. Distances and travel times from various healthcare facilities were calculated using geocoded locations from UCM FWHS to study their relationship with healthcare utilization, and semi-structured, in-depth, qualitative interviews were conducted with healthcare providers, employers, and advocates who serve agricultural workers to examine their perspectives on barriers and facilitators to healthcare access among these workers.

The study indicates that distance from FQHC or Migrant health clinics is not significantly associated with delays in seeking healthcare services. Although workers who live far away from hospitals and rehabilitation facilities are more likely to delay seeking needed services than those who live near these facilities, the overall impact of distance was limited. The major themes from the interviews revealed that most workers lived close to various healthcare facilities, and their healthcare usage patterns were influenced by the cost of care, sense of financial security, convenience, health insurance coverage, level of health

literacy, availability of culturally competent services and their ability to trust and navigate a tortuous healthcare system.[3,58,78]

The study also indicated the upside of using new methods of care delivery, such as telemedicine, worksite clinics, and mobile clinics, which helped to overcome the barriers of distance, transportation, and convenience, highlighting the need to consider these factors in unison and not isolation while formulating policies to improve access for state agricultural workers and can help to deliver more easily accessible, integrated healthcare services to agricultural workers in the state. A multifaceted approach that incorporates affordable, high-quality services, access to reliable means of public transportation, and providing culturally competent healthcare services at a convenient time and location is needed to address healthcare access and utilization needs among agricultural workers in California. There is an urgent need to not only incorporate contemporary methods but also consider creative solutions such as delivering services after work hours or over weekends using digital or non-digital modalities, ensuring easy availability of reliable transportation services, and building trust by incorporating the services of culturally sensitive peer educators within the existing healthcare system in rural farmworker communities.

Major conclusions from Study 2

Previous studies examining healthcare utilization and care seeking, particularly for occupational symptoms among agricultural workers, were limited in scope, had few workers from California, have become outdated, and do not reflect the status quo. This study filled this gap by examining their actual and intended healthcare utilization patterns within the current health policy landscape in California using data from the UCM Farm Worker Health Study conducted in 2021-22. This study examined the self-reported patterns of routine and emergency healthcare utilization and the intended patterns of information and care-seeking among agricultural workers in California when exposed to symptoms of common occupational illnesses (HRI, PRI, and Valley Fever).

The predictors for healthcare utilization were analyzed using the Anderson model, and their usage patterns were further compared by insurance status through cross-tabulations, Chi-square tests, and regression analyses. Agricultural workers who were survey respondents in the UCM FWHS dataset were found to have reported lower levels of utilization of routine preventive healthcare services compared with other low-income Latino working-age individuals in California. They delayed seeking healthcare services and obtaining prescription drugs more often compared with other low-income Latinos in California. Agricultural workers who had health insurance coverage reported higher levels of utilization of routine preventive services and lower levels of delay in seeking services compared with those who did not have insurance. Insured workers who reported being financially secure enough to cover emergency expenses and had a usual place of care were more likely to use any healthcare services.

Principal Component Analysis was used to classify information-seeking patterns in three occupational illness scenarios. When exposed to symptoms of occupational illness, information and care-seeking patterns among agricultural workers were classified as self-management, use of healthcare service, and community management. The study revealed

that their ability to recognize and appropriately manage symptoms of occupational illnesses remains low despite recent occupational health education initiatives. Workers with lower levels of health literacy are more likely to prefer self-management resources than workers with higher health literacy. A small percentage of agricultural workers were found to use online sources of information when faced with symptoms of any occupational illness. Younger workers without a usual place of care with higher levels of fear of deportation were more likely to use online sources of information for guidance and could benefit from digital community outreach and telemedicine initiatives. Agricultural workers who use online sources of information tend to be younger and less likely to have a usual place of care. New policy options, such as expansion of health insurance coverage and better occupational health education programs, including digital outreach, are needed to improve health literacy and facilitate appropriate healthcare utilization among agricultural workers in California.

Major conclusions from Study 3

Digital health interventions help overcome many barriers to providing farmworkers with high-quality, integrated healthcare services. The COVID-19 pandemic substantially increased their utilization. This study examined the digital utilization patterns among these workers and the views of healthcare professionals and advocates on using digital health to improve services for farm workers using a mixed methods approach and proposed delivery models that might enhance care integration. It used data from the National Agricultural Worker Survey (NAWS) 2018 digital access supplement, California Health Interview Survey (CHIS) 2021-22, and 20 semi-structured, in-depth interviews conducted with farmworker-serving healthcare providers and advocates in California to get an overarching view of the issue.

The findings from the study indicated that agricultural workers had high levels of digital access even before the COVID-19 pandemic, but lower health-related utilization compared with the general population of California. The predictors for using digital services for health-related purposes included having higher educational attainment, need for an appointment, working in a nursery, higher levels of income, and having access to a cellphone with internet or a computer. Data analysis from the CHIS survey revealed that approximately two-thirds of low-income Latinos rated audio visits as similar or better than in-person visits, while over half rated video visits as similar or better. However, their levels of telehealth utilization were lower compared with the working-age population of California.

Most healthcare providers interviewed for the study reported that they mostly use audio visits and have technical difficulties and privacy concerns with video visits. They revealed that lack of technical literacy, unreliable digital infrastructure, lack of financial incentives for providers, and distrust of the healthcare system remain barriers to digital health integration for agricultural workers in the state. Most stakeholders reported that tele visits increased access for agricultural workers, reduced waiting times, and improved follow-up rates. They stated that trained Promotoras acting as culturally competent care coordinators can help improve health literacy and digital health utilization. Although the interviewees

suggested that Promotoras can act as care coordinators and digital navigators, currently, they are not well-trained and widely utilized.

Digital health interventions can help integrate healthcare services for agricultural workers through digital navigators that help connect with tele visits at home or telehealth access points located at community venues with private rooms equipped with high-speed internet services and smart devices. They also recommended the creation of a separate system delivering services exclusively to these workers, developing binational plans and international telehealth licensure and health information exchange agreements to improve access and utilization of digital health services. However, these digital tools need to be simplified, their use financially incentivized for providers, and care coordination provided through trusted messengers to integrate healthcare systems effectively to deliver high-quality services for agricultural workers. The state should ensure access to affordable, fast, and reliable internet access, provide financial incentives for providers, and implement pilot projects on health system integration using trained Promotoras equipped with digital tools affiliated with the healthcare system.

Potentially suitable models for agricultural workers

Agricultural workers live in medically underserved areas with few providers and facilities, leading to long waiting times, inconvenient hours, and a lack of culturally competent providers,[36,51,174] and their actual self-reported patterns and intended care-seeking decisions are influenced by their health literacy, health insurance coverage, financial security, need for services, and having a usual place of care. Despite numerous efforts aimed at increasing awareness about occupational illnesses and methods for reporting illnesses by state regulators, agricultural workers have low levels of occupational health literacy and are often unable to identify symptoms of common occupational illnesses.

In light of the widespread expansion of these services during the pandemic, high levels of digital access among agricultural workers and relatively positive experiences reported by their healthcare providers with these digital health modalities present a viable option to facilitate health system integration for agricultural workers in the state. A versatile and multifarious system is needed to overcome the multiple barriers faced by these workers in trying to access and utilize healthcare services within the current policy framework. Several models to facilitate digital health integration emerged from this project, some of which are briefly discussed here.

The interviewees suggested that Promotoras recruited from within the farmworker communities can be trained as community health workers under special training programs that teach them how to use these devices to access tele visits, set up appointments, and help patients seek health and social care services.[139,315] Some interviewees suggested that they should act as care coordinators and go to the farmworker homes with broadband-enabled devices as utilized for digital outreach and specific clinical trials.[160,249,320] It would help to overcome the barriers of distance, transportation, and convenience and build a friendly atmosphere while keeping them on track with appointments and treatment regimens, as it will create a sense of obligation towards their care coordinator. [160,235,321]

This model resembles the *Case management model* for health system integration wherein patients who are "high utilizers" of healthcare services are assigned a case manager who helps them manage their health condition and ensure regular follow-up and continuity of care.[124,322] This model traditionally does not overcome the problems of provider shortage or cultural competence but the use of telehealth services to connect with distant providers to reduce waiting times, the use of empathetic case managers from their community who make healthcare and social services more accessible, and easily navigable can help create a more integrated healthcare system.[125,126,323]

The second model involves the creation of telehealth access points in communities without access to devices with high-speed internet services, as being done in certain states[174,241], with access to Promotoras, who are trained digital navigators who can help them access visits and facilitate follow-up care stationed at private rooms in user-friendly venues such as schools, libraries or corner stores. The third model envisions grower-run worksite clinics with farmworker-serving trained medical staff serving as initial care providers and digital navigators for telehealth access points, enabling workers to seek care from trained professionals in the fields without needing time off, although some interviewees worried about the lack of patient confidentiality and fear that employer retribution among workers.

These models resemble the *Chronic Care model* for the management of diseases such as diabetes, wherein healthcare providers at large facilities use in-house care coordinators to facilitate better treatment adherence and continuity of care.[119,128,324] Some studies have shown the benefits of creating telehealth access points in vulnerable communities during the pandemic.[178] However, this model is limited to managing select diseases by limited healthcare systems with restricted use of telehealth. Moreover, some interviewees stated that many FQHCs are located within farmworker communities, and this model would not overcome the barriers of transportation and distance unless services were offered outside traditional hours.

The fourth model considers the existing healthcare system too fragmented and complicated for farmworkers to seek healthcare services and recommends creating a separate system with primary, specialist, and ancillary service providers delivering services exclusively to farmworkers through digital and traditional modalities. Although there is an existing system of migrant clinics and FQHCs, they provide limited services, have long waiting times, and often lack culturally competent services, leading to low utilization.[53,54,104] Telemedicine systems can help strengthen the existing systems to deliver high-quality integrated services to farm workers.

The fifth model attempts to overcome the feelings of mistrust in the healthcare system by employing physicians from Mexico who can better understand the health problems and provide services in a culturally sensitive manner. The interviewees recommended the creation of bi-national health insurance plans and telehealth licensure agreements allowing workers to seek care via digital and non-digital means on both sides of the border. These models resemble the *Kaiser model* for health system integration, or a single all-encompassing exclusive system of health insurance and healthcare delivery focused on farmworkers in the state.[108,111,133]

Although such a model can prove very beneficial, it would require substantial policy changes and the release of significant funds to build a new system exclusively for farmworkers, which may not be feasible during the era of budget deficits. Alternatively, some stakeholders recommended the inclusion of agricultural workers under Cal AIM, which provided "Enhanced Care management" and "Social supports" wherein Promotoras can be trained and paid as community health workers.[190] However, not all workers qualify for Medi-Cal under the existing income eligibility limits; it does not have a defined telehealth policy, and this system is focused on "high utilizers," while farmworkers are traditionally considered "low utilizers" of healthcare services.[51]

No single model will work best for all agricultural workers in the state. The stakeholders revealed that a combination of these models comprising a hybrid framework with in-person trained Promotoras engaged in home visits or serving as Digital navigators at telehealth access points should be developed based on the preference of the agricultural workers. They should collaborate closely with culturally sensitive healthcare providers connected via in-person and telemedicine visits while seamlessly sharing information electronically across the state. Efforts should be made to simplify these digital tools, and financial incentives should be created for providers to continue delivering digital services.

Despite the well-documented benefits , some recent policy changes have reduced the impact of digital health interventions, including the end of the Affordable Connectivity Program (ACP), which provided subsidies for broadband coverage for low-income households and the withdrawal of parity payments for in-person and tele visits, particularly audio-only visits except for FQHCs and RHCs, and restricting payments to visits only for continuity of care except for mental health visits.[178,186,307,313] Some interviewees stated that many farmworker-serving primary care and specialist providers who do not work for FQHCs would be disincentivized to conduct tele visits, reducing access in underserved regions.

There is an urgent need to reconfigure these policies in this technological era. Figure 4.1 shows a potential pathway for creating such a system to improve health system integration for this vulnerable community. It can be built on a foundation of reliable high-speed broadband access through affordable smart devices, easily accessible to these workers through subsidies similar to the ACP or paid for through their health insurance providers. They should be able to easily connect to a network of multilingual, culturally competent providers through a hybrid model of in-person and tele visits at a convenient time and location, preferably outside traditional working hours, with Promotoras acting as digital navigators and care coordinators. Finally, this model should be supported by a statewide digital exchange permitting rural providers to create comprehensive and coherent treatment plans for agricultural workers through the seamless exchange of health information across the state.

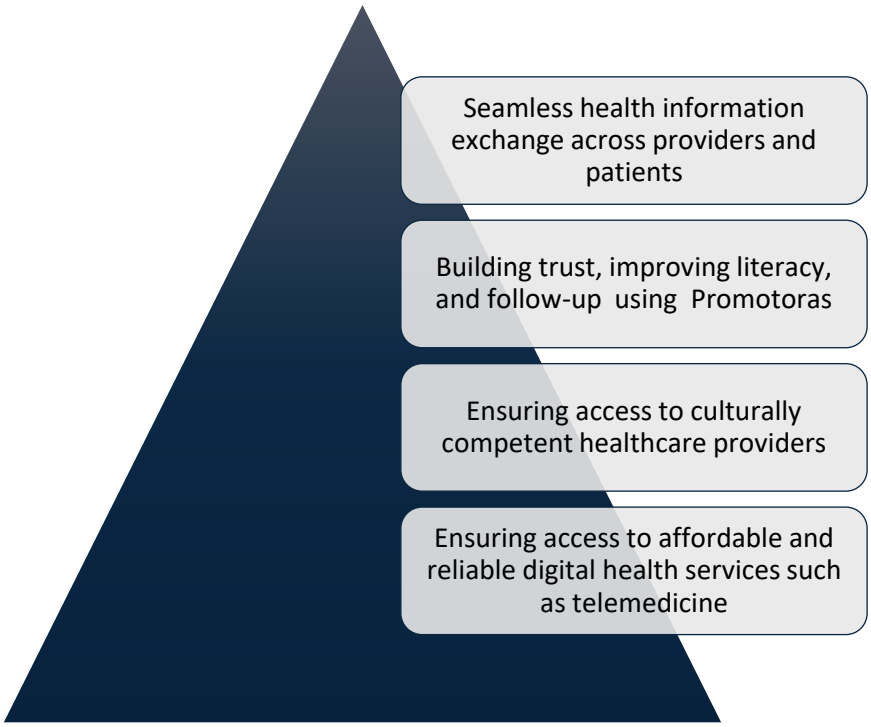

Figure 4.1. Pathway for health system integration for agricultural workers

Policy Implications

The UCM FWHS is a state-funded survey of agricultural workers in California. It is a comprehensive farmworker health survey that collected detailed information about their health status, healthcare access, actual and intended healthcare utilization patterns.[59] The studies described in this dissertation combine the analysis of the results from the survey with qualitative interviews with farmworker-serving healthcare providers, employers, and advocates to help the readers develop an in-depth understanding of the existing healthcare framework in the state under which agricultural workers attempt to take care of their health while working in hazardous occupational conditions.

These studies demonstrate the complexity of improving healthcare access and utilization for agricultural workers in the state and emphasize the need for a comprehensive analysis of the issue with a panoramic viewpoint. Policymakers and healthcare providers should consider making high-quality yet affordable services available to agricultural workers in a convenient manner. Attempts should be made to develop policy initiatives that provide financial incentives for rural healthcare providers to offer their services during non-traditional working hours, such as in the evenings or on the weekends, so that workers can seek services without the fear of losing wages due to a lack of paid time off or face employer retaliation such as having reduced hours or getting fired from their job.[54,95,97,213] New policies should be created to ensure the widespread availability of reliable public

transportation services in rural areas in conjunction with paid time off and job security so that these workers can utilize healthcare services conveniently and without fear.[4,36]

There is also an urgent need to introduce culturally competent healthcare providers in rural communities supported by peer educators such as Promotoras in farm worker communities to build trust and dispel myths and fears about the healthcare system.[139,140,235] In the absence of a bipartisan federal push for universal health insurance coverage, state policymakers should consider expanding health insurance coverage for all vulnerable and marginalized communities, such as agricultural workers, regardless of income or immigration status. Although Medi-Cal expansion has helped to improve access to health insurance coverage for previously uninsured undocumented workers, studies have shown that uptake remains limited, and these benefits will not extend to all workers due to the current income eligibility limits.[51,57] Efforts should be made to explore new policies to expand health insurance, such as opening the Covered California health insurance exchange for undocumented workers and ensuring higher take-up and utilization of Medi-Cal and other forms of health insurance by eligible workers.[57,58,263]

The second study also helps to examine the ability of agricultural workers to identify the typical symptoms related to common occupational illnesses associated with exposure to heat, pesticides, and Valley fever. It also describes their information and care-seeking patterns when exposed to such diseases. Although there have been several efforts by state agencies to educate agricultural workers on these pressing issues, the findings of this study are in agreement with other recent studies that highlight the deficiencies in these occupational health education programs and an urgent need to improve occupational health literacy among these workers.[27,241,325,326] There is an urgent need to develop more effective, culturally competent educational interventions to better prevent and manage occupational injuries and diseases using traditional and digital channels for community outreach.

This mixed methods study on digital access and utilization among agricultural workers in California can help policymakers understand the current state of digital health access and utilization among these workers compared with the rest of the country. It enables the readers to understand the significant barriers and facilitators for utilizing digital health interventions among these workers from the perspectives of healthcare providers and farmworker advocates. It also helps to explore innovative ways in which digital tools can help farmworker-serving rural healthcare providers improve access to care and integrate healthcare services in medically underserved rural areas. It also highlights the critical role of culturally competent providers in rural areas and the need to invest in healthcare-related training for Promotoras to serve as effective case managers in an integrated healthcare services framework.

The state should consider extending pandemic-era telehealth policies such as parity payments for in-person and virtual visits to improve healthcare accessibility and affordability. The state should consider policies to provide subsidized high-speed broadband services or create telehealth access points for vulnerable populations in underserved communities. The state should consider funding a pilot project using Promotoras, who are trained and affiliated with the healthcare system, to train workers on using digital resources and navigating the healthcare system. The state should consider

including farm workers under the Cal Aim initiative for providing integrated healthcare services for vulnerable communities. The state should consider creating binational health plans and telehealth agreements with culturally competent physicians from Mexico.

Creative solutions to healthcare delivery problems, such as mobile clinics, worksite services, and telemedicine, should be incorporated within the existing system and further expanded to ensure that agricultural workers in California have easy and convenient access to healthcare services.[59,174,327,328] It also helps to identify the policy barriers to the expansion of digital health services, such as the lack of financial incentives for providers following the withdrawal of parity reimbursement rates for audio visits similar to in-person visits after the end of the pandemic, except for FQHCs or RHCs[301,313] There are significant challenges in telehealth expansion associated with ensuring reliable broadband services for low-income communities following the end of the Affordable Connectivity program (ACP). [186] The current version of the Community Health Worker model lacks appropriate training and financial incentives for Promotoras, particularly those who function as undocumented volunteers and lack sufficient knowledge of the healthcare system to serve as effective care coordinators[235,236,315]

Opportunities for future research

The studies described in this dissertation provide an overview of the current state of healthcare access, utilization, and healthcare delivery systems for agricultural workers in California. These studies present numerous opportunities to examine ways to improve the delivery and utilization of healthcare services via traditional and digital modalities for outreach and service delivery. Some potential opportunities for future research in this field are briefly described in the paragraphs below.

Future studies can use the information presented in this manuscript to better understand the existing framework for healthcare delivery for agricultural workers in the state. They can then examine the gaps in care due to the current state policies and help identify opportunities for improvement. They can also identify new techniques to improve the utilization of routine preventive services and prevent delays in seeking services among these workers. They can examine the impact of the widespread expansion of mobile clinics and the setting up of some worksite clinics during the COVID-19 pandemic on healthcare access and utilization for these workers while delving deeper into whether the workers receive culturally competent healthcare services at farmworker serving FQHCs and, if not, how these services can be improved.

There are limited sources of information on the actual patterns of healthcare utilization of in-person services and various digital health services among agricultural workers before, during, and after the pandemic.[246,296,297,329] Future researchers can attempt to fill this gap through surveys examining the use of digital health services focused on this vulnerable population on an ongoing basis, thereby analyzing their use within the current policy framework and providing recommendations on improving healthcare utilization. They can also explore the relationship between the utilization of online sources of

information when exposed to symptoms of occupational injuries and illnesses and actual healthcare utilization among these workers.

Researchers can also conduct Discrete Choice Experiments (DCEs) to determine the type of healthcare services agricultural workers prefer to seek via in-person and telehealth interactions. It can help determine the kind of provider they want to see, the type of service they desire, the hours of operation that are most convenient, and the type of devices they prefer to use when seeking digital health services. It can also help determine their willingness to pay for such treatment, generating valuable information for state policymakers and health insurance providers to make strategic decisions related to reimbursement for these services and can also help to design more user-friendly, affordable, and effective healthcare programs for agricultural workers and similar vulnerable populations in the state.

They can attempt to examine the barriers and facilitators for the utilization of digital devices for healthcare-related reasons among these workers. They can evaluate the impact of new policy changes, including sequential MediCal expansion for undocumented workers and the rapid extension of telemedicine during the COVID-19 pandemic. They can examine the benefits and drawbacks of using digital community outreach to disseminate occupational health messages among agricultural workers in California. Researchers can focus on investigating the impact of digital health-related policies, such as the restrictions on new patient interactions via telehealth, end-of-parity payments for telehealth services, and lower reimbursements specifically for audio visits delivered outside FQHCs and RHCs. Similarly, they can investigate the effects of the termination of the Affordable Connectivity program on ensuring continuity of care through telemedicine services and present a case for the state-sponsored extension of this scheme.[186,190,313] They can examine the effects of these policies on the availability and utilization of healthcare services by agricultural workers by comparing usage patterns before and after their enactment and asking for patient and provider perspectives on the effects of these changes.

Another avenue for research includes examining the impact of using integrated care coordination systems for currently defined “high utilizer” populations under the Cal AIM initiative and analyzing the potential for their extension to agricultural workers. This study helps to inform health services researchers about various innovative models that can overcome challenges to digital health access and utilization among agricultural workers. Pilot projects can also be conducted using information from this study to help design and evaluate new frameworks for delivering high-quality, integrated, and coordinated healthcare services for California farm workers. Researchers can also assess the impact of innovative telehealth-based projects such as ACTIVATE[160] focused on improving the management of diabetes and hypertension among low-income Latino households and the creation of telehealth access points for rural populations in states such as North Carolina[174,241]. They can use the knowledge gained from these projects to design affordable, easily accessible, tailored, telemedicine-based, integrated, and coordinated healthcare services for farmworker communities in California.

References

1. Kassel K, Martin A. USDA ERS - Ag and Food Sectors and the Economy. February 24, 2022. Accessed September 4, 2022. https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/ag-and-food-sectors-and-the-economy/
2. USDA ERS. United States Department of Agriculture FAQs. March 2024. Accessed August 28, 2024. https://www.ers.usda.gov/faqs#:~:text=Agriculture%2C%20food%2C%20and%20related%20industries,products;%20and%20forestry%20and%20fishing.
3. Becot F, Inwood S, Bendixsen C, Henning-Smith C. Health Care and Health Insurance Access for Farm Families in the United States during COVID-19: Essential Workers without Essential Resources? *https://doi.org/101080/1059924X20201814924*. 2020;25(4):374-377. doi:10.1080/1059924X.2020.1814924
4. Goldman S, Aspenson A, Bhatnagar P, Martin R. *Essential and in Crisis a Review of the Public Health Threats Facing Farmworkers in the U.S.*; 2021.
5. Kim KH, Kabir E, Jahan SA. Exposure to pesticides and the associated human health effects. *Science of The Total Environment*. 2017;575:525-535. doi:10.1016/J.SCITOTENV.2016.09.009
6. Curl CL, Spivak M, Phinney R, Montrose L. Synthetic Pesticides and Health in Vulnerable Populations: Agricultural Workers. *Curr Environ Health Rep*. Published online 2020:13-29. doi:10.1007/s40572-020-00266-5
7. Martin-Reina J, Casanova AG, Dahiri B, et al. Adverse health effects in women farmers indirectly exposed to pesticides. *Int J Environ Res Public Health*. 2021;18(11). doi:10.3390/IJERPH18115909
8. Heinzerling A, Laws RL, Frederick M, et al. Risk factors for occupational heat-related illness among California workers, 2000–2017. *Am J Ind Med*. 2020;63(12):1145-1154. doi:10.1002/AJIM.23191
9. Jackson LL, Rosenberg HR. Preventing Heat-Related Illness Among Agricultural Workers. *https://doi.org/101080/1059924X2010487021*. 2010;15(3):200-215. doi:10.1080/1059924X.2010.487021
10. National Safety Council. Workers' Compensation Costs - Injury Facts. 2023. Accessed March 12, 2023. https://injuryfacts.nsc.org/work/costs/workers-compensation-costs/
11. Missikpode C, Peek-Asa C, Wright B, Ramirez M. Characteristics of agricultural and occupational injuries by workers' compensation and other payer sources. *Am J Ind Med*. 2019;62(11):969-977. doi:10.1002/AJIM.23040
12. BLS. Injuries, Illnesses and Fatalities. U.S. Bureau of Labor Statistics.
13. Gorucu S, Michael J, Chege K. Nonfatal Agricultural Injuries Treated in Emergency Departments: 2015-2019. *J Agromedicine*. Published online January 2022:41-50.

14. Lee D. Fatal Occupational injuries in California. Department of Industrial Relations.

15. Jackslitsch B, Musolin K, Kim JH, Williams J, Tuner N, Coca A. *Occupational Exposure to Heat and Hot Environments Revised Criteria 2016*.; 2016.

16. El Khayat M, Halwani DA, Hneiny L, Alameddine I, Haidar MA, Habib RR. Impacts of Climate Change and Heat Stress on Farmworkers' Health: A Scoping Review. *Front Public Health*. 2022;10:782811. doi:10.3389/FPUBH.2022.782811/FULL

17. Cordero M, Tesfaye E. *Poor Regulatory Safeguards Leave Farmworkers Suffocating in the Face of Increasing Heat Waves*.; 2024.

18. Langer CE, Armitage TL, Beckman S, Tancredi DJ, Mitchell DC, Schenker MB. How Does Environmental Temperature Affect Farmworkers' Work Rates in the California Heat Illness Prevention Study? *J Occup Environ Med*. 2023;65(7):e458. doi:10.1097/JOM.0000000000002853

19. Adewumi-Gunn T, Constible J. *Feeling the Heat*.; 2022.

20. Hesketh M, Wuellner S, Robinson A, Adams D, Smith C, Bonauto D. Heat related illness among workers in Washington State: A descriptive study using workers' compensation claims, 2006-2017. *Am J Ind Med*. 2020;63(4):300-311. doi:10.1002/AJIM.23092

21. Smith DJ, Ferranti EP, Hertzberg VS, Mac V. Knowledge of Heat-Related Illness First Aid and Self-Reported Hydration and Heat-Related Illness Symptoms in Migrant Farmworkers. *Workplace Health Saf*. 2021;69(1):15-21. doi:10.1177/2165079920934478

22. Langer CE, Mitchell DC, Armitage TL, et al. Are Cal/OSHA Regulations Protecting Farmworkers in California From Heat-Related Illness? *Journal of Occupational Environmental Medicine*. Published online 2021:532-539.

23. Prado JB, Mulay PR, Kasner EJ, Bojes HK, Calvert GM. Acute Pesticide-Related Illness Among Farmworkers: Barriers to Reporting to Public Health Authorities. *J Agromedicine*. 2017;22(4):395. doi:10.1080/1059924X.2017.1353936

24. Sellen J. *Number of Farmworkers Sickened by Pesticides More than Doubled in One Year, According to State Report | Californians for Pesticide Reform*.; 2020. Accessed July 13, 2023. https://www.pesticidereform.org/xnumber-of-farmworkers-sickened-by-pesticides-more-than-doubled-in-one-year-according-to-state-report/

25. Amaral AFS. Pesticides and asthma: Challenges for epidemiology. *Front Public Health*. 2014;2(JAN). doi:10.3389/FPUBH.2014.00006

26. Bailey HD, Infante-Rivard C, Metayer C, et al. Home pesticide exposures and risk of childhood leukemia: Findings from the childhood leukemia international consortium. *Int J Cancer*. 2015;137(11):2644-2663. doi:10.1002/IJC.29631

27. Rao P, Quandt SA, Doran AM, Snively BM, Arcury TA. Pesticides in the homes of farmworkers: Latino mothers' perceptions of risk to their children's health. *Health Educ Behav*. 2007;34(2):335-353. doi:10.1177/1090198106288045

28. Cushing L, Faust J, August LM, Cendak R, Wieland W, Alexeeff G. Racial/ethnic disparities in cumulative environmental health impacts in California: Evidence from a statewide environmental justice screening tool (CalEnviroScreen 1.1). *Am J Public Health*. 2015;105(11):2341-2348. doi:10.2105/AJPH.2015.302643

29. Marlier ME, Brenner KI, Liu JC, et al. Exposure of agricultural workers in California to wildfire smoke under past and future climate conditions. *Environmental Research Letters*. 2022;17(9):094045. doi:10.1088/1748-9326/AC8C58

30. CDC. Prevention and Control of Tuberculosis in Migrant Farm Workers Recommendations of the Advisory Council for the Elimination of Tuberculosis *. CDC. 1992. Accessed March 12, 2023. https://www.cdc.gov/mmwr/preview/mmwrhtml/00032773.htm

31. Raysoni AU. A Socio-Ecological Model to Assess Tuberculosis in Migrant Farmworkers in the US-Mexico Border Region. *Occupational Diseases and Environmental Medicine*. 2022;10:132-147. doi:10.4236/odem.2022.102011

32. Boggess B, Prager S, Lincoln JM, et al. CDC-Supported National Network of Farmworker-Serving Organizations to Mitigate COVID-19. *https://doi.org/102105/AJPH2022307159*. 2023;113(2):166-169. doi:10.2105/AJPH.2022.307159

33. Lusk JL, Chandra R. Farmer and farm worker illnesses and deaths from COVID-19 and impacts on agricultural output. *PLoS One*. 2021;16(4):e0250621. doi:10.1371/JOURNAL.PONE.0250621

34. McCurdy SA, Portillo-Silva C, Sipan CL, Bang H, Emery KW. Risk for Coccidioidomycosis among Hispanic Farm Workers, California, USA, 2018. *Emerg Infect Dis*. 2020;26(7):1430. doi:10.3201/EID2607.200024

35. Ornelas I, Fung W, Gabbard S, Carroll D. *California Findings from the National Agricultural Workers Survey (NAWS) 2015–2019: A Demographic and Employment Profile of California Farmworkers Research Report No. 15*.; 2022.

36. Soto S, Yoder AM, Aceves B, Nuno T, Sepulveda R, Ballesteros C. Determining Regional Differences in Barriers to Accessing Health Care Among Farmworkers Using the National Agricultural Workers Survey. *J Immigr Minor Health*. Published online 2022.

37. Pearson D, Ebisu K, Wu X, Basu R. A Review of Coccidioidomycosis in California: Exploring the Intersection of Land Use, Population Movement, and Climate Change. *Epidemiol Rev*. 2019;41(1):145-157. doi:10.1093/EPIREV/MXZ004

38. Ornelas I, Fung W, Gabbard S, Carroll D. Findings from the National Agricultural Workers Survey (NAWS) 2017-2018: A Demographic and Employment Profile of United States Farmworkers. Published online March 2021.

39. Kandilov AMG, Kandilov IT. The impact of the Affordable Care Act Medicaid expansions on agricultural workers' health insurance coverage, medical care

utilization, and labor supply. *Am J Agric Econ*. 2022;104(3):1026-1049. doi:10.1111/AJAE.12263

40. Kiehne E, Mendoza NS. Migrant and Seasonal Farmworker Food Insecurity: Prevalence, Impact, Risk Factors, and Coping Strategies. *http://dx.doi.org/101080/1937191820151019173*. 2015;30(5):397-409. doi:10.1080/19371918.2015.1019173

41. Quandt SA, Kinzer HT, Trejo G, Mora DC, Sandberg JC. The health of women farmworkers and women in farmworker families in the eastern United States. *Latinx Farmworkers in the Eastern United States: Health, Safety, and Justice: Second Edition*. Published online April 7, 2020:133-161. doi:10.1007/978-3-030-36643-8_6/FIGURES/2

42. Chengane S, Beseler C, Duysen E, Rautiainen R. Occupational stress among farm and ranch operators in the midwestern United States. *BMC Public Health*. 2021;1:12-21.

43. Block SM. Invisible Survivors: Female Farmworkers in the United States and the Systematic Failure to Report Workplace Harassment and Abuse. *Texas Journal of Women, Gender, and the Law*. 2014;24. Accessed January 22, 2023. https://heinonline.org/HOL/Page?handle=hein.journals/tjwl24&id=133&div=&collection=

44. Mora DC, Quandt SA, Chen H, Arcury TA. Associations of Poor Housing with Mental Health Among North Carolina Latino Migrant Farmworkers. *J Agromedicine*. 2016;21(4):327. doi:10.1080/1059924X.2016.1211053

45. Arcury TA, Talton JW, Summers P, Chen H, Laurienti PJ, Quandt SA. Alcohol Consumption and Risk for Dependence Among Male Latino Migrant Farmworkers Compared to Latino Nonfarmworkers in North Carolina. *Alcohol Clin Exp Res*. 2016;40(2):377-384. doi:10.1111/ACER.12969

46. Mora DC, Quandt SA, Chen H, Arcury TA. Associations of Poor Housing with Mental Health Among North Carolina Latino Migrant Farmworkers. *J Agromedicine*. 2016;21(4):327-334. doi:10.1080/1059924X.2016.1211053

47. Moyce S, Hernandez K, Schenker M. Diagnosed and Undiagnosed Diabetes among Agricultural Workers in California. *J Health Care Poor Underserved*. 2019;30(4):1289-1301. doi:10.1353/HPU.2019.0102

48. Thompson RH, Snyder AE, Burt DR, Greiner DS, Luna MA. Risk screening for cardiovascular disease and diabetes in Latino migrant farmworkers: a role for the community health worker. *J Community Health*. 2015;40(1):131-137. doi:10.1007/S10900-014-9910-2

49. Matias SL, French CD, Gomez-Lara A, Schenker MB. Chronic disease burden among Latino farmworkers in California. *Front Public Health*. 2022;10. doi:10.3389/FPUBH.2022.1024083

50. Deka MA. The Geography of Farmworker Health in Colorado: An Examination of Disease Clusters and Healthcare Accessibility. *J Agromedicine*. 2021;26(2):162-173. doi:10.1080/1059924X.2020.1765930

51. Cha P, Collins J. *Health Care Access among California's Farmworkers*.; 2022.

52. Schenker MB, McCurdy SA, Riden HE, Viallarejo D. *Improving the Health of Agricultural Workers and Their Families in California Current Status and Policy Recommendations*.; 2015.

53. Garcia D, Hopewell J, Liebman AK, Mountain K. The migrant clinicians network: connecting practice to need and patients to care. *J Agromedicine*. 2012;17(1):5-14. doi:10.1080/1059924X.2012.632746

54. Arcury TA, Quandt SA. Delivery of Health Services to Migrant and Seasonal Farmworkers. *Annu Rev Public Health*. 2007;28:345-363. doi:10.1146/annurev.publhealth.27.021405.102106

55. RHIhub. Rural Migrant Health.

56. Bloss JE, LePrevost CE, Zahra AG, et al. Advancing the Health of Migrant and Seasonal Farmworkers in the United States: Identifying Gaps in the Existing Literature. *Health Promotion Practice in Rural Settings*. 2021;23:432-444. doi:10.1177/15248399211033308

57. Kandilov AMG, Kandilov IT. The impact of the Affordable Care Act Medicaid expansions on agricultural workers' health insurance coverage, medical care utilization, and labor supply. *Am J Agric Econ*. 2022;104(3):1026-1049. doi:10.1111/AJAE.12263

58. Sandhu N, Strochlic R, Getz C, Diringer J, Brown P. Health Insurance coverage for Farmworkers in California After the Introduction of the Affordable Care Act A Mixed-methods Study. *Med Care*. Published online December 2022.

59. Brown P, Flores E, Padilla A. *Farmworker Health in California: Health in a Time of Contagion, Drought and Climate Change*.; 2023.

60. Hoerster KD, Mayer JA, Gabbard S, et al. Impact of Individual-, Environmental-, and Policy-Level Factors on Health Care Utilization Among US Farmworkers. *Am J Public Health*. 2011;101(4):685-692. doi:10.2105/AJPH.2009

61. NILC. Public Charge - National Immigration Law Center. 2022. Accessed September 5, 2022. https://www.nilc.org/issues/economic-support/pubcharge/

62. Touw S, McCormack G, Himmelstein DU, Woolhandler S, Zallman L. Immigrant Essential Workers Likely Avoided Medicaid And SNAP Because Of A Change To The Public Charge Rule. *Health Aff (Millwood)*. 2021;40(7):1090. doi:10.1377/HLTHAFF.2021.00059

63. Cyr ME, Etchin AG, Guthrie BJ, Benneyan JC. Access to specialty healthcare in urban versus rural US populations: A systematic literature review. *BMC Health Serv Res*. 2019;19(1):1-17. doi:10.1186/S12913-019-4815-5/FIGURES/4

64. Liss B. *Its Time to Re-Examine Gain Sharing: An Elegant Solution to Critical Issues Facing Rural and Unaffiliated Hospitals*.; 2019. Accessed November 11, 2022. https://media.gibbonslaw.com/wp-content/uploads/2019/10/09155739/Gibbons-P.C.-Healthcare-White-Paper-Its-Time-to-Re-Examine-Gainsharing-B.-Liss-October-2019.pdf

65. HRSA. What is Shortage Designation? | Bureau of Health Workforce. 2022. Accessed January 22, 2023. https://bhw.hrsa.gov/workforce-shortage-areas/shortage-designation#hpsas

66. Kirby JB, Yabroff KR. Rural–Urban Differences in Access to Primary Care: Beyond the Usual Source of Care Provider. *Am J Prev Med*. 2020;58(1):89-96. doi:10.1016/J.AMEPRE.2019.08.026

67. Coughlin S, Clary C, Johnson JA, et al. Continuing Challenges in Rural Health in the United States. *Journal of Environmental Health Science*. Published online December 2019:90-92.

68. Chatterjee P, Werner R, Joynt Maddox K. Medicaid Expansion Alone Not Associated With Improved Finances, Staffing, Or Quality At Critical Access Hospitals. *Health Affairs (Millwood)*. Published online 2021:1846-1855.

69. Jiang HJ, Fingar KR, Liang L, Henke RM. Risk of Closure Among Independent and Multihospital-Affiliated Rural Hospitals. *JAMA Health Forum*. 2022;3(7):e221835-e221835. doi:10.1001/JAMAHEALTHFORUM.2022.1835

70. Zhang D, Son H, Shen Y, et al. Assessment of Changes in Rural and Urban Primary Care Workforce in the United States From 2009 to 2017. *JAMA Netw Open*. 2020;3(10):e2022914-e2022914. doi:10.1001/JAMANETWORKOPEN.2020.22914

71. Germack HD, Kandrack R, Martsolf GR. When rural hospitals close, the physician workforce goes. *Health Aff*. 2019;38(12):2086-2094. doi:10.1377/HLTHAFF.2019.00916/ASSET/IMAGES/LARGE/FIGUREEX2.JPEG

72. Ricketts TC. Workforce issues in rural areas: A focus on policy equity. *Am J Public Health*. 2005;95(1):42-48. doi:10.2105/AJPH.2004.047597

73. Syed ST, Gerber BS, Sharp LK. Traveling towards disease: Transportation barriers to health care access. *J Community Health*. 2013;38(5):976-993. doi:10.1007/S10900-013-9681-1/TABLES/1

74. Arcury TA, Preisser JS, Gesler WM, Powers JM. Access to transportation and health care utilization in a rural region. *J Rural Health*. 2005;21(1):31-38. doi:10.1111/J.1748-0361.2005.TB00059.X

75. Gold A, Fung W, Gabbard S, Carroll D. *Findings from the National Agricultural Workers Survey (NAWS) 2019–2020: A Demographic and Employment Profile of United States Farmworkers Research Report No. 16* .; 2022.

76. Mattson J. Transportation, Distance, and Health Care Utilization for Older Adults in Rural and Small Urban Areas. *https://doi.org/103141/2265-22*. 2011;(2265):192-199. doi:10.3141/2265-22

77. Schmalzried HD, Fallon LF. Reducing barriers associated with delivering health care services to migratory agricultural workers. Published online 2012. doi:10.3316/INFORMIT.625993321016939

78. Arcury TA, Estrada JM, Quandt SA. ASHCA/NIOSH conference: Panel presentation: Overcoming language and literacy barriers in safety and health training of agricultural workers. *J Agromedicine*. 2010;15(3):236-248. doi:10.1080/1059924X.2010.486958

79. Held ML, Nulu S, Faulkner M, Gerlach B. Climate of Fear: Provider Perceptions of Latinx Immigrant Service Utilization. *J Racial Ethn Health Disparities*. 2020;7(5):901-912. doi:10.1007/S40615-020-00714-W/TABLES/4

80. Nakayama M, Inoue R, Miyata S, Shimizu H. Health Information Exchange between Specialists and General Practitioners Benefits Rural Patients. *Appl Clin Inform*. 2021;12(3):564-572. doi:10.1055/S-0041-1731287/ID/JR210045RA-39

81. Brems C, Johnson ME, Warner TD, Roberts LW. Barriers to healthcare as reported by rural and urban interprofessional providers. *J Interprof Care*. 2006;20(2):105-118. doi:10.1080/13561820600622208

82. Vest JR, Gamm LD. Health information exchange: persistent challenges and new strategies. *Journal of Informatics in Health and Biomedicine*. Published online 2009. doi:10.1136/jamia.2010.003673

83. Chaudhary OA. Developing the Foundation for Syndromic Surveillance and Health Information Exchange for Yolo County, California. *Online J Public Health Inform*. 2012;4(2). doi:10.5210/OJPHI.V4I2.4213

84. Curry Natasha, Ham Chris, Sugarman Jane, King Edward's Hospital Fund for London. Clinical and service integration. The route to improved outcomes. *Int J Integr Care*. 2012;12:56. Accessed October 24, 2022. /pmc/articles/PMC3601513/

85. Klompas M, McVetta J, Lazarus R, et al. Integrating clinical practice and public health surveillance using electronic medical record systems. *Am J Prev Med*. 2012;42(6 Suppl 2). doi:10.1016/J.AMEPRE.2012.04.005

86. WHO. *Strengthening People-Centred Health Systems in the WHO European Region: Framework for Action on Integrated Health Services Delivery Working Document REGIONAL COMMITTEE FOR EUROPE 66th SESSION*.; 2016. Accessed October 24, 2022. http://www.euro.who.int/en/who-we-are/governance

87. Allen D, Gillen E, Rixson L. The Effectiveness of Integrated Care Pathways for Adults and Children in Health Care Settings: A Systematic Review. *JBI Libr Syst Rev*. Published online 2009. Accessed October 30, 2022. https://pubmed.ncbi.nlm.nih.gov/27820426/

88. Leider JP, Meit M, Mac McCullough J, et al. The State of Rural Public Health: Enduring Needs in a New Decade. *Am J Public Health*. 2020;110(9):1283. doi:10.2105/AJPH.2020.305728

89. Doshi M, Lopez WD, Mesa H, et al. Barriers & facilitators to healthcare and social services among undocumented Latino(a)/Latinx immigrant clients: Perspectives from frontline service providers in Southeast Michigan. *PLoS One*. 2020;15(6):e0233839. doi:10.1371/JOURNAL.PONE.0233839

90. Mendez IM, Pories ML, Cordova L, Malki A, Wiggins MF, Lee JGL. A pilot project to increase health literacy among youth from seasonal farmworker families in rural eastern North Carolina: a qualitative exploration of implementation and impact. *J Med Libr Assoc*. 2019;107(2):179. doi:10.5195/JMLA.2019.560

91. Sudhinaraset M, Nwankwo E, Choi HY. Immigration enforcement exposures and COVID-19 vaccine intentions among undocumented immigrants in California. *Prev Med Rep*. 2022;27. doi:10.1016/J.PMEDR.2022.101808

92. Lor M, Xiong P, Park L, Schwei RJ, Jacobs EA. Western or Traditional Healers? Understanding Decision Making in the Hmong Population. *West J Nurs Res*. 2017;39(3):400. doi:10.1177/0193945916636484

93. McCullagh MC, Sanon MA, Foley JG. Cultural Health Practices of Migrant Seasonal Farmworkers. *J Cult Divers*. 2015;22(2):64. Accessed January 27, 2023. /pmc/articles/PMC4778556/

94. Walker R, Ceo C, Looout Meno Ya S, et al. Sioux Lookout Meno Ya Win Health Centre. Barbara Linkewich, RN, HBScN, IBCLC, CHPCN(C). Vice President of Health Services, Sioux Lookout Meno Ya Win Health Centre. *Achieving Cultural Integration in Health Services*. Published online 2010.

95. Hoerster KD, Mayer JA, Gabbard S, et al. Impact of individual-, environmental-, and policy-level factors on health care utilization among US farmworkers. *Am J Public Health*. 2011;101(4):685-692. doi:10.2105/AJPH.2009.190892

96. Saldanha K. The invisibility of farmworkers: Implications and remedies. *Lat Stud*. 2022;20(1):28. doi:10.1057/S41276-021-00349-W

97. Hoerster KD, Beddawi S, Michael Peddecord K, Ayala GX. Healthcare use among California farmworkers: Predisposing and enabling factors. *J Immigr Minor Health*. 2010;12(4):506-512. doi:10.1007/S10903-009-9305-0/TABLES/3

98. Bail KM, Foster J, Dalmida G, et al. The Impact of Invisibility on the Health of Migrant Farmworkers in the Southeastern United States: A Case Study from Georgia. *Nurs Res Pract*. 2012;2012. doi:10.1155/2012/760418

99. Harley DA, Ysasi NA, Bishop ML, Fleming AR. Disability and vocational rehabilitation in rural settings: Challenges to service delivery. *Disability and Vocational Rehabilitation in Rural Settings: Challenges to Service Delivery*. Published online November 3, 2017:1-717. doi:10.1007/978-3-319-64786-9/COVER

100. Schneider EC, Shah A, Doty MM, Tikkanen R, Fields K, Williams II rEginald D. *Mirror, Mirror 2021: Reflecting Poorly Health Care in the U.S. Compared to Other High-Income Countries*.; 2021.

101. Morgan D, Lorenzoni L, Colombo F, Scarpetta S, Pearson M. *Understanding Differences in Health Expenditure between the United States and OECD Countries*.; 2022. Accessed October 31, 2022. https://www.oecd.org/health/Health-expenditure-differences-USA-OECD-countries-Brief-July-2022.pdf

102. Byrnes H. *This Is How Much California Spends on Your Health*.; 2022. Accessed November 6, 2022. https://247wallst.com/state/this-is-how-much-california-spends-on-your-health/

103. Radley DC, Baumgartner JC, Collins SR, Zephyrin LC. *2023 Scorecard on State Health System Performance*.; 2023.

104. Cole DC, McLaughlin JE, Hennebry JL, Tew MA. Precarious patients: Health professionals' perspectives on providing care to Mexican and Jamaican migrants in Canada's Seasonal Agricultural Worker Program. *Rural Remote Health*. 2019;19(4). doi:10.22605/RRH5313

105. NHS. *A Narrative for Person-Centred Coordinated Care*.; 2016. Accessed October 26, 2022. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1480401/

106. Fichtenberg C, Delva J, Minyard K, Gottlieb L. Health And Human Services Integration: Generating Sustained Health And Equity Improvements. *Health Aff*. 2020;39(4). Accessed November 7, 2022. https://www.healthaffairs.org/doi/10.1377/hlthaff.2019.01594

107. Goodwin N. Understanding Integrated Care. *Int J Integr Care*. 2016;16(4):1-4. doi:10.5334/ijic.2530

108. Lewis R, Goodwin N, Dixon J, Rosen R. *Where next for Integrated Care Organisations in the English NHS?*; 2010. Accessed October 29, 2022. https://www.nuffieldtrust.org.uk/files/2017-01/where-next-integrated-care-english-nhs-web-final.pdf

109. Westphal EC, Alkema G, Seidel R, Chernof B, Goodwin C. How to Get Better Care with Lower Costs? See the Person, Not the Patient. *J Am Geriatr Soc*. 2016;64(1):19-21. doi:10.1111/JGS.13867

110. Tello-Leal E, Chiotti O, David Villarreal P. Process-Oriented Integration and Coordination of Healthcare Services across Organizational Boundaries. *J Med Syst*. Published online 2012. doi:10.1007/s10916-012-9844-0

111. Goodwin N, Stein V, Satylganova A, Tello J, Barbazza E. *Integrated Care Models: An Overview*.; 2016. Accessed October 29, 2022. https://www.euro.who.int/__data/assets/pdf_file/0005/322475/Integrated-care-models-overview.pdf

112. Fineide M, Huag E, Bjorkquist C. Organisational and Professional Integration Between Specialist and Primary Healthcare Services: A Municipal Perspective. *Int J Integr Care*. Published online 2021. doi:10.5334/ijic.5606

113. van Duijn S, Zonneveld N, Lara Montero A, Minkman M, Nies H. Service integration across sectors in Europe: Literature and practice. *Int J Integr Care*. 2018;18(2). doi:10.5334/IJIC.3107/METRICS/

114. Goodwin N, Stein V, Amelung V. What is Integrated Care? *Handbook Integrated Care*. Published online 2021:3-25. doi:10.1007/978-3-030-69262-9_1

115. Bodenheimer T, Sinsky C. From Triple to Quadruple Aim: Care of the Patient Requires Care of the Provider. *Ann Fam Med*. Published online 2014. doi:10.1370/afm.1713

116. IHI. Institute for Healthcare Improvement Triple Aim Initiative. 2022. Accessed November 6, 2022. https://www.ihi.org/Engage/Initiatives/TripleAim/Pages/default.aspx

117. Nundy S, Cooper LA, Mate KS. The Quintuple Aim for Health Care Improvement: A New Imperative to Advance Health Equity. *JAMA*. 2022;327(6):521-522. doi:10.1001/JAMA.2021.25181

118. Denis JL, Touati N, Rodríguez C. *The Integration of Healthcare: Dimensions and Implementation*.; 2003.

119. John JR, Jani H, Peters K, Agho K, Kathy Tannous W. The Effectiveness of Patient-Centred Medical Home-Based Models of Care versus Standard Primary Care in Chronic Disease Management: A Systematic Review and Meta-Analysis of Randomised and Non-Randomised Controlled Trials. *Int J Environ Res Public Health*. 2020;17:6886. doi:10.3390/ijerph17186886

120. DeVries A, Li CHW, Sridhar G, Hummel JR, Breidbart S, Barron JJ. Impact of medical homes on quality, healthcare utilization, and costs. *Am J Manag Care*. 2012;18(9):534-544. Accessed November 12, 2022. https://europepmc.org/article/med/23009304

121. Fout B, Trombley M, Bengtsson A, et al. *Evaluation of the Accountable Care Organization Investment Model*.; 2020. Accessed January 29, 2023. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://innovation.cms.gov/data-and-reports/2020/aim-final-annrpt

122. Barnes AJ, Unruh L, Chukmaitov A, van Ginneken E. Accountable care organizations in the USA: Types, developments and challenges. *Health Policy (New York)*. 2014;118(1):1-7. doi:10.1016/J.HEALTHPOL.2014.07.019

123. Muhlestein D. Growth And Dispersion Of Accountable Care Organizations In 2015. *Health Affairs Forefront*. Published online 2015. doi:10.1377/FOREFRONT.20150331.045829

124. Lukersmith S, Millington M, Salvador-Carulla L. What is case management? A scoping and mapping review. *Int J Integr Care*. 2016;16(4):1-13. doi:10.5334/IJIC.2477/GALLEY/3311/DOWNLOAD/

125. Fabbri E, De Maria M, Bertolaccini L. Case management: an up-to-date review of literature and a proposal of a county utilization. *Ann Transl Med*. Published online 2017. doi:10.21037/atm.2017.07.26

126. Doucet S, Luke A, Splane J, Azar R. Patient Navigation as an Approach to Improve the Integration of Care: The Case of NaviCare/SoinsNavi. Published online 2019. doi:10.5334/ijic.4648

127. Nuño R, Coleman K, Bengoa R, Sauto R. Integrated care for chronic conditions: The contribution of the ICCC Framework. *Health Policy (New York)*. 2012;105(1):55-64. doi:10.1016/J.HEALTHPOL.2011.10.006

128. Yeoh EK, Wong MCS, Wong ELY, et al. Benefits and limitations of implementing Chronic Care Model (CCM) in primary care programs: A systematic review. *Int J Cardiol*. 2018;258:279-288. doi:10.1016/J.IJCARD.2017.11.057

129. Wagner EH, Austin BT, Davis C, Hindmarsh M, Schaefer J, Bonomi A. Improving chronic illness care: translating evidence into action. *Health Aff (Millwood)*. 2001;20(6):64-78. doi:10.1377/HLTHAFF.20.6.64

130. Pruitt S, Annadale S, Epping-Jordan J, et al. *Innovative Care for Chronic Conditions: Building Blocks for Action*.; 2002. Accessed October 31, 2022. https://apps.who.int/iris/bitstream/handle/10665/42500/WHO_NMC_CCH_02.01.pdf?sequence=1&isAllowed=y

131. Grover A, Joshi A. An Overview of Chronic Disease Models: A Systematic Literature Review. *Glob J Health Sci*. 2015;7(2):210. doi:10.5539/GJHS.V7N2P210

132. Hirschman K, Shaid E, McCauley K, Pauly M, Naylor M. Continuity of Care: The Transitional Care Model. *Online Journal of Nursing Issues*. Published online 2015. Accessed October 31, 2022. https://ojin.nursingworld.org/MainMenuCategories/ANAMarketplace/ANAPeriodicals/OJIN/TableofContents/Vol-20-2015/No3-Sept-2015/Continuity-of-Care-Transitional-Care-Model.html

133. Kaiser Institute for Health Policy. An overview of our integrated care model - Kaiser Permanente Institute for Health Policy. Kaiser Permanente Institute for Health Policy. 2022. Accessed November 12, 2022. https://www.kpihp.org/blog/integrated-care-stories-overview/

134. Leung LB, Rubenstein L V., Yoon J, et al. Veterans health administration investments in primary care and mental health integration improved care access. *Health Aff*. 2019;38(8):1281-1288. doi:10.1377/HLTHAFF.2019.00270/ASSET/IMAGES/LARGE/FIGUREEX2.JPEG

135. Sidawy AN. Pay for performance: The process and its evolution. *J Vasc Surg*. 2006;44(4):892-902. doi:10.1016/J.JVS.2006.07.017

136. CMS. Bundled Payments for Care Improvement (BPCI) Initiative: General Information | CMS Innovation Center. 2023. Accessed March 13, 2023. https://innovation.cms.gov/innovation-models/bundled-payments

137. Schrijvers G, van Hoorn A, Huiskes N. The care pathway: Concepts and theories: An introduction. *Int J Integr Care*. 2012;12(SPECIAL EDITION I). doi:10.5334/IJIC.812/GALLEY/1895/DOWNLOAD/

138. Malone NC, Williams MM, Smith Fawzi MC, et al. Mobile health clinics in the United States. *Int J Equity Health*. 2020;19(1). doi:10.1186/S12939-020-1135-7

139. Hilfinger Messias DAK, Parra-Medina D, Sharpe PA, Treviño L, Koskan AM, Morales-Campos D. Promotoras de Salud: Roles, Responsibilities, and Contributions in a Multi-Site Community-Based Randomized Controlled Trial. *Hisp Health Care Int*. 2013;11(2):62. doi:10.1891/1540-4153.11.2.62

140. Reinschmidt K, Hunter J, Fernandez ML, Lacey-Martinez CR, de Zapien JG, Meister J. Understanding the Success of Promotoras in Increasing Chronic Diseases Screening. *Journal of healthcare for the Poor and underserved*. Published online 2006. Accessed January 28, 2023. https://muse.jhu.edu/pub/1/article/197590/summary?casa_token=wiPriMSTPh4AAAAA:ekeqYZpWrlgSc4OZTVf1BdpTiCo8wYqNQAFGe23UqQM0mGoMv_ts0r32823az7JwmYs6Wdsf

141. Attipoe-Dorcoo S. An overview of costs, utilization, geographical distribution & influence of Mobile clinics in rural healthcare delivery in the United States. Published online 2018.

142. Malone NC, Williams MM, Smith Fawzi MC, et al. Mobile health clinics in the United States. *Int J Equity Health*. 2020;19(1). doi:10.1186/S12939-020-1135-7

143. Liebman AK, Juárez PM, Leyva C, Corona A. A Pilot Program Using Promotoras de Salud to Educate Farmworker Families About the Risks from Pesticide Exposure. *http://dx.doi.org/101300/J096v12n02_04*. 2008;12(2):33-43. doi:10.1300/J096V12N02_04

144. Dutcher MV, Phicil SN, Goldenkranz SB, et al. "Positive Examples": A Bottom-Up Approach to Identifying Best Practices in HIV Care and Treatment Based on the Experiences of Peer Educators. *https://home.liebertpub.com/apc*. 2011;25(7):403-411. doi:10.1089/APC.2010.0388

145. Gajarawala SN, Pelkowski JN. Telehealth Benefits and Barriers. *The Journal for Nurse Practitioners*. 2021;17(2):218. doi:10.1016/J.NURPRA.2020.09.013

146. AHA. Fact Sheet: Telehealth | AHA. 2019. Accessed November 25, 2022. https://www.aha.org/factsheet/telehealth

147. Reed T, Tuckson V, Edmunds M, Hodgkins ML. Telehealth. *https://doi.org/101056/NEJMsr1503323*. 2017;377(16):1585-1592. doi:10.1056/NEJMSR1503323

148. Saira T, Haque N, Hayden EM. Telehealth. *Clinical Informatics Study Guide*. Published online 2022:255-259. doi:10.1007/978-3-030-93765-2_18

149. DHCS Telehealth: Research and Evaluation Plan. Published online 2022.

150. Mechanic OJ, Persaud Y, Kimball AB. Telehealth Systems. *StatPearls*. Published online September 12, 2022. Accessed November 23, 2022. https://www.ncbi.nlm.nih.gov/books/NBK459384/

151. HHS. Health Information Technology. Health Information Privacy. 2022. Accessed November 21, 2022. https://www.hhs.gov/hipaa/for-professionals/special-topics/health-information-technology/index.html

152. Ambinder EP. Electronic Health Records. *J Oncol Pract*. 2005;1(2):57. doi:10.1200/JOP.2005.1.2.57

153. Prgomet M, Li L, Niazkhani Z, Georgiou A, Westbrook JI. Impact of commercial computerized provider order entry (CPOE) and clinical decision support systems (CDSSs) on medication errors, length of stay, and mortality in intensive care units: a systematic review and meta-analysis. *Journal of the American Medical Informatics Association*. 2017;24(2):413-422. doi:10.1093/jamia/ocw145

154. Kuperman GJ. Health-information exchange: why are we doing it, and what are we doing? *Journal of the American Medical Informatics Association*. Published online 2011. doi:10.1136/amiajnl-2010-000021

155. Haux R. Health information systems - Past, present, future. *Int J Med Inform*. 2006;75(3-4 SPEC. ISS.):268-281. doi:10.1016/J.IJMEDINF.2005.08.002

156. Mukhopadhyay SC. Wearable sensors for human activity monitoring: A review. *IEEE Sens J*. 2015;15(3):1321-1330. doi:10.1109/JSEN.2014.2370945

157. Singh Y, Jackson D, Bhardwaj S, Titus N, Goga A. National surveillance using mobile systems for health monitoring: complexity, functionality and feasibility. *BMC Infect Dis*. 2019;19(1):786. doi:10.1186/S12879-019-4338-Z/TABLES/4

158. Nedungadi P, Jayakumar A, Raman R. Personalized Health Monitoring System for Managing Well-Being in Rural Areas. *J Med Syst*. 2018;42(1). doi:10.1007/S10916-017-0854-9

159. Kearns A, Whitley E. Associations of internet access with social integration, wellbeing and physical activity among adults in deprived communities: Evidence from a household survey. *BMC Public Health*. 2019;19(1):1-15. doi:10.1186/S12889-019-7199-X/TABLES/6

160. Kim KK, McGrath SP, Solorza JL, Lindeman D. CIC 2022: The ACTIVATE Digital Health Pilot Program for Diabetes and Hypertension in an Underserved and Rural Community. *Appl Clin Inform*. 2023;0. doi:10.1055/A-2096-0326

161. Reyes I, Ellis T, Yoder A, Keifer MC. An Evaluation Tool for Agricultural Health and Safety Mobile Applications. *J Agromedicine*. 2016;21(4):301-309. Accessed February 1, 2023. https://www.tandfonline.com/doi/full/10.1080/1059924X.2016.1211054?casa_token=mSkRuGvdGEYAAAAA%3AvfOvXEy5dJX7P9sQCSNq15osHOItIi-LLPFAFa1cCHgW8mrFU8u86fRXaPZtjSVmDya1PH_SPOU

162. Choudhury A, Asan O, Choudhury M. Mobile health technology to improve maternal health awareness in tribal populations: mobile for mothers. *Journal of American Medical Informatics Association*. Published online 2021. Accessed February 3, 2023. https://academic.oup.com/jamia/article/28/11/2467/6359598

163. Boyce SP, Nyangara F, Kamunyori J. A mixed-methods quasi-experimental evaluation of a mobile health application and quality of care in the integrated community case management program in Malawi. *J Glob Health*. 2019;9(1):10811. doi:10.7189/JOGH.09.010811

164. Oladeji O, Oladeji B, Diaaeldin Omer M, et al. Exploring opportunities to enhance effectiveness of mobile health and nutrition strategy for providing health and nutrition services amongst pastoralists in Somali region, Ethiopia. *Afr J Prim Health Care Fam Med*. 2021;13(1). doi:10.4102/PHCFM.V13I1.2723

165. Alslaity A, Oyebode O, Fowles J, et al. Mobile Applications for Health and Wellness: A Systematic Review. *Proc ACM Hum-Comput Interact*. 2022;6. doi:10.1145/3534525

166. Wu N, Gong E, Wang B, et al. A Smart and Multifaceted Mobile Health System for Delivering Evidence-Based Secondary Prevention of Stroke in Rural China: Design, Development, and Feasibility Study. *JMIR Mhealth Uhealth*. 2019;7(7). doi:10.2196/13503

167. Ali O, Abdelbaki W, Shrestha A, Elbasi E, Alryalat MAA, Dwivedi YK. A systematic literature review of artificial intelligence in the healthcare sector: Benefits, challenges, methodologies, and functionalities. *Journal of Innovation & Knowledge*. 2023;8(1):100333. doi:10.1016/J.JIK.2023.100333

168. Mariani MM, Machado I, Nambisan S. Types of innovation and artificial intelligence: A systematic quantitative literature review and research agenda. *J Bus Res*. 2023;155:113364. doi:10.1016/J.JBUSRES.2022.113364

169. Stanfill MH, Marc DT. Health Information Management: Implications of Artificial Intelligence on Healthcare Data and Information Management. *Yearb Med Inform*. 2019;28(1):56-64. doi:10.1055/S-0039-1677913

170. Wiljer D, Hakim Z. Developing an Artificial Intelligence-Enabled Health Care Practice: Rewiring Health Care Professions for Better Care. *J Med Imaging Radiat Sci*. 2019;50(4 Suppl 2):S8-S14. doi:10.1016/J.JMIR.2019.09.010

171. Secinaro S, Calandra D, Secinaro A, Muthurangu V, Biancone P. The role of artificial intelligence in healthcare: a structured literature review. *BMC Med Inform Decis Mak*. 2021;21(1). doi:10.1186/S12911-021-01488-9

172. Farringer D. A Telehealth Explosion: Using Lessons from the Pandemic to Shape the Future of Telehealth Regulation. *SSRN Electronic Journal*. Published online August 5, 2020. doi:10.2139/SSRN.3681070

173. Farmworker Justice. *Unidos : Telehealth Situational Analysis Project & Needs Assessment Understanding and Seasonal Agricultural Worker Opportunities for Telehealth Communities Services* .; 2018. Accessed February 1, 2023. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.farmworkerjustice.org/wp-content/uploads/2019/11/Final-Telehealth-SA-Report-FJ_0.pdf

174. Bey N. Ensuring Telehealth Access For North Carolina Farmworkers. *Health Affairs Forefront*. Published online 2022. doi:10.1377/FOREFRONT.20220422.227909

175. Kolluri S, Stead TS, Mangal RK, Coffee RL, Littell J, Ganti L. Telehealth in Response to the Rural Health Disparity. *Health Psychol Res*. 2022;10:2022. doi:10.52965/001c.37445

176. Myers CR. Using Telehealth to Remediate Rural Mental Health and Healthcare Disparities. *Issues Ment Health Nurs*. 2019;40(3):233-239. doi:10.1080/01612840.2018.1499157

177. Calleja P, Wilkes S, Spencer M, Woodbridge S. Telehealth use in rural and remote health practitioner education: an integrative review. *Rural Remote Health*. 2022;22(1). doi:10.22605/RRH6467

178. Garfan S, Alamoodi AH, Zaidan BB, et al. Telehealth utilization during the Covid-19 pandemic: A systematic review. *Comput Biol Med*. 2021;138:104878. doi:10.1016/J.COMPBIOMED.2021.104878

179. Xu P, Hudnall M, Zhao S, Raja U, Parton J, Lewis D. Pandemic-Triggered Adoption of Telehealth in Underserved Communities: Descriptive Study of Pre- and Postshutdown Trends. *J Med Internet Res*. 2022;24(7). doi:10.2196/38602

180. Parks CA, Nugent NB, Fleischhacker SE, Yaroch AL. Food system workers are the unexpected but under protected COVID heroes. *Journal of Nutrition*. 2020;150(8):2006-2008. doi:10.1093/jn/nxaa173

181. Engels D, Austin M, Doty S, Sanders K, McNichol L. Broadening our bandwidth a multiple case report of expanded use of telehealth technology to perform wound consultations during the Covid-19 pandemic. *Journal of Wound, Ostomy and Continence Nursing*. 2020;47(5):450-455. doi:10.1097/WON.0000000000000697

182. Hirko KA, Kerver JM, Ford S, et al. Telehealth in response to the COVID-19 pandemic: Implications for rural health disparities. *Journal of the American Medical Informatics Association*. Published online 2020:1816-1818. doi:10.1093/jamia/ocaa156

183. Catterson R, Rabinowitz L, Alvarez E. *The 2022 CHCF California Health Policy Survey*.; 2022. Accessed November 6, 2022. www.chcf.org.

184. Uscher-Pines L, Arora N, Jones M, et al. Experiences of Health Centers in Implementing Telehealth Visits for Underserved Patients During the COVID-19

Pandemic: Results from the Connected Care Accelerator Initiative. *Experiences of Health Centers in Implementing Telehealth Visits for Underserved Patients During the COVID-19 Pandemic: Results from the Connected Care Accelerator Initiative*. Published online March 15, 2022. doi:10.7249/RRA1840-1

185. Belmonte-Ureña J, Štreimikien D, Sanders CE, Gibson KE, Lamm AJ. Rural Broadband and Precision Agriculture: A Frame Analysis of United States Federal Policy Outreach under the Biden Administration. *Sustainability 2022, Vol 14, Page 460*. 2022;14(1):460. doi:10.3390/SU14010460

186. Schieberl R, Ahmadi N. Measuring the Success of the Affordable Connectivity Program. *SSRN Electronic Journal*. Published online July 31, 2023. doi:10.2139/SSRN.4528690

187. CDC. *DMI Snapshot Building a Strong Foundation CDC's Data Modernization Initiative* .; 2021. Accessed February 5, 2023. https://www.cdc.gov/surveillance/pubs-resources/dmi_snapshot.html

188. Whaley CM, Ito Y, Kolstad JT, Cowling DW, Handel B. The Health Plan Environment In California Contributed To Differential Use Of Telehealth During The COVID-19 Pandemic. *https://doi.org/101377/hlthaff202200464*. 2022;41(12):1812-1820. doi:10.1377/HLTHAFF.2022.00464

189. CalHHS. California's Health and Human Services Data Exchange Framework — An Essential Next Step Toward Equitable, Affordable, Whole Person Care. 2022. Accessed February 4, 2023. https://www.chhs.ca.gov/data-exchange-framework/

190. Figueroa R. *California Advancing and Innovating Medi-Cal : A High Level Summary*.; 2022. Accessed February 4, 2023. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.dhcs.ca.gov/provgovpart/Documents/CalAIM/CalAIM-High-Level-Summary.pdf

191. Babitsch B, Gohl D, von Lengerke T. Re-revisiting Andersen's Behavioral Model of Health Services Use: a systematic review of studies from 1998–2011. *GMS Psycho-Social-Medicine*. 2012;9. doi:10.3205/PSM000089

192. Gelberg L, Andersen RM, Leake BD. The Behavioral Model for Vulnerable Populations: application to medical care use and outcomes for homeless people. *Health Serv Res*. 2000;34(6):1273. Accessed July 6, 2023. /pmc/articles/PMC1089079/?report=abstract

193. Charmaz K. Grounded Theory. *Rethinking Methods in Psychology*. Published online 1995:27-49. doi:10.4135/9781446221792.N3

194. Walker D, Myrick F. Grounded theory: An exploration of process and procedure. *Qual Health Res*. 2006;16(4):547-559. doi:10.1177/1049732305285972

195. Mills J, Bonner A, Francis K. The Development of Constructivist Grounded Theory. *http://dx.doi.org/101177/160940690600500103*. 2006;5(1):25-35. doi:10.1177/160940690600500103

196. Corbin JM, Strauss A. Grounded theory research: Procedures, canons, and evaluative criteria. *Qual Sociol*. 1990;13(1):3-21. doi:10.1007/BF00988593/METRICS

197. Seidel S, Urquhart C. On emergence and forcing in information systems grounded theory studies: The case of Strauss and Corbin. *Journal of Information Technology*. 2013;28(3):237-260. doi:10.1057/JIT.2013.17/TABLES/13

198. Nader L. Up the Anthropologist: Perspectives Gained From Studying Up. Published online 1972.

199. Aydarova E. Flipping the Paradigm: Studying Up and Research for Social Justice. *Research Methods for Social Justice and Equity in Education*. Published online February 26, 2019:33-43. doi:10.1007/978-3-030-05900-2_3

200. Ponce NA, Lavarreda SA, Yen W, Brown ER, DiSogra C, Satter DE. The California health interview survey 2001: Translation of a major survey for California's multiethnic population. *Public Health Reports*. 2004;119(4):388-395. doi:10.1016/J.PHR.2004.05.002

201. Brown ER, Holtby S, Zahnd E, Abbott GB. Peer Reviewed: Community-based Participatory Research in the California Health Interview Survey. *Prev Chronic Dis*. 2005;2(4). Accessed May 10, 2024. /pmc/articles/PMC1435701/

202. BLS. *NATIONAL CENSUS OF FATAL OCCUPATIONAL INJURIES IN 2021*.; 2022.

203. Weichelt BP, Gorucu S, Burke RR, Salzwedel MA, Murphy DJ, Lee BC. Agricultural youth injuries: An updated review of cases from U.S. news media reports, 2016-2021. *Front Public Health*. 2022;10. doi:10.3389/FPUBH.2022.1045858

204. Baidwan NK, Ramirez MR, Gerr F, Boonstra D, Cavanaugh JE, Casteel C. Cost, Severity and Prevalence of Agricultural-Related Injury Workers' Compensation Claims in Farming Operations from 14 U.S. States. *Int J Environ Res Public Health*. Published online 2021.

205. Okeke N, Schmidt C, Alborn S, Kumian E. Implementing Value-Based Primary Care Delivery in Federally Qualified Health Centers. *Population Health Mangement*. 2021;24(1). Accessed January 30, 2023. https://www.liebertpub.com/doi/full/10.1089/pop.2019.0221?casa_token=x7BQFZMnAXcAAAAA%3AnzJqECfJKHXe4qmfRWufwmymJdTiMH03zg_Lj55EAFHUnE4Cet0DDRHUu0asZn32whXrgiNCrg

206. Cole MB, Galárraga O, Wilson IB, Wright B, Trivedi AN. At federally funded health centers, medicaid expansion was associated with improved quality of care. *Health Aff*. 2017;36(1):40-48. doi:10.1377/HLTHAFF.2016.0804/ASSET/IMAGES/LARGE/2016.0804FIGEX3.JPEG

207. McGrail MR, Humphreys JS, Ward B. Accessing doctors at times of need-measuring the distance tolerance of rural residents for health-related travel. *BMC Health Serv Res*. 2015;15(1). doi:10.1186/S12913-015-0880-6

208. Kelly C, Hulme C, Farragher T, Clarke G. Are differences in travel time or distance to healthcare for adults in global north countries associated with an impact on health outcomes? A systematic review. *BMJ Open*. 2016;6(11). doi:10.1136/BMJOPEN-2016-013059

209. Smith ML, Towne SD, Bergeron CD, et al. Geographic disparities associated with travel to medical care and attendance in programs to prevent/manage chronic illness among middle-aged and older adults in Texas. *Rural Remote Health*. 2019;19(4). doi:10.22605/RRH5147

210. Boggess B, Bogue HO. The health of U.S. agricultural worker families: A descriptive study of over 790,000 migratory and seasonal agricultural workers and dependents. *J Health Care Poor Underserved*. 2016;27(2):778-792. doi:10.1353/HPU.2016.0089

211. Donkor KB, Perloff JM. The effects of the Affordable Care Act on seasonal agricultural workers. *Journal of the Agricultural and Applied Economics Association*. 2022;1(4):435-445. doi:10.1002/JAA2.36

212. Madu R. USING TECHNOLOGY TO REDUCE BARRIERS IN COMMUNITY HEALTH: AN INTERSECTION BETWEEN BROADBAND ACCESS, EHR & TELEHEALTH ADOPTION IN FEDERALLY QUALIFIED HEALTH CENTERS. Accessed April 3, 2023. https://digitalcommons.library.tmc.edu/uthsph_dissertsopen/127

213. Bojorquez G. Health Care Access and Utilization by U.S. Farmworkers. *Dissertations*. Published online May 1, 2020. doi:https://doi.org/10.22371/07.2020.037

214. Rieger KL. Discriminating among grounded theory approaches. *Nurs Inq*. 2019;26(1). doi:10.1111/NIN.12261

215. Villarejo D, McCurdy SA. The California Agricultural Workers Health Survey. *J Agric Saf Health*. 2008;14(2):135-146. doi:10.13031/2013.24347

216. Saunders B, Sim J, Kingstone T, et al. Saturation in qualitative research: exploring its conceptualization and operationalization. *Qual Quant*. 2018;52(4):1893. doi:10.1007/S11135-017-0574-8

217. Burns E, Fenwick J, Schmied V, Sheehan A. Reflexivity in midwifery research: The insider/outsider debate. *Midwifery*. 2012;28(1):52-60. doi:10.1016/j.midw.2010.10.018

218. Bonner A, Tolhurst G. Insider-outsider perspectives of participant observation. *Nurse Res*. 2002;9(4):7-19. doi:10.7748/NR2002.07.9.4.7.C6194

219. Kelly C, Hulme C, Farragher T, Clarke G. Are differences in travel time or distance to healthcare for adults in global north countries associated with an impact on health

outcomes? A systematic review. *BMJ Open*. 2016;6(11). doi:10.1136/BMJOPEN-2016-013059

220. Swanton A, Peek-Asa C, Torner J. Time to definitive care among severely injured farmers compared to other work-related injuries in a Midwestern state. *Inj Epidemiol*. 2020;7(1). doi:10.1186/S40621-020-00259-W

221. Jia P, Wang F, Xierali IM. Differential effects of distance decay on hospital inpatient visits among subpopulations in Florida, USA. *Environ Monit Assess*. 2019;191(Suppl 2). doi:10.1007/S10661-019-7468-2

222. Weiss DJ, Nelson A, Vargas-Ruiz CA, et al. Global maps of travel time to healthcare facilities. *Nature Medicine 2020 26:12*. 2020;26(12):1835-1838. doi:10.1038/s41591-020-1059-1

223. Lam O, Broderick B, Toor S. *How Far Americans Live from the Closest Hospital Differs by Community Type*.; 2018.

224. Bobitt J, Aguayo L, Payne L, Jansen T, Schwingel A. Geographic and Social Factors Associated With Chronic Disease Self-Management Program Participation: Going the "Extra-Mile" for Disease Prevention. *Prev Chronic Dis*. 2019;16(3). doi:10.5888/PCD16.180385

225. Sanders SR, Erickson LD, Call VRA, Mcknight ML, Hedges DW. Rural health care bypass behavior: How community and spatial characteristics affect primary health care selection. *Journal of Rural Health*. 2015;31(2):146-156. doi:10.1111/jrh.12093

226. Jackson JE, Cope MR, Sanders SR, Pierce H. Privilege and Place: an exploratory study about healthcare bypass behavior. *Rural Remote Health*. 2021;21(1):1-13. doi:10.22605/RRH5952

227. Kichloo A, Albosta M, Dettloff K, et al. Telemedicine, the current COVID-19 pandemic and the future: a narrative review and perspectives moving forward in the USA. *Fam Med Community Health*. 2020;8(3):530. doi:10.1136/FMCH-2020-000530

228. Chang JE, Lindenfeld Z, Albert SL, et al. Telephone vs. Video Visits During COVID-19: Safety-Net Provider Perspectives. *The Journal of the American Board of Family Medicine*. 2021;34(6):1103-1114. doi:10.3122/JABFM.2021.06.210186

229. Attipoe-Dorcoo S, Delgado R, Gupta A, Bennet J, Oriol NE, Jain SH. Mobile health clinic model in the COVID-19 pandemic: Lessons learned and opportunities for policy changes and innovation. *Int J Equity Health*. 2020;19(1):1-5. doi:10.1186/S12939-020-01175-7/FIGURES/1

230. Brünig L, Kahrass H, Salloch S. The concept of intersectionality in bioethics: a systematic review. *BMC Med Ethics*. 2024;25(1). doi:10.1186/s12910-024-01057-5

231. Siira E, Linden K, Wallström S, Björkman I. Intersectionality in nursing research: A systematic review. *Nurs Open*. 2023;10(12):7509-7527. doi:10.1002/NOP2.2021

232. Cu A, Meister S, Lefebvre B, Ridde V. Assessing healthcare access using the Levesque's conceptual framework– a scoping review. *Int J Equity Health*. 2021;20(1):1-14. doi:10.1186/S12939-021-01416-3/TABLES/4

233. Levesque JF, Harris MF, Russell G. Patient-centred access to health care: conceptualising access at the interface of health systems and populations. *Int J Equity Health*. 2013;12(1). doi:10.1186/1475-9276-12-18

234. Guild A, Richards C, Ruiz V. Out of sight, out of mind: The implementation and impact of the affordable care act in U.S. farmworker communities. *J Health Care Poor Underserved*. 2016;27(4):73-82. doi:10.1353/HPU.2016.0183

235. Promotora de Salud/Lay Health Worker Program Models - RHIhub Community Health Workers Toolkit. Accessed July 11, 2023. https://www.ruralhealthinfo.org/toolkits/community-health-workers/2/layhealth

236. Cáceres NA, Shirazipour CH, Herrera E, Figueiredo JC, Salvy SJ. Exploring Latino Promotores/a de Salud (Community Health Workers) knowledge, attitudes, and perceptions of COVID-19 vaccines. *SSM - Qualitative Research in Health*. 2022;2:100033. doi:10.1016/J.SSMQR.2021.100033

237. Brooks LA, Manias E, Bloomer MJ. How do intensive care clinicians ensure culturally sensitive care for family members at the end of life? A retrospective descriptive study. *Intensive Crit Care Nurs*. 2022;73. doi:10.1016/J.ICCN.2022.103303

238. Quinton JK, Ong MK, Vangala S, et al. The Association of Broadband Internet Access and Telemedicine Utilization in rural Western Tennessee: an observational study. *BMC Health Serv Res*. 2021;21(1):1-6. doi:10.1186/S12913-021-06746-0/TABLES/2

239. Finlayson TL, Gansky SA, Shain SG, Weintraub JA. Dental utilization among Hispanic adults in agricultural worker families in California's Central Valley. *J Public Health Dent*. 2010;70(4):292-299. doi:10.1111/J.1752-7325.2010.00184.X

240. Arcury TA, Jensen A, Mann M, et al. Providing Health Information to Latino Farmworkers: The Case of the Affordable Care Act. *https://doi.org/101080/1059924X20171319314*. 2017;22(3):275-281. doi:10.1080/1059924X.2017.1319314

241. Cofie LE, Rivera ND, Santillán-Deras JR, Knox G, Lee JGL. Digital Inclusion for Farmworkers in a Pandemic: The North Carolina Farmworker Health Program Internet Connectivity Project, 2020-2021. *Am J Public Health*. 2022;112(11):1551-1555. doi:10.2105/AJPH.2022.307017

242. Sipan CL, Portillo-Silva C, Bang H, McCurdy S. Coccidioidomycosis Knowledge and Behaviors of California Hispanic Farm Workers. *J Agromedicine*. 2022;27(2):197-206. doi:10.1080/1059924X.2021.2002223

243. Flocks J, Mac VVT, Runkle J, Tovar-Aguilar JA, Economos J, McCauley L. Female Farmworkers' Perceptions of Heat-Related Illness and Pregnancy Health. *J Agromedicine*. Published online 2013:350-358.

244. LePrevost CE, Cofie LE, Bloss JE, Lee JGL. Focus groups revealed how community health workers in North Carolina find, verify, and process health information for migrant and seasonal farmworkers. *Health Info Libr J*. 2024;41(1):43-52. doi:10.1111/HIR.12445

245. Harwell EL, Wright MZ, LePrevost CE, Bloss JE, Lee JGL. An Analysis of the Availability of Health Education Materials for Migrant and Seasonal Farmworkers. *J Agromedicine*. 2023;28(3):615-619. doi:10.1080/1059924X.2023.2169424

246. Early J, Hernandez A. Digital Disenfranchisement and COVID-19: Broadband Internet Access as a Social Determinant of Health. *Health Promot Pract*. 2021;22(5):605-610. doi:10.1177/15248399211014490/ASSET/IMAGES/LARGE/10.1177_15248399211014490-FIG2.JPEG

247. Dearinger AT. Covid-19 reveals emerging opportunities for rural public health. *Am J Public Health*. 2020;110(9):1277-1278. doi:10.2105/AJPH.2020.305864

248. Salvatore AL, Bradman A, Castorina R, et al. Occupational behaviors and farmworkers' pesticide exposure: findings from a study in Monterey County, California. *Am J Ind Med*. 2008;51(10):782-794. doi:10.1002/AJIM.20622

249. Ramos AK, Duysen E, Carvajal-Suarez M, Trinidad N. Virtual Outreach: Using Social Media to Reach Spanish-speaking Agricultural Workers during the COVID-19 Pandemic. Published online 2020. doi:10.1080/1059924X.2020.1814919

250. Lee HY, Jin SW, Henning-Smith C, Lee J, Lee J. Role of Health Literacy in Health-Related Information-Seeking Behavior Online: Cross-sectional Study. *J Med Internet Res 2021;23(1):e14088 https://www.jmir.org/2021/1/e14088*. 2021;23(1):e14088. doi:10.2196/14088

251. Price M, Williamson D, McCandless R, et al. Hispanic migrant farm workers' attitudes toward mobile phone-based telehealth for management of chronic health conditions. *J Med Internet Res*. 2013;15(4). doi:10.2196/JMIR.2500

252. Field A. Discovering statistics using IBM SPSS statistics. *SAGE*. Published online 2013.

253. Hair J. A Meta-Analysis of Variance Accounted for and Factor Loadings in Exploratory Factor Analysis. In: *International Encyclopedia of Statistical Science*. ; 2011:904-907.

254. Moreira J, Silva B, Faria H, Santos R, Sousa ASP. Systematic Review on the Applicability of Principal Component Analysis for the Study of Movement in the Older Adult Population. *Sensors (Basel)*. 2022;23(1). doi:10.3390/S23010205

255. Ringnér M. What is principal component analysis? *Nat Biotechnol*. 2008;26(3):303-304. doi:10.1038/NBT0308-303

256. NCHS. Summary Health Statistics for adults 2019-2021. 2022. Accessed January 23, 2023. https://wwwn.cdc.gov/NHISDataQueryTool/SHS_adult/index.html

257. Schiller JS, Norris T. Early Release of Selected Estimates Based on Data From the 2022 National Health Interview Survey. *National Health Interview Survey Early Release Program*. Published online 2022.

258. NCHS. Interactive Summary Health Statistics for adults . National Health Interview Survey .

259. Barker AR, Li L. The cumulative impact of health insurance on health status. *Health Serv Res*. 2020;55(S2):815-822. doi:10.1111/1475-6773.13325

260. Woolhandler S, Himmelstein DU. The relationship of health insurance and mortality: Is lack of insurance deadly? *Ann Intern Med*. 2017;167(6):424-431. doi:10.7326/M17-1403

261. Barker AR, Li L. The cumulative impact of health insurance on health status. *Health Serv Res*. 2020;55 Suppl 2(Suppl 2):815-822. doi:10.1111/1475-6773.13325

262. Daw JR, Winkelman TNA, Dalton VK, Kozhimannil KB, Admon LK. Medicaid expansion improved perinatal insurance continuity for low-income women. *Health Aff*. 2020;39(9):1531-1539. doi:10.1377/HLTHAFF.2019.01835

263. Manzanilla A, Lucia L. Expanding Covered California for All by Ending Immigration Status-Based Exclusions. University of California Berkeley Labor Center.

264. Van Der Heide I, Wang J, Droomers M, Spreeuwenberg P, Rademakers J, Uiters E. The relationship between health, education, and health literacy: Results from the dutch adult literacy and life skills survey. *J Health Commun*. 2013;18(SUPPL. 1):172-184. doi:10.1080/10810730.2013.825668

265. Rasu RS, Bawa1 WA, Suminski R, Snella K, Warady B. Health literacy impact on national healthcare utilization and expenditure. *Int J Health Policy Manag*. 2015;4(11):747-755. doi:10.15171/ijhpm.2015.151

266. Stoecklin-Marios M, Hennessy-Burt T, Mitchell D, Schenker M. Heat-related illness knowledge and practices among California hired farm workers in The MICASA Study. *Ind Health*. Published online 2013:47-55.

267. Hyland C, Hernandez A, Gaudreau É, et al. Examination of urinary pesticide concentrations, protective behaviors, and risk perceptions among Latino and Latina farmworkers in Southwestern Idaho. *Int J Hyg Environ Health*. 2024;255. doi:10.1016/J.IJHEH.2023.114275

268. Koball H, Kirby J, Hartig S. The Relationship Between States' Immigrant-Related Policies and Access to Health Care Among Children of Immigrants. *J Immigr Minor Health*. 2022;24(4):834-841. doi:10.1007/s10903-021-01282-9

269. Kiehne E, Hafen Q. State and local integrationist policies and the physical and psychological health of undocumented immigrants. *Curr Opin Psychol*. 2022;48. doi:10.1016/J.COPSYC.2022.101453

270. Sudhinaraset M, Choi HY, Nwankwo E, De Trinidad Young ME. Association between immigration enforcement encounters and COVID-19 testing and delays in care: a cross-sectional study of undocumented young adult immigrants in california. *BMC Public Health*. 2022;22(1). doi:10.1186/s12889-022-13994-0

271. Koskan AM, Hilfinger Messias DK, Friedman DB, Brandt HM, Walsemann KM. Program planners' perspectives of promotora roles, recruitment, and selection. *Ethn Health*. 2013;18(3):262-279. doi:10.1080/13557858.2012.730605

272. Valentín-Sívico J, Canfield C, Low SA, Gollnick C. Evaluating the impact of broadband access and internet use in a small underserved rural community. *Telecomm Policy*. 2023;47(4):102499. doi:10.1016/J.TELPOL.2023.102499

273. Ko JS, El-Toukhy S, Quintero SM, et al. Disparities in telehealth access, not willingness to use services, likely explain rural telehealth disparities. *J Rural Health*. 2023;39(3):617-624. doi:10.1111/JRH.12759

274. Saadi A, Rodriguez JA. Addressing Privacy Concerns Central To Success Of Telehealth Use Among Undocumented Immigrants. *Health Affairs Forefront*. Published online 2020. doi:10.1377/FOREFRONT.20201118.621497

275. Bhasin A. The Telehealth "Revolution" & How it Fails to Transform Care for Undocumented Immigrants. Published online November 28, 2022. Accessed July 11, 2023. https://papers.ssrn.com/abstract=4287882

276. Meyer C, Becot F, Burke R, Weichelt B. Rural Telehealth Use during the COVID-19 Pandemic: How Long-term Infrastructure Commitment May Support Rural Health Care Systems Resilience. *https://doi.org/101080/1059924X20201814921*. 2020;25(4):362-366. doi:10.1080/1059924X.2020.1814921

277. Vetter TR, Mascha EJ. Bias, Confounding, and Interaction: Lions and Tigers, and Bears, Oh My! *Anesth Analg*. 2017;125(3):1042-1048. doi:10.1213/ANE.0000000000002332

278. O'Brien B, Kane L, Houle SA, Aquilina F, Ashbaugh AR. Recall, response bias and recognition are differentially impacted by social anxiety irrespective of feedback modality. *J Behav Ther Exp Psychiatry*. 2022;74. doi:10.1016/J.JBTEP.2021.101694

279. Meyer C, Becot F, Burke R, Weichelt B. Rural Telehealth Use during the COVID-19 Pandemic: How Long-term Infrastructure Commitment May Support Rural Health Care Systems Resilience. *J Agromedicine*. 2020;25(4):362-366. doi:10.1080/1059924X.2020.1814921

280. Jackson KE, Yeb J, Gosliner W, Fernald LCH, Hamad R. Characterizing the Landscape of Safety Net Programs and Policies in California during the COVID-19 Pandemic. *Int J Environ Res Public Health*. 2022;19(5). doi:10.3390/IJERPH19052747

281. Jansen T, Rademakers J, Waverijn G, Verheij R, Osborne R, Heijmans M. The role of health literacy in explaining the association between educational attainment and

the use of out-of-hours primary care services in chronically ill people: A survey study. *BMC Health Serv Res*. 2018;18(1):1-13. doi:10.1186/S12913-018-3197-4/TABLES/7

282. Portela De-Assis M, Barcella RC, Chiogna Padilha J, Pohl HH, Beatriz S, Krug F. Health problems in agricultural workers occupationally exposed to pesticides Problemas de saúde identificados em trabalhadores rurais expostos ocupacionalmente a agrotóxicos. *Rev Bras Med Trab*. 2020;18(3):352-363. doi:10.47626/1679-4435-2020-532

283. Spears CR, Summers Mph PY, Spencer KM, Arcury TA. Informal Occupational Safety Information Exchange Among Latino Migrant and Seasonal Farmworkers. *J Agromedicine*. 2012;17(4):415-420. doi:10.1080/1059924X.2012.713830

284. Mbunge E. Integrating emerging technologies into COVID-19 contact tracing: Opportunities, challenges and pitfalls. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*. 2020;14(6):1631-1636. doi:10.1016/J.DSX.2020.08.029

285. Petrovic N, Dimovski V, Peterlin J, Meško M, Petrović NN, Roblek V. Data-Driven Solutions in Smart Cities: The case of Covid-19 Apps. Published online 2021. doi:10.1145/3442442.3453469

286. Talbot JA, Burgess AR, Thayer D, Parenteau L, Paluso N, Coburn AF. Patterns of Telehealth Use Among Rural Medicaid Beneficiaries. *The Journal of Rural Health*. 2019;35(3):298-307. doi:10.1111/JRH.12324

287. Meyer C, Becot F, Burke R, Weichelt B. Rural Telehealth Use during the COVID-19 Pandemic: How Long-term Infrastructure Commitment May Support Rural Health Care Systems Resilience. *https://doi.org/101080/1059924X20201814921*. 2020;25(4):362-366. doi:10.1080/1059924X.2020.1814921

288. Brewer LPC, Fortuna KL, Jones C, et al. Back to the Future: Achieving Health Equity Through Health Informatics and Digital Health. *JMIR Mhealth Uhealth*. 2020;8(1). doi:10.2196/14512

289. Raj C, Jain C, Arif W. HEMAN: Health monitoring and nous: An IoT based e-health care system for remote telemedicine. *Proceedings of the 2017 International Conference on Wireless Communications, Signal Processing and Networking, WiSPNET 2017*. 2018;2018-January:2115-2119. doi:10.1109/WISPNET.2017.8300134

290. Lin CCC, Dievler A, Robbins C, Sripipatana A, Quinn M, Nair S. Telehealth in health centers: Key adoption factors, barriers, and opportunities. *Health Aff*. 2018;37(12):1967-1974. doi:10.1377/HLTHAFF.2018.05125/ASSET/IMAGES/LARGE/FIGUREEX4.JPEG

291. Avalone L, King C, Popeo D, et al. Increased Attendance During Rapid Implementation of Telehealth for Substance Use Disorders During COVID-19 at the Largest Public Hospital System in the United States.

https://doi.org/101080/1082608420222079140. 2022;57(8):1322-1327. doi:10.1080/10826084.2022.2079140

292. Myers CR. Using Telehealth to Remediate Rural Mental Health and Healthcare Disparities. *https://doi.org/101080/01612840201814991 57*. 2018;40(3):233-239. doi:10.1080/01612840.2018.1499157

293. Menachemi N, Rahurkar S, Harle CA, Vest JR. The benefits of health information exchange: an updated systematic review. *Journal of American Medical Informatics*. 2018;25:1259-1265. doi:10.1093/jamia/ocy035

294. Mutanu L, Gupta K, Gohil J. Leveraging IoT solutions for enhanced health information exchange. *Technol Soc*. 2022;68:101882. doi:10.1016/J.TECHSOC.2022.101882

295. Sieck CJ, Sheon A, Ancker JS, Castek J, Callahan B, Siefer A. Digital inclusion as a social determinant of health. *npj Digital Medicine 2021 4:1*. 2021;4(1):1-3. doi:10.1038/s41746-021-00413-8

296. Cortelyou-Ward K, Atkins DN, Noblin A, Rotarius T, White P, Carey C. Navigating the Digital Divide: Barriers to Telehealth in Rural Areas. *J Health Care Poor Underserved*. 2020;31(4):1546-1556. doi:10.1353/HPU.2020.0116

297. Smith B, Magnani JW. New technologies, new disparities: The intersection of electronic health and digital health literacy. *Int J Cardiol*. 2019;292:280-282. doi:10.1016/J.IJCARD.2019.05.066

298. Kumar D, Hemmige V, Kallen MA, et al. Mobile Phones May Not Bridge the Digital Divide: A Look at Mobile Phone Literacy in an Underserved Patient Population. *Cureus*. 2019;11(2). doi:10.7759/CUREUS.4104

299. Wymant C, Ferretti L, Tsallis D, et al. The epidemiological impact of the NHS COVID-19 app. *Nature 2021 594:7863*. 2021;594(7863):408-412. doi:10.1038/s41586-021-03606-z

300. Miller MJ, Pak SS, Keller DR, Barnes DE. Evaluation of Pragmatic Telehealth Physical Therapy Implementation During the COVID-19 Pandemic. *Phys Ther*. 2021;101(1):1-10. doi:10.1093/PTJ/PZAA193

301. Uscher-Pines L, Sousa J, Jones M, et al. Telehealth Use among Safety-Net Organizations in California during the COVID-19 Pandemic. *JAMA - Journal of the American Medical Association*. 2021;325(11):1106-1107. doi:10.1001/JAMA.2021.0282

302. Adepoju OE, Chae M, Liaw W, Angelocci T, Millard P, Matuk-Villazon O. Transition to telemedicine and its impact on missed appointments in community-based clinics. *Ann Med*. 2022;54(1):98-107. doi:10.1080/07853890.2021.2019826

303. Noy C. Sampling Knowledge: The Hermeneutics of Snowball Sampling in Qualitative Research. *https://doi.org/101080/13645570701401305*. 2008;11(4):327-344. doi:10.1080/13645570701401305

304. Dodgson JE. Reflexivity in Qualitative Research. *https://doi.org/101177/0890334419830990*. 2019;35(2):220-222. doi:10.1177/0890334419830990

305. American Community Survey. Computer and internet usage. United States Census Bureau.

306. Mahajan S, Lu Y, Spatz ES, Nasir K, Krumholz HM. Trends and Predictors of Use of Digital Health Technology in the United States. *Am J Med*. 2021;134(1):129-134. doi:10.1016/J.AMJMED.2020.06.033

307. Karri K, Yarra P. Inequities still exist in the use of digital health technology across different sociodemographic subgroups. *Evid Based Nurs*. 2022;25(1):23. doi:10.1136/ebnurs-2020-103355

308. Zhang D, Shi L, Han X, et al. Disparities in telehealth utilization during the COVID-19 pandemic: Findings from a nationally representative survey in the United States. *J Telemed Telecare*. 2024;30(1):90-97. doi:10.1177/1357633X211051677

309. Holden RJ, Karsh BT. The Technology Acceptance Model: Its past and its future in health care. *J Biomed Inform*. 2010;43(1):159-172. doi:10.1016/j.jbi.2009.07.002

310. Ammenwerth E. Technology Acceptance Models in Health Informatics: TAM and UTAUT. *Stud Health Technol Inform*. 2019;263:64-71. doi:10.3233/SHTI190111

311. Shachak A, Kuziemsky C, Petersen C. Beyond TAM and UTAUT: Future directions for HIT implementation research. *J Biomed Inform*. 2019;100. doi:10.1016/J.JBI.2019.103315

312. Ghaddar S, Vatcheva KP, Alvarado SG, Mykyta L. Understanding the Intention to Use Telehealth Services in Underserved Hispanic Border Communities: Cross-Sectional Study. *J Med Internet Res*. 2020;22(9). doi:10.2196/21012

313. Uscher-Pines L, Mccullough CM, Sousa JL, et al. Changes in In-Person, Audio-Only, and Video Visits in California's Federally Qualified Health Centers, 2019-2022. *JAMA*. 2023;329(14):1219. doi:10.1001/JAMA.2023.1307

314. Lee JGL, Leprevost CE, Emery ;, et al. Coronavirus pandemic highlights critical gaps in rural Internet access for migrant and seasonal farmworkers: a call for partnership with medical libraries. *Journal of the Medical Library Association*. 2020;108(4). doi:10.5195/jmla.2020.1045

315. Logan RI, Castañeda H. Addressing Health Disparities in the Rural United States: Advocacy as Caregiving among Community Health Workers and Promotores de Salud. *International Journal of Environmental Research and Public Health 2020, Vol 17, Page 9223*. 2020;17(24):9223. doi:10.3390/IJERPH17249223

316. Cho J, Trent A. Validity in qualitative research revisited. *http://dx.doi.org/101177/1468794106065006*. 2006;6(3):319-340. doi:10.1177/1468794106065006

317. JP L, SA M, MB S. Costs of occupational injuries in agriculture. *Public Health Rep*. 2001;116(3):235-248. doi:10.1093/PHR/116.3.235

318. Olivares L V., Engle-Stone R, Arnold CD, Langer CE, Schenker MB. Anemia, Weight Status, and Fatigue Among Farmworkers in California: A Cross-Sectional Study. *J Occup Environ Med*. 2022;64(8):e459. doi:10.1097/JOM.0000000000002578

319. Moyce S, Hernandez K, Schenker M. Diagnosed and Undiagnosed Diabetes among Agricultural Workers in California. *J Health Care Poor Underserved*. 2019;30(4):1289-1301. doi:10.1353/HPU.2019.0102

320. Luque JS, Reyes-Ortiz C, Marella P, et al. Mobile Farm Clinic Outreach to Address Health Conditions Among Latino Migrant Farmworkers in Georgia. *http://dx.doi.org/101080/1059924X2012713837*. 2012;17(4):386-397. doi:10.1080/1059924X.2012.713837

321. Ingram M, Torres E, Redondo F, Bradford G, Wang C, O'Toole ML. The impact of promotoras on social support and glycemic control among members of a farmworker community on the US-Mexico border. *Diabetes Educ*. 2007;33 Suppl 6(SUPPL. 6). doi:10.1177/0145721707304170

322. Joo JY, Huber DL. Case Management Effectiveness on Health Care Utilization Outcomes: A Systematic Review of Reviews. *West J Nurs Res*. 2019;41(1):111-133. doi:10.1177/0193945918762135/FORMAT/EPUB

323. Lu C, Chuang E, Albertson EM, Ann Haley L, Pourat N. Health Policy Case Study Care Coordination in California's Whole Person Care Pilot Program: San Joaquin County. Published online 2019.

324. Roberts A, Philip L, Currie M, Mort A. Striking a balance between in-person care and the use of eHealth to support the older rural population with chronic pain. *http://dx.doi.org/103402/qhw.v1027536*. 2015;10. doi:10.3402/QHW.V10.27536

325. Caffaro F, Bagagiolo G, Cremasco MM, Vigoroso L, Cavallo E. Tailoring Safety Training Material to Migrant Farmworkers: An Ergonomic User-Centred Approach. *International Journal of Environmental Research and Public Health 2020, Vol 17, Page 2104*. 2020;17(6):2104. doi:10.3390/IJERPH17062104

326. Hyland C, Meierotto L, Som Castellano RL, Curl CL. Mixed-Methods Assessment of Farmworkers' Perceptions of Workplace Compliance with Worker Protection Standards and Implications for Risk Perceptions and Protective Behaviors. *J Agromedicine*. Published online January 29, 2024:1-18. doi:10.1080/1059924X.2024.2307483

327. Sandberg JC, Spears Johnson CR, Nguyen HT, et al. Mobile and Traditional Modes of Communication Among Male Latino Farmworkers: Implications for Health Communication and Dissemination. *J Immigr Minor Health*. 2016;18(3):522-531. doi:10.1007/S10903-015-0299-5/TABLES/5

328. Salvatore AL, Castorina R, Camacho J, et al. Home-based community health worker intervention to reduce pesticide exposures to farmworkers' children: A randomized-controlled trial. *J Expo Sci Environ Epidemiol*. 2015;25(6):608-615. doi:10.1038/JES.2015.39

329. Cuadros DF, Moreno CM, Miller FD, Omori R, MacKinnon NJ. Assessing Access to Digital Services in Health Care–Underserved Communities in the United States: A Cross-Sectional Study. *Mayo Clinic Proceedings: Digital Health*. 2023;1(3):217-225. doi:10.1016/J.MCPDIG.2023.04.004

Appendix

List of abbreviations used

ACA	Affordable Care Act
ACO	Accountable Care Organization
ACP	Affordable Connectivity Program
AI	Aritificial Intelligence
ACTIVATE	Accountability, Coordination, and Telehealth In the Valley to Achieve Transformation and Equity
Cal AIM	California Advancing and Innovating Medi-Cal
CCA	Connected Care Accelerator
CDPH	California Department of Public Health
CDSS	Clinical Decision Support System
CHIS	California Health Interview Survey
CCM	Chronic Care Model
CPOE	Computerized Provider Order Entry
DHCS	Department of Healthcare Services
DCE	Discrete Choice Experiment
FQHC	Federally Qualified Healthcare Center
GDP	Gross Domestic Product
GIS	Geospatial Information Systems
HPSA	Health Professional Shortage Area
HRI	Heat-Related Illness
HRSA	Health Resources and Services Administration
ICIC	Improving Chronic Illness Care Model
ICC	Innovative Care for Chronic Conditions Model
MUA	Medically Underserved Area
NIOSH	National Institute of Occupational Safety and Health
NAWS	National Agricultural Worker Survey
OECD	Organization for Economic Cooperation and Development
PCA	Principal Component Analysis
PCMH	Patient-Centered Medical Home
PRI	Pesticide-Related Illness

OSHA	Occupational Safety and Health Administration
RHC	Rural Healthcare Center
RPMS	Remote Patient Monitoring System
TCM	Transitional Care Model
UCM FWHS	University of California Merced Farmworker Health Study
USDA ERS	United States Department of Agriculture Economic Research Service

Interview guide (Study 1)

I. Paperwork (7 minutes)

Informed consent: Before the start of the interview session, the interviewer will verbally summarize the informed consent form and ask the participant to read and sign the consent form.

Demographic survey: The interviewer asks the interviewee to fill out the demographic survey, which contains questions related to the age, gender, ethnicity, medical specialty, and area of practice of the participant. Additionally, the form will contain questions related to the average number of agriculture workers seen by the interviewee, their average age, gender, ethnicity, preferred language, and immigration status.

II. Introduction to the Interview Session (5 minutes)

The interviewer welcomes the person, introduces herself, and reviews the following points:

- Assures the participant of confidentiality
- Asks for oral agreement to respect one another's confidentiality
- Explains that the session will be recorded and reviewed by a small group of researchers
- Affirms that participant will not be identified personally in transcripts or other reports
- Affirms that only first names or nicknames will be recorded in transcripts or other reports
- Affirms that participant may choose not to answer a question
- Assures the participant that there are no right or wrong answers
- Affirms that disagreement is ok; the researchers want to hear all types of thoughts/opinions
- Affirms that researchers are interested in honest answers to the questions
- The participant is made aware that the interview will take no more than an hour, and thank-you gift cards will be given out at the end of the interview.

The interviewer starts recording and thanks the participant for his/her cooperation. The interviewer asks the participant to state either a first name or a nickname that they would like to use as an identifier. The participant is encouraged to speak their mind freely in response to various questions.

III. Introduction to the issue (5 minutes)

EXPLAIN THE ISSUE...

- Agriculture workers constitute a vulnerable population group. They work long hours in the field and are exposed to multiple occupational hazards, including

exposure to pesticides, injuries associated with the use of farm equipment, heat-related illnesses, and now the COVID-19 pandemic.

- Most of the agriculture workers have low levels of educational attainment and are not fully aware of how to protect themselves from these threats to their health. Many of them lack health insurance coverage, and among those who do have health insurance, few utilize healthcare services unless there is an urgent need.
- A large proportion of the agriculture workers are undocumented. They are not eligible for government-sponsored public health services. Moreover, under the current administration, there is widespread panic and fear of deportation upon utilizing government benefits or healthcare services.
- A large segment of the agriculture workers do not understand the English language and can only communicate in their native language. Consequently, they are often ignored by public health organizations while trying to warn the public about potential threats to the health of the general public.
- Moreover, there are certain culture-specific issues that affect the delivery of healthcare services to this population. In some cultures, health issues such as obesity and high blood pressure are often ignored. Additionally, there exist some ethnic-specific illnesses, such as Nervios, which may be hard to translate into modern medical terminology.
- As a result of all these issues, many agricultural workers have low rates of healthcare access and utilization. These issues have increased significance in the context of the ongoing COVID-19 pandemic. Most of the research has been focused on these issues from the perspective of farm workers.

"We are trying to understand the various **factors** that influence the **availability** and **delivery of healthcare services** to **agriculture workers** from the perspective of their **healthcare providers**."

"We would like to start by asking some general questions. There are no right or wrong answers...we are just interested in hearing your views."

IV. Interview Session (40-60 minutes)

1. General Health Service Access and Utilization

a. What is your (organization's) role vis a vis farmworker access to health services? Beyond direct care??? (probe for a detailed description of all components of related work)

b. What do you see as the main reasons farmworkers do not have access to health services?

> Probe: *Aside from not having health insurance*, what are the most pressing issues affecting farmworker utilization of specific types of health services? (ie. Community clinics, emergency rooms, private doctors, workers comp, dental services, mental health services)

c. What are your thoughts on challenges facing particular farmworker subpopulations in accessing health services? (women, children, undocumented, Indigenous, Punjabi, Southeast Asian, Central American)

d. In California, who are the key players involved in farmworker access to health services? Institutions? Individuals? What are their respective roles?

e. What do you know about the landscape, utilization, and efficacy of migrant community clinics in terms of serving migrant and undocumented farmworkers and accompanying family members? Are there other clinic systems that you are aware of beyond the government-funded clinic systems?

f. How has expanded clinic capacity in rural California served farmworkers?

g. In your opinion, what types of efforts, be they private, public, or nonprofit, have had the most value - in terms of low cost but high return - in improving farmworker access to health services?

2. Health Insurance

a. What is your knowledge and opinion about the landscape of existing farmworker health insurance plans?

b. Do you know what types of plans are typically offered by ag employers?

c. Based on the FELS survey, XX% of growers provide access to health insurance.

   i. What motivates these growers to do so?

   ii. What are the main reasons that others do not?

   iii. What are the barriers to employer participation in health insurance plans?

d. What are the barriers to farmworker uptake of health insurance? Dental insurance?

e. What are your thoughts about how the Affordable Care Act (ACA), with its expanded access to coverage and large employer mandate, has affected California's agricultural employers? Workers? (probe: has ACA affected grower hiring practices?)

f. How would expanding access to Medi-Cal without immigration status requirements help farmworkers? How feasible does that seem?

3. Innovative Practices

a. What are some of the innovative practices that you know of aimed at improving farmworker health or farmworker access to health services? Are you familiar with any innovative practices regarding health promotion among other underserved/hard-to-reach populations that could be replicated with farmworkers?

b. What other groups addressing this issue (i.e., nonprofits, community-based health organizations, and unions) come to mind? Innovative partnerships/coalitions?

c. What employers come to mind when you think about folks who are implementing innovative practices to improve farmworker health or access to health services?

4. Policy & Recommendations

a. If you could wave a magic wand and implement policy change to improve farmworker health care coverage or access to health services, what policies would you implement?

b. What can state agencies (i.e., CDPH, Cal/OSHA, CDFA) do to a) promote grower efforts to improve farmworker access to healthcare and 2) promote farmworker utilization of these services?

c. How has the health of farmworkers been affected by the State's preventative health efforts? [general education efforts on things such as healthy eating, tobacco, active living, etc. And now COVID-19 education on safe practices, PPE, testing, etc.]

d. Any thoughts on how communication or collaboration might be facilitated among the various stakeholders/providers involved in farmworker health system integration?

e. Do you have any thoughts about how changes in immigration policy and enforcement, such as public charge determination, have affected farmworker utilization of healthcare services?

f. Do you have any thoughts about how the COVID crisis and related responses might be leveraged to affect long-term improvements in farmworker health and/or healthcare?

g. How would investments in improving farmworker health positively affect the health of non-farmworker populations in CA? In what ways?

Interview Guide (Study 3)

Health system integration for Agricultural Workers from the perspectives of Healthcare Providers and advocates

V. Paperwork (5 minutes)

Informed consent: Before the start of the interview session, the interviewer will verbally summarize the informed consent form and ask the participant to read and sign the consent form. The participant can also choose to give verbal consent, which will be recorded by the interviewer.

Demographic survey: The interviewer asks the interviewee to complete the demographic survey, which contains questions about age, gender, ethnicity, medical specialty, area of practice, organization, and number of years spent working on farmworker health-related issues.

VI. Introduction to the Interview Session (5 minutes)

The interviewer welcomes the person, introduces herself, and reviews the following points:

- Assures participants of confidentiality
- Explains that the session will be recorded and reviewed by a small group of researchers
- Affirms that participant will not be identified personally in transcripts or other reports
- Affirms that only first names or nicknames will be recorded in transcripts or other reports
- Affirms that participant may choose not to answer a question
- Assures the participant that there are no right or wrong answers
- Affirms that researchers are interested in honest answers to the questions
- The participant is made aware that the interview will take no more than an hour
- The interviewee will be asked for feedback about the interview guide and study techniques

The interviewer starts recording and thanks the participants for their cooperation. The interviewer asks the participant to state a first name or nickname they would like to use as an identifier. The participant is encouraged to speak freely in response to various questions.

VII. Introduction to the issue (5 minutes)

“Agricultural workers in California constitute a vulnerable population group. They have the highest occupational injury rate among workers in all occupations in California and the

U.S. More than half are undocumented and fear deportation upon utilizing healthcare services. Most of them reside in Medically Underserved rural areas with limited healthcare services and lack access to reliable means of transportation to use their available services. Digital Health interventions can help overcome these barriers by allowing workers to access healthcare services conveniently from their phones or smart devices at a convenient time and location. The COVID-19 pandemic led to the large-scale expansion of these services in rural areas, allowing patients and providers to utilize these services in underserved communities. However, many workers lack the technical literacy and internet access to use these services effectively. Most of the research on this topic has focused on farm workers' experiences and perspectives. We intend to highlight the difficulties faced by rural providers who work under resource-strained conditions in trying to deliver high-quality integrated healthcare services to these workers. We also intend to examine the role of digital health interventions in helping improve the delivery and coordination of services for managing occupational injuries and illnesses for agricultural workers in California."

"We would like to start by asking some general questions. There are no right or wrong answers...we are just interested in hearing your views."

VIII. Interview Session (45 minutes)

Initial Introduction Questions

- Please introduce yourself by stating your name and occupation. Even though I will address you by name during this interview, it will not appear in the transcript.
- Can you briefly describe your organization?
    - Location
    - Mission
    - Services provided
    - Type of farmworkers seen

QUESTIONS:

"We would now like to discuss your experiences concerning the overall health, barriers to healthcare access, and integration of the healthcare system for agricultural workers with a particular focus on managing occupational injuries/ illnesses."

1. Can you describe how an agricultural worker with an occupational injury or illness is managed at your organization?
    - Most common types of occupational injuries seen in your practice
    - Experience in providing referrals for agricultural workers

- Sharing patient health information with other providers
- What level of follow-up is seen among patients with occupational injuries/ illnesses?
- Possible reasons behind this trend

2. We now want to focus on using digital health interventions such as Telehealth, electronic health information exchange, smart devices, and mobile health applications.
   - What type of telehealth services are being provided in your facility?
     - Audio visits
     - Video visits
     - Remote Patient Monitoring
     - Mobile health applications
   - How can the delivery of such services be improved?
     - Should such services be improved through funding devices and better at-home connectivity for farm workers
     - Should such services be improved by creating telehealth access points at user-friendly locations such as schools and libraries?
     - Should such services be improved by connecting with on-site nurses or M.A.s on farms through grower-run clinics?
     - Any other recommendations

3. What can be the role of Spanish-speaking community health educators or Promotoras in helping to improve healthcare access for agricultural workers using digital health interventions?
   - Interpretation
   - Community Outreach
   - Care coordination
   - Promotion of technical literacy
   - Help with social determinants

4. What can be the role of employers in helping to improve healthcare access for agricultural workers using digital health interventions?
   - Providing in-person and virtual healthcare services through grower-run clinics

- Facilitating access by helping workers connect to specialists at worksite clinics
- Providing occupational safety information via social media apps
- Providing paid time off or convenient clinic hours

5. Migrant workers often move across the border to seek cheaper healthcare services. Some employer plans also provide coverage for such services, and recently, there has been a pilot project exploring the role of Mexican physicians in providing culturally competent care for these workers. What are your thoughts on the creation of a binational health system?

   - Creation of binational telehealth licensure agreements
   - Creation of binational data-sharing agreements
   - Type of payment mechanisms for reimbursement of such services
   - Creation of a separate system for farm workers

6. The Cal AIM framework covers enhanced care management such as transportation, care coordination, housing, and nutritional needs for Medi-Cal-eligible special populations. Agricultural workers are not currently included under this framework. What are your thoughts on having them as a special population?

   - Benefits of inclusions
   - Challenges of inclusion
   - Any recommendations

7. Finally, I would like to ask how you envision creating an integrated and coordinated healthcare system for agricultural workers in California.

   - What would the role of digital technologies be in achieving this vision?
   - What are the significant barriers to achieving that vision?
   - What policy changes do you think are needed to achieve that vision?
   - Any additional recommendations or comments?

V. Wrap-up (final 3 minutes)

"Is there anything else we should know about your experiences...either positive or negative...with access to and utilization of healthcare services via telemedicine among agricultural workers with occupational injuries and illnesses?"

"Do you have any last thoughts or comments about the interview session?"

The interviewer thanks the participant and asks for any feedback about the interview guide and study techniques.

Interview Guide (Study 3)

Health system integration for Agricultural Workers from the perspectives of Healthcare Providers and advocates

IX. Paperwork (5 minutes)

Informed consent: Before the start of the interview session, the interviewer will verbally summarize the informed consent form and ask the participant to read and sign the consent form. The participant can also choose to give verbal consent, which will be recorded by the interviewer.

X. Introduction to the Interview Session (5 minutes)

The interviewer welcomes the person, introduces herself, and reviews the following points:

- Assures participants of confidentiality
- Explains that the session will be recorded and reviewed by a small group of researchers
- Affirms that participant will not be identified personally in transcripts or other reports
- Affirms that only first names or nicknames will be recorded in transcripts or other reports
- Affirms that participant may choose not to answer a question
- Assures the participant that there are no right or wrong answers
- Affirms that researchers are interested in honest answers to the questions
- The participant is made aware that the interview will take no more than an hour
- The interviewee will be asked for feedback about the interview guide and study techniques

The interviewer starts recording and thanks the participants for their cooperation. The interviewer asks the participant to state a first name or nickname they would like to use as an identifier. The participant is encouraged to speak freely in response to various questions.

XI. Introduction to the issue (5 minutes)

"First, I would like to thank you for agreeing to take part in this interview. As you know, agricultural workers in California constitute a vulnerable population group. They have the highest occupational injury rate among workers in all occupations in California and the U.S. More than half are undocumented and fear deportation upon utilizing healthcare services. Most of them reside in Medically Underserved rural

areas with limited healthcare services and lack access to reliable means of transportation to use their available services.

Over the past few years, I have been involved in several studies aimed at helping improve access to health care for farm workers in California. To date, most of our research has focused on ways to expand coverage to farmworkers. But we understand that just having coverage does not ensure access to good, quality healthcare services. So, we are looking at how best to organize and deliver care to farm workers in California. Our discussions have highlighted the opportunities for new approaches, including digital health approaches, to provide access to care. After speaking with several healthcare professionals, we have developed four potential models that might be trialed. We were hoping that we could describe each model to you and then see what you think would be the benefits and the challenges with each model.

Do you have any questions so far?"

IV. Interview Session (45 minutes)

Initial Introduction Questions

Okay, to start, please describe your current position and any experience you might have with developing policies or providing healthcare to farm workers.

- Can you briefly describe your experience?
    - What types of farm workers are seen in your practice?
    - What has your experience been in providing healthcare services to agricultural workers?
    - What has been your experience providing telehealth services to agricultural workers?
    - What has your experience been sharing patient health information electronically with other providers?
    - What is the level of follow-up seen among these patients?
    - What are the possible reasons behind this trend?

Thank you. I would now like to briefly describe possible ways of delivering health care to farm workers. Please provide your perspectives and comments on each model based on your real-world experiences.

Model 1: Promotoras (Spanish-speaking peer educators), who can be farm workers, tech-savvy high school graduates, or students from farm-working communities, are recruited and trained to facilitate telemedicine utilization and care navigation for agricultural workers. They are paid workers with specific job-related training embedded within the healthcare system. They go to patients' homes and establish one-on-one trusting relationships. They provide digital devices, internet services, and training on accessing tele visits, electronic health records, and remote patient monitoring tools. They help schedule appointments, facilitate adherence to follow-up instructions, and help with prescription drug coverage, transportation, food, etc. Is this model feasible in the real world?

- Potential challenges
- Potential facilitators
- How should Promotoras be embedded in the healthcare system?
- How should these devices and services be funded?
- What type of training should the Promotoras have?
- Any suggestions or recommendations

Model 2: Promotoras are recruited from the community as digital navigators at telehealth access points. They are paid workers with specific job-related training. These remote hubs or telehealth access points utilize user-friendly venues such as schools, libraries, or corner stores. They use existing broadband access and smart devices available at these locations. Promotoras establish trusting relationships with agricultural workers. They provide training on accessing tele visits, electronic health records, and remote patient monitoring tools. They help schedule appointments, facilitate adherence to follow-up instructions, and help with prescription drug coverage, transportation, food, etc. Is this model feasible in the real world?

- Potential challenges
- Potential facilitators
- What type of training should the Promotoras have?
- How should Promotoras be embedded in the healthcare system?
- Any suggestions or recommendations

Model 3: Some large-scale growers have established their worksite clinics. These clinics are run by Nurse practitioners, nurses, and medical assistants. They can conduct physical

examinations, laboratory tests, and procedures and accurately report the findings to nearby healthcare providers via telemedicine services. They can also connect patients to specialists in the clinic, acting as telehealth access points, helping to overcome barriers related to transportation and lack of paid time off. They can also help to provide occupational health education and screening services. Is this model feasible in the real world?

- Potential challenges
- Potential facilitators
- How should these devices and services be funded?
- What type of additional training should these nurses or M.A.s have?
- Any suggestions or recommendations

Model 4: Many migrant workers travel to Mexico for cheaper treatment. They are provided with binational health insurance plans that cover healthcare services in both countries. A culturally competent physician from Mexico examines them at a designated farm worker clinic in the U.S. via telemedicine and provides treatment and referrals. When workers cross the border, they can seek treatment from a similar clinic in that country where the healthcare provider can access their medical records and continue their care seamlessly through binational telehealth licensure and data sharing agreements. They can connect to their doctor in either country via in-person or tele visits and share their records and concerns. Is this model feasible in the real world?

- Potential challenges
- Potential facilitators
- How should these devices and services be funded?
- What are your concerns about the quality of services delivered under this model?
- Any suggestions or recommendations

Finally, I would like to ask how you envision creating an integrated and coordinated healthcare system for agricultural workers in California.

- What would the role of digital technologies be in achieving this vision?
- What are the significant barriers to achieving that vision?
- What policy changes do you think are needed to achieve that vision?
- Do you think including farm workers under Cal Aim would be feasible?

- Any additional recommendations or comments?

V. Wrap-up (final 3 minutes)

“Thank you for sharing your perspective and valuable insight on this crucial topic. Do you have any last thoughts or comments about the interview session?”

The interviewer thanks the participant and asks for any feedback about the interview guide and study techniques.