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Implementation of an Awareness Level Training to Prepare the Workforce for Future Infectious Disease Outbreaks

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Original Research

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Abstract

Objective: The COVID-19 pandemic underscores the need for workforce awareness-level training for infectious disease outbreaks. A training program was created and evaluated to provide strategies for emergency preparedness as well as worker health and safety during a disease outbreak.

Methods: Participants ($N = 292$) completed instructor-led synchronous online training modules between January 2022 and February 2023. Training covered 5 areas: vaccine awareness, infectious disease transmission and prevention, pandemic awareness, and inapparent infections, as well as workplace controls to reduce or remove hazards. Participants completed a survey before and after training to assess knowledge change in the five areas. Chi-square analyses assessed how predictors were related to knowledge change.

Results: Overall, an increase in knowledge was observed between pre- (80.9%) and post-training (92.7%). Participants from small businesses, with less work experience, and in non-health care roles were under-informed. Knowledge of disease transmission and prevention improved for non-health care professions and workers with less experience. All participants gained knowledge in identifying and ranking safeguards to protect workers from injuries and illness at job sites.

Conclusions: Training improved employee knowledge about safe work practices and pandemic preparedness. Studies should continue to evaluate the effectiveness of preparedness training to prepare the workforce for infectious disease outbreaks and pandemics.

Introduction

The impact of the Coronavirus Disease 2019 (COVID-19) pandemic highlighted the importance of preparing the workforce to respond to future pandemics and communicable disease exposure in workplaces.[1] Employees in certain occupations are at an increased risk of exposure to airborne and percutaneously transmitted diseases, given job duties that require interactions with patients, customers, other employees, and livestock.[2–4] Specifically, employees that work away from home, are in close contact with the public, and work indoors in close proximity to their coworkers in poorly ventilated areas are at significant risk for contracting infectious diseases, including COVID-19.[5,6]

Research shows that workers in health care settings face increased exposure to infectious agents while providing patient care. However, workers in health care may also have better infectious disease protection plans and policies than other occupational settings.[1,7] Additionally, health care workers have a greater access to training and personal protective equipment (PPE), (e.g., respirator, gloves, and protective wear), potentially limiting the transmission of disease to co-workers and community members.[1,8,9] Workers in other occupations, such as the construction, food processing and preparation, cleaning, and transportation industries may also be at risk for exposure to communicable diseases.[10] However, these workers encounter stressors including inadequate training, inefficient, or missing PPE, and inaccurate information about disease transmission.[10]

During the COVID-19 pandemic, new occupations including janitorial staff and food service workers, were designated "essential" to the workforce.[11] Persons who held these jobs suddenly had to cope with increased vulnerability to disease exposure, without concomitant education about how to prevent disease transmission.[11,12] Utilizing workplaces to initiate successful control and prevention measures such as awareness training to educate the workforce on emergency preparedness and response has proven effective.[3,6,13] However, more knowledge is

Table 1. Overview of the training program's core curriculum

Modules	Lessons
Module 1: Infectious Disease Basics	• Worker rights under the OSH Act • Infectious Agents • Chain of Infection • Infection Control Measures
Module 2: COVID-19 Basics	• Information on SARS-CoV-2 • Symptoms and Transmission • CDC Guidance • Assessing the Potential for Exposure in the Workplace
Module 3: Protecting Workers and Strategies for Business Continuity	• Workplace Prevention Strategies • Collaborating with Health Departments • Testing and Vaccination Programs • Business Continuity Planning • NIOSH Hierarchy of Controls
Module 4: OSHA Guidance and Standards that Protect Workers	• COVID-19 National Emphasis Program and Emergency Temporary Standards • PPE Standard • Respiratory Protection Standard • Hazard Communication Standard

Abbreviations: OSH Act, Occupational Safety and Health Act of 1970; CDC, Centers for Disease Control and Prevention; OSHA, Occupational Safety and Health Administration; NIOSH, National Institute for Occupational Safety and Health; PPE, Personal Protective Equipment.

needed to assess the impact of training designed to improve workers' awareness of disease exposure and familiarity of safe work practices during a disease outbreak. Furthermore, addressing infectious diseases, and other workplace hazards with training can be beneficial in increasing employee capacity to identify hazards, change attitudes, and promote collective action to successfully eliminate or decrease disease transmission.[2,14]

Prior to the COVID-19 pandemic, many companies had not incorporated training about safety practices during pandemics and disease outbreaks, nor had they educated workers about the importance of vaccination to prevent the spread of infectious diseases.[3,15] To combat misinformation and educate the workforce about transmission and response to disease outbreaks, the first author created a training program to provide a curriculum for emergency preparedness, and strategies to protect workers during the COVID-19 pandemic. The current study presents information about the training program, which focused on education about infectious diseases and emergency preparedness response during an infectious disease outbreak as well as reviewing strategies for reaching workers with training. Additionally, we assessed knowledge change related to participating in the training sessions to evaluate the training program. Findings provide information for implementing emergency preparedness response interventions to inform future training related to disease transmission.

Methods

Participants

Participants ($N = 292$) completed 1 of 15 instructor-led synchronous online training modules for infectious disease awareness, transmission, and control measures. The University of Cincinnati Institutional Review Board approved this research as exempt.

Materials

The curriculum was modified from existing materials available from the Centers for Disease Control and Prevention,[16] the National Institute of Environmental Health Sciences,[17] and the Occupational Safety and Health Administration (OSHA),[18] by a panel of experts in infectious diseases and occupational safety and health. The development of the program was grant funded and the curriculum is available (open access) on a university sponsored webpage.[19] The training modules included a broad overview of all infectious agents (bacteria, fungi, viruses, and parasites), as well as specific examples of past disease outbreaks and pandemic events. Specifically, modules included details for the chain of infection, modes of transmission for infectious agents, and key information regarding symptoms and transmission of COVID-19. The training also informed participants of their rights to a safe workplace, as protected by the Occupation Safety and Health Act of 1970, and provided details for COVID-19 testing and vaccinations. Controlling and safeguarding exposures to hazards in the workplace applicable to the National Institute for Occupational Safety and Health (NIOSH)'s hierarchy of controls was discussed.[20] Further, the training provided information for assessing the potential for exposure to COVID-19 in various work settings, business continuity planning, and guidance and standards from OSHA that can protect workers. Table 1 provides a detailed outline of the course components.

Procedures

The target audience for the training program was adults currently employed within the United States (US). A flyer promoting the training was circulated through local Chambers of Commerce, social media marketing ads, and via a listserv consisting of workers who had previously attended a university continuing education training program focusing on environmental health and safety for the workforce. The flyer contained a secure registration link, where participants provided basic contact information details and reviewed an informed consent form. Participants were invited to attend synchronous online training via a Zoom® meeting link approximately 1 week prior to the training start date. During the 3-hour facilitated training session an instructor presented PowerPoint slides to the participants.[19] A total of 15 training sessions were delivered January 2022 through February 2023. Participants completed a survey before and after training to assess their knowledge reflecting five domains, including vaccination and immunity, indirect disease transmission, pandemic awareness, asymptomatic disease transmission, and the use of NIOSH's

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Table 2. Survey questions and correct answers pre- and post-training

Question	Correct Answer
1. Vaccines reduce the risk of infection by working with the body's natural defenses to safely develop immunity to disease "true," or "false"	True
2. Indirect transmission includes all the following EXCEPT	Skin-to-skin contact
3. A pandemic refers to an epidemic that has spread over several countries or continents, usually affecting many people "true," or "false"	True
4. Which of the following describes an inapparent infection	An infection of a susceptible host without clinical signs
5. Which of the following would be considered an administrative control	Limiting the number of staff present for high potential exposure tasks

Hierarchy of Controls to limit COVID-19 transmission in the workplace.[20] Specifically, knowledge of administrative and engineering work controls were evaluated. Questions were developed based on expert review of the curriculum and are presented in Table 2.

Statistical Analyses

All data analyses were performed using the IBM SPSS software Version 29 (IBM Corp., Armonk, New York, USA). Descriptive statistics were calculated to provide information on frequencies and percentages for demographic variables. Differences before and after training for knowledge questions were analyzed using chi-square tests. The analysis variable for the chi-square tests was the number of correct answers, coded "1" versus the number of incorrect answers, coded "0." Bonferroni corrections were used to adjust P values for evaluating the 5 knowledge questions ($0.05/5 = 0.01$). Next, chi-square tests were conducted to compare differences in knowledge pre-training and differences in knowledge post-training for independent variables, including sex, level of work experience (measured by age; Median = 40 years), which was dichotomized, "low," (younger or equal to 40 years) or "high," (older than 41 years), size of company, dichotomized as, "small business," (companies employing 100 or less employees) or "large business," (100 or more employees), and occupation. We had a particular interest in analyzing data for respondents who worked in health care (nursing, patient care, and support occupations) compared with other occupations, and those working in occupational health and safety (specialists and technicians) compared with other occupations.

Results

Table 3 presents demographic information. Most participants were white and male. More than 50% of the participants fell in the 41 to 60 age group. More than a third of participants worked in companies with less than 25 employees. More than 50% of the participants worked in occupational health and safety, and 11% were employed in health care.

The training was successful in improving participants' knowledge. Pre-training 80.9% of respondents answered all survey questions correctly and post-training the percentage answering all questions correctly increased to 92.7%. Table 4 presents results for chi-square analyses and percent change in "correct" responses for the five knowledge questions. Knowledge gain was defined as an increase in the percentage of participants who answered the knowledge questions correctly. For question 1, evaluating knowledge of vaccination and immunity, the chi-square test did not indicate a significant gain in

Table 3. Demographic details for participants ($N = 292$)

Characteristic	*n* (%)
Sex	
Male	171 (58.6)
Female	121 (41.4)
Race	
Asian or Pacific Islander	8 (2.7)
Black or African American	64 (21.9)
White or Caucasian	189 (64.7)
Hispanic or Latino	19 (6.5)
Other	12 (4.1)
Age Range	
18 to 24	13 (4.5)
25 to 31	22 (7.5)
32 to 40	56 (19.2)
41 to 50	77 (26.4)
51 to 60	76 (26.4)
61 to70	44 (15.1)
71 or older	4 (1.4)
Company Size (No. of employees)	
Under 25	106 (36.3)
25 to 50	24 (8.2)
50 to 100	42 (14.4)
100 to 200	41 (14.0)
200 to 250	30 (10.3)
Over 250	49 (16.8)
Years of Experience	
1 to 5	82 (28.1)
6 to 10	49 (16.8)
11 to 15	37 (12.7)
16 to 20	90 (30.8)
Over 21	5 (1.7)
Occupation Group	
Cleaning and maintenance	5 (1.7)
Community and social services	4 (1.4)
Construction trades	30 (10.3)
Education and training	25 (8.6)
Food preparation and serving	5 (1.7)
Health care	32 (11)
Insurance claims processing	8 (2.7)
Management	26 (8.9)
Occupational health and safety	147 (50.3)
Office and administrative support	8 (2.7)
Other, not applicable	2 (0.7)

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Table 4. Chi-square analyses for pre- and post-training for survey domains

Survey Domains	Pre-training correct responses n (%)	Post-training correct responses n (%)	*P*
1. Vaccination and Immunity	282 (96.6)	291 (99.7)	0.850
2. Indirect Disease Transmission	147 (50.3)	239 (81.8)	0.001
3. Pandemic Awareness	290 (99.3)	289 (99)	0.885
4. Asymptomatic Disease Transmission	227 (77.7)	261 (89.4)	< 0.001
5. Administrative and Engineering Controls	235 (80.5)	273 (93.5)	< 0.001

knowledge (Table 4). Specifically, participants were knowledgeable pre-training, scoring 96.6% vs 99.7% post-training. For question 2, evaluating indirect transmission of disease, the chi-square test indicated significant knowledge change, participants scored 50.3% pre-training vs 81.8% post-training. The chi-square analyses did not indicate a significant gain in knowledge for question 3, which evaluated knowledge of the COVID-19 pandemic. Participants were knowledgeable of the ongoing pandemic, scoring 99.3% pre-training vs 99.0% post-training. For question 4, evaluating asymptomatic transmission of diseases, the chi-square analysis indicated significant knowledge change, participants scored 77.7% pre-training vs 89.4% post-training. For the fifth question, evaluating knowledge of administrative and engineering controls that protect the health of workers, the chi-square test was statistically significant (Table 4), participants increased their knowledge from 80.5% pre-training vs 93.5% post-training.

Table 5 provides information about comparisons of knowledge change in answers on the pre- and post-training questions for 4 predictors: sex, level of work experience, size of company, and occupation (health professional or occupational health and safety professional). Few statistically significant differences were observed for knowledge change by the predictors when the Bonferroni corrections were applied. Inspection of the data in Table 5 indicated knowledge about vaccination and immunity was high pre-training and remained high after training. Those who did not identify as healthcare workers showed a gain in knowledge.

Table 5 reveals pre- to post-training changes in knowledge about indirect disease transmission. There were not significant differences for predictors, when the Bonferoni correction was applied. However, visual inspection of Table 5 shows an increase in knowledge of indirect disease transmission post-training. Females showed greater knowledge gains than males about indirect disease transmission, although inspection of Table 5 indicated both groups showed improvement. Inspection of the data suggests that participants with work experience achieved more correct answers about knowledge of indirect disease transmission post-training compared with those without work experience post-training. Employee knowledge about indirect disease transmission showed improvement post-training irrespective of company size or occupational status (i.e., health care professional, safety professional). As anticipated, participant scores for knowledge question 3, assessing pandemic awareness remained stable from pre- to post-training. Pandemic awareness scores were not influenced by sex, company size, work experience, or occupational status.

Furthermore, Table 5 presents knowledge for asymptomatic disease transmission and visual inspection shows gains from training – specifically, gaps between males and females closed post-training, with males having less knowledge about asymptomatic disease transmission compared with females pre-training. Similarly, although those with lower levels of work experience showed less knowledge of asymptomatic disease transmission pre-training, this difference disappeared post-training. Inspection of the data indicates gains in correct answers post-training for participants, irrespective of work or demographic category.

Inspection of responses for pre- to post-training differences in knowledge of administrative and engineering controls indicated knowledge gain after training regardless of sex, work experience, or occupational status (Table 5). Safety professionals had more preexisting knowledge of the hierarchy of work control behaviors to prevent disease spread than other professional groups. There was one significant finding, participants employed at larger companies (> 100 employees) had more knowledge of administrative and engineering controls prior to training than those employed at small companies (< 100 employees). However, both groups improved their knowledge in this area post-training.

Discussion

This study provides one of the few descriptions of the development and implementation of an awareness training for disease outbreaks delivered during the COVID-19 pandemic, which was not exclusively designed for health care workers. The training was successful in improving participants' knowledge from pre-training to post-training. Prior to receiving training, some participants were underinformed in specific areas of the training and participating in Zoom® sessions remedied this lack of knowledge, providing workers with what they needed to know to stay safe on the job. Data indicated that workers not in health care industries had less knowledge and benefitted from this training. This type of training will be important to continue as infectious diseases, including COVID-19 are still present and negatively impact worker health and productivity.[12] Recruitment for future training interventions should target these workers outside the health care industry to improve their awareness of how to remain safe during an infectious disease outbreak.

Another group in need of training may be workers who are new in their field. In our study, participants who had less work experience were less likely to accurately define indirect disease transmission and asymptomatic disease transmission prior to receiving training when compared with participants with more work experience. Perhaps, workers with more experience were more knowledgeable from their work experience during past outbreaks and pandemics.[4,6] Reaching less experienced workers with critical information for disease exposure and transmission may protect workers and communities during future outbreaks resulting from COVID-19, seasonal influenza, and other natural hazards.[21] Workplace outbreaks present a challenge to employers and public health departments, whereby personnel at most workplaces may have little experience controlling and preventing airborne infectious disease exposures.[2] To this effect,

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Table 5. Chi-square analyses for pre- and post-training by survey question for predictors

Survey Domains	Predictors/ Responses	Pre-Training	*P*	Post-Training	*P*
Vaccinations and Immunity		Correct n (%)		Correct n (%)	
	Sex		0.925		0.234
	Male	165 (96.5)		171 (100)	
	Female	117 (96.7)		120 (99.2)	
	Work Experience		0.539		0.500
	Low	87 (95.6)		91 (100)	
	High	195 (97)		200 (99.5)	
	Company Size		0.468		0.230
	Small	165 (95.9)		172 (100)	
	Large	117 (97.5)		119 (99.2)	
	Healthcare Professional		0.259		0.004
	Yes	32 (100)		31 (96.6)	
	No	250 (96.2)		260 (100)	
	Safety Professional		0.506		0.313
	Yes	143 (97.3)		147 (100)	
	No	139 (95.9)		144 (99.3)	
Indirect Disease Transmission	Sex		0.649		0.032
	Male	88 (51.5)		133 (77.8)	
	Female	59 (48.8)		106 (87.6)	
	Work Experience		0.039		0.409
	Low	54 (59.3)		77 (84.6)	
	High	93 (46.3)		162 (80.6)	
	Company Size		0.198		0.193
	Small	92 (53.5)		145 (84.3)	
	Large	55 (45.8)		94 (78.3)	
	Healthcare Professional		0.056		0.562
	Yes	11 (34.4)		25 (78.1)	
	No	136 (52.3)		214 (82.3)	
	Safety Professional		0.814		0.264
	Yes	73 (49.7)		124 (84.4)	
	No	74 (51)		115 (79.3)	
Pandemic Awareness	Sex		0.805		0.373
	Male	170 (99.4)		170 (99.4)	
	Female	120 (99.2)		119 (98.3)	
	Work Experience		0.564		0.182
	Low	90 (98.9)		89 (97.8)	
	High	200 (99.5)		200 (99.5)	
	Company Size		0.797		0.146
	Small	171 (99.4)		169 (98.3)	
	Large	119 (99.2)		120 (100)	
	Healthcare Professional		0.619		0.212
	Yes	32 (100)		31 (96.9)	
	No	258 (99.2)		258 (99.2)	
	Safety Professional		0.159		0.554
	Yes	145 (98.6)		146 (99.3)	
	No	145 (100)		143 (98.6)	

(*Continued*)

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Table 5. (*Continued*)

Survey Domains	Predictors/ Responses	Pre-Training	*P*	Post-Training	*P*
Asymptomatic Disease Transmission	Sex		0.002		0.477
	Male	122 (71.3)		151 (88.3)	
	Female	105 (86.8)		110 (90.9)	
	Work Experience		0.019		0.786
	Low	63 (69.2)		82 (90.1)	
	High	164 (81.6)		179 (89.1)	
	Company Size		0.934		0.627
	Small	134 (77.9)		155 (90.1)	
	Large	93 (77.5)		106 (88.3)	
	Healthcare Professional		0.613		0.714
	Yes	26 (81.3)		28 (87.5)	
	No	201 (77.3)		233 (89.6)	
	Safety Professional		0.839		0.596
	Yes	115 (78.2)		130 (88.4)	
	No	112 (77.2)		131 (90.3)	
Administrative and Engineering Controls	Sex		0.476		0.306
	Male	140 (81.9)		162 (94.7)	
	Female	95 (78.5)		111 (91.7)	
	Work Experience		0.095		0.115
	Low	68 (74.7)		82 (90.1)	
	High	167 (83.1)		191 (95)	
	Company Size		0.026		0.926
	Small	131 (76.2)		161 (93.6)	
	Large	104 (86.7)		112 (93.3)	
	Healthcare Professional		0.076		0.145
	Yes	22 (68.8)		28 (87.5)	
	No	213 (81.9)		245 (94.2)	
	Safety Professional		0.093		0.224
	Yes	124 (84.4)		140 (95.2)	
	No	111 (76.6)		133 (91.7)	

COVID-19 may be the first outbreak less experienced workers have worked through.

Results of the training indicate that pre-training knowledge regarding how vaccinations assist the immune system in developing protection against disease and knowledge of the COVID-19 pandemic was high. This could be due to the large media and societal impacts of the current ongoing pandemic and discussion of OSHA's Emergency Temporary Standard (ETS) on vaccination and testing that was announced during training implementation.[22] The ETS intended to protect unvaccinated employees of large employers with 100 or more employees from workplace exposure to COVID-19 by requiring vaccination or daily testing for the unvaccinated. It is possible that companies were already implementing training in these areas in preparation for the roll out of the ETS. Nevertheless, the vaccination and testing ETS was proscribed by the US Supreme Court and withdrawn by the Department of Labor OSHA before going into effect.[22]

Participants employed at larger companies had significantly more knowledge of administrative and engineering controls prior to training than those employed at small companies. Indicating employees of lager companies may have more resources for training that provide information for controls to improve workplace safety. Controlling exposures to all hazards, including infectious agents in the workplace is vital to protecting workers.[6,23] NIOSH hierarchy of controls provides information for the preferred order of action that can protect workers from many workplace hazards.[20] The preferred order of action is elimination, substitution, engineering controls, administrative controls, and lastly the least effective control PPE.[20] Workplaces cannot eliminate infectious agents or substitute them with a safer alternative, however, education for engineering controls, such as modifying workspace and using protective barriers, and educating the workforce on administrative controls, such as hybrid work schedules and encouraging sick workers to stay at home, both play an important role in decreasing disease transmission in the workplace.[6,23] More training in the beforementioned workplace controls may perhaps benefit workers during future disease outbreaks.

This study is not without limitations. The training was made available to participants one year after the declaration of the COVID-19 pandemic, suggesting that participants may have been exposed to the contents of the training modules through other workplace training programs and thus may have more baseline knowledge, affecting overall results. There was also a possibility of selection bias, as participants were not randomly selected. This study did not assess whether knowledge regarding disease

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outbreaks was retained over time or whether the knowledge changed work practices. There was no assessment of change in worker safety behaviors, which will be important to evaluate in future studies. Another limitation concerns restrictions regarding the nature of the survey questions. In efforts to increase pre-test and post-test response rates, the length of the questionnaire was kept brief; therefore, some information regarding vaccinations and the COVID-19 pandemic were formatted as "true" and "false" questions, limited the usefulness of these questions in analysis. However, the brevity of the pre- and post-educational intervention survey may have increased participation by reducing the perceived subject burden of time to complete the survey. The pre-test to post-test study design is a weaker design and does not lend much evidence toward causality. Further, questions were quantitative in nature, and future qualitative studies may provide insights into future needs of the workforce to better prepare for future pandemic events.

This study holds implications for future research. This training program was grant funded and the curriculum is available (open access) on a university webpage for future implementation.[19] Training, such as this one, should be disseminated online through occupational safety organizations and listservs. This has the potential to make awareness of safety practices available on a broad scale, reaching those who otherwise might not have access to critical on-the-job training that improves worker health and wellness.[2,7,24] Future research should explore how the training curriculum can be implemented using a train-the-trainer approach. This approach may expand the reach of the curriculum and increase participant enrollment and engagement in the training to different occupational settings that were not reached in the current study. Furthermore, future studies should explore how companies may edit and disseminate the curriculum to their staff and examine effective and ineffective components of the revised curriculum.

Conclusion

The COVID-19 outbreak underscores the need for training and other preparations for infectious diseases. Further, more work is needed to ensure all workers are appropriately trained to protect themselves from the transmission of infectious diseases, and organizations should be supported in efforts and materials should be made publicly available to adequately prepare their staff.[13,24] The training was effective in reaching workers with a unique training program for infectious disease awareness, transmission, and control measures during the COVID-19 pandemic. Further, the training was effective in closing knowledge gaps pre- to post-training in important topics that can protect the workforce from infectious disease outbreaks. Participants from small businesses, with less work experience, and in non-health care roles were underinformed, indicating a path forward for dissemination of the training. In conclusion, more research on workplace training during an infectious disease pandemic, and how this training changes behavior and mitigates disease transmission is needed and future studies should continue to evaluate training effectiveness for the workforce.

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Competing interests. The authors declare none.

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