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Assessing the Understandability and Actionability of Education Materials for Agricultural Workers' Health

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ABSTRACT

Objectives: Agricultural health and safety educators, including community health workers and Extension agents, represent an important community of practice, connecting agricultural workers (i.e. migrant and seasonal farmworkers) to health information and care. We sought to identify and evaluate existing education resources available to educators for use in health education and outreach with farmworkers.

Methods: This study used a systemized search process to identify health education materials in English and Spanish used in the United States. Two independent coders coded each material for its understandability and actionability using the Patient Educational Material Assessment Tool (PEMAT). We report descriptive statistics by type of material, topic, and publication date of the material.

Results: We identified farmworker health education materials ($n = 602$) from across the United States. The average understandability score was 86%, and the average actionability score was 76%. Materials were most commonly print material in the format of handouts, brochures, and posters. Some topic areas (e.g. musculoskeletal injuries) had considerably more resources than others (e.g. green tobacco).

Conclusion: This research represents the first, to our knowledge, comprehensive assessment of health education materials for education and outreach to agricultural workers. While the average scores for understandability and actionability were high among materials, there is room to build a stronger set of resources in some topic areas and to modernize materials for electronic delivery. Using PEMAT tools can help the Extension and community health worker communities of practice improve the quality of materials they share with agricultural workers.

KEYWORDS

Community of practice; consumer health information; health equity; health promotion; migrant workers

Introduction

The agriculture industry is considered one of the most hazardous in the United States (U.S.). In the U.S., agricultural workers (specifically, migrant and seasonal farmworkers; hereafter "farmworkers") are often Spanish-speaking workers who move across the agricultural season (migrant farmworkers) or work just during the agricultural season (seasonal farmworkers) performing physical labor (e.g., maintaining crops, tending livestock) and operating machinery under the supervision of farmers, ranchers, or other agricultural managers.[1] These farmworkers experience significant work-related injuries and adverse health effects.[2,3] Common work-related injuries and health impacts for farmworkers include pesticide exposure,[4–6] heat illness,[7,8] and musculoskeletal conditions.[9,10] Education and health promotion efforts can help mitigate these work-related injuries and illnesses among farmworkers. One strategy for reducing injuries and illnesses among farmworkers is by using health education materials to improve health literacy.

Health literacy is important for preventing and managing health problems.[11] Health literacy gives people access to health information and directly and indirectly influences health outcomes through its association with social determinants of health (e.g., housing, education, healthcare quality, and income).[12] Health literacy and information are broadly understood to help change behaviors and provide the information

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necessary to make informed choices that can protect health and guard against injury. They are an important part of promoting health in the context of other upstream determinants and protections such as addressing structural vulnerability, eliminating hazards, and introducing engineering controls to reduce risks of work tasks (e.g., the higher levels of the Hierarchy of Controls for occupational safety). However, there are many barriers to farmworkers for accessing important health information including language barriers, the limited availability of culturally-relevant information,[13] as well as literal barriers to access in the form of not having internet access.[14] Community health workers and Extension educators are a key bridge between farmworkers and health information and systems.[15] Outreach to farmworker housing is often a key part of health services and typically includes health education and information brought and shared by a community health worker or Extension educator. Thus, community health workers and Extension educators have a need to identify, create, and use materials to address problems faced by farmworkers.

With the abundance of health education materials available online, in print, and through other media, studies have documented that most are too complex for the average person.[16,17] As a result, several assessment tools have been developed and used to assess the quality of health education content. One of these tools is the Patient Education Materials Assessment Tool (PEMAT), created for the Agency for Healthcare Research and Quality (AHRQ).[17] To our knowledge, no previous studies have evaluated the quality of health education materials currently available for use with farmworker communities. Furthermore, few studies have analyzed the specific topic areas covered by existing health education materials for farmworkers, and there is a notable lack of information regarding key descriptive elements of education materials, such as the types of publications (e.g., handouts, brochures, posters), publication dates, and language availability. Therefore, our study utilized PEMAT to assess the quality of health education content related to farmworker health, which is often shared with farmworkers by community health workers and Extension educators. Additionally, we collected information on the types of health education materials and resources available for use in farmworker health education and outreach, including the topics covered, publication types, language options, and publication dates.

Literature review

The following section offers a brief overview of the Patient Education Materials Assessment Tool (PEMAT), highlighting its unique features compared to other assessment tools, its benefits and limitations, and its history of use in health fields. The U.S. Department of Human Health and Human Services has emphasized the importance of understandable and actionable health materials for behavior change.[18] Many readability formulas (e.g., Flesch – Kincaid Grade Level [FKGL], Simple Measure of Gobbledygook Grade Level [SMOG], Coleman – Liau Index [CLI]) have been used in studies to assess health education materials[19,20]; however, these instruments fail to evaluate the understandability and actionability of the materials for the audience. The PEMAT was unique at the time of its development for being able to assess both. While a few instruments existed to assess comprehensibility (e.g., Suitability Assessment of Materials, Health Literacy Index, CDC Clear Communication Index),[21,22] PEMAT was the first tool created to assess actionability.[17] In addition, PEMAT is one of only a few assessment tools capable of evaluating print and audiovisual materials.[17] Social media (e.g., YouTube and TikTok) has increased people's access to audiovisual material, so having a single tool capable of assessing both types of materials is important for educators and public health professionals. Other benefits of the PEMAT tool include its ability to be used by untrained practitioners, being the first tool to undergo consumer testing to establish construct validity, and the ability to assess materials with only the materials themselves and no supplemental information (e.g., who it was developed for).[17]

While PEMAT is a powerful tool, it is not without its limitations, as no assessment tool currently exists that measures all the different quality components of education materials. For example,

PEMAT does not analyze accuracy, comprehensiveness, or readability.[17] Other evaluation tools may be needed alongside PEMAT, depending on the user's specific goals. Since its development, additional research[23,24] has provided "best practices" suggestions when utilizing PEMAT to improve the tool's reliability.

PEMAT has become a popular assessment tool in the public health field, as it has been used in hundreds of studies across different health fields. This instrument tool has been validated[17] and translated into several languages.[25,26] Researchers have used PEMAT to analyze content ranging from sleep apnea[27] and COVID-19[28–30] to diabetes.[31–34] PEMAT has also been used for systematic reviews of health education materials, like online international breast density information,[35] mobile apps designed for parents of infants in neonatal intensive care units,[36] and health education resources on advance care planning.[37] In addition, it has been used in comparative analysis studies that compare health education materials in English and Spanish. For example, Garland and colleagues[38] used PEMAT to compare online Spanish and English content on pancreatic cancer treatment; they found there were no significant differences in understandability between the two languages. Another study[39] comparing carpal tunnel syndrome materials in English and Spanish found no significant differences in understandability and actionability scores. Research has shown that Spanish speakers in the United States tend to have lower health literacy levels than English speakers,[40] making it important to check the understandability and actionability of materials for communities where Spanish is a primary language.

While PEMAT has been used to evaluate thousands of health materials, its use to assess education materials regarding occupational health and safety is limited. Research has utilized PEMAT to review maritime health information for seafarers[41]; however, it has not been used to assess materials for other high-risk occupations such as farm work. Other instruments, like the CDC's Clear Communication Index (CCI), have been sparsely used to assess health education material for occupational fields, such as construction.[42,43]

In addition to the critical need to create more health and safety education materials for farmworkers as documented in prior studies,[44,45] it is equally important that the quality (e.g., readability, understandability, actionability, reliability) of existing materials available for farmworker health education and outreach is assessed. And although PEMAT has not been actively used for health education materials aimed at farmworkers, it has been used to assess education materials for migrant communities[46] and immigrants,[47] characteristics common among U.S. farmworkers.

Theoretical framework

There is a large network of agricultural health and safety educators, including community health workers and Cooperative Extension educators, who are committed to protecting and improving the health and safety of farmworkers.[48–50] Therefore, our study is grounded in the theory of Communities of Practice (CoP) to help contextualize how PEMAT can serve as a tool for this network of educators and ultimately improve health education for farmworkers. In a community of practice, a group of people share a common interest or concern for a topic and work together to exchange best practices and develop new knowledge.[51] All communities of practice have three defining characteristics: *domain*, *community*, and *practice*. A community of practice's *domain* is the topic of interest that unites the members of the community and contributes to their shared identity (e.g., the health and safety of farmworkers). The *community* allows members to interact with each other and share knowledge of best practices and resources.[52] The *practice* of a community consists of the stories, tools, or experiences that are shared among the community to form a collection of resources.[53] Specifically, health education materials (e.g., fotonovelas, pamphlets, websites, videos) are important tools community health workers and Extension educators use. The PEMAT can be a new resource for this community to improve its practices in providing quality education to farmworkers.

Research questions

The purpose of this study was to evaluate existing health education materials for farmworkers using PEMAT to assess their understandability and actionability. The following research questions guided this study:

(1) What health education materials and resources are available for use in farmworker health education and outreach?
(2) How understandable and actionable are the available materials to farmworker audiences?

Methods

To answer these research questions, we conducted an observational study that used a national search and screening process where we first inventoried existing materials and then coded materials using the PEMAT. We undertook this project as part of a National Library of Medicine Health Disparities Resources Grant (G08LM013198), which included a partnership with a state farmworker health program and an advisory board that included students from farmworker families, community health workers, health education specialists, and librarian/information science specialists. The research protocol was reviewed and approved by the East Carolina University and Medical Center Institutional Review Board (#19–001817). The review of existing materials presented here did not involve human subjects.

Our first task was locating available health education materials for use with farmworkers. To identify topics for farmworker health education resources, we engaged an advisory board and representatives of a state Department of Health and Human Services who suggested and voted on the most important topics for farmworker health education and outreach. A health sciences librarian led the systematized search process. We started by searching key resources for farmworker health education materials such as the Migrant Clinicians Network website, the National Center for Farmworker Health website, and the National Agricultural Safety Database. From there, we reviewed additional organizations' websites – some identified via word of mouth from our advisory board and other project members – and others identified by using targeted advanced Google searches for patient education and health resources aimed at agricultural workers broadly or migrant and seasonal farmworkers specifically. We also used backwards and forwards chaining in the search, as many websites linked to other programs' websites, which had additional resources. As our search broadened, we requested materials from community health workers by e-mail and asked for suggestions from the now defunct Migrant Health Listserv. We also solicited materials by mail, sending prepaid envelopes to community health workers and others in the field to find out what types of materials they were using, scanning and cataloguing unique submissions. Many agricultural research and safety institutes' websites were included in the search as well. The full listing of organizations/resources searched is included in Appendix A. Websites like the CDC's website, Medlineplus.gov, and HealthReach (which was still active at the time) were not thoroughly searched because, although the information they contain is excellent from a health literacy and consumer health resource standpoint, it is not targeted to the farmworker population specifically.[13] Some resources from the CDC were included in the evaluation because they were linked to farmworker-targeted services. We accepted all materials that were actively in use or currently available for use, without applying a publication date cutoff as an exclusion criterion for eligibility.

Much of our search for health education materials was implemented using Google standard and advanced search because that is where most of the farmworker targeted materials live – on the websites of farmworker advocacy and outreach organizations and researchers. However, to capture peer-reviewed literature that might have mentioned health education materials being evaluated or interventions aimed at farmworkers, we also conducted a separate mapping review covering all of the major academic agricultural and health databases.[41] The mapping review coded journal

articles if they were related to or discussed specific interventions or education materials for farmworkers. If these articles had also been published in the last 10 years, then we contacted the corresponding author to request the related materials. We conducted the search from fall 2019 through June 2022 with the requests to researchers happening in June 2020.

All of the materials found in the above sources were catalogued in a spreadsheet. Information on the origin of the material, the creator or potential copyright holder of the material, the title, date created or uploaded, URL to the material, publication or item type, language, and how it was obtained were all included. Table 1 shows our coding scheme for topics and publication type.

To assess the health education materials, we conducted coding using the Patient Education Materials Assessment Tool (PEMAT).[17] We used 23 questions from the PEMAT-P (for printed materials) questions. We used 16 questions from the PEMAT-AV (for audiovisual materials). Both assessments were intended for use by health educators with no formal training in coding.

Regarding inter-coder reliability, a separate paper documents the process of establishing coding reliability for the PEMAT.[23] Briefly, after independently reviewing the PEMAT codebook and its user guide, three coders scored five materials, the results of which were tested with Krippendorff's alpha.[54] Both understandability and actionability reliability scores were unacceptably low, so the coding team reviewed divergent coding, discussed, and recalibrated, then coded 15 new materials. Reliability scores remained low, prompting the team to adopt an iterative approach. This included creating an annotated guide for coders and implementing a new coding strategy that involved averaging scores, similar to the scoring method used in Olympic gymnastics competitions. That strategy resulted in acceptable reliability, with intraclass correlations of 0.76 for understandability and 0.73 for actionability. Each item was coded by two of the three coders, and scores were averaged. Coders were fluent in English and Spanish and included a physician assistant graduate student, an undergraduate public health student, and a research assistant.

Results

Our comprehensive search for health education materials revealed 602 materials that were analyzed for understandability and actionability using the Patient Educational Materials Assessment Tool (PEMAT). Two hundred and twenty-six of the materials had publication dates ranging from 1997 to 2020, while no publication date was found for the remaining 376 materials (62%). Health education materials were either presented in English ($n = 225$), Spanish ($n = 293$), or a combination of both languages (English and Spanish $n = 66$, Spanish with English subtitles $n = 18$).

The average understandability score for all 602 materials was 85.82 ($\sigma = 9.19$, see Figure 1), and the average actionability score was 76.16 ($\sigma = 15.86$, see Figure 2). Understandability and actionability scores were found to be moderately positively correlated, $r(600) = 0.37$, $p < .01$ (see Figure 3). Ninety-three percent ($n = 561$) of the materials had a high understandability score (≥70), 82% ($n = 495$) had a high actionability score (≥70), and 78% ($n = 472$) had both a high understandability and actionability score.

PEMAT scores by publication type

A variety of publication types were represented in this sample of materials (Table 2). The three most frequently occurring types of publications were handouts ($n = 216$), brochures ($n = 136$), and posters ($n = 100$), accounting for 75% of the total materials found in this study. The least frequently occurring materials were websites ($n = 4$), slides ($n = 6$), and images ($n = 9$). Table 2 also displays the descriptive statistics of the understandability and actionability scores for each of the publication types. All of the publication types had an average understandability score ≥ 70. The highest-averaging publication types for understandability were posters (x = 90.27), websites (x = 88.74), and images (x = 88.41). The average actionability score was ≥ 70 for all the publication types except images (x = 66.67) and materials classified as miscellaneous (x = 66.20). Table 3 describes the number of health education materials with high understandability scores, actionability scores, or both

Table 1. Coding definitions for inclusion, topics, and publication type.

Eligibility	Further definition
Is the material intended to be used by a professional such as a health educator, outreach worker, teacher, clinician, or other professional?	Not eligible but assessed for inclusion of patient education material (e.g., patient materials within toolkits)
Is the material targeted to migrant or seasonal farmworkers?	Eligible using definition of migratory and seasonal farmworkers in the Public Health Service Act section 330(g)(3)(A): the term "migratory agricultural worker" means "an individual whose principal employment is in agriculture, who has so been so employed within the last 24 months, and who establishes for the purposes of such employment a temporary abode." Per section 330(g)(3)(B), "seasonal agricultural worker" means "an individual whose principal employment is in agriculture on a seasonal basis and who is not a migratory agricultural worker."
Is the material not targeted to migrant or seasonal farmworkers but is relevant to farm work or could be used in migrant or seasonal farmworker outreach?	Eligible
Is the material targeted to growers or farm owners/managers?	Not eligible but assessed for inclusion of patient education material (e.g., patient materials within toolkits)
Topic	**Definition**
Alcohol, Tobacco, & Other Drugs	Includes information related to substance use and health risks of alcohol, tobaccos, or other drugs
Chronic Disease- Diabetes	Includes information related to type 1, type 2, or gestational diabetes
COVID-19	Includes information related to the COVID-19 pandemic and/or coronavirus
Dental & Oral Health	Includes information related to dental and/or oral care (e.g., brushing teeth, cavities)
Emergency Preparedness	Includes information related to emergency preparedness and resiliency for natural disasters (e.g., hurricanes, tornadoes)
Green Tobacco Sickness	Includes information related to green tobacco sickness (e.g., exposure, risks, prevention)
Health Care, Enabling Services, and Insurance	Includes information related to clinic services, community resources, cultural competence, or health insurance
Living Conditions and Sanitation	Includes information related to farmworker housing conditions, or sanitation
Mental, Emotional, and Behavioral Health	Includes information related to mental, emotional, or behavioral health (e.g., anxiety, depression, therapy counseling)
Musculoskeletal Injuries (Back Pain, Injury Prevention, Occupational Ergonomics)	Includes information related to back pain, safety & injury prevention, musculoskeletal issues, or occupational safety
Other Chronic Diseases (Prevention & Treatment)	Includes information related to arthritis, autoimmune diseases, cancer, cholesterol, gastroesophageal reflux disease (GERD), heart failure, hypertension, nutrition, or physical activities & exercise
Other Topics	Includes information related to adolescent & teen health; men's health, or respiratory system
Pesticides	Includes information related to pesticides (e.g., exposure, risks, safety precautions)
Sexual Harassment & Domestic Violence	Includes information related to sexual violence (e.g., harassment, assault, rape) or domestic violence (e.g., verbal, physical)
Sexually Transmitted Infections/HIV/AIDS & Sexual Reproductive Health	Includes information related to sexual health and reproductive health (e.g., hepatitis, HIV, AIDS, OBGYN)
Skin or Dermatological Conditions- Excluding Sun Exposure	Includes information related to rashes or infections of the skin
Sun Exposure (Heat Stress, Heat Stroke, Hydration, Skin Cancer)	Includes information related to the prevention, symptoms, and treatment of heat stress, heat stroke, dehydration, or skin cancer
Vaccines and Immunizations	Includes information related to vaccinations and immunizations
Material Type	**Definition**
Article/Newsletter	Includes information presented in an article or newsletter
Brochure	Includes information presented in a brochure, booklet, fotonovela, accordion, or leaflet
Guide/Manual	Includes information presented in an employer training guide, training manual, or planning guide
Handout	Includes information presented in a factsheet, flyer, or handout
Image	Includes information presented in a graphic(s) or image file
Miscellaneous	Includes information presented in a wallet card, quick card, body map, self-assessment, comic, flip chart, short stories, cook book, picture dictionary, toolkit, screening questionnaire, workbook, emergency card, script, or curricula and resources,
Poster(s)	Includes information presented in a poster(s)
Slide(s)	Includes information presented in a PowerPoint(s), slide deck, or presentation

(*Continued*)

Table 1. (Continued).

Eligibility	Further definition
Video(s)	Includes information presented in a DVD, VHS, video playlist/channel, etc.
Website	Includes information presented in a webpage

Note: If a non-eligible piece of material (e.g., a curriculum for use by clinicians) included sample pieces of patient education material, an author and Extension specialist/professor selected the most representative piece of patient education material.

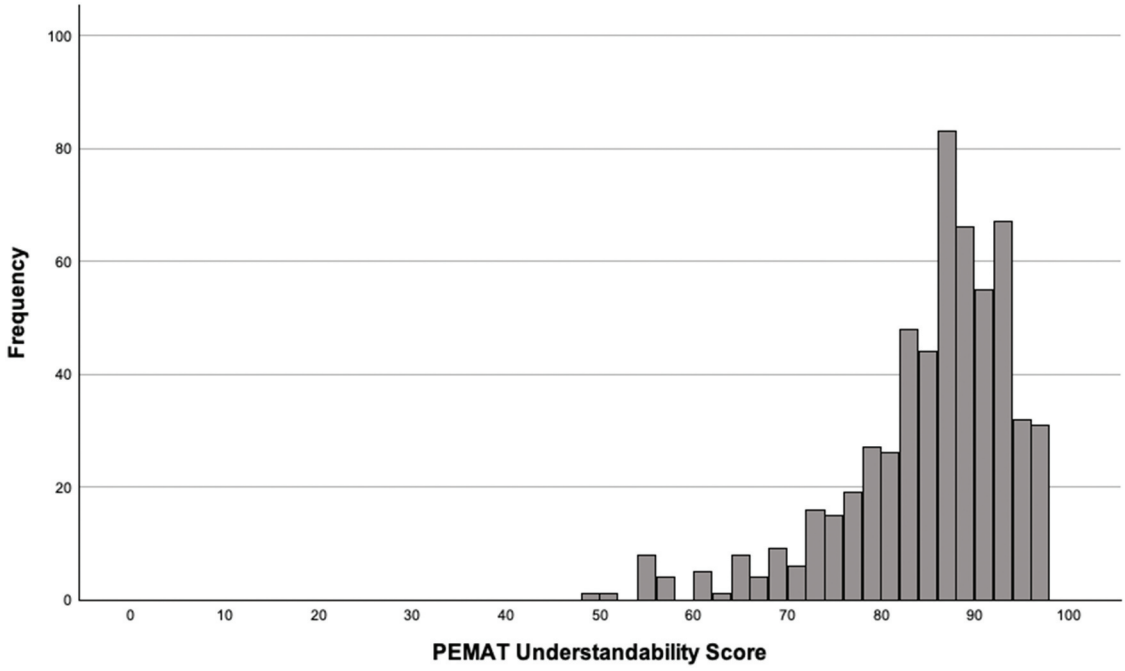

Figure 1. Histogram of understandability scores.

for each publication type. Websites and guides/manuals were the only two types of publications to have no materials with an understandability and actionability score < 70, and none of the articles/newsletters and slides had an understandability score < 70. Approximately a quarter ($n = 51$) of the handout materials evaluated in this study did not have both a high understandability and actionability score (i.e., scores ≥ 70). Pearson Chi-Square analysis revealed no significant relationship between high actionability scores and publication type x^2 (9, $N = 602$) = 16.955, $p = .05$. There was a statistically significant relationship between publication type and high understandability scores, x^2 (9, $N = 602$) = 40.612, $p < .01$, and a material achieving both high understandability and actionability, x^2 (9, $N = 602$) = 21.695, $p = .01$.

PEMAT scores by topic area

A range of topics were represented among the 602 health education materials (see Table 4). The most common topic areas covered in materials were musculoskeletal injuries ($n = 227$), prevention and treatment of non-diabetic chronic diseases ($n = 83$), sexually transmitted infections and sexual reproductive health ($n = 67$), and diabetes ($n = 63$). No health education materials were found that covered emergency preparedness, sexual harassment and domestic violence, or skin and dermatological conditions (non-sun exposure related). Table 4 displays the descriptive statistics of the understandability and actionability scores for each topic area covered by the health education materials. All 18 of the topic areas covered by the health education materials

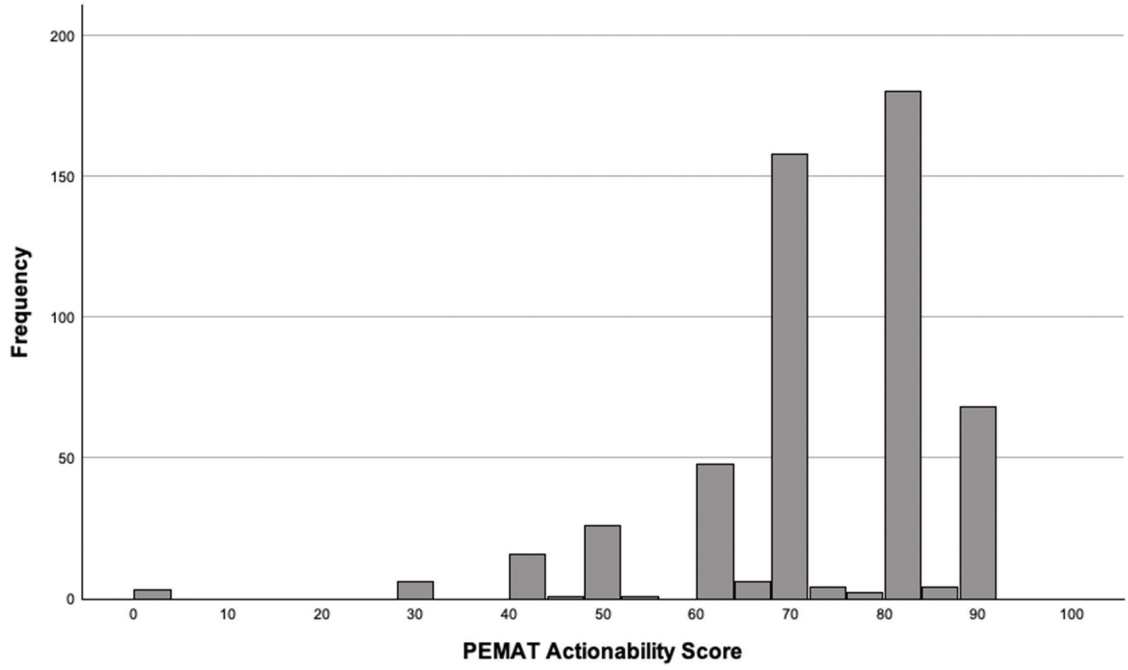

Figure 2. Histogram of actionability scores.

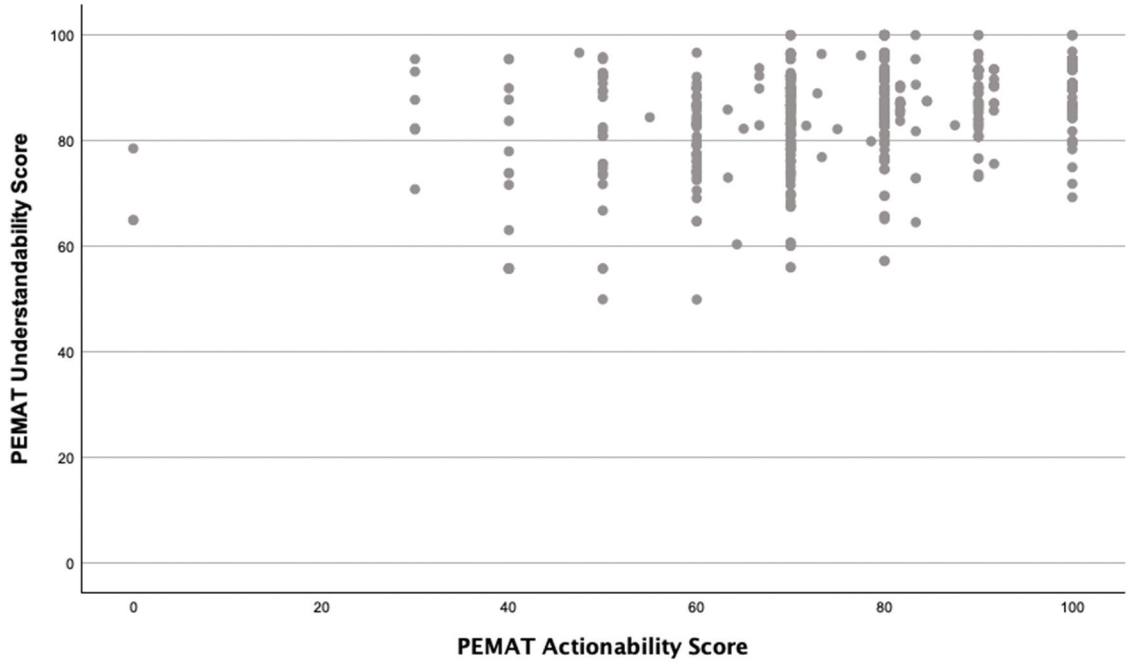

Figure 3. Correlation of understandability and actionability scores.

had an average understandability score ≥ 70. The highest-averaging topic areas were musculoskeletal injuries (x = 88.02), diabetes (x = 87.96), COVID-19 (x = 87.93), dental and oral health (x = 87.43), and sun exposure (x = 87.32). All but three of the topic areas had an average actionability score ≥ 70; they were health care-enabling services and insurance (x = 69.54), vaccines and immunizations (x = 69.26), and green tobacco sickness (x = 66.67). Further analysis of these three topic areas showed that this average was driven by a substantial number of materials

Table 2. Descriptive statistics of materials by publication type.

		Understandability				Actionability			
Publication Type	Frequency	Mean	±sd	Range	Min, Max	Mean	±sd	Range	Min, Max
Handout	216	84.66	8.81	50.03	49.97, 100.00	74.59	12.82	100.00	00.00, 100.00
Brochure	136	85.32	6.87	36.25	60.42, 96.67	76.64	14.12	70.00	30.00, 100.00
Poster(s)	100	90.27	8.94	39.86	60.14, 100.00	72.14	13.52	60.00	30.00, 90.00
Video(s)	66	88.50	9.71	50.00	50.00, 100.00	92.23	19.76	100.00	00.00, 100.00
Miscellaneous	39	78.59	13.91	44.16	55.84, 100.00	66.20	17.77	70.00	30.00, 100.00
Article/Newsletter	16	82.16	4.61	15.00	74.17, 89.17	71.35	10.97	40.00	60.00, 100.00
Guide/Manual	10	85.35	5.50	12.99	79.51, 92.50	93.66	11.52	30.00	70.00, 100.00
Image	9	88.41	8.02	27.62	68.53, 96.15	66.67	11.18	30.00	50.00, 80.00
Slide(s)	6	86.78	4.20	11.22	81.04, 92.26	70.00	16.73	40.00	50.00, 90.00
Website	4	88.74	2.69	6.15	86.11, 92.26	82.50	9.57	20.00	70.00, 90.00
Total	602	85.82	9.19	50.04	49.96, 100.00	76.16	15.86	100.00	00.00, 100.00

Table 3. Frequency of materials achieving high PEMAT scores by publication type.

	Total Frequency	High Understandability	High Actionability	High Both
Publication Type	n	n (%)	n (%)	n (%)
Article/Newsletter	16	16 (100.00)	11 (68.75)	11 (68.75)
Brochure	136	133 (97.79)	117 (86.03)	116 (85.29)
Guide/Manual	10	10 (100.00)	10 (100.00)	10 (100.00)
Handout	216	197 (90.74)	179 (82.87)	165 (76.39)
Image	9	8 (88.89)	6 (66.67)	5 (55.56)
Miscellaneous	39	28 (71.79)	27 (69.23)	24 (61.54)
Poster(s)	100	98 (98.00)	78 (78.00)	76 (76.00)
Slide(s)	6	6 (100.00)	4 (66.67)	4 (66.67)
Videos	66	61 (92.42)	59 (89.39)	57 (86.36)
Websites	4	4 (100.00)	4 (100.00)	4 (100.00)
Total	602	561 (93.19)	495 (82.23)	472 (78.41)

with low levels of actionability (see Table 5). Approximately one-third of the healthcare enabling services and insurance materials and vaccines and immunization materials had a low actionability, and half of the green tobacco sickness materials had a low actionability. Additionally, more than 30% of the healthcare enabling services and insurance-related materials had understandability and actionability scores < 70. Two topic areas did have 100% of their materials earn both a high understandability and actionability score; they were dental and oral health materials and COVID-19 materials.

PEMAT scores by language

The understandability and actionability scores for each material were not significantly impacted by the language it was presented in, x^2 (4, $N = 602$) = 7.216, $p = .13$ (Pearson Chi-Square between high understandability and language), x^2 (4, $N = 602$) = 1.136, $p = .89$ (Pearson Chi-Square between high actionability and language), and x^2 (4, $N = 602$) = 1.63, $p = .80$ (Pearson Chi-Square between both high understandability and actionability and language). Table 6 shows the frequency of materials achieving high PEMAT scores by language.

PEMAT scores by date of publication

A Spearman's rank correlation was run to determine the relationship between the year of publication and, separately, high actionability, high understandability, and both high actionability and understandability. The understandability and actionability score for each material did not appear to be significantly impacted by the year it was published, $r_s(600) = -.04$, $p = .54$ (date of publication and high actionability), $r_s(600) = .03$, $p = .61$ (date of publication and high understandability), and $r_s(600) = -.02$, $p = .82$ (date of publication and both high actionability and understandability). PEMAT scores were consistently high across the range of publication years represented in this study.

Table 4. Descriptive statistics of materials by topic area.

		Understandability				Actionability			
Topic Area	Frequency	Mean	±sd	Range	Min, Max	Mean	±sd	Range	Min, Max
Musculoskeletal Injuries (Back Pain, Injury Prevention, Occupational Ergonomics)	227	88.02	8.81	50.00	50.00, 100.00	77.32	16.76	100.00	0.00, 100.00
Other Chronic Diseases (Prevention & Treatment)	83	84.41	11.24	46.88	50.00, 96.88	76.94	18.59	100.00	0.00, 100.00
Sexually-Transmitted Infection, HIV/AIDS, & Sexual/ Reproductive Health	67	81.92	10.06	39.61	55.84, 95.45	76.24	17.01	70.00	30.00, 100.00
Chronic Disease-Diabetes	63	87.96	5.51	23.75	70.00, 93.75	81.37	11.83	50.00	50.00, 100.00
Sun Exposure (Heat Stress, Heat Stroke, Hydration, Skin Cancer)	48	87.32	9.50	50.04	49.97, 100.00	70.94	13.27	60.00	30.00, 90.00
Health Care, Enabling Services & Insurance	40	80.86	12.08	40.83	55.84, 96.67	69.54	17.92	70.00	30.00, 100.00
Living Conditions & Sanitation	39	85.19	7.41	30.385	55.84, 96.67	77.31	12.20	60.00	40.00, 100.00
Mental, Emotional & Behavioral Health	36	83.26	6.95	28.32	65.00, 93.32	72.55	22	100.00	0.00, 100.00
Pesticides	27	83.61	10.86	43.94	56.06, 100.00	80.77	13.55	60.00	40.00, 100.00
Other Topics	20	87.13	7.46	31.48	68.53, 100.00	77.00	14.90	60.00	40.00, 100.00
Alcohol, Tobacco & Other Drugs	10	82.12	10.26	27.58	65.73, 93.32	83.00	11.60	40.00	60.00, 100.00
Dental & Oral Health	9	87.43	7.86	19.23	76.92, 96.15	80.00	7.07	20.00	70.00, 90.00
Vaccines & Immunizations	9	83.73	6.19	18.35	71.67, 90.02	69.26	15.17	50.00	40.00, 90.00
Green Tobacco Sickness	4	78.41	10.46	23.15	70.60, 93.75	66.67	4.71	10.00	60.00, 70.00
COVID-19	3	87.93	3.93	7.50	83.50, 91.00	76.67	11.55	20.00	70.00, 90.00
Emergency Preparedness	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Sexual Harassment & Domestic Violence	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Skin or Dermatological Conditions (Excluding Sun Exposure)	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Note. Some of the materials addressed more than one topic, so the total frequency count for by topic area ($n = 685$) exceeds the total number of materials ($n = 602$).

Discussion

This study examined the understandability and actionability of health education materials focused on farmworkers' occupational health and safety that are available to a community of practice made up of agricultural health and safety educators, including community health workers and Extension educators. The study's evaluation of health education materials and health resources using PEMAT revealed that most of the materials currently available for farmworker health education and outreach score well overall for being understandable and actionable. This finding is a positive one and is likely due to substantial investment in material development by Extension and public health educators, National Institute for Occupational Safety and Health centers, and community health workers, among others. An individual's understanding of and ability to take action upon key health education messages improves as an education material's understandability and actionability PEMAT scores increase.[17] That is, having materials designed specifically for farmworker health can likely increase effectiveness and represents one important part of work to advance agricultural safety and health.

However, this study highlights significant limitations in the resources currently available to educators focused on farmworker health and safety. We identified gaps in the materials, including outdated or undated information, content that is likely obsolete or approaching obsolescence, and materials that lack clarity and practical applicability. While the average score is good based on PEMAT standards, there are still a substantial number of materials that do not score well. Thus, there is also room for improvement in the available materials for this community of practice.

Table 5. Frequency of materials achieving high (≥70) PEMAT scores by topic area.

Topic Area	Total Frequency n	High Understandability n (%)	High Actionability n (%)	High Both n (%)
Musculoskeletal Injuries (Back Pain, Injury Prevention, Occupational Ergonomics)	227	217 (95.59)	183 (80.62)	176 (77.53)
Other Chronic Diseases (Prevention & Treatment)	83	73 (87.95)	67 (80.72)	64 (77.12)
Sexually-Transmitted Infection, HIV/AIDS, & Sexual/Reproductive Health	67	60 (89.55)	55 (82.09)	55 (82.09)
Chronic Disease-Diabetes	63	61 (96.83)	59 (93.65)	57 (93.65)
Sun Exposure (Heat Stress, Heat Stroke, Hydration, Skin Cancer)	48	45 (93.75)	37 (77.08)	37 (77.08)
Health Care, Enabling Services & Insurance	40	33 (82.50)	27 (67.50)	24 (60.00)
Living Conditions & Sanitation	39	37 (94.87)	36 (92.31)	34 (87.18)
Mental, Emotional & Behavioral Health	36	33 (91.67)	29 (80.56)	28 (77.78)
Pesticides	27	25 (95.59)	25 (95.59)	23 (85.19)
Other Topics	20	19 (95.00)	17 (85.00)	16 (80.00)
Alcohol, Tobacco & Other Drugs	10	8 (80.00)	9 (90.00)	7 (70.00)
Dental & Oral Health	9	9 (100.00)	9 (100.00)	9 (100.00)
Vaccines & Immunizations	9	9 (100.00)	6 (66.67)	6 (66.67)
Green Tobacco Sickness	4	4 (100.00)	2 (50.00)	2 (50.00)
COVID-19	3	3 (100.00)	3 (100.00)	3 (100.00)
Emergency Preparedness	0	n/a	n/a	n/a
Sexual Harassment & Domestic Violence	0	n/a	n/a	n/a
Skin or Dermatological Conditions (Excluding Sun Exposure)	0	n/a	n/a	n/a

Table 6. Frequency of materials achieving high PEMAT scores (≥70) by language.

Language	Total Frequency n	High Understandability n (%)	High Actionability n (%)	High Both n (%)
English	225	208 (92.44)	189 (84.00)	180 (80.00)
English & Spanish	66	66 (100.00)	53 (80.30)	53 (80.30)
Spanish	293	269 (91.81)	238 (81.22)	224 (76.45)
Spanish w/English Subtitles	18	18 (100.00)	15 (83.33)	15 (83.33)
Total	602	561 (93.19)	495 (82.23)	472 (78.41)

When educators are selecting health education materials for agricultural communities, it is important to consider both the reading abilities of agricultural workers and the PEMAT criteria. The National Library of Medicine recommends that health education materials be written at or below the sixth-grade reading level.[55] A report from the 2019–2020 National Agriculture Workers Survey found that 35% of farmworkers completed school up to the 6th grade or lower.[56] Additionally, negative correlations have been found between PEMAT scores and readability.[24,57] Therefore, it is important for community health workers, Extension educators, and others to purposefully select materials with high understandability and actionability as well as high readability to be inclusive of farmworkers with varying reading levels.

In this study, scores for health education materials did not vary by the language used, which is a positive finding. Average understandability scores ranged from 78% to 90% across publication types, and average actionability ranged from 66% to 94% across publication types. Both represent strong average scores. As for topics, scores were high, on average, for understandability, ranging from 78% to 88%, and scores were nearly as high, on average, for actionability, ranging from 67% to 83%. The scores we identified did not significantly vary across time, which indicates no worsening of scores; however, it also indicates materials did not improve according to PEMAT criteria over the time periods captured in this study. This finding may warrant further attention to new ways of developing materials.

Another area of consideration for material development is the number of materials for each topic area. While our search was not exhaustive, it was comprehensive. Nonetheless, while we identified 227 materials related to occupational ergonomics and musculoskeletal injuries, we identified far fewer materials (<10) for oral health,

vaccination, green tobacco sickness, emergency preparedness, sexual harassment, and skin conditions (outside of sun exposure and cancer). The relatively few items about COVID-19 reflect the dates of the searches. But, there are clearly some topics where there are simply fewer materials available to the community of practice.

Of course, these results are part of a broader set of scientific research. Our findings fit with calls to conceptualize access to information as both a direct and indirect determinant of health.[12] While access to health information and high-quality health education materials is important for workers, it is not sufficient in the absence of other higher-level controls within the Hierarchy of Controls for occupational safety. Farmworkers have a right to know about workplace hazards and health topics, and information plays a key role in empowering individual-level decisions. Prior research has identified gaps in available resources that are tailored to farmworker communities as well as gaps in stock photo libraries that might be used to create new materials.[13] Chichester and collegues[58] identified that stock photos representing a diversity of skin colors and ages were more likely to be behind a paywall – and thus not available for free use in education materials. Relatively few images in stock photo libraries depict farmworkers in ways that represent work tasks and the diversity of farmworkers.[59]

Thus, while this paper identifies strengths of existing health education materials, it also represents a challenge to the community of practice working with farmworkers to develop and strengthen the resources available. Certainly, this study is a call to developers of existing materials to broaden dissemination, funders to invest in work that updates and improves resources, and researchers to bring user-centered design, participatory methods, and community-led approaches to the development of resources. Examples of community-engaged approaches reflected among the resources included in this study are the Pesticides and Farmworker Health Toolkit that engaged workers in developing imagery for risk communication,[60] radio campaigns for farmworkers that engaged community health workers in their development while also leveraging community organization experience,[61] and a breast cancer screening intervention for farmworkers in Florida that leveraged community-based participatory design techniques.[62] New strategies used by the community of practice may also necessitate new types of resources. For example, use of WhatsApp, TikTok, and other platforms is increasingly common among community health workers, allowing them to provide virtual outreach and education to farmworkers[63,64]; resources may need to be updated to keep up with these innovations in farmworker health education and outreach. Ideally, newly created resources will be supplemented by policy and other interventions to maximize their impact on equity in health and safety.

Strengths and limitations

There are several strengths to this paper. First, we worked with an advisory board and community partners to inform our search topics and to solicit materials for review. This yielded a large number of materials representing a diverse set of agricultural safety and health topics. Second, we used a validated assessment tool that is commonly used in the public health field, and we established inter-rater reliability of our coding. Our assessment was language agnostic for English and Spanish; our coders were fluent in both languages. Thus, we were able to provide a rigorous assessment of a large number of materials sourced from across the country. However, this study has its weaknesses. First, although robust, our search certainly missed some materials, and we likely included materials that are obsolete or are no longer being used (but are still available for use). Additionally, it is possible that health education materials developed for other outdoor workers exposed to similar work hazards (e.g., construction and landscaping workers) may also be applicable to farmworkers. Second, we did not include farmworkers directly in the assessment of the materials. Third, we did not assess the accuracy of the content; future studies should do so. Fourth, this study does not test the efficacy of materials. Future research can test material acceptability, efficacy, and effectiveness. Fifth, and more globally, health education materials are just one part of promoting safety and health. Workplace controls and policies – such as the higher-tier components of the

Hierarchy of Controls (i.e., elimination, substitution, and engineering controls) – are critically important and likely even more essential components of efforts to address safety and health for agricultural workers.[65] Sixth, this study took place during the COVID-19 pandemic which raised the awareness among the importance of health literacy and the quality of health information. Other researchers should consider studying materials that have been developed and published in the years since the pandemic to see if the quality of materials has improved.

Conclusions

This paper assessed the health education material resources available to a community of practice working with farmworkers to advance health and safety. We identified areas of strength in the existing resources but also areas needing further development. Specifically, the development of health education materials for topic areas that are lacking health materials (e.g., non-sun exposure-related skin or dermatological conditions [e.g., rashes], sexual harassment and domestic violence, emergency preparedness), the inclusion of dates for when the materials were created or last updated, and the improved actionability of education materials for specific topic areas (e.g., green tobacco sickness, health care, enabling services, and insurance) are needed. Our findings fit with the existing literature showing limited availability in key resource sites of materials specific to farmworkers, gaps in the availability of stock photos for development of materials, and the need for implementation of evidence-based approaches to the development of outreach and education materials. Materials for agricultural workers represent an area with real strengths but also a need for investment to update and ultimately provide better resources for the agricultural health and safety educators serving farmworkers and their families.

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