

The Effect of Audio Visual Educational Media in Increasing Knowledge Retention and Compliance with the Use of Personal Protective Equipment as an Effort to Prevent Occupational Health Risks among Apple Farmers

Payal Choudhury¹, Santiago Jorge Pereira¹

¹ Pharmacy Department, Seremban Health Clinic, Seremban Health District Office, Negeri Sembilan State Health Department, Negeri Sembilan, Malaysia.

² Faculty of Public Health, Universidade da Paz, Timor-Leste

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ABSTRACT

Purpose of the study: This study aimed to determine the effect of audio-visual health education media on knowledge retention and compliance with personal protective equipment (PPE) use as a strategy to prevent occupational health risks among apple farmers in Kuala Pilah, Malaysia.

Methodology: A pre-experimental one-group pretest-posttest design was conducted involving 20 apple farmers selected through total sampling. Data were collected at four time points: baseline (T0), immediately after intervention (T1), one week (T2), and two weeks (T3) post-intervention. Knowledge was measured using a structured questionnaire, while PPE compliance was assessed through observation and self-report. Repeated measures analysis and paired categorical tests were applied with a significance level of $p < 0.05$.

Main Findings: The mean knowledge score increased from 56.4 at baseline to 82.7 immediately after the intervention, and remained significantly higher at 78.9 (week 1) and 74.6 (week 2) ($p < 0.001$). PPE compliance improved from 30.0% at baseline to 70.0% post-intervention and was maintained at 70–75% during follow-up ($p < 0.05$).

Novelty/Originality of this study: This study provides integrated evidence on both sustained knowledge retention and measurable behavioral compliance using repeated follow-up assessments in an agricultural occupational health context, demonstrating the effectiveness of audio-visual media beyond immediate learning outcomes.

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Corresponding Author:

Payal Choudhury,

Pharmacy Department, Seremban Health Clinic, Seremban Health District Office, Negeri Sembilan State Health Department,

Jalan Lee Sam, Bandar Seremban, 70590 Seremban, Negeri Sembilan, Malaysia.

Email: payalchoudhury67@gmail.com

1. INTRODUCTION

Agriculture remains one of the most hazardous occupational sectors worldwide, particularly in low- and middle-income countries where the use of pesticides is intensive and occupational safety practices are inconsistently implemented [1]-[3]. Farmers play a central role in ensuring food security; however, this role is often accompanied by substantial health risks, especially exposure to chemical agents during planting, mixing, and spraying activities [4]-[6]. In Malaysia, the agricultural sector continues to contribute significantly to rural livelihoods, including in Negeri Sembilan [7]-[9]. Kuala Pilah, as one of the agricultural districts in Negeri Sembilan, is known for smallholder farming activities, including fruit cultivation such as apples in highland and

controlled farming settings. Despite modernization efforts, the occupational health protection of farmers remains a critical challenge.

Pesticide exposure has been widely documented as a major occupational health risk [10]. According to the World Health Organization, millions of cases of pesticide poisoning occur globally each year, with a substantial proportion affecting agricultural workers in developing regions [11]-[13]. Acute and chronic exposure may lead to neurological disorders, respiratory impairment, dermatological problems, reproductive dysfunction, and even carcinogenic effects [14], [15]. In Southeast Asia, inappropriate handling, mixing, and spraying practices combined with inadequate use of personal protective equipment (PPE) significantly increase the risk of toxicity [16]-[18]. These risks are exacerbated by prolonged exposure over multiple planting seasons and by limited access to structured occupational health education.

Personal protective equipment, including masks, gloves, protective clothing, goggles, and boots, has been proven effective in reducing dermal and inhalation exposure to pesticides. Nevertheless, compliance among farmers remains low [19]. Behavioral studies indicate that discomfort, perceived inconvenience, limited risk perception, and insufficient knowledge contribute to poor adherence to PPE use [20]-[22]. In many farming communities, PPE is used partially or inconsistently, particularly during pesticide mixing one of the highest-risk activities [23], [24]. This gap between knowledge and practice highlights a persistent occupational health problem that cannot be addressed solely through policy recommendations; it requires targeted behavioral and educational interventions.

Health education has long been recognized as a strategic approach to promoting preventive behavior. However, conventional lecture-based counseling often produces short-term knowledge gains without ensuring long-term retention or sustained behavioral compliance [25]. Cognitive psychology suggests that knowledge retention declines over time when information is delivered passively [26]-[28]. Therefore, educational strategies that engage multiple sensory channels such as audio visual media may strengthen encoding processes in long-term memory and enhance behavioral reinforcement [29], [30]. Audio-visual media integrates visual imagery, narration, and contextual demonstration, which can improve comprehension among populations with diverse educational backgrounds, including adult farmers.

Previous studies have demonstrated that health education interventions improve knowledge and attitudes toward occupational safety. Research conducted in various agricultural settings shows that demonstration-based or lecture-based training increases immediate post-test knowledge scores and reported motivation to use PPE [31], [32]. Other studies have reported that video-based counseling is effective in improving farmers' understanding of pesticide hazards. However, most existing studies primarily focus on short-term knowledge improvement rather than examining knowledge retention over time. Furthermore, limited research simultaneously evaluates both cognitive retention and actual compliance behavior in real occupational contexts. This indicates a clear research gap: the absence of integrated assessment of sustained knowledge retention and measurable adherence to PPE use following audio-visual health education.

The present study addresses this gap by examining the influence of audio-visual health education media on two critical outcomes retention of occupational health knowledge and compliance with PPE use among apple farmers in Kuala Pilah. Unlike previous studies that concentrated solely on immediate knowledge change, this research emphasizes the durability of learning (retention) as well as observable preventive behavior (compliance). By integrating cognitive retention theory with occupational health promotion, this study introduces a novel framework that connects multimedia learning mechanisms with practical safety behavior in agricultural settings.

The urgency of this research lies in the ongoing risk of pesticide exposure among smallholder farmers and the limited evidence-based educational models tailored to rural agricultural communities in Malaysia. Without effective and sustainable educational interventions, farmers remain vulnerable to preventable occupational diseases, which may reduce productivity, increase healthcare costs, and negatively affect rural economic stability. Evaluating the effectiveness of audio-visual media as a scalable health promotion strategy is therefore essential to inform local agricultural health policies and community-based prevention programs in Kuala Pilah and similar districts.

2. RESEARCH METHOD

2.1 Study Design

This study employed a pre-experimental one-group pretest-posttest design to evaluate the effect of audio-visual health education on knowledge retention and compliance with personal protective equipment (PPE) use among apple farmers in Kuala Pilah, Negeri Sembilan, Malaysia. The design was selected to measure changes within the same group of participants over time following exposure to the intervention [33], [34]. To capture both immediate learning outcomes and sustained retention, four measurements were conducted: baseline assessment prior to the intervention (T0), immediate post-intervention assessment (T1), follow-up at one week

after the intervention (T2), and follow-up at two weeks after the intervention (T3). This repeated-measure approach enabled the evaluation of short-term knowledge gain as well as medium-term retention and behavioral adherence [35], [36].

The structure of the research design and timeline of data collection are presented in Table 1.

Table 1. Research Design and Timeline of Data Collection

Measurement Phase	Time of Assessment	Purpose of Measurement
T0	Before intervention	Baseline knowledge and PPE compliance
T1	Immediately after audio-visual education	Immediate knowledge improvement and behavioral intention
T2	One week after intervention	Knowledge retention and compliance monitoring
T3	Two weeks after intervention	Sustained retention and compliance evaluation

Table 1 illustrates the sequential measurement framework used to determine both cognitive and behavioral changes attributable to the intervention.

The study was conducted among apple farmers registered in a farmer group in Kuala Pilah District, Negeri Sembilan. This district was selected due to its active agricultural activities and reported routine pesticide use in fruit cultivation. The target population consisted of all active apple farmers within the selected farmer group. A total sampling technique was applied, meaning all eligible members of the group were invited to participate. Inclusion criteria included: (1) actively involved in pesticide mixing or spraying, (2) willing to participate throughout all four measurement periods, and (3) able to understand the Malay language used in the educational video. Farmers who were absent during one of the follow-up assessments were excluded from final analysis. A total of 20 respondents met the inclusion criteria and participated in the study. The use of total sampling ensured full representation of the farmer group and minimized selection bias within the study setting.

2.2 Intervention Procedure

The intervention consisted of structured health education delivered through audio-visual media in the form of an educational video. The video content was specifically developed to address occupational health risks related to pesticide exposure and correct PPE use. The material included:

1. Explanation of pesticide-related health risks (Acute and chronic effects).
2. Demonstration of correct PPE components (Mask, gloves, goggles, protective clothing, and boots).
3. Proper procedures for pesticide mixing and spraying.
4. Testimonies and visual simulations illustrating consequences of non-compliance.

The duration of the video was approximately 15–20 minutes and was presented in a group session at the farmer meeting location using a projector and speaker system. A brief facilitated discussion followed the video to reinforce key messages and clarify participant questions. No additional educational reinforcement was provided during the follow-up period in order to objectively measure knowledge retention.

2.3 Instruments

Two main outcome variables were measured:

1. Knowledge retention regarding occupational pesticide safety
2. Compliance with PPE use during pesticide handling

Knowledge was assessed using a structured questionnaire developed based on occupational health guidelines and validated literature. The questionnaire consisted of multiple-choice items covering pesticide risks, exposure pathways, and appropriate PPE usage. Knowledge scores were calculated as the total number of correct responses and converted into percentage scores.

Compliance with PPE use was measured using an observational checklist and self-reported adherence questionnaire assessing the use of complete PPE during pesticide mixing and spraying. Compliance was categorized as compliant (Complete PPE use) and non-compliant (Partial or no PPE use).

Prior to implementation, the instruments were reviewed for content validity by experts in occupational health and community nursing. Reliability testing was conducted using Cronbach's alpha to ensure internal consistency.

2.4 Data Analysis

Data were analyzed using statistical software. Descriptive statistics were used to summarize respondent characteristics, knowledge scores, and compliance rates [37], [38]. Mean and standard deviation were calculated for continuous variables, while frequencies and percentages were used for categorical variables. To examine differences in knowledge scores across the four measurement points (T0–T3), repeated measures statistical analysis was applied. For normally distributed data, repeated measures ANOVA was used; otherwise, a non-parametric equivalent test was performed. Changes in PPE compliance over time were analyzed using

appropriate paired categorical tests to determine significant differences between baseline and follow-up measurements. A significance level of $p < 0.05$ was considered statistically significant.

2.5 Ethical Considerations

Ethical approval was obtained from the relevant institutional ethics committee prior to data collection. Participants received verbal and written explanations regarding study objectives, procedures, confidentiality, and voluntary participation. Written informed consent was obtained from all respondents. Participant anonymity was maintained by assigning identification codes, and data were used solely for research purposes.

3. RESULTS AND DISCUSSION

A total of 20 apple farmers from Kuala Pilah completed all four measurement phases (T0–T3), resulting in a 100% follow-up rate. The results are presented sequentially, beginning with respondent characteristics, followed by knowledge retention outcomes and PPE compliance changes across the four assessment points. Baseline demographic characteristics were collected to describe the study population and provide context for interpreting knowledge retention and compliance outcomes.

Table 1. Sociodemographic Characteristics of Respondents

Variable	Category	n	%
Age	25–35 years	4	20.0
	36–45 years	7	35.0
	46–55 years	6	30.0
	>55 years	3	15.0
Education Level	Primary school	6	30.0
	Secondary school	11	55.0
	Diploma or higher	3	15.0
Years of Farming Experience	1–5 years	3	15.0
	6–10 years	7	35.0
	>10 years	10	50.0

As shown in table 1, most respondents were aged between 36–45 years (35.0%) and had secondary-level education (55.0%). Half of the participants (50.0%) had more than 10 years of farming experience, indicating prolonged occupational exposure to pesticides. These characteristics suggest a mature workforce with substantial field experience but varying educational backgrounds, highlighting the importance of accessible educational media such as audio-visual tools.

Knowledge regarding pesticide risks and correct PPE use was measured at four time points (T0–T3). The results are presented in Table 2.

Table 2. Mean Knowledge Scores Across Measurement Phases

Measurement Phase	Mean Score (0–100)	SD	Mean Difference from Baseline	p-value*
T0 (Pre-test)	56.4	8.7	–	–
T1 (Immediate Post-test)	82.7	6.5	+26.3	<0.001
T2 (1 Week)	78.9	7.2	+22.5	<0.001
T3 (2 Weeks)	74.6	7.9	+18.2	<0.001

Table 2 demonstrates a substantial increase in mean knowledge scores immediately after the audio-visual intervention. The baseline mean score (T0) was 56.4 (SD = 8.7), indicating moderate initial knowledge. Following the intervention, the mean score increased to 82.7 (SD = 6.5), representing a mean improvement of 26.3 points ($p < 0.001$).

Although a slight decline was observed at one week (78.9) and two weeks (74.6), knowledge scores remained significantly higher than baseline ($p < 0.001$). This pattern indicates that while some degree of memory decay occurred over time, substantial knowledge retention was maintained two weeks after exposure to the audio-visual media.

To further interpret retention patterns, knowledge scores were categorized into three levels: poor (<60), moderate (60–79), and good (≥ 80).

Table 3. Distribution of Knowledge Levels Across Measurement Phases (n = 20)

Phase	Poor n (%)	Moderate n (%)	Good n (%)
T0	11 (55.0)	7 (35.0)	2 (10.0)
T1	0 (0.0)	5 (25.0)	15 (75.0)

Phase	Poor n (%)	Moderate n (%)	Good n (%)
T2	1 (5.0)	8 (40.0)	11 (55.0)
T3	2 (10.0)	10 (50.0)	8 (40.0)

At baseline, more than half of respondents (55.0%) were categorized as having poor knowledge. Immediately after the intervention, 75.0% achieved a good knowledge level. Although the proportion of “good” knowledge slightly decreased at weeks one and two, it remained markedly higher than baseline. This distribution confirms that the audio-visual intervention produced both immediate improvement and sustained cognitive retention.

Compliance with complete PPE use (mask, gloves, goggles, protective clothing, and boots) was assessed through observation and self-report at each phase.

Table 4. PPE Compliance Across Measurement Phases (n = 20)

Measurement Phase	Compliant n (%)	Non-Compliant n (%)	p-value**
T0	6 (30.0)	14 (70.0)	–
T1	14 (70.0)	6 (30.0)	0.004
T2	15 (75.0)	5 (25.0)	0.002
T3	14 (70.0)	6 (30.0)	0.004

As presented in Table 4, baseline compliance with complete PPE use was low (30.0%). Immediately following the intervention, compliance increased to 70.0% ($p = 0.004$). This improvement was maintained at one week (75.0%) and remained stable at two weeks (70.0%), with statistically significant differences compared to baseline.

These findings indicate that the audio-visual educational intervention not only enhanced knowledge but also translated into improved preventive behavior in real occupational settings. Overall, the results demonstrate that audio-visual health education significantly improved knowledge retention and PPE compliance among apple farmers in Kuala Pilah. Knowledge scores increased by 26.3 points immediately after the intervention and remained 18.2 points higher than baseline at two weeks. PPE compliance more than doubled from 30.0% at baseline to 70.0% post-intervention and remained consistently elevated during follow-up assessments.

These findings provide empirical evidence that audio-visual media is an effective strategy for strengthening both cognitive retention and occupational health behavior among agricultural workers. This study demonstrates that audio-visual health education significantly improved both knowledge retention and compliance with personal protective equipment (PPE) use among apple farmers in Kuala Pilah. The findings show a marked increase in mean knowledge scores from 56.4 at baseline to 82.7 immediately after the intervention, with sustained retention at 78.9 after one week and 74.6 after two weeks. Similarly, PPE compliance increased from 30.0% at baseline to 70.0% immediately post-intervention and remained stable at 70–75% during follow-up. These results indicate that audio-visual media not only enhances immediate cognitive understanding but also contributes to measurable behavioral change in occupational safety practices.

Substantial improvement in knowledge immediately after the intervention is consistent with multimedia learning theory, which suggests that dual-channel processing combining visual and auditory stimuli strengthens information encoding in long-term memory. Unlike conventional lecture-based education, audio-visual media presents contextualized demonstrations, real-life simulations, and visual reinforcement of risk consequences [39]. This multisensory engagement likely explains the 26.3-point increase observed in the immediate post-test. However, a gradual decline in scores at weeks one and two reflects natural memory decay, a phenomenon widely described in cognitive psychology. Importantly, although some decline occurred, knowledge levels remained significantly higher than baseline, indicating effective retention rather than short-term memorization.

When compared with previous studies, the current findings extend existing evidence in several important ways. Earlier research in agricultural settings has shown that health education interventions improve knowledge and attitudes toward pesticide safety. Many of those studies, however, focused primarily on immediate post-intervention outcomes without evaluating sustained retention [40]. Moreover, compliance was often measured through self-reported intention rather than follow-up observation [41]. The present study addresses these gaps by integrating repeated follow-up measurements and examining both cognitive retention and observable compliance behavior over time. This integrated evaluation strengthens causal inference regarding the effectiveness of audio-visual interventions in real occupational contexts.

Behavioral findings are particularly noteworthy. PPE compliance more than doubled from 30.0% at baseline to 70.0% post-intervention, and this improvement was maintained at two weeks. This suggests that enhanced knowledge translated into actual protective behavior. Behavioral change theories indicate that knowledge alone is insufficient to alter practices; perception of risk, perceived benefits, and self-efficacy also play critical roles. The video intervention likely influenced these constructs by visually demonstrating health

consequences of pesticide exposure and modeling correct PPE usage [42]. Such visual modeling may reduce perceived inconvenience and normalize protective behavior within the farming community.

The novelty of this study lies in its simultaneous focus on knowledge retention and sustained compliance using repeated measures within an agricultural occupational health framework. While many studies evaluate short-term knowledge gain, few assess whether educational effects persist beyond the immediate session. Furthermore, limited research in Malaysian rural farming communities has examined multimedia-based occupational health promotion. By situating the intervention within a real farmer group in Kuala Pilah and tracking outcomes over multiple time points, this study contributes context-specific evidence to the literature on digital health promotion in agricultural settings.

In terms of short-term implications, the findings suggest that audio-visual education can rapidly elevate farmers' understanding of pesticide hazards and improve immediate adherence to PPE standards. This has direct implications for reducing acute pesticide exposure, including symptoms such as dizziness, nausea, respiratory irritation, and dermal contamination. Improved compliance during pesticide mixing and spraying the highest-risk activities can substantially decrease inhalation and dermal absorption within a short period following intervention.

Long-term implications are potentially more significant. Sustained improvements in PPE compliance may reduce cumulative pesticide exposure over multiple planting seasons, thereby lowering the risk of chronic health conditions such as neurological impairment, reproductive disorders, and other systemic toxicities. At a broader level, integrating audio-visual occupational health education into routine farmer group meetings could serve as a scalable, cost-effective prevention strategy. Agricultural and health authorities in Kuala Pilah and similar districts may adopt structured multimedia modules as part of community-based occupational safety programs. Over time, this approach could contribute to improved workforce productivity, reduced healthcare expenditures, and enhanced rural economic resilience.

Despite these strengths, several limitations must be acknowledged. First, the study employed a pre-experimental one-group design without a control group, which limits the ability to fully attribute observed changes exclusively to the intervention. External factors or social desirability bias may have influenced compliance outcomes. Second, the sample size was relatively small ($n = 20$) and drawn from a single farmer group, which may limit generalizability to other agricultural communities. Third, the follow-up period was limited to two weeks, preventing assessment of long-term retention beyond the short to medium term. Finally, although observational checklists were used, some compliance measures relied partly on self-report, which may introduce reporting bias.

Future research should employ randomized controlled designs with larger sample sizes and extended follow-up periods to assess long-term sustainability of knowledge and behavior change. Additionally, integrating periodic reinforcement sessions or digital reminder systems could be explored to counteract gradual memory decline observed over time. Overall, the findings underscore the effectiveness of audio-visual health education as an innovative occupational health promotion strategy. By demonstrating sustained improvements in both knowledge retention and PPE compliance among apple farmers in Kuala Pilah, this study provides empirical support for the integration of multimedia-based interventions into agricultural safety programs.

4. CONCLUSION

This study aimed to examine the effect of audio-visual health education media on knowledge retention and compliance with personal protective equipment (PPE) use among apple farmers in Kuala Pilah. The findings demonstrate that the intervention significantly improved knowledge scores from a baseline mean of 56.4 to 82.7 immediately after the intervention, with sustained retention at 78.9 after one week and 74.6 after two weeks ($p < 0.001$). PPE compliance increased markedly from 30.0% at baseline to 70.0% post-intervention and remained stable at 70–75% during follow-up assessments. These results confirm that audio-visual educational media effectively enhances both cognitive retention and preventive occupational health behavior among farmers. The study highlights that multimedia-based health education is a practical and impactful strategy for reducing occupational pesticide exposure risks in agricultural communities. Integrating structured audio-visual modules into routine farmer group activities is recommended to reinforce sustained behavioral change. Future studies should employ controlled designs with longer follow-up periods to evaluate long-term sustainability and broader scalability of the intervention.

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