Web-Based Learning About COVID-19 Vaccination for Improved Knowledge and Perception Among Community Health Workers

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Abstract

CHWs play a crucial role in assisting health workers to empower communities and promote health through vaccination. However, they still have limited knowledge and perceptions in supporting the COVID-19 vaccination program. Several educational methods have been used, most of which are based on conventional approaches, and evidence regarding the effectiveness of web-based learning for CHWs is still limited. This study aimed to assess changes in CHWs' knowledge and perceptions about COVID-19 immunization before and after an intervention and to determine the effect of group (intervention and control) and time on these changes. Linear Mixed Model (LMM) analysis was used to evaluate longitudinal changes in knowledge and perception scores. Group and time variables were included in the model as covariates to assess their influence on score changes. A total of 44 CHWs in Pontianak City were divided into an intervention group (n=22) and a control group (n=22). Results showed a significant increase in knowledge and perception scores after the intervention. Knowledge scores increased significantly from pre-test to post-test ($p<0.001$), with a higher average in the intervention group than in the control group. The perception score also showed a significant increase, with a p-value of less than 0.001. LMM analysis showed that the average change in knowledge scores ($\beta = 4.04$, $p < 0.001$) and perception ($\beta = 6.77$, $p < 0.001$) was higher in the intervention group than in the control group. Furthermore, time had a significant effect on changes in knowledge scores ($\beta = -2.41$, $p < 0.001$) and perception ($\beta = -4.77$, $p < 0.001$). The interaction between group and time was also significant for knowledge ($\beta = -3.55$, $p < 0.001$) and perception ($\beta = -5.59$, $p < 0.001$). Web-based learning was effective in CHWs' knowledge and perceptions regarding COVID-19 immunization, with changes influenced by group and time factors.

Keywords: Web-Based Learning, Knowledge, Perception, COVID-19 Vaccination, Community Health Workers (CHWs)

INTRODUCTION

The global coronavirus disease 2019 (COVID-19) pandemic is caused by SARS-COV-2 and was first identified in Wuhan City, Hubei Province, China, in December 2019 (Xu et al., 2020). The virus initially spread to various regions in Asia and then rapidly expanded worldwide in early 2020; by May 2023, the WHO declared the public health emergency caused by COVID-19 to be over (Wise, 2023). In line with the WHO's declaration, the Indonesian government issued the Presidential Decree of the Republic of Indonesia Number 17 of 2023 concerning the Determination of the End of the Coronavirus Disease 2019 (COVID-19) Pandemic Status in Indonesia in June 2023.

The change in the endemic status of COVID-19 in Indonesia does not diminish efforts to address it. The Indonesian government, based on Minister of Health Regulation number 7 of 2023, needs to conduct vaccinations as part of the COVID-19 pandemic response. Especially in high-risk groups for COVID-19, such as the elderly (Müller et al., 2022), individuals with comorbidities (Silaghi-Dumitrescu et al., 2023), primary immunodeficiency diseases, pregnancy, smoking, those receiving corticosteroids or other immunosuppressive medications (NIH, 2023), obesity (Kuehn, 2021), and healthcare workers (WHO, 2022).

Acceptance of the COVID-19 vaccination remains a challenge for the Indonesian government. Although the number of first and second doses administered exceeds 70% (Kemenkes, 2024), vaccination coverage among vulnerable groups, especially the elderly, is still low (Kemenkes, 2025). According to data from the West Kalimantan Provincial Health Office, COVID-19 vaccination coverage among the elderly remains relatively low compared to the established national target. Based on 2024 data, the third dose of the booster vaccination reached 25.1% and the fourth dose, 0.8%. Vaccination coverage among the elderly is also very low at around 0.5% (Kemenkes, 2025) of the total elderly population of 333,275 (Dukcapil, 2025). Furthermore, other vulnerable groups have recorded a vaccination coverage of only around 0.2%. This low vaccination uptake means that if they are not vaccinated promptly, there are threats to their health, such as hypoxia, cardiovascular disorders, thromboembolic complications, and severe renal and gastrointestinal disorders (Gupta et al., 2020).

Low vaccination rates among vulnerable groups can be influenced by many factors such as vaccine availability (WHO, 2021), public knowledge and awareness (Lazarus et al., 2021), and religious and cultural beliefs (Chait et al., 2024). Furthermore, vaccine hesitancy is also influenced by individual factors such as trust in and intention to vaccinate, lack of concern about rapid vaccine development, limited research, and potential side effects (Rancher et al., 2023). The influence of social media and the spread of misinformation also exacerbate this hesitancy (Puri et al., 2020). Other studies have also shown that low public perceptions of the safety, effectiveness, and necessity of COVID-19 vaccination are significantly associated with low vaccine acceptance (Alfikrie et al., 2023). Concerns about the safety of certain vaccine types are also a major barrier to vaccination implementation (Perveen et al., 2022). In Indonesia, efforts to increase vaccination coverage during the endemic period are supported by government policy through the COVID-19 immunization program, as stipulated in Minister of Health Regulation No. HK.02.02/C/2024. One strategy implemented is to involve health cadres as part of health promotion efforts and post-immunization monitoring. Therefore, the Indonesian government is striving to increase vaccination coverage through the COVID-19

immunization program, as outlined in Ministerial Regulation No. HK.02.02/C/2024. One strategy is to involve health workers in health promotion and post-immunization monitoring.

The role of community health workers (CHWs) is crucial in efforts to socialize and motivate the community to accept vaccination (WHO, 2021). CHWs, as educators, provide information about vaccination, its benefits, and procedures and correct misinformation circulating in the community using a communication- and trust-based approach (Kemenkes, 2021). However, the gap between CHWs' knowledge and perceptions and their role in increasing COVID-19 vaccination acceptance remains a challenge. A preliminary study indicated that there is a gap between CHWs' knowledge and perceptions of COVID-19 vaccination boosters in Pontianak City. Most CHWs had low levels of knowledge regarding the meaning, benefits, and purpose of vaccination. Furthermore, five CHWs expressed negative perceptions of vaccination, such as doubts about the safety and effectiveness of the vaccine.

A person's lack of knowledge can lead to misinformation about health issues, particularly COVID-19 immunization. Conceptually, information processing theory explains the relationship between knowledge and individual behavior regarding health. An individual's behavior can be influenced by how the information is received, processed, stored, and interpreted. This theory explains that individuals function as active systems that receive, process, store, and utilize information (Gordon & Woods, 2022). This dynamic process involves the relationship between attention and memory in processing information from the external environment, which then shapes a person's behavioral domain (Cowan et al., 2024). Disinformation originates from false or inaccurate information created and disseminated with or without the explicit intent to cause harm. Disinformation can lead to motivational and cognitive biases in information processing. The category includes health-related information (Zhou & Shen, 2024).

Errors in processing the information received lead to distortions in interpretation, leading individuals to produce biased and inaccurate judgments about the information. Such distortion occurs due to the limited quality and relevance of the information processed and the presence of cognitive biases in the interpretation process, which ultimately influence judgments and decision-making (Rieu et al., 2024). A previous study showed that 55.7% of participants perceived barriers to the COVID-19 vaccine, while 52.5% reported similar perceptions (Mohamed et al., 2023). Additionally, there is much misinformation about vaccination obtained through social media and chain messages and also sourced from Indonesian online news portals and others, such as misleading stories and myths. Such misinformation can lead to resistance and doubt among the Indonesian public toward the vaccine. This iteration can

shape public attitudes, fostering distrust in the government and leading to misinformation about vaccination programs (Ida et al., 2024).

Several strategies have been implemented to improve vaccination coverage in Indonesia, such as home visits by ambassadors to promote vaccination (Islam et al., 2024) and the use of a mobile application (AREEMA Self-Screening) by CHWs for tracking and education to improve protective behaviors and vaccination (Sujarwoto et al., 2025). However, some have limitations, such as non-adaptive interventions, non-interactive and unsustainable education, and increased burden on CHWs to operate the application.

Therefore, strategies are needed to improve the knowledge and perceptions of health workers regarding COVID-19 vaccination, providing easy access to clear and repeatable information, such as web-based learning. In this digital age, information technology has become an essential tool in the learning process. Learning through websites offers flexibility, ease of access, and the ability to present information interactively. Websites can be used as a platform to provide educational materials, such as videos, infographics, articles, and quizzes, which can be accessed anytime and anywhere (Dhawan, 2020). This study aims to determine the effectiveness of using website-based learning in improving knowledge levels and perceptions among CHWs in Pontianak City.

METHODS

This study is a study of the effectiveness of a web-based learning system on CHWs' knowledge and perceptions about COVID-19 vaccination in Pontianak City and was conducted from July to November 2025. This quasi-experimental study measured two groups: an intervention group that received website-based learning and a control group that received learning using conventional printed modules. Each group was recruited using a purposive technique, and during the recruitment process, restrictions were applied through selection criteria. The CHWs involved were aged 35-45 years, had a minimum of junior high school education, and had not received formal training on COVID-19 vaccination. Furthermore, respondents were allocated to each intervention and control group based on their place of duty to prevent bias. To ensure that each group started with the same level of knowledge and perception, statistical tests were conducted before the intervention began.

The population of this study was CHWs in Pontianak City. The sample size was selected using the formula for comparing two independent groups with equal variance (α = 0.05; power = 0.80) (Rosner, 2016). The standard deviation parameter (γ) was selected from a previous study by Sinuraya et al. with a standard deviation of 1.74 and the difference between

pre-test and post-test (α) of 1.5, which is equivalent to Cohen's effect size in the large category, namely (d = 0.86) (Sinuraya et al., 2023). The number of samples for each group was determined to be 22 respondents, so the total sample size was 44 respondents.

The research subjects were then divided into two large groups: an intervention group receiving web-based learning and a control group receiving conventional learning methods using printed learning modules. The intervention group combined web-based independent learning with facilitated online discussions. The intervention aimed to increase participant understanding and engagement. In contrast, the control group received independent learning using printed modules without any discussion. Details are described in Table 1.

Table 1. The learning process for Community Health Workers (CHWs) is facilitated through the COVID-19 learning website

Objective	Indicator	Study materials	Duration of learning hours	Activities Completed
Knowing the level of knowledge and perception about COVID-19 vaccination before learning begins	Knowledge and perceptions about COVID-19 vaccination	Pre-test questionnaire on knowledge and perceptions about COVID-19 vaccination	20 minutes	On the first day, knowledge and perception measurements were conducted.
Able to explain COVID-19	a. Able to explain the definition, causes, and transmission b. Able to explain signs and symptoms, management, and prevention.	a. Introduction b. Definition of COVID-19 c. Causes and virology d. Transmission of COVID-19 e. Signs and symptoms f. Management g. Prevention	Intervention Group: 100 minutes of self-study on the web and 100 minutes of online discussion Control Group: 100 minutes of self-study using modules	a. On the second day, participants independently read and learned about the concept of COVID-19. b. On the third day, the researchers conducted follow-up and online discussions regarding the understanding of the COVID-19 concept.
Able to explain the COVID-19 vaccination	a. Able to explain the definition, purpose, and target groups of COVID-19 vaccination. b. Able to explain the side effects, monitoring of side effects, and factors	a. Definition of vaccination b. Goals and benefits of vaccination c. Types of vaccination d. Target groups for vaccination e. Side effects	Intervention Group: 100 minutes of self-study on the web and 100 minutes of online discussion Control Group: 100 minutes of self-study using modules	a. On the fourth day, participants independently read about the concept of COVID-19 vaccination. b. On the fifth day, the researchers conducted a follow-up and

Objective	Indicator	Study materials	Duration of learning hours	Activities Completed
	influencing vaccination.	f. Monitoring and management mechanisms for post-immunization events g. Safety of vaccination h. Factors influencing vaccination		online discussion regarding the understanding of COVID-19 vaccination
To understand the level of comprehension and perception after learning about the COVID-19 vaccination.	Knowledge of COVID-19 vaccination and perceptions about COVID-19 vaccination	Post-test questionnaire on COVID-19 vaccination knowledge and perceptions about COVID-19 vaccination	20 minutes	On the final day, participants took a post-test on their knowledge and perceptions of COVID-19 vaccination.

Subjects in each group received instruction for six days. Each activity was conducted in stages, and the researcher followed up on learning outcomes and provided guidance/instructions to the intervention group through the group. In the control group, each subject received a printed teaching module about COVID-19 vaccination.

This study uses two research questionnaires: a questionnaire on the level of knowledge about COVID-19 vaccination and a questionnaire on CHWs' perceptions of COVID-19 vaccination. The questionnaires were developed based on the main theoretical concepts of COVID-19 vaccination during the endemic period and a perception questionnaire based on the theory of perception formation (Goldstein, 1989). The knowledge questionnaire consists of 20 questions using a Guttman scale, and the COVID-19 vaccination perception questionnaire consists of 13 questions using a Likert scale. The instrument's validity is assessed through content validity by two experts (community health center nurses), and they all stated that the questionnaire was appropriate for the concepts being measured. Construct validity was assessed with 30 respondents at the Pontianak City Health Center. The results of the item-total correlation test on the knowledge questionnaire showed that all question items had a calculated r value > r table (0.361) and a Cronbach's alpha value of 0.9. Meanwhile, the results of the construct validity test on the perception questionnaire with item-total correlation showed that all r values were greater than the r table (0.361), and the Cronbach's alpha value was 0.9.

Statistical analyses were performed using linear mixed models (LMM) to assess longitudinal changes in knowledge and perception scores and to evaluate the effects of group

(intervention vs. control) and time (pre-test vs. post-test). Group and time were entered into the model as fixed effects along with their interaction term (group × time). A random intercept was applied to account for individual variability among participants. The covariance structure for repeated measures was specified as unstructured. Parameter estimation was performed using restricted maximum likelihood (REML). Continuous variables are presented as mean ± standard error (SE). Additionally, paired t-test analyses were performed as supplementary analyses to evaluate changes in scores within each group (intervention and control) between pre-test and post-test. A p-value <0.05 was considered statistically significant. This research has received ethical clearance from the ethical commission for health research at Yarsi College of Health Sciences Pontianak, with letter number 060/KEPK/STIKes.YSI/V/2025.

RESULT

This study involved 44 subjects divided into two groups: an intervention group that received web-based learning and a control group that received printed teaching modules. The average age of the CHWs' involved in the experimental group was 39.5 (SD 4.0), and the average age in the control group was 42 (SD 2.6). The majority of CHWs' have a junior high school education (54.8%) and work as housewives (59.1%). The characteristics of the subjects in this study are explained in Table 2.

Table 2. Demographic characteristics of CHWs (N=44)

No	Demographic	Experimental Group		Control Group		Total	
		n	%	n	%	N	%
1	**Age** (mean and SD)	39.5 (4.0)		42.0 (2.6)		-	
2	**Education**						
	Junior High School	8	36.4	17	77.3	25	54.8
	Senior High School	10	45.5	5	22.7	15	34.0
	University	4	18.2	0	0	4	9.0
3	**Occupation**						
	Housewife	10	45.5	16	72.7	26	59.1
	Self-employed	6	27.3	4	18.2	10	22.7
	Private sector	6	27.3	2	9.1	8	18.1

Following web-based learning, CHWs' in the experimental group had higher average knowledge and perceptual scores (p = 0.001, p = 0.001). Furthermore, following traditional module-based learning, CHWs' in the control group also saw an increase in their average knowledge and perception scores (p = 0.001, p = 0.001) (Tables 3 and 4).

Table 3. Paired t-tests were used to compare the test scores before and after training in each course to determine the knowledge and perception test outcomes for the experimental group before and after web-based learning

Experimental Group (n=22)	Pre-test		Post-test		t	p-value
CHWs' Knowledge and Perceptions of Vaccination	Mean	S.D.	Mean	S.D.		
CHWs' Knowledge	8.5	1.5	14.5	1.6	14.2	0.001
CHWs' Perceptions	34.0	2.1	44.4	2.0	19.3	0.001

Table 4. Using a traditional module and a paired t-test statistical analysis, the control group's knowledge and views of the COVID-19 immunization

Control Group (n=22)	Pre-test		Post-test		t	p-value
CHWs' Knowledge and Perceptions of Vaccination	Mean	S.D.	Mean	S.D.		
CHWs' Knowledge	8.0	1.5	10.4	1.4	6.5	0.001
CHWs' Perceptions	32.8	1.8	37.6	1.5	10.4	0.001

Table 5. Linear Mixed Model Analysis of Changes in Knowledge and Perception of COVID-19 Immunization among CHWs

Variables	Mean ± SE	Group (β)	p-value	Time (β)	p-value	Cohen's d
Knowledge	Intervention = 11.5 ± 0.9	β = 4.0	0.001			
	Control = 9.2 ± 0.9			β = −2.4	0.001	2.6
	Interaction	β = −3.5	0.001			
Perception	Intervention = 39.2 ± 2.4	β = 6.7	0.001			
	Control = 35.2 ± 2.4			β = −4.7	0.001	1.5
	Interaction	B = −5.5	0.001			

Analysis using a linear mixed model (LMM) was conducted to assess changes in knowledge and perception scores and the influence of group and time on these changes. For the knowledge variable, group had a significant influence on score changes ($\beta = 4.0$, $p < 0.001$), with a higher average score in the intervention group (11.5 ± 0.9) compared to the control group (9.2 ± 0.9). In addition, time showed a significant influence on changes in knowledge scores ($\beta = -2.4$, $p < 0.001$). The interaction between group and time was also significant ($\beta = -3.5$, $p < 0.001$). Furthermore, effect size analysis based on post-test differences demonstrated a very large intervention effect (Cohen's $d = 2.61$).

Analysis of the perception variable group also showed a significant influence on changes in scores ($\beta = 6.7$, $p < 0.001$), with a higher average score in the intervention group (39.2 ± 2.4) compared to the control group (35.2 ± 2.4). Time had a significant effect on changes in perception scores ($\beta = -4.7$, $p < 0.001$). The interaction between group and time was also significant ($\beta = -5.5$, $p < 0.001$). Furthermore, effect size analysis based on post-test differences in perception variables indicated a substantial intervention effect (Cohen's $d = 1.5$).

DISCUSSION

The results of this study have shown that web-based learning about COVID-19 vaccination significantly improved CHWs' knowledge and perceptions compared to conventional methods. Further analysis using a linear mixed model (LMM) showed that the mean score was higher in the intervention group than in the control group and had a significant effect on knowledge scores ($\beta = 4.0$; $p < 0.001$). Further analysis revealed that time and the interaction between group and time were significant, indicating that changes in knowledge were influenced by the intervention as well as time. Moreover, effect size analysis showed a substantial intervention effect (Cohen's $d = 2.6$).

The results of this study are consistent with previous studies showing that web-based learning can improve health workers' knowledge and confidence in immunization practices. (Mahimbo et al., 2023). Web-based learning is effective because it is convenient, interactive, and provides participants with a pleasant learning experience (Naciri et al., 2021). Participants benefit from convenience, the ability to adjust their pace, access to downloadable materials, the ability to replay materials, and improved concentration (Goldin et al., 2021).

The results of the analysis of the perception variable showed that scores were higher in the intervention group than in the control group and that the group had a significant relationship with the perception score ($\beta = 6.77$; $p < 0.001$). Analysis of time and the interaction between group and time also had significant values, indicating that changes in perception were influenced by the combination of intervention and time dynamics. Moreover, effect size analysis showed a substantial intervention effect (Cohen's $d = 1.5$). These findings are consistent with previous studies that explained that online learning using educational videos increased participants' attitudes, efficacy, and self-confidence (Shirahmadi et al., 2023). Another study indicated that online learning through short videos also increased confidence, willingness, and perceptions about the safety of the influenza vaccine (Jiang et al., 2022). Furthermore, increased knowledge and self-efficacy also occurred among health workers in providing immunization services to children after participating in web-based learning (Shamsi et al., 2025).

This study also demonstrated an increase in knowledge and perceptions in both the intervention and control groups. This is because both computer-based learning and conventional methods are capable of significantly improving students' knowledge, as both provide structured and systematic information for learners (Al-Awaysheh et al., 2024). Furthermore, web-based learning has advantages over print media. E-learning, or online learning, encompasses a flexible approach, creates an interactive and collaborative

environment, and enables the use of gamification and virtual reality in education. Tools such as electronic platforms, online communication, cloud technology, and data analytics facilitate effective material delivery, interaction between students and instructors, and adaptation of the educational process to changing needs (Kerimbayev et al., 2023). Learning through websites offers flexibility, ease of access, and the ability to present information interactively. Websites can be used as a platform to provide educational materials about COVID-19 vaccination, such as videos, infographics, articles, and quizzes, which can be accessed anytime and anywhere by participants (Dhawan, 2020).

Web-based learning also provides convenience to CHWs, most of whom are housewives, because of its flexibility without having to leave their household activities or chores. Web platforms also offer learning flexibility, allowing participants to access learning materials at their own pace and needs. This approach has been associated with improved knowledge scores among participants participating in online learning compared to face-to-face learning (Martin et al., 2022).

Increased knowledge among CHWs has led to positive perceptions about COVID-19 vaccination. The information CHWs obtained through online learning media also contributed to positive perceptions about COVID-19 vaccination. According to information processing theory, the quality of information on the web, including material, language, and data within the system, allows for memory utilization, information processing, and adjustment to the user's cognitive style, leading to improved knowledge and perception (Alqurni, 2023). However, the improvement also observed in the control group suggests that structured learning, both web-based and conventional, can contribute to improved knowledge and perception.

However, the results of this study should be interpreted with caution. Several confounding factors could influence changes in scores, such as exposure to information from other sources, including the media and discussions among participants. Another factor, the relatively short duration of the intervention, also suggests that the results reflect short-term effects. Improved perceptions are not necessarily a direct result of the intervention. Several factors, such as general learning effects and exposure to the external environment, may also contribute. Furthermore, the learning program for CHWs who have improved their understanding and perceptions regarding COVID-19 immunization needs to be maintained and regularly monitored by community health center (Puskesmas) health workers to ensure that their knowledge and perceptions are maintained.

This study has several limitations that need to be considered when generalizing the results. Knowledge and perception measurements were conducted over a short period of time,

so the results are more representative of short-term changes and cannot yet confirm the sustainability of the effects in the long term. This study was not fully able to control for confounding factors such as exposure to information from other sources, including media and interactions between participants, which can influence changes in knowledge and perception. Furthermore, this study used a relatively small sample size and only studied one region with certain characteristics, thus limiting the generalizability of the results to a broader population. Therefore, future research is recommended using a larger sample size, intervention duration, and long-term measurements so that the effects of the intervention can better represent long-term levels of knowledge.

CONCLUSION

The results of this study indicate that web-based learning can improve CHWs' knowledge and perceptions about COVID-19 immunization, compared to conventional methods using printed modules. Despite the improvement in knowledge and perceptions, the generalizability of the results remains a limitation of this study, as several factors that were not fully controlled, such as the diversity of the CHWs' backgrounds and the varying levels of access to technology, could have influenced the results. Therefore, web-based learning can be considered as a potential educational strategy to increase the capacity of CHWs in supporting vaccination programs, especially for vulnerable groups such as the elderly. Future research should employ a more rigorous design, incorporate a larger sample size, and implement long-term measurements to ascertain the sustainability of the intervention's effects.

REFERENCES

Al-Awaysheh, H., AlRuzzeih, M., & Alloubani, A. (2024). Comparing the effectiveness of computer-based teaching versus face-to-face teaching of clinically related courses among newly hired oncology nurses. *Educación Médica, 25*(3), 100894. https://doi.org/10.1016/j.edumed.2024.100894

Alfikrie, F., Hidayat, U. R., Hatmalyakin, D., & Anjarwadi, I. A. (2023). Persepsi masyarakat pesisir tentang vaksin booster selama masa pandemi COVID-19. *Malahayati Nursing Journal, 5*(8), 2746-2754. https://doi.org/10.33024/mnj.v5i8.9301

Alqurni, J. S. (2023). Evaluating the user interface and usability approaches for e-learning systems. *International Journal of Information Technology and Web Engineering (IJITWE), 18*(1), 1-25. https://doi.org/10.4018/ijitwe.333638

Chait, R. M., Nastiti, A., Chintana, D. A., Sari, P. N., Marasabessy, N., Firdaus, M. I., Dirgawati, M., Agustian, D., West, H., & Ariesyady, H. D. (2024). Using the Social–Ecological Model to Assess Vaccine Hesitancy and Refusal in a Highly Religious Lower–Middle-Income Country. *International Journal of Environmental Research and Public Health, 21*(10), 1335. https://doi.org/10.3390/ijerph21101335

Cowan, N., Bao, C., Bishop-Chrzanowski, B. M., Costa, A. N., Greene, N. R., Guitard, D., Li,

C., Musich, M. L., & Ünal, Z. E. (2024). The relation between attention and memory. *Annual Review of Psychology*, *75*(1), 183-214. https://doi.org/10.1146/annurev-psych-040723-012736

Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. *Journal of Educational Technology Systems*, *49*(1), 5-22. https://doi.org/10.1177/0047239520934018

Dukcapil. (2025). *Data Kependudukan Provinsi Kalimantan Barat*. Retrieved from: https://dukcapil.kalbarprov.go.id/data/kelompok-umur

Goldin, S., Kong, S. Y. J., Tokar, A., Utunen, H., Ndiaye, N., Bahl, J., Appuhamy, R., & Moen, A. (2021). Learning from a massive open online COVID-19 vaccination training experience: survey study. *JMIR Public Health and Surveillance*, *7*(12), e33455. https://doi.org/10.2196/33455

Goldstein, E. B. (1989). *Sensation and perception*. Wadsworth/Thomson Learning.

Gordon, M., & Woods, A. J. (2022). Information-processing theory. In *Encyclopedia of Gerontology and Population Aging* (pp. 2618-2620). Springer. https://doi.org/10.1007/978-3-030-22009-9_698

Gupta, A., Madhavan, M. V., Sehgal, K., Nair, N., Mahajan, S., Sehrawat, T. S., Bikdeli, B., Ahluwalia, N., Ausiello, J. C., & Wan, E. Y. (2020). Extrapulmonary manifestations of COVID-19. *Nature Medicine*, *26*(7), 1017-1032. https://doi.org/10.1038/s41591-020-0968-3

Ida, R., Kinasih, S. E., Febriyanti, S. N., Puspa, R., Saud, M., & Bakar, M. S. A. (2024). COVID-19 vaccine rumour and resistance in Indonesia: Analysing vaccine hesitancy and cultural myths circulated on online platforms. *Vacunas (English Edition)*, *25*(3), 313-322. https://doi.org/10.1016/j.vacune.2024.08.003

Islam, A., Kusnadi, G., Rezki, J., Sim, A., van Empel, G., Vlassopoulos, M., & Zenou, Y. (2024). Addressing vaccine hesitancy using local ambassadors: A randomized controlled trial in Indonesia. *European Economic Review*, *163*, 104683. https://doi.org/10.1016/j.euroecorev.2024.104683

Jiang, M., Yao, X., Li, P., Fang, Y., Feng, L., Hayat, K., Shi, X., Gong, Y., Peng, J., & Atif, N. (2022). Impact of video-led educational intervention on uptake of influenza vaccine among the elderly in western China: a community-based randomized controlled trial. *BMC public health*, *22*(1), 1128. https://doi.org/10.1186/s12889-022-13536-8

Kemenkes. (2021). *Petunjuk teknis pelaksanaan vaksinasi dalam rangka penanggulangan pandemi corona virus disease 2019 (COVID-19)*. Retrieved from: https://peraturan.bpk.go.id/Details/171640/keputusan-menkes-no-hk0107menkes46382021

Kemenkes. (2024). *Petunjuk teknis pemberian imunisasi covid-19 program*. Kementerian Kesehatan Direktorat Jendral Pencegahan dan Pengendalian Penyakit (P2P). Retrieved from https://repository.kemkes.go.id/book/1290

Kemenkes. (2025). *Vaksinasi covid-19 Nasional*. Retrieved from: https://vaksin.kemkes.go.id/#/provinces

Kerimbayev, N., Umirzakova, Z., Shadiev, R., & Jotsov, V. (2023). A student-centered approach using modern technologies in distance learning: a systematic review of the literature. *Smart Learning Environments*, *10*(1), 61. https://doi.org/10.1186/s40561-023-00280-8

Kuehn, B. M. (2021). More severe obesity leads to more severe COVID-19 in study. *JAMA*, *325*(16), 1603-1603. https://doi.org/10.1001/jama.2021.4853

Lazarus, J. V., Ratzan, S. C., Palayew, A., Gostin, L. O., Larson, H. J., Rabin, K., Kimball, S., & El-Mohandes, A. (2021). A global survey of potential acceptance of a COVID-19 vaccine. *Nature Medicine*, *27*(2), 225-228. https://doi.org/10.1038/s41591-020-1124-9

Mahimbo, A., Tiwari, P., Abdi, I., Seale, H., Charania, N., & Heywood, A. E. (2023). Designing an online educational program to improve immunisation service delivery for migrants and refugees in Australia and New Zealand. *Discover Health Systems, 2*(1), 28. https://doi.org/10.1007/s44250-023-00043-9

Martin, F., Sun, T., Westine, C. D., & Ritzhaupt, A. D. (2022). Examining research on the impact of distance and online learning: A second-order meta-analysis study. *Educational Research Review, 36*, 100438. https://doi.org/10.1016/j.edurev.2022.100438

Mohamed, N. A., Solehan, H. M., Mohd Rani, M. D., Ithnin, M., & Arujanan, M. (2023). Understanding COVID-19 vaccine hesitancy in Malaysia: Public perception, knowledge, and acceptance. *PLOS ONE, 18*(4), e0284973. https://doi.org/10.1371/journal.pone.0284973

Müller, V., Polivka, L., Valyi-Nagy, I., Nagy, A., Szekanecz, Z., Bogos, K., Vago, H., Kamondi, A., Fekete, F., & Szlavik, J. (2022). Booster vaccination decreases 28-day all-cause mortality of the elderly hospitalized due to SARS-CoV-2 delta variant. *Vaccines, 10*(7), 986. https://doi.org/10.3390/vaccines10070986

Naciri, A., Radid, M., Kharbach, A., & Chemsi, G. (2021). E-learning in health professions education during the COVID-19 pandemic: a systematic review. *Journal of Educational Evaluation for Health Professions, 18*. https://doi.org/10.3352/jeehp.2021.18.27

NIH. (2023). COVID-19 treatment guidelines panel: Coronavirus diseases 2019 (COVID-19) treatment guidelines. Retrieved from: https://www.ncbi.nlm.nih.gov/books/NBK570371/pdf/Bookshelf_NBK570371.pdf

Perveen, S., Akram, M., Nasar, A., Arshad-Ayaz, A., & Naseem, A. (2022). Vaccination-hesitancy and vaccination-inequality as challenges in Pakistan's COVID-19 response. *Journal of Community Psychology, 50*(2), 666-683. https://doi.org/10.1002/jcop.22652

Puri, N., Coomes, E. A., Haghbayan, H., & Gunaratne, K. (2020). Social media and vaccine hesitancy: new updates for the era of COVID-19 and globalized infectious diseases. *Human Vaccines & Immunotherapeutics, 16*(11), 2586-2593. https://doi.org/10.1080/21645515.2020.1780846

Rancher, C., Moreland, A. D., Smith, D. W., Cornelison, V., Schmidt, M. G., Boyle, J., Dayton, J., & Kilpatrick, D. G. (2023). Using the 5C model to understand COVID-19 vaccine hesitancy across a National and South Carolina sample. *Journal of Psychiatric Research, 160*, 180-186. https://doi.org/10.1016/j.jpsychires.2023.02.018

Rieu, A., Loibl, K., & Leuders, T. (2024). How context influences the processing of relevant information and judgment accuracy—the role of information restriction in judgment processes in diagnosing misconceptions. *Frontiers in Psychology, 15*, 1405756. https://doi.org/10.3389/fpsyg.2024.1405756

Rosner, B. (2016). *Fundamentals of biostatistics* (Vol. 8). Cengage Learning.

Shamsi, L., Janighorban, M., & Mohamadirizi, S. (2025). The effect of educational intervention based on mobile learning on the knowledge and self-efficacy of healthcare providers in vaccination. *Journal of Education and Health Promotion, 14*(1), 7. https://doi.org/10.4103/jehp.jehp_1426_23

Shirahmadi, S., Hazavehei, S. M. M., Abbasi, H., Otogara, M., Etesamifard, T., Roshanaei, G., Dadaei, N., & Taheri, M. (2023). Effectiveness of online practical education on vaccination training in the students of bachelor programs during the Covid-19 pandemic. *PLOS ONE, 18*(1), e0280312. https://doi.org/10.1371/journal.pone.0280312

Silaghi-Dumitrescu, R., Patrascu, I., Lehene, M., & Bercea, I. (2023). Comorbidities of COVID-19 patients. *Medicina, 59*(8), 1393. https://doi.org/10.3390/medicina59081393

Sinuraya, R. K., Wulandari, C., Amalia, R., & Puspitasari, I. M. (2023). Public knowledge,

attitudes, and practices during the first wave of COVID-19 in Indonesia. *Frontiers in Public Health, 11*, 1238371. https://doi.org/10.3389/fpubh.2023.1238371

Sujarwoto, S., Holipah, H., Andarini, S., Aknuranda, I., Pakpahan, E., Oceandy, D., Tampubolon, G., & Maharani, A. (2025). Evaluating community-based digital health interventions to improve COVID-19 outcomes in rural Indonesia: a quasi-experimental study. *BMJ Health & Care Informatics, 32*(1), e101511. https://doi.org/10.1136/bmjhci-2025-101511

WHO. (2021). *The role of community health workers in COVID-19 vaccination: Implementation support guide*. Retrieved from: https://www.who.int/publications/i/item/WHO-2019-nCoV-NDVP-CHWs-role-2021.1

WHO. (2022). *Implementation guide for vaccination of health workers*. Retrieved from: https://iris.who.int/server/api/core/bitstreams/740c5ee7-d437-4f27-b5f0-7e07fe599232/content

Wise, J. (2023). Covid-19: WHO declares end of global health emergency. *BMJ, 381*, 1041. https://doi.org/10.1136/bmj.p1041

Xu, Z., Shi, L., Wang, Y., Zhang, J., Huang, L., Zhang, C., Liu, S., Zhao, P., Liu, H., & Zhu, L. (2020). Pathological findings of COVID-19 associated with acute respiratory distress syndrome. *The Lancet Respiratory Medicine, 8*(4), 420-422. https://doi.org/10.1016/S2213-2600(20)30076-X

Zhou, Y., & Shen, L. (2024). Processing of misinformation as motivational and cognitive biases. *Frontiers in Psychology, 15*, 1430953. https://doi.org/10.3389/fpsyg.2024.143095