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Digital pills: Leveraging whatsapp for antibiotic resistance awareness

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Abstract

The growing threat of antibiotic resistance, caused by the misuse and overuse of antibiotics, creates a severe public health crisis that requires immediate and innovative solutions. This study aims to evaluate the effectiveness of educational interventions using audio-visual media through WhatsApp in increasing the knowledge and attitudes of health Worker and the Maternal and Child Health Services Movement related to antibiotic resistance. The study is based on the Elaboration Likelihood Model (ELM) and Social Cognitive Theory (SCT), which explain how media-based interventions affect knowledge acquisition and attitude change. A pre-test and post-test experiment design was carried out involving 100 rural participants in Kebak Kramat District, Karanganyar Regency, Central Java. Participants' knowledge and attitudes were assessed through a structured questionnaire before and after the intervention. The intervention consists of educational audio-visual content disseminated through WhatsApp, aimed at increasing understanding and encouraging responsible use of antibiotics. These findings reveal a significant increase in knowledge, as indicated by the Z value of the Mann-Whitney U test of -2.044 (p=0.041) when comparing Maternal and Child Health Services and Volunteer Health Worker. However, no significant change was observed in attitudes, with a value of Z -0.944 (p = 0.345). These results suggest that although WhatsApp-based interventions effectively improve knowledge, they are less effective in influencing attitudes towards antibiotic resistance. The study focuses on the potential of WhatsApp as a platform that can be accessed and used for health education in rural areas. However, the study also suggests the need for a more interactive and participatory approach to facilitate deeper attitude change and promote sustained attitude change in antibiotic use. Future research should explore the integration of engagement-driven strategies to increase the impact of digital health interventions.

Keywords: Audio-visual Education; WhatsApp Intervention; Maternal and Child Health Services; Volunteer Health Worker

Introduction

Antibiotic resistance (RA) is becoming an increasing concern in Indonesia due to the widespread irrational use of antibiotics in households and health facilities. Inappropriate use of antibiotics remains prevalent, with a limit of 81.4% in public hospitals and 86.2% in private hospitals (Suminar, 2022). This abuse has led to increased treatment failures, prolonged illness, and rising healthcare costs. Ramdhani et al. (2021) reported a high level of resistance in Indonesia, such as 38.0% for cefixime and 92.86% for tetracycline, which is further exacerbated by inappropriate use of antibiotics and early discontinuation of treatment. These factors are accelerating the development of resistant bacteria, highlighting the urgent need for stricter prescribing regulations and increased public awareness.

Indonesia's situation reflects a much larger global crisis. Antibiotic resistance is the most significant challenge in public health around the world (Aslam et al., 2018). Bacteria that develop resistance not only cause more difficult-to-treat infections but also contribute to increased mortality, longer duration of treatment, and higher health costs (Kaur et al., 2024; Okeke et al., 2024). According to the World Health Organization, more than 700,000 people die each year from infections caused by resistant bacteria. The results are projected to reach 10 million deaths per year by 2050 if no stronger interventions are implemented (WHO, 2023).

In addition to harming individual patients, antibiotic resistance threatens important medical advances. The WHO warns that without effective antibiotics, procedures such as cancer treatment, organ transplants, and major surgeries will face greater risks due to the inability to prevent postoperative infections (Murray et al., 2022; WHO, 2023). This means the importance of global and national efforts to control antibiotic use, implement stricter regulations, and improve public

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education to reduce the impact of antibiotic abuse postoperative infections (Murray et al., 2022; WHO, 2023). This means the importance of global and national efforts to control antibiotic use, implement stricter regulations, and improve public education to reduce the impact of antibiotic abuse. Strict regulations and medical interventions continue to be campaigned to anticipate antibiotic resistance. However, its effectiveness depends on how well the public understands and internalizes the importance of responsible use of antibiotics (Sehrawat et al., 2024). Health communication is not only a tool for disseminating information but also a perspective of meaning, understanding, and social practices, related to the use of antibiotics continues to be built and negotiated (Virhia et al., 2024). The paradigm shift from a biomedical approach to a digital communication strategy is becoming increasingly relevant, especially with technological advancements that allow for more interactive and participatory health messages (Bell & Wozniak, 2024; Sehrawat et al., 2024).

Meanwhile previous research has extensively explored antibiotic resistance through medical and pharmacological perspectives, studies on the role of health communication in shaping public awareness and attitudes remain limited (Odongo, 2024). A critical gap in the literature lies in the lack of exploration of how digital communication strategies, particularly social media-based interventions, influence how individuals comprehend and respond to antibiotic use. Dominant discourses in AR research continue to focus on direct medical interventions, with few studies providing an in-depth analysis of how targeted communication campaigns can contribute to more effective and sustainable antibiotic management. In an increasingly complex digital communication ecosystem, traditional approaches to health messaging must be re-examined to understand how audiences not only receive but also negotiate the meaning of the messages being conveyed (Hefshan et al., 2024; Liu et al., 2025).

In Indonesia, the high penetration of mobile technology and the widespread use of WhatsApp as a key communication tool have created a strategic opportunity to increase awareness and shift attitudes towards the use of antibiotics (Nikolic et al., 2018). WhatsApp not only serves as a platform for information dissemination but also as a space for social interaction where users engage in a more dynamic discursive process (Dharmapalan & Gavhane, 2020). The distribution of audio-visual content through WhatsApp introduces a new dimension to health communication, it is messages are not only consumed passively but can also be questioned, discussed, and interpreted differently depending on the individual's social and cultural context.

The theoretical approach of this study is based on the Social Cognitive Theory which explains that social learning occurs through observation, reinforcement, and modeling (Bandura, 1989; Islam et al., 2022). In the context of WhatsApp-based interventions, repeated exposure to audio-visual health messages has the potential to reinforce expected behavioural norms, especially regarding the appropriate use of antibiotics (Abdollahi et al., 2024; Hertz, 2024). In addition, the Elaboration Likelihood Model (ELM) is applied to understand how audiences process health messages and whether multimedia-based messaging results in lasting attitude changes (Abbasian et al., 2024; Petty et al., 1983). The combination of the two theories allows for a deeper analysis of how digital media functions not only as a means of conveying information but also as a space to build meaning and shape attitudes towards antibiotic resistance.

An important conceptual aspect that must be clarified in this study is the fundamental difference between social media as a communication infrastructure and audio-visual content as a mode of message delivery in such platforms. Commonly misconception is the assumption that the effectiveness of health messages is solely determined by the platform used, while the way the message is presented, whether in terms of visuals, narrative, or interactivity, plays an equally important role (Suchkov, 2023). WhatsApp, as a text-based and multimedia communication application, offers a more personalized communication model than conventional mass media campaigns (Dharmapalan & Gavhane, 2020). This advantage allows for more contextualized and tailored messaging to the needs of the audience, in contrast to the top-down approach to health communication and is based on the assumption that the disseminated information will be received and understood uniformly by the public (Huo & Turner, 2019; Thapliyal et al., 2024).

This study aims to improve the gap in health communication research by shifting the focus from a clinical approach to a more participatory digital communication strategy.The goal is to

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analyze the effectiveness of WhatsApp-based audio-visual interventions both Maternal and Child Health Services and Volunteer Health Worker, this research contributes to understanding how technology-based communication can be utilized to increase awareness of antibiotic resistance. Previous studies have not comprehensively examined the intersection of digital communication, social learning, and interactive media in the context of AR prevention. By addressing these gaps, the study offers a new perspective on public health education, emphasizing the importance of communication that is not only informative but also dialogical and participatory. In addition, by integrating social learning mechanisms into digital communication strategies, this study highlights the potential of WhatsApp as a medium that enhancing public understanding and shaping attitudes toward antibiotic resistance.

Method

This study used a quasi-experimental design with a two-group pretest-posttest approach to assess the effectiveness of educational video interventions about antibiotic resistance in influencing changes in public knowledge and attitudes. This design was chosen to facilitate comparison between two groups: trained public health volunteers at integrated Maternal and Child Health Services and Health Worker group in Kebak Kramat, Karanganyar Regency, Central Java Province, involving a total of 100 participants. The quasi-experimental design was chosen because of the implementation of the research in the social structure of the well-established community, which made full randomization impractical (Shadish et al., 2002).

The selection of Maternal and Child Health Services and Health Worker members as the experimental groups was based on their strategic role in community health promotion. Maternal and Child Health Services are trained health facilitators with prior exposure to medical information, making them key figures in disseminating health knowledge. Meanwhile, Health Worker members, primarily composed of mothers responsible for household health decisions, have significant influence in shaping family health behaviours. By involving these two groups, the study aimed to assess the effectiveness of digital health communication among individuals with different levels of prior health information exposure. Additionally, their active participation in community-based health programs enables broader dissemination of acquired knowledge, ensuring a more sustainable impact of the intervention.

This study was conducted in a post-positivist paradigm, applying a quantitative approach to measure changes in respondents' knowledge and attitudes after exposure to educational video interventions. This study belongs to the category of applied research, as it seeks to evaluate the practical impact of communication strategies in public health education. Furthermore, it adopts an evaluative type of research, which aims to assess the effectiveness of digital health communication interventions in promoting antibiotic resistance-related awareness and behavioural change.

The study used a structured questionnaire to assess participants' knowledge and attitudes towards antibiotic resistance before and after the intervention. The knowledge questionnaire was initially in the form of 15 questions but was refined into 10 valid items after conducting validity tests. These questions explore key aspects of antibiotic resistance, including common misconceptions, such as the belief that antibiotics can treat viral infections, the consequences of improper use, the impact of resistance on the effectiveness of treatment, and the role of human behaviour in driving resistance.

In addition to the knowledge assessment, 10 statement questionnaires were designed to measure participants' perceptions and behaviours regarding antibiotic use. On the five-point Likert Scale, this instrument evaluates participants' views on the importance of antibiotic resistance education, adherence to prescriptions, willingness to engage and share educational content, and personal responsibility in preventing antibiotic abuse. All statements related to the attitude are confirmed to be valid through validity testing.

In order to evaluate the effectiveness of the intervention, both questionnaires were administered during the pre-test and post-test phases. The reliability test results showed strong internal consistency, with Cronbach's Alpha 0.773 for the knowledge questionnaire and 0.731 for the attitude questionnaire, which further confirmed the robustness of this measurement tool (Hair et al., 2010). This structured approach in designing and validating the instrument ensures that the data

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collected accurately captures participants' knowledge levels and changes in attitudes, allowing for a comprehensive analysis of the impact of the intervention.

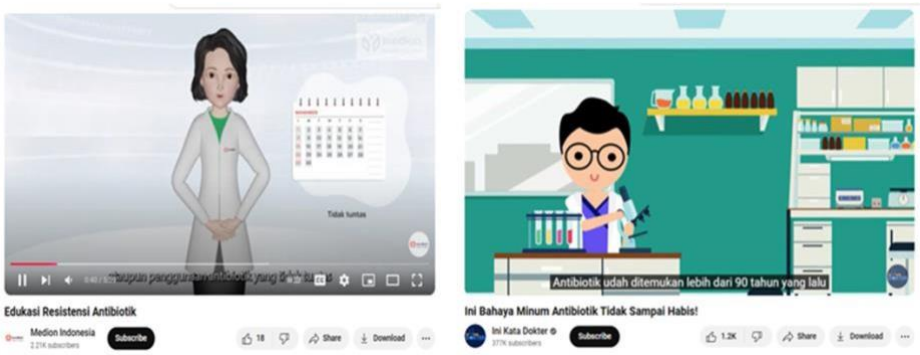

Figure 1. Sample Video Used for Education from Social Media
Source: Medion Indonesia (2024), Ini Kata Dokter (2022)

The intervention involves educational videos sourced from social media, which are disseminated through WhatsApp groups. The research team scheduled the distribution of videos, each two to five minutes long, ensuring accessibility and understanding of participants. The video content covers important topics, including the proper use of antibiotics, the mechanisms of antibiotic resistance, and the consequences of antibiotic abuse. WhatsApp groups also facilitate discussions, allowing respondents to engage with the research team for further clarification, thereby enhancing the learning experience (Ghozali et al., 2023; Siregar et al., 2023) The study uses non-parametric statistical methods for data analysis. The Wilcoxon marked rating test was used to assess group differences in knowledge and attitudes before and after the intervention. This test does not require the assumption of normality. To compare the differences between the two groups (Maternal and Child Health Services and Health Worker members), the Mann-Whitney U test was applied (Bagdonavičius et al., 2013; Denis, 2018). This statistical method ensures rigorous evaluation of the impact of the intervention, offering insights into the effectiveness of digital health communication strategies in raising antibiotic resistance awareness.

Results and Discussion

The use of social media has significant implications for aspects of society, including communication, information dissemination, and social engagement. As a powerful tool for connecting individuals, social media platforms also serve as channels for the exchange of knowledge, especially groups involved in development and public health. In this context, this study aims to explore the demographic characteristics and social media behaviour of health worker volunteer involved in community-based programs such as Maternal and Child Health Services and Health Worker members, highlighting their educational backgrounds, jobs, and social media usage patterns.

The research sample consisted of two main groups: as Maternal and Child Health Services and Health Worker. Initially, the same number of respondents was anticipated; However, the data discontinuation resulted in Maternal and Child Health Services becoming the dominant group with 56 respondents (56.0%), while Health Worker amounted to 44 people (44.0%). Higher participation rates of Maternal and Child Health Services are associated with their more active roles in health-based activities and greater involvement in community-based health intervention programs (Ramadhan & Herawati, 2024). In addition, this difference in the level of involvement reflects the organizational dynamics that shape the pattern of volunteer health worker participation. In the Maternal and Child Health Services, they assume direct responsibility for managing basic health services for the community, such as immunization, child growth monitoring, and nutrition education (Sandra & Choiriyah, 2024; Sudiyono, 2024). Conversely, health worker, while also contributing to community empowerment, have a broader scope of work not confined to the health sector, potentially leading to more varied levels of engagement in digital-based activities (Ramadhan & Herawati, 2024).

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The level of education of volunteer affects their social media usage patterns. The distribution of respondents' education levels showed that the majority had completed high school education (52 people, 52.0%), followed by higher education (24 people, 24.0%), junior high school education (18 people, 18.0%), and elementary school education (6 people, 6.0%). The high percentage of volunteer with higher education shows that most have better access and skills in utilizing digital technology. As highlighted by Lybeck et al. (2023), access to technology is influenced not only by the availability of digital devices, but by the level of digital literacy and the ability of individuals to critically manage information. Volunteer with higher education tend to have a better understanding of various digital platforms and effectively use social media as a source of information (Feng et al., 2019; Monday, 2013). Therefore, an inclusive education approach is needed to ensure that all volunteers, regardless of their level of education, can effectively use social media to support their duties and responsibilities.

In terms of employment, the majority of respondents were housewives (63 individuals, 63.0%), followed by private sector employees (32 individuals, 32.0%), with the smallest group being civil servants (5 individuals, 5.0%). This composition reflects that most volunteers come from groups with higher time flexibility, allowing them to be more active in community activities (Awang & Nadzri, 2023; Samtharam & Baskaran, 2023). Volunteers who are housewives tend to allocate more time to community-based activities compared to those who work in the formal sector. This is in line with the finding that community engagement is higher among individuals with greater work flexibility (Milkie et al., 2024). However, this active participation also shows the blurring of boundaries between the domestic and public spheres in women's activities, reflecting the broader social dynamics in the digital era.

Regarding social media use, most volunteers (49.0%) spend 1-2 hours per day on digital platforms, while longer duration of use, which is more than 4 hours per day, was only reported by 11.0% of respondents. This moderate usage trend shows that although digital technology has become a part of volunteers' daily lives, community-based activities remain their primary focus. The findings suggest that digital engagement serves as an additional tool rather than a dominant aspect of their daily routine. While social media facilitates access to information and communication, its role does not rule out the main commitment of volunteers to offline community activities. It also reflects a selective approach to digital consumption, where technology is pragmatically used to support community initiatives rather than as a primary space for interaction and engagement (Bokase, 2023; Yadav et al., 2023).

On platform preferences, YouTube was the most popular among volunteers, chosen by 34.0% of respondents, followed by WhatsApp (28.0%), Instagram (22.0%), and Facebook (16.0%). These findings show a shift in media consumption patterns from text-based platforms to audiovisual-based platforms (Montero & Mora-Fernandez, 2020). This shift reflects the tendency of individuals to consume information through more interactive and visual formats, emphasizing the importance of media convergence in shaping digital communication patterns (Montero & Mora-Fernandez, 2020).

Besides usage patterns and platforms, content preferences are also an important aspect of understanding how volunteers utilize social media. The results showed that 76.0% of respondents preferred video-based content, compared to text and images, each only 12.0% of respondents chose it. This trend shows that volunteers are more interested in visual and dynamic content, allowing them to understand information more easily and interestingly. In the context of public education, using video as a medium for conveying information can increase the effectiveness of messages, because multimedia-based learning is more effective than conventional text-based methods (Almitamy et al., 2023).

Analysis of Changes in Knowledge and Attitudes

The Wilcoxon Signed Ranks test was used in this study because the data did not follow a normal distribution, thus failing to meet the assumptions of parametric tests. This test is appropriate for assessing differences between two paired conditions, namely before and after the intervention. Table 1. presents the results of the Wilcoxon test for knowledge and attitude variables.

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The results of the Wilcoxon Signed Ranks Test show significant differences in both variables analysis, namely knowledge and attitudes. For the knowledge variable, the Z-value was -8.445 with a p-value of 0.000, indicating a very significant change in the respondents' knowledge after the intervention. This result suggests that the intervention had a substantial impact on the improvement of the volunteers' knowledge, both Volunteer Maternal and Child Health Services and Health Worker.

Further analysis by group reveals that volunteer Maternal and Child Health Services had a Z-value of -6.477 with a p-value of 0.000, also showing a significant change in their knowledge after the intervention. Meanwhile, Health Worker had a Z-value of -5.458 with a p-value of 0.000, confirming that the intervention positively impacted the improvement of PKK cadres' knowledge.

In addition to knowledge, the respondents' attitudes also showed significant changes. For the attitude variable, the Z-value was -7.702 with a p-value of 0.000, indicating a significant change in the respondents' attitudes after the intervention. This improvement in attitude is crucial as it demonstrates that the intervention affected not only the knowledge but also the attitudes of the cadres toward the topic being addressed. At the group level, Volunteer Maternal and Child Health Services had a Z-value of -5.855 and a p-value of 0.000, indicating a significant change in attitude. Similarly, Volunteer Health Workers showed a Z-value of -5.050 with a p-value of 0.000, supporting the findings that the intervention had an effect on their attitudes.

Table 1. Wilcoxon Signed Ranks Test Results

Test Variables	Z-Value	p-value
Knowledge	-8.445	0.000*
Maternal & Child Health Services	-6.477	0.000*
Volunteer Health Workers	-5.458	0.000*
Attitude	-7.702	0.000*
Maternal & Child Health Services	-5.855	0.000*
Volunteer Health Workers	-5.050	0.000*

Source: Research Results, 2024

The integration of educational interventions through audio-visual media through WhatsApp emerges as an effective mechanism to shape knowledge, utilizing mobile technology everywhere (Abuhammad et al., 2025). An era in which the boundaries of traditional learning are dissolved into the fluidity of the digital space, this approach presents itself as an effective channel for the dissemination of knowledge, especially in contexts where conventional educational infrastructure is constrained (Ar Royo et al., 2024; Gcabashe, 2024) The visual and auditory stimuli embedded in the content invite participants into a more immersive cognitive experience, where knowledge is not only absorbed but reconstructed through interaction with the media.

In this study, WhatsApp served as more than just a platform for content distribution; it functioned as a dynamic space where learning was shaped through asynchronous exchanges of videos, images, and voice messages. The immediacy of interaction, questions posed and answered in real time, feedback exchanged organically dismantles the rigid structures of conventional pedagogy, replacing them with an evolving, participatory model of knowledge construction (Pohan et al., 2022). The digital environment, rather than being a passive repository of information, becomes an active terrain where meaning is co-created, negotiated, and reinterpreted.

Parallel findings in contemporary research reinforce this notion, illustrating how mobile-based interventions recalibrate the pathways through which knowledge and attitudes are formed. Hicks et al. (2023) demonstrated that WhatsApp-driven health interventions not only heightened awareness but also subtly altered behavioural tendencies among participants. Similarly, Ferret et al. (2021) emphasized the potency of audio-visual content when embedded within an interactive, feedback-oriented ecosystem, suggesting that transformation is less about the mere reception of information and more about the relational dynamics between the medium, the message, and the individual. These insights challenge the idea of linear knowledge transmission, instead positioning learning as a fragmented yet interconnected process, where meaning is constantly reshaped in the interplay between perception, engagement, and digital mediation.

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The Effectiveness of Intervention in Improving Knowledge and Attitudes

The data presented in Table 2 illustrates the results of the Mann-Whitney U test, which was used to compare the knowledge and attitudes of Maternal and Child Health Services and Health Workers. This test was chosen due to the non-normal distribution of the data. The following analysis highlights the key findings related to the differences between the two groups in terms of knowledge and attitude after the intervention.

Table 2. Mann-Whitney U Test Results for Knowledge and Attitude

Group	N	Mean Rank	Z-Value	p-value
Knowledge				
Maternal and Child Health Services	56	55.65	-2.044	0.041*
Health Workers	44	43.94		
Attitude				
Maternal and Child Health Services	56	52.92	-0.944	0.345
Health Workers	44	47.42		

Source: Research Results, 2024

The Mann-Whitney U test was conducted to assess the differences in knowledge and attitudes between Volunteer Maternal and Child Health Services and Health Worker. For the knowledge variable, Maternal and Child Health Servicer had a mean rank of 55.65, while Volunteer Health Worker had a mean rank of 43.94. The Z-value for this comparison was -2.044, with a p-value of 0.041, indicating a statistically significant difference in knowledge between the two groups. This suggests that volunteer Maternal and Child Health Servicer had a higher level of knowledge compared to Volunteer Health Worker after the intervention.

In contrast, for the attitude variable, the mean rank for Maternal and Child Health Servicer was 52.92, while Volunteer Health Worker had a mean rank of 47.42. The Z-value for the attitude comparison was -0.944, with a p-value of 0.345. This result suggests that there was no statistically significant difference in attitudes between the two groups, as the p-value is greater than the significance threshold of 0.05.

The results of the Mann-Whitney U test show a significant difference in knowledge between Volunteer Maternal and Child Health Services and Health Workers after the intervention. Volunteer Maternal and Child Health Services had a higher mean rank in knowledge compared to Health Worker, indicating that the intervention was more effective in improving the knowledge of Health Volunteer. However, in terms of attitude, no significant difference was found between the two groups, suggesting that while knowledge improved, the cadres' attitudes were not significantly influenced by the intervention.

Similar research investigating the effectiveness of interventions using audio-visual media via WhatsApp also showed varied results. Alsaad & AlDossary, (2024) revealed that the use of WhatsApp media, supplemented with audio-visual materials, significantly improved participants' knowledge, similar to the findings of this study regarding knowledge enhancement. However, this study also found that although knowledge increased, changes in participants' attitudes toward the taught topic were not as pronounced, similar to the findings in this study concerning the attitudes of Volunteer Maternal and Child Health Services and Health Worker (Arif P & Wardaningsih, 2023).

Meanwhile, audio-visual-based interventions through WhatsApp have proven to be effective in increasing knowledge, changing attitudes requires a more in-depth approach that goes beyond just providing information through the media. Attitude change is a complex process that is influenced not only by exposure to information but also by personal experiences, social interactions, and cultural contexts (Ajzen, 2001). This suggests that while WhatsApp can serve as an effective tool for delivering educational content, its impact on attitudes may be limited if it doesn't incorporate interactive discussions, personalized engagement, or reinforcement strategies.

Further research is needed to explore how this medium can be optimized in order to influence participants' attitudes more effectively. Factors such as message framing, peer influence roles, and the need for repeated exposure to persuasive messages should be considered (Petty et al.,

Bricolage ; Jurnal Magister Ilmu Komunikasi
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1983). In addition, integrating elements of behaviour change theory, such as self-efficacy and social norms, can increase the effectiveness of interventions in shaping long-term attitudes and health-related behaviours (Bandura, 1997).

Relevance of Social Learning Theory

This study results indicate that audio-visual media interventions via WhatsApp contribute to increasing the knowledge of Volunteer Maternal and Child Health Servicer and Health Worker but do not significantly alter attitudes. These findings can be contextualized through Bandura's Social Learning Theory (1977), which emphasizes that individuals learn by observing behaviours in social environments, where such behaviours can be reinforced or diminished depending on their consequences. In this study, the materials delivered via WhatsApp can be considered a learning model that cadres observe and replicate. WhatsApp contribute to increasing the knowledge of Maternal and Child Health Servicer and Health Worker but do not significantly alter attitudes. These findings can be contextualized through Bandura's Social Learning Theory (1977), which emphasizes that individuals learn by observing behaviours in social environments, where such behaviours can be reinforced or diminished depending on their consequences. In this study, the materials delivered via WhatsApp can be considered a learning model that cadres observe and replicate.

However, a more critical question arises regarding the extent to which this theory sufficiently explains the complexity of attitude change. If social learning operates linearly as Bandura suggests, an increase in knowledge should directly impact attitudes. However, the findings of this study indicate a gap between knowledge acquisition and attitude transformation. This suggests that behavioural change cannot be reduced to mere observation and imitation mechanisms but is instead intertwined within broader social relationships and the negotiation of meaning (Ferret et al., 2021; Manik et al., 2022).

Bandura indeed highlights the importance of reinforcement in modifying behaviour, whether through positive feedback or consequences that strengthen new attitudes (Manik et al., 2022). However, this approach risks overlooking the dynamics of individual subjectivity and the complexity of social systems in which interactions occur. In this study, although cadres received educational materials, the absence of active social interaction or collective engagement in reflecting on their experiences appears to limit the intervention's impact on attitude change. Learning is not merely a process of knowledge transfer but also an arena for meaning production influenced by competing discourses (Akuiyibo et al., 2022).

Furthermore, the role of the social environment in shaping attitudes cannot be ignored. In Social Learning Theory, social interactions are considered factors that can either reinforce or hinder behavioural change. However, this model tends to view the environment as something fixed and manipulable to influence individuals. In reality, the social environment is dynamic and full of contradictions, where individuals are not only influenced by their surroundings but also shape them through social practices (Lawrent, 2022; McMahon, 2023). If cadres lack space to discuss and negotiate the meaning of the information they receive, attitude change cannot occur automatically.

Additionally, Bandura emphasizes the importance of self-efficacy in adopting new behaviours, meaning that individuals are more likely to change their attitudes when they feel confident in their ability to apply acquired knowledge (Usher & Morris, 2023). However, self-efficacy is not merely an individual attribute measurable in quantitative terms but also a social construct influenced by subjective experiences and collective expectations (Donkoh, 2023). Thus, the limited attitude change observed in this study may be linked to the absence of mechanisms that allow cadres to collectively build confidence in applying the information they acquire.

Consistent with these findings, Ferret et al. (2021) who also used WhatsApp as an intervention medium, found that while participants' knowledge increased, attitude change remained limited. This reinforces the idea that digital media-based interventions, although effective in enhancing access to information, are not always sufficient to produce profound attitude changes (Christanti et al., 2024). Learning cannot be reduced to a linear and universal process. Instead, attitude change results from the complex interaction between individuals, the social environment, and the ongoing negotiation of meaning in everyday social practices. Therefore, a more contextual

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and participatory approach is needed in designing media-based interventions to effectively achieve sustainable attitude change.

Relevance of the Elaboration Likelihood Model (ELM)

The findings of this study, which show significant changes in knowledge but less pronounced changes in attitudes after the intervention using audio-visual media via WhatsApp, can also be examined through the lens of the Elaboration Likelihood Model (ELM) proposed by Richard E. Petty and John Cacioppo (1986). The ELM, as a dual-process theory, underscores the complexity of how individuals navigate persuasive messages, delineating two primary routes of persuasion: the central route and the peripheral route. These routes represent not just cognitive effort but also the socio-cultural and digital entanglements that shape meaning-making in a hypermediated world (Petty & Turnes, 2020).

In this study, the audio-visual materials disseminated through WhatsApp exist within a digital ecology where meaning is fragmented, negotiated, and contested. These materials, as persuasive artifacts, engage with the knowledge and attitudes of Volunteer Maternal and Child Health Servicer and Health Worker not merely as rational agents but as subjects enmeshed in an intricate web of media saturation, affect, and algorithmic conditioning. Whether processed through the central or peripheral route, the reception of these messages is mediated by the fluidity of digital attention, the play of hyperreality, and the postmodern condition of knowledge itself (Guyer. et al., 2019).

a. Central Route to Persuasion

According to the central route, individuals process messages carefully and thoughtfully, focusing on the quality of the arguments presented. This route leads to lasting attitude change because individuals are actively engaged in processing information. The finding that significant changes in knowledge were observed in this study suggests that participants were able to engage meaningfully with the content of the audio-visual materials, reflecting a more deliberate cognitive processing of the information. When the messages delivered via WhatsApp were perceived as relevant and clear, participants were likely to engage in deeper cognitive processing, leading to improved knowledge retention (Manca. et al., 2020).

However, the less pronounced change in attitudes suggests that the intervention may not have been entirely effective in engaging participants through the central route for attitude change. In a communication landscape increasingly shaped by digital stimuli, audio-visual materials alone may not be sufficient to foster deep cognitive engagement, especially in terms of attitudes, which often require more than just information processing (Jannah et al., 2024). Attitude change demands emotional engagement, persuasive appeal, and motivation to act, elements that are now increasingly conditioned by the fast-paced rhythm of information consumption, algorithm-driven interactions, and the way individuals navigate an ever-shifting reality (Mialkovska et al., 2024; Zvetomira, 2023). Thus, while knowledge improvement can be explained through the central route's emphasis on cognitive processing, attitude change often requires deeper involvement and stronger motivation, which may not have been fully addressed by this digital intervention.

b. Peripheral Route to Persuasion

On the other hand, the peripheral route involves less cognitive effort and relies on external cues or superficial characteristics of the message, such as the source's credibility, attractiveness, or emotional appeal. In this study, the lack of significant attitude change, despite improvements in knowledge, suggests that participants may have engaged with the message in a way that was shaped more by external impressions than by deep cognitive engagement. While audio-visual media can effectively deliver clear and engaging content, it may not have embedded enough persuasive elements to evoke the kind of emotional resonance or motivational impulse necessary for attitude transformation (Manca & Fornara, 2019). The rapid and fragmented nature of digital communication, particularly through WhatsApp, may have encouraged a more passive mode of engagement, where information is consumed but not necessarily internalized in a way that alters personal perspectives.

Furthermore, the credibility of the source (i.e., the sender of the WhatsApp messages) and the perceived relevance of the content likely influenced how participants processed the messages. If

Bricolage ; Jurnal Magister Ilmu Komunikasi
Vol.11 (No. 1) : 187 - 198. Th. 2025
p-ISSN: 2502-0935
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the messages were seen as trustworthy and authoritative, they may have been cognitively processed in a way that facilitated knowledge acquisition. However, without sufficiently immersive or affective triggers, the messages may not have disrupted existing mental frameworks enough to foster attitude change (Petty & Turnes, 2020). In a media environment where attention is constantly pulled in multiple directions, the interplay between information, emotion, and persuasion becomes more fluid, making deep, lasting attitude shifts more elusive.

Implications of ELM for Future Interventions

The facts of this study show that interventions using audio-visual media through WhatsApp are effective in increasing knowledge but not leading to significant attitudinal changes unless additional strategies are implemented to encourage deeper cognitive engagement or trigger peripheral cues that influence attitudes. In an ever-evolving digital communications landscape, information circulates rapidly and is often consumed in a fragmented manner, the main challenge is not to convey messages but to ensure that they penetrate the shifting tide of attention.

Future interventions benefit by integrating interactive elements, personalized messages, or feedback mechanisms that are more responsive to increasingly dynamic information consumption patterns. In this way, the central route can be strengthened to support knowledge retention, while the peripheral route can be optimized to foster deeper emotional resonance. Petty et al. (1983) support this idea by emphasizing that the central route requires greater personal involvement and cognitive elaboration, while the peripheral route relies more on emotional attraction or environmental cues. In a digital ecosystem increasingly shaped by algorithmic interaction and instant information consumption, combining the two approaches can serve as a more adaptive and effective strategy to drive changes in knowledge and attitudes.

Conclusion

This study assessed the effectiveness of an audio-visual intervention delivered via WhatsApp in improving the knowledge and attitudes of Volunteer Maternal and Child Health Services and Health Workers regarding antibiotic resistance. The results indicated a significant improvement in knowledge, particularly among Maternal and Child Health Servicer. However, the intervention did not result in meaningful changes in attitudes. These findings suggest that while digital media facilitates rapid information dissemination, its ability to reshape deeply embedded attitudes remains uncertain. In an era where knowledge is increasingly fragmented and absorbed through fleeting digital interactions, the challenge is not only to inform but to create meaningful engagement that disrupts existing cognitive and behavioural patterns.

Based on these findings, the development of more interactive and immersive strategies is essential to support digital media-based interventions. Incorporating group discussions or case-based training can help volunteer navigate the complexities of antibiotic resistance instead of recalling information, allowing them to build meaning in their own social and cultural realities. In addition, integrating personalized narratives, stories that resonate with volunteers' life experiences, can increase the emotional and contextual relevance of the interventions, allowing for shifting attitudes in an environment where belief systems are shaped not only by facts but by collective interpretations of those facts.

Future research should explore the long-term interactions between digital media and behavioural change, transforming beyond traditional methods to examine how technological engagement builds new ways of knowing and acting. Testing more innovative approaches, such as gamification or direct feedback loops, can offer insights into how digital interventions can move from passive information transfer to active transformation. In addition, hybrid models that combine digital platforms with face-to-face interaction or ongoing mentoring can provide a more holistic approach, recognizing that profound attitude change requires more than just media exposure, but demands ongoing negotiation in an ever-changing landscape of perception and meaning.

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