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Effectiveness of Enis Pneumonia Care QR Code-Based E-Health Platform on Maternal Knowledge of Toddler Pneumonia Detection and Early Treatment

Novi Enis Rosuliana[1]✉, Dini Mariani[1], Kusmiyati[1], Ely Mawaddah[2], Mira Utami Ningsih[2]

[1] Department of Nursing, Poltekkes Kemenkes Tasikmalaya, Tasikmalaya, West Java, Indonesia
[2] Department of Nursing, Poltekkes Kemenkes Mataram, Mataram, West Nusa Tenggara, Indonesia

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Abstract

Delayed recognition of pneumonia danger signs may postpone appropriate care for children under five. Conventional leaflet-based education offers limited opportunities for interactive and repeated learning, whereas QR codes provide direct access to structured multimedia without requiring a separate application. This study examined the association between QR code-linked e-health education and maternal knowledge of pneumonia danger-sign recognition and early care. This controlled quasi-experimental pretest–posttest study included 120 mothers recruited through accidental sampling and allocated non-randomly in sequential time blocks to intervention and control groups (60 participants each). Maternal knowledge was measured using a 23-item questionnaire scored from 0 to 23. The intervention group accessed QR code-linked education over a five-day period, while the control group received leaflet-based education. Knowledge increased by 1.55 points in the intervention group (SD = 2.39; $p < 0.001$) and by 0.33 points in the control group (SD = 1.80; $p = 0.157$). The unadjusted between-group difference in change was 1.22 points (95% CI: 0.45 to 1.98; Welch's $t(109.68) = 3.150$; $p = 0.002$; Cohen's $d = 0.58$). Baseline knowledge differed substantially between groups. After adjustment for baseline knowledge, the group difference was 0.77 points (95% CI: −0.26 to 1.80; $F(1, 117) = 2.190$; $p = 0.142$; partial $\eta^2 = 0.018$). QR code-linked education was associated with a greater unadjusted short-term increase in maternal knowledge, but the adjusted group effect was not statistically significant. Non-random allocation and baseline imbalance limit causal interpretation.

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Corresponding Author:

✉ Novi Enis Rosuliana
Department of Nursing, Poltekkes Kemenkes Tasikmalaya, Tasikmalaya, West Java, Indonesia
Email: novi.enis@dosen.poltekkestasikmalaya.ac.id

1. INTRODUCTION

Pneumonia is an acute infectious disease of the parenchyma tissue of the lungs or alveoli (lower respiratory system) which is mainly caused by the invasion of pathogens such as bacteria, viruses, fungi and atypical microorganisms (Long, Mallampalli, & Horowitz, 2022; Funaguchi et al., 2024). Pneumonia is still a serious global health problem and dominates as the a leading infectious cause of death in children under five (Sapunkov et al., 2025). Globally, the latest data shows that in 2023 pneumonia caused around 739,000 deaths among children under five. This condition is very worrying because the equivalent of one toddler dies every 43 seconds from a disease that is actually medically preventable and treatable (International Vaccine Access Center, 2023). Pneumonia in Indonesia also contributes significantly to the high mortality rate of toddlers, with the number of case discoveries reaching 166,702 in 2022. The mortality rate of toddlers in Indonesia due to pneumonia reaches around 0.12%, where the highest mortality rate definitively occurs in the infant age group, which is three times higher than the 1-4 year age group (Direktorat Pencegahan dan Pengendalian penyakit Menular Kementerian Kesehatan, 2022).

The high incidence and fatality of pneumonia in toddlers is inseparable from various risk factors that interact with each other. The main risk factors of the environment and nutrition include malnutrition, failure to fulfill exclusive breastfeeding in the first six months, inaccuracies in the administration of Complementary Foods (MP-ASI), history of low birth weight (BBLR), the presence of congenital diseases, to exposure to air pollution in the house such as cigarette smoke and cooking stove smoke (Cao et al., 2023; Sutriana et al., 2021).

Infants and toddlers physiologically show that the body's immune system is not fully mature so it is very susceptible to infectious diseases (Scheible, 2024). Clinical signs and symptoms of pneumonia in toddlers are generally in the form of fever, rapid breathing (tachypnea), inward pull of the lower chest wall (chest wall retraction), hearing additional breathing sounds such as ronkhi, wheezing or stridor, to hypoxia conditions in severe cases (Li et al., 2022). However, delays in treating pneumonia at home cause 7-13% of pediatric pneumonia patients who come to the hospital to already suffer from severe pneumonia. The delay in identifying the worsening of these symptoms suggests that early detection capabilities at the family level are still weak. Mothers are the ones closest to children, so it is very important for them to be aware of changes in clinical conditions and make decisions about treatment and medical referrals (Chowdhury et al., 2022).

However, the conditions in society show that many mothers do not understand the signs and symptoms of pneumonia in their children. Maternal knowledge and skills levels about early detection and early care of toddlers with pneumonia are still low in many places, especially in areas that do not have access to continuing health education services. Cases of pneumonia in toddlers in West Java Province ranked 8th nationally, with a percentage of 44.90% in 2022 and increased to 45% in 2023 (Dinas Kesehatan Jawa Barat, 2026). Based on a case rate of 53.6%, Tasikmalaya City is in 11th place for pneumonia incidence, with the highest cases found in the Cilembang Health Center Working Area. Based on these conditions, efforts are needed to reduce the morbidity and mortality rate of toddlers in the region, namely the availability of a transformative and innovative health education program that teaches mothers to identify critical symptoms as early as possible. The use of electronics health (E-health) offers a strategic solution to patient health information and education problems in today's digital transformation era. E-health is a combination of the internet and information technology to provide medical resources, services, and information with the aim of promoting health promotion and care (Chalouf, 2021). Conventional face-to-face education and static printed materials provide

limited opportunities for repeated, self-paced access after the education session (Barik et al., 2019; Jawad et al., 2023). In contrast, a QR code can provide direct smartphone access to structured text, images, and demonstration videos without requiring a separate application installation (Hu et al., 2024).

The e-health-based education system leads to the delivery of health information independently, evidence-based, and functions to empower the wider community through a patient-centered treatment transition. Quick Response (QR) Code technology can be used as the main bridge medium to increase the ease and accessibility of e-health for mothers (Hu et al., 2024). QR codes are interactive matrices that make it easy to instantly scan and access information on the user's smartphone without the need for complicated installation (Wahsheh & Al-Zahrani, 2023). Recent indexed empirical research shows that QR Code-based health education lowers patient or family anxiety about disease, improves material interaction, and makes repetitive accessibility easier. All of this happens without considering the patient's level of formal education (Ma et al., 2025). The QR code was selected as the access mechanism to the web-based platform because, unlike a stand-alone mobile application, it does not require a separate download or installation. Unlike a single educational video, the platform organizes text, images, and demonstration videos in one location that mothers can revisit during the intervention period.

Previous QR code-based health-education studies have mainly examined access, usability, anxiety, or outcomes in clinical patient groups (Hu et al., 2024; Ma et al., 2025). Evidence remains limited regarding QR code-linked multimedia education for mothers of children under five in community primary care, particularly studies using a controlled pretest-post-test design and maternal knowledge of pneumonia danger signs and early care as the outcome. The present study addressed this gap by comparing short-term changes in maternal knowledge between QR code-linked multimedia education and leaflet-based education in the working area of the Cilembang Health Center.

2. METHODS

This quantitative study used a quasi-experimental study design with a pretest and posttest control-group design (Tang, 2024). A quasi-experimental design was selected because participants were recruited during routine community activities and random assignment was not feasible. The comparison group and identical pretest-post-test assessment interval were used to support group comparisons while acknowledging the limitation of non-random allocation. Study preparation began in January 2026. The research was carried out in the working area of the Cilembang Health Center, Tasikmalaya City, where the area recorded the highest prevalence of pneumonia cases among toddlers.

The population in this study is all mothers who have children under five and are registered in the work area of the Cilembang Health Center, with a total of 1,967 mothers. Sampling was carried out using an accidental sampling technique with a total of 120 respondents, which was divided into 60 respondents for the intervention group and 60 respondents for the control group. Mothers who were present during the recruitment period, met the eligibility criteria, and provided written informed consent were enrolled consecutively through accidental sampling until 60 participants had been obtained for each group. This non-probability method was used because recruitment depended on participant attendance and availability during the scheduled community activities. The determination of the sample size was scientifically validated through statistical power analysis using G*Power software. Assuming a significance error limit of alpha = 0.05, a standard power of 0.80, and a medium effect size (d = 0.5) in an independent two-group numerical comparative test, the minimum required sample size was actually 51

respondents per group (Kang, 2021). The determination of 60 respondents per group was made to anticipate the potential for subject loss (drop-out) or sample shrinkage of 15–20% during the study period, as well as to ensure the fulfillment of the assumption of normality of data distribution based on the Central Limit Theorem (Petrovic, 2025).

The inclusion criteria for the sample included mothers who have toddlers, have and are able to operate an Android smartphone, can read and write, and are cooperative. As for the exclusion criteria, namely mothers who experience sudden illness, change domicile during the study, or experience technical problems/damage to smartphone devices.The maternal knowledge questionnaire was developed by Novi Enis Rosuliana and contained 23 true-false items covering the concept of pneumonia, recognition of danger signs, and early care. Each correct answer was scored 1 and each incorrect answer 0, producing a total score of 0-23. The total score was analyzed numerically without classification into good, sufficient, or poor categories. Content validity was assessed by two pediatric nursing experts, who judged the instrument to be valid. Item testing used product-moment correlations, and the reported alpha coefficient was 0.932, exceeding the reference value of 0.632. The same questionnaire and scoring procedure were used for the pretest and post-test in both groups. Intervention media in the form of QR Code-based E-health education applications have previously been tested for effectiveness. Before being implemented to respondents, this application system has gone through a series of technical testing stages, including material tests by pediatric nursing experts, unit tests by programmers, and system integration tests.

Participants were assigned non-randomly in sequential time blocks. The intervention group was recruited and assessed first, followed by the control group, to reduce possible information transfer between groups. In the intervention group, written informed consent, the pretest, and the first education session were completed on 15 May 2026. Participants accessed the Enis-Pneumonia Care web platform through a QR code during a five-day schedule and completed the post-test on day 5. The control group received leaflet-based education and completed the same knowledge questionnaire at pretest and on day 5; control-group data collection was conducted from 29 May to 2 June 2026. Both groups therefore used the same outcome measure and assessment interval. Because allocation was non-random and recruitment occurred in separate time blocks, selection bias and residual confounding could not be excluded.

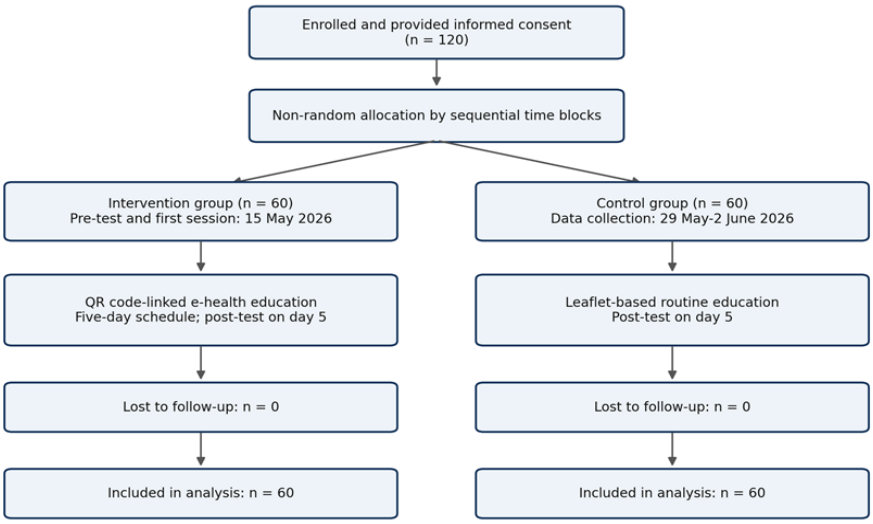


Figure 1. Participant flow through the study.

Descriptive statistics were used to summarize participant characteristics and knowledge scores. Baseline categorical characteristics were compared using Fisher's exact test or the Fisher-Freeman-Halton exact test for variables with more than two categories. Within-group pretest-post-test changes were examined using paired t-tests and reported with Cohen's dz. Between-group post-test scores were compared using an independent t-test with Cohen's d. Because the variance of change scores was unequal (Levene's p = 0.040), the between-group difference in change was evaluated using Welch's t-test. Shapiro-Wilk tests were used to assess score, change-score, and model-residual distributions, while Levene's test assessed homogeneity of variance. To address baseline knowledge imbalance, analysis of covariance was performed with post-test knowledge as the dependent variable, study group as the fixed factor, and pretest knowledge as the covariate; the group-by-pretest interaction was examined to assess homogeneity of regression slopes. Partial eta-squared was reported for the adjusted group effect, and HC3 robust standard errors were examined as a sensitivity analysis. All tests were two-sided with alpha = 0.05. Initial descriptive and t-test analyses were conducted using SPSS Statistics Release 16.0.0, as identified in the supplied SPSS output.

This research has met the ethical principles of health research and was declared to have passed the ethics test by the Health Research Ethics Committee of the Tasikmalaya Health Polytechnic based on the Certificate of Ethical Feasibility (Ethical Approval) No.DP.04.03/F.XVIII.1.3.1/307/2026. All participants were informed about the study objectives and procedures, and informed consent was obtained before their participation. The confidentiality and anonymity of participants were maintained throughout the study.

3. RESULTS AND DISCUSSION

This section presents the findings on maternal knowledge of pneumonia danger-sign recognition and early care. Complete pretest and post-test data were available for all 120 enrolled participants (60 intervention and 60 control), with no loss to follow-up during the five-day assessment period.

Table 1. Baseline characteristics of participants by study group (N = 120).

Characteristics	Intervention Group		Control Group		Total		p-value
	n	%	n	%	n	%	
Maternal Age							
< 21 years old	0	0	2	3.3	2	1.67	<0.001
21-35 years old	54	90	33	55.0	87	72.5	
> 35 years old	6	10	25	41.7	31	25.8	
Education							
Elementary school	3	5	20	33.3	23	19.2	
Junior high school	15	25	12	20.0	27	22.5	0.001
Senior high school	37	61.7	26	43.3	63	52.5	
Diploma/Bachelor's degree	5	8.3	2	3.3	7	5.8	
Occupation							
Homemakers	58	96.6	55	91.7	113	94.2	
Private-sector employee/entrepreneur	1	1.7	2	3.3	3	2.5	0.567
Government employee	1	1.7	2	3.3	3	2.5	

Characteristics	Intervention Group		Control Group		Total		p-value
	n	%	n	%	n	%	
Manual Labor	0	0	1	1.7	1	0.8	
Religion							-
Islam	60	100	60	100	120	100	
Ethnic group							-
Sundanese	60	100	60	100	120	100	
Experience of caring for toddlers with pneumonia							
No experience	51	85	54	90	105	87.5	0.582
Have experience	9	15	6	10	15	12.5	
Information about pneumonia							
No/never	14	23.3	43	71.7	57	47.5	<0.001
Yes	46	76.7	17	28.3	63	52.5	
History of pneumonia in the child							
Never	54	90	55	91.7	109	90.8	
Once	4	6.7	5	8.3	9	7.5	0.578
More than once	2	3.3	0	0	2	1.7	
Previous health-center visit for childhood pneumonia							
Never	55	91.7	55	91.7	110	91.7	1.000
Ever 1 time	4	6.7	5	8.3	9	7.5	
Have > 1 time	1	1.7	0	0	1	0.8	
Total	60	100	60	100	120	100	

Among the 120 participants, 87 (72.5%) were aged 21–35 years, 63 (52.5%) had completed senior high school, and 113 (94.2%) were homemakers. All participants were Muslim and Sundanese. Most participants had no previous experience caring for a child with pneumonia (105; 87.5%). Sixty-three participants (52.5%) had previously received information about pneumonia, 109 (90.8%) reported no history of pneumonia in their child, and 110 (91.7%) had never visited a health center for childhood pneumonia.

Baseline distributions differed between groups for maternal age ($p < 0.001$), education ($p = 0.001$), and previous receipt of pneumonia information ($p < 0.001$). No statistically significant differences were observed for occupation ($p = 0.567$), previous experience caring for a child with pneumonia ($p = 0.582$), history of pneumonia in the child ($p = 0.578$), or previous health-center visits for childhood pneumonia ($p = 1.000$). Religion and ethnicity were not tested because all participants were Muslim and Sundanese. Thus, the groups were not fully comparable at baseline, consistent with the non-random allocation procedure.

Table 2. Pretest and post-test maternal knowledge scores by study group.

Assessment		Mean	Std. Deviation	Min-Max	CI 95%
Intervention groups	Pre-test knowledge	13.18	2.38	7-17	12.5-13.8
	Post-test knowledge	14.73	3.06	7-23	13.9-15.5
Control Group	Pre-test knowledge	17.85	2.76	10-23	17.1-18.6
	Post-test knowledge	18.18	3.21	7-23	17.3-19.0

In the intervention group, the mean knowledge score increased from 13.18 (SD = 2.39) at pretest to 14.73 (SD = 3.07) at post-test. In the control group, the corresponding means were 17.85 (SD = 2.76) and 18.18 (SD = 3.21). The intervention group began with a substantially lower mean knowledge score than the control group (mean difference, intervention minus control = -4.67; 95% CI: -5.60 to -3.73; t(118) = -9.900; p < 0.001; Cohen's d = -1.81). Because this imbalance could affect post-test comparisons and contribute to regression to the mean, post-test knowledge was also analyzed using analysis of covariance adjusted for pretest knowledge.

Table 3. Within-group changes in maternal knowledge scores.

Group	Pretest mean (SD)	Post-test mean (SD)	Mean change (95% CI)	t (df)	p-value	Cohen's d
Intervention	13.18 (2.39)	14.73 (3.07)	1.55 (0.93 to 2.17)	5.025 (59)	< 0.001	0.65
Control	17.85 (2.76)	18.18 (3.21)	0.33 (-0.13 to 0.80)	1.434 (59)	0.157	0.19

The intervention group had a mean increase of 1.55 points (95% CI: 0.93 to 2.17), t(59) = 5.025, p < 0.001, with Cohen's d = 0.65. The control group had a mean increase of 0.33 points (95% CI: -0.13 to 0.80), t(59) = 1.434, p = 0.157, with Cohen's dz = 0.19. These within-group tests describe change in each group and do not by themselves establish a between-group intervention effect.

Table 4. Between-group comparison of post-test maternal knowledge.

Outcome	Intervention mean (SD)	Control mean (SD)	Mean difference (95% CI)	t (df)	p-value	Cohen's d
Post-test knowledge	14.73 (3.07)	18.18 (3.21)	-3.45 (-4.59 to -2.31)	-6.015 (118)	< 0.001	-1.10
Post-test knowledge	14.73 (3.07)	18.18 (3.21)	-3.45 (-4.59 to -2.31)	-6.015 (118)	< 0.001	-1.10

At post-test, the intervention group had a lower mean knowledge score than the control group (mean difference, intervention minus control = -3.45; 95% CI: -4.59 to -2.31; t(118) = -6.015; p < 0.001; Cohen's d = -1.10). Because the control group also had a substantially higher baseline score, this unadjusted post-test difference should not be interpreted as the intervention effect. Comparison of change scores showed a 1.22-point greater increase in the intervention group (95% CI: 0.45 to 1.98; Welch's t(109.68) = 3.150; p = 0.002; Cohen's d = 0.58).

After adjustment for pretest knowledge, the estimated post-test mean was 16.84 (95% CI: 16.20 to 17.49) in the intervention group and 16.07 (95% CI: 15.43 to 16.71) in the control group. The adjusted difference was 0.77 points (95% CI: -0.26 to 1.80), F(1, 117) = 2.190, p = 0.142, with partial eta-squared = 0.018. The group-by-pretest interaction was not significant (p = 0.361), supporting the homogeneity-of-slopes assumption. Residual variance did not differ significantly between groups (Levene's p = 0.063), although residuals departed from normality (Shapiro-Wilk W = 0.930, p < 0.001). The HC3 sensitivity analysis reached the same inferential conclusion (p = 0.226).

This study examined whether QR code-linked e-health education was associated with short-term changes in maternal knowledge of pneumonia danger-sign recognition and early care. The intervention group demonstrated a statistically significant increase in knowledge, whereas the change in the control group was not statistically significant. The unadjusted comparison of change scores also showed a greater increase in the intervention group. However, the two groups differed substantially in baseline knowledge, and the adjusted analysis did not demonstrate a statistically significant group effect. These findings therefore indicate an association with short-term knowledge change but do not provide sufficient evidence to establish a causal effect or the superiority of QR code-linked education over leaflet-based education.

Several baseline characteristics differed between the groups, including maternal age, education, previous receipt of pneumonia information, and pretest knowledge scores. These imbalances were consistent with the non-random sequential allocation procedure and may have influenced both the participants' initial knowledge and their subsequent score changes. In contrast, occupation, previous experience caring for a child with pneumonia, history of pneumonia in the child, and previous health-center visits did not differ statistically between the groups. Religion and ethnicity could not be evaluated as explanatory factors because all participants were Muslim and Sundanese. Consequently, the two groups should not be considered fully comparable before the intervention.

Most participants were housewives, and most had no previous experience caring for a child with pneumonia. Although slightly more than half of the participants had previously received information about pneumonia, the distribution of previous information exposure differed between the groups. These characteristics provide important context for interpreting the results but do not demonstrate differences in technology acceptance, digital literacy, self-efficacy, or clinical caregiving ability because these variables were not measured. The findings should therefore remain limited to the measured outcome of maternal knowledge.

In the intervention group, the mean knowledge score increased by 1.55 points, $t(59) = 5.025$, $p < 0.001$, with Cohen's $dz = 0.65$. The QR code-linked platform allowed participants to revisit structured text, images, and demonstration videos during the five-day intervention period. This repeated access may have supported continued exposure to the educational material. Nevertheless, frequency of access, duration of platform use, engagement with individual content, and information retention beyond the immediate post-test were not measured. Therefore, repeated exposure should be regarded as a plausible educational mechanism rather than a mechanism directly demonstrated by the study.

The control group showed a mean increase of 0.33 points, $t(59) = 1.434$, $p = 0.157$, with Cohen's $dz = 0.19$. The absence of a statistically significant within-group change does not establish that leaflet education was ineffective. Traditional printed materials remain a commonly used approach to community health education and may support health-promotion activities when their content and delivery are appropriate (Barik et al., 2019). Furthermore, separate within-group tests cannot determine whether one educational method is superior to another. Such a conclusion requires a valid between-group comparison that considers differences present before the intervention.

The post-test-only comparison showed that the intervention group had a lower mean knowledge score than the control group, with a mean difference of −3.45 points (95% CI: −4.59 to −2.31), $t(118) = -6.015$, $p < 0.001$, and Cohen's $d = -1.10$. However, the control group also had a substantially higher baseline score. The unadjusted comparison of change scores favored the intervention group by 1.22 points (95% CI: 0.45 to 1.98), Welch's $t(109.68) = 3.150$, $p = 0.002$, with Cohen's $d = 0.58$. Because this difference could

have been influenced by baseline imbalance and regression to the mean, it should not be interpreted as a pure treatment effect.

After adjustment for pretest knowledge using analysis of covariance, the estimated difference between groups was 0.77 points (95% CI: −0.26 to 1.80), $F(1, 117) = 2.190$, $p = 0.142$, with partial $\eta^2 = 0.018$. Thus, the adjusted group effect was not statistically significant. The group-by-pretest interaction was also not statistically significant ($p = 0.361$), supporting the homogeneity-of-regression-slopes assumption. Although residual variance did not differ significantly between groups (Levene's $p = 0.063$), the residual distribution departed from normality (Shapiro–Wilk $W = 0.930$, $p < 0.001$). The HC3 robust sensitivity analysis produced the same inferential conclusion ($p = 0.226$). Taken together, these results require a more cautious interpretation than the unadjusted analysis alone.

The use of QR codes as an access mechanism is consistent with previous research demonstrating their feasibility for connecting patients with digital health resources in primary-care settings (Hu et al., 2024). Structured digital health messages may also facilitate the consistent delivery of educational information across users and settings (Holst et al., 2021). Ma et al. (2025) examined QR code-delivered prehospital education in patients with breast nodules; however, the study population, measured outcomes, and retrospective design differed from those of the present study. These studies support the feasibility of QR code-based information delivery, but they do not directly establish its effectiveness for improving maternal clinical performance or child-health outcomes.

Maternal knowledge of pneumonia danger signs remains relevant because delayed recognition and delayed care-seeking can contribute to the progression of childhood pneumonia (Chowdhury et al., 2022). Nevertheless, increased questionnaire scores cannot be assumed to result automatically in accurate clinical recognition, timely referral, or appropriate treatment. The present study did not assess observed respiratory-rate measurement, danger-sign identification in clinical scenarios, actual care-seeking behavior, referral delay, morbidity, or mortality. It therefore cannot establish that participants became faster or more accurate in detecting and managing pneumonia.

This study has several limitations. Participants were recruited through accidental sampling and allocated non-randomly in sequential time blocks, creating risks of selection bias, temporal differences, and residual confounding. The substantial baseline difference in knowledge further limits causal interpretation, even though ANCOVA was used to adjust for pretest scores. The outcome was measured immediately after a five-day intervention, so long-term knowledge retention remains unknown. Platform usage and adherence were not objectively recorded, and the study was conducted in one primary-care setting, which may limit generalizability.

Future studies should consider randomized allocation where feasible, recruitment from multiple primary-care settings, objective monitoring of platform use, and longer follow-up periods. In addition to maternal knowledge, subsequent research should assess observed recognition of pneumonia danger signs, respiratory-rate assessment skills, appropriate care-seeking, referral timing, feasibility, user acceptability, and relevant child-health outcomes. Based on the current findings, QR code-linked e-health education may be considered a supplementary method for delivering maternal health information, but stronger evidence is required before concluding that it is more effective than leaflet education or improves clinical performance.

4. CONCLUSION

Maternal knowledge increased significantly within the intervention group following five days of QR code-linked e-health education, whereas the change within the leaflet control group was not statistically significant. Although the unadjusted increase in

knowledge was greater in the intervention group, the group effect was not statistically significant after adjustment for the substantial baseline difference. These findings suggest that QR code-linked education may support short-term maternal learning; however, they do not establish its superiority over leaflet-based education or demonstrate improvement in the clinical detection and treatment of pneumonia. QR code-linked education may be considered a supplementary educational resource in community and primary-care settings. Future studies should employ randomized allocation where feasible, include longer follow-up periods, and evaluate knowledge retention, observed recognition of pneumonia danger signs, appropriate care-seeking behavior, implementation feasibility, and relevant clinical outcomes.

CONFLICT OF INTEREST

The authors declared no conflicts of interest.

ETHICAL CONSIDERATIONS

This research has met the ethical principles of health research and was declared to have passed the ethics test by the Health Research Ethics Committee of the Tasikmalaya Health Polytechnic based on the Certificate of Ethical Feasibility (Ethical Approval) No.DP.04.03/F.XVIII.1.3.1/307/2026. All participants were informed about the study objectives and procedures, and informed consent was obtained before their participation. The confidentiality and anonymity of participants were maintained throughout the study.

AUTHOR CONTRIBUTIONS

Novi Enis Rosuliana contributed to conceptualization, methodology, investigation, data collection, formal analysis, and writing – original draft. Dini Mariani contributed to methodology, supervision, and validation. Kusmiyati contributed to investigation, data curation, and validation. Ely Mawaddah contributed to data collection, formal analysis, and visualization. Mira Utami Ningsih contributed to supervision, writing – review and editing, and project administration. All authors read and approved the final version of the manuscript.

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DECLARATION OF ARTIFICIAL INTELLIGENCE USE

Generative artificial intelligence (AI) tools were used to assist with language refinement and editorial improvements during manuscript preparation. The authors reviewed and verified all AI-assisted content and take full responsibility for the accuracy, integrity, and originality of the manuscript.

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