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Comparative Effectiveness of Video and Leaflet-Based Health Education on Pregnant Women's Immediate Knowledge and Attitudes Toward Multiple Micronutrient Supplement Consumption: A Quasi-Experimental Study

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ABSTRACT Limited knowledge and unfavorable attitudes toward Multiple Micronutrient Supplement (MMS) consumption may hinder adherence to antenatal supplementation and reduce the potential benefits of maternal nutrition programs. Although video and leaflet media are commonly used in maternal health education, evidence directly comparing their immediate effectiveness for MMS-related knowledge and attitudes remains limited. This study aimed to compare the effectiveness of video- and leaflet-based health education in improving pregnant women's knowledge and attitudes toward MMS consumption. A quantitative quasi-experimental study using a nonequivalent control-group pretest–posttest design was conducted among 60 pregnant women attending Puskesmas Sukomoro, Magetan, Indonesia. Participants were allocated to a video group (n = 30) or leaflet group (n = 30). Knowledge and attitudes were measured using validated questionnaires before and immediately after the intervention. Because the data were non-normally distributed, within-group changes were assessed using the Wilcoxon Signed-Rank Test, while post-intervention differences between groups were evaluated using the Mann–Whitney U test at $\alpha = 0.05$. Both interventions produced significant improvements in knowledge and attitudes (all $p < 0.001$), with large within-group effect sizes ($r = 0.86–0.88$). Median knowledge scores increased from 5.00 to 9.00 in both groups. Median attitude scores increased from 25.00 to 37.50 in the video group and from 19.50 to 38.50 in the leaflet group. However, no significant differences were identified between video and leaflet groups for post-intervention knowledge ($p = 0.059$) or attitude ($p = 0.496$), with small-to-negligible effect sizes. Both video- and leaflet-based education therefore demonstrated comparable short-term effectiveness in improving pregnant women's MMS-related knowledge and attitudes. These findings support the use of either medium according to local resources and participant characteristics, while longer follow-up studies are needed to determine sustained adherence and behavioral outcomes.

INDEX TERMS Multiple Micronutrient Supplements (MMS), Pregnant Women, Health Education, Video, Leaflet.

I. INTRODUCTION

Multiple Micronutrient Supplement (MMS) consumption during pregnancy is an important component of maternal nutrition because pregnancy increases the physiological demand for iron, folate, zinc, vitamin A, and other micronutrients required for maternal health and fetal development [1], [2]. Micronutrient deficiencies can adversely affect maternal well-being and pregnancy outcomes, while appropriate antenatal supplementation remains an important preventive strategy [1], [3]. However, supplement availability does not necessarily translate into appropriate utilization. Evidence indicates that knowledge, attitudes, perceived benefits, barriers, and access to health information influence pregnant women's adherence to supplementation recommendations [4]–[6]. In Indonesia, the transition toward MMS and continued provision of iron-containing supplements therefore requires health education that is understandable, accessible, and appropriate to maternal needs.

The problem is particularly relevant because gaps between receiving supplements and consuming them as recommended remain evident. The present manuscript reports that a preliminary assessment at Puskesmas Sukomoro found adequate knowledge in 75% of pregnant women, yet 60% expressed negative attitudes toward MMS consumption, suggesting that knowledge alone may not be sufficient to produce favorable attitudes [7]. Previous Indonesian studies

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similarly indicate that educational exposure can improve knowledge, attitudes, and supplementation-related behaviors [8]–[11]. A recent systematic review and meta-analysis found that nutrition education during pregnancy increased adherence to iron–folic acid supplementation and was associated with improved hemoglobin concentrations and reduced anemia risk [12]. These findings emphasize the need to identify practical educational approaches that strengthen maternal understanding and attitudes as proximal determinants of supplementation behavior.

The state of the art increasingly incorporates audiovisual and printed media into antenatal health promotion. Video combines visual and auditory information, potentially improving attention, comprehension, recall, and engagement [13], [14]. Recent studies among pregnant women have reported significant improvements in knowledge following video-based education concerning iron supplementation and anemia prevention [15], [16]. Short-form health videos may also provide concise and repeatable information suited to contemporary health communication [17]. In contrast, leaflets remain a low-cost and portable medium that allows participants to reread information independently after counseling [18], [19]. Recent Indonesian research has demonstrated significant improvements in knowledge and attitudes following leaflet-based education concerning iron tablets and anemia prevention [20]–[22]. Digital and mobile educational approaches have also shown potential for improving anemia-prevention knowledge and iron–folic acid tablet consumption among Indonesian pregnant women [23]. Recent Indonesian evidence likewise demonstrates significant improvements in knowledge and attitudes following video-based anemia education, while leaflet counseling has produced improvements in knowledge and attitudes related to iron-tablet consumption.

Despite this growing evidence, an important research gap remains. Many previous studies have evaluated a single educational medium against a pretest–posttest baseline or focused primarily on iron tablets, anemia prevention, or adherence rather than MMS-specific knowledge and attitudes. Comparative evidence examining video and leaflet media using the same educational content, population, outcomes, and immediate assessment framework is limited. Evidence from primary healthcare settings in rural Indonesian communities is also insufficient to determine whether the greater sensory richness of video provides an immediate advantage over printed education. This study addresses this gap by directly comparing video and leaflet interventions under a quasi-experimental design at Puskesmas Sukomoro.

Accordingly, this study aimed to compare the immediate effectiveness of video- and leaflet-based health education in improving pregnant women's knowledge and attitudes toward MMS consumption. The contributions are threefold: (1) directly comparing audiovisual and printed media using the same MMS content framework; (2) quantifying changes in knowledge and attitudes using validated instruments and non-parametric testing; and (3) providing practice-oriented evidence for selecting feasible educational media in primary healthcare and antenatal education. The remainder of this article is organized as follows: Section II describes the methods; Section III presents the results; Section IV discusses the findings and limitations; and Section V concludes the study and outlines future research.

II. METHOD

A. STUDY DESIGN

This study employed a quantitative quasi-experimental design using a nonequivalent control-group pretest–posttest approach. The design was selected to evaluate changes in pregnant women's knowledge and attitudes toward Multiple Micronutrient Supplement (MMS) consumption following exposure to two different health-education media. Similar quasi-experimental approaches have been applied to evaluate nutrition and reproductive-health education among pregnant women and have demonstrated measurable changes in maternal knowledge, attitudes, and practices [24]. Both study groups received a pretest before the educational intervention and an immediate posttest after the intervention. The primary outcomes were knowledge and attitudes toward MMS consumption.

The study was prospective because participants were recruited and assessed before the intervention, followed by standardized administration of the assigned educational intervention and immediate post-intervention assessment. Individual randomization was not performed. Instead, allocation was conducted at the village level to reduce the possibility of information contamination between participants living in the same community.

B. STUDY SETTING, POPULATION, AND SAMPLE

The study was conducted in the working area of Puskesmas Sukomoro, Kecamatan Sukomoro, Kabupaten Magetan, East Java, Indonesia, from January to May 2026. The target population comprised 63 pregnant women registered for antenatal care at the health center. A total of 60 participants were selected as the study sample using the Slovin formula with a 5% margin of error. Participant recruitment within each village was performed using simple random sampling.

The nine villages within the Puskesmas Sukomoro working area were used as the allocation units. Four villages comprising 30 participants were assigned to the video group, whereas five villages comprising 30 participants were assigned to the leaflet group. Thus, each intervention group contained 30 pregnant women. Because allocation was performed at the village rather than individual level, the study was classified as a cluster-based quasi-experimental study rather than an individually randomized controlled trial. The absence of individual randomization was considered when interpreting between-group differences.

C. RESEARCH INSTRUMENTS

Two structured questionnaires were used to measure the study outcomes: a knowledge questionnaire and an attitude questionnaire. The knowledge instrument consisted of 10 true-or-false items addressing the definition, composition, benefits, consumption procedures, consequences of non-consumption, and potential side effects of MMS. Each correct response

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received a score of 1, whereas an incorrect response received a score of 0, producing a total score ranging from 0 to 10.

The attitude instrument comprised 10 Likert-scale statements assessing participants' acceptance and rejection of MMS, preparedness to consume MMS, responses to potential side effects, and trust in healthcare providers. Responses were scored from 1 to 5, with reverse scoring applied to negatively worded items. The resulting total attitude score ranged from 10 to 50. The use of structured knowledge and attitude instruments is consistent with previous maternal nutrition-education research in which questionnaires were used to assess changes following educational interventions [24], [25].

Prior to implementation, the instruments were subjected to validity and reliability testing. Item validity was evaluated using Pearson Product–Moment correlation, with items considered valid when $r > 0.361$ and $p < 0.05$. Internal consistency was assessed using Cronbach's alpha. The knowledge questionnaire demonstrated a Cronbach's alpha coefficient of 0.912, whereas the attitude questionnaire demonstrated a coefficient of 0.947, indicating high internal consistency.

D. EDUCATIONAL INTERVENTIONS

The video group received a 7-min 8-sec audiovisual educational intervention concerning MMS consumption. The video was obtained from the "Ilmugiziku" YouTube channel and covered the definition and composition of MMS, its benefits during pregnancy, recommended consumption procedures, and consequences associated with non-adherence. The video was reviewed by the researcher and thesis supervisor before implementation to ensure its content corresponded with the study objectives.

The video was delivered individually using participants' personal smartphones under direct researcher supervision. The leaflet group received a printed educational leaflet developed by the researcher. The leaflet addressed the same five thematic components as the video: MMS definition, composition, benefits, consumption procedures, and consequences of non-adherence. The educational content was organized using a common content outline to maintain thematic equivalence between the two intervention media. The leaflet was distributed directly to participants and explained by the researcher.

Both interventions were delivered during village-level antenatal class sessions. Participants who were unable to attend the scheduled session received the intervention through a home visit. To minimize cross-group contamination, participants were instructed not to distribute or share the educational video or leaflet with participants assigned to the other intervention group during the study period. The posttest was administered immediately after exposure to the assigned educational medium on the same day. The use of standardized content across different educational media is consistent with comparative health-education intervention research [25], [26].

E. DATA COLLECTION PROCEDURE

Data collection consisted of four sequential stages. First, eligible pregnant women were identified from the antenatal-care registration records. Second, eligible participants completed the pretest questionnaires measuring baseline knowledge and attitudes toward MMS consumption. Third, the assigned educational intervention was administered according to the participant's village allocation. Fourth, participants completed the same outcome questionnaires immediately after the intervention. The identical measurement framework was used for both intervention groups to ensure comparability of pretest and posttest scores.

F. STATISTICAL ANALYSIS

Data were edited, coded, entered, and tabulated using IBM SPSS. Descriptive statistics were used to summarize participant characteristics and outcome scores. Data distribution was assessed using the Shapiro–Wilk test. Because the outcome variables did not satisfy the normality assumption ($p < 0.05$), non-parametric statistical procedures were applied.

Within-group differences between pretest and posttest scores were analyzed using the Wilcoxon Signed-Rank Test. Differences between the video and leaflet groups were evaluated using the Mann–Whitney U Test. Statistical significance was established at $\alpha = 0.05$. Effect sizes were reported to complement statistical significance. For the Wilcoxon analysis, matched-pairs rank-biserial correlation was used, whereas the Mann–Whitney effect size was calculated as $r = Z/\sqrt{N}$. Effect sizes were interpreted as approximately small (0.10), moderate (0.30), and large (0.50). Median and interquartile range (IQR) were reported because the data were non-normally distributed. Comparable use of Wilcoxon and Mann–Whitney procedures has been reported in recent health-education intervention studies involving video and leaflet/e-leaflet media [26].

G. ETHICAL CONSIDERATIONS

Ethical approval was obtained from the Ethics Committee of Poltekkes Kemenkes Surabaya, Indonesia, under approval number EA/4427/KEPK-Poltekkes_Sby/V/2026. All participants provided written informed consent before data collection. Participation was voluntary, and participants were informed of their right to withdraw at any stage without consequences. Participant information was anonymized, and collected data were securely stored with access restricted to the research team.

III. RESULTS

This study was conducted from January to May 2026, involving 60 pregnant women at Puskesmas Sukomoro, Magetan Regency, East Java. The health center serves a multicultural rural population across nine villages, with residents primarily employed in agriculture, trade, and micro-enterprises. Groups were balanced across all sociodemographic characteristics prior to intervention.

Based on TABLE 1, the majority of pregnant women in the video group were older than 35 years (43.3%), while the leaflet group showed equal proportions of women over 35 years and those aged 20–35 years (each 40.0%). Overall, 63.4% of participants were in high-risk age categories (<20 or

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>35 years). Both groups were predominantly educated to secondary level, with a higher proportion in the leaflet group (63.3% vs. 46.7%). Trimester II was the most common gestational period in both groups.

TABLE 1
Sociodemographic Characteristics of Pregnant Women Respondents

Characteristics	Video (n=30)		Leaflet (n=30)		Total (n=60)
	f	%	f	%	%
Age					
<20 years	7	23.3	6	20.0	21.7
20-35 years	10	33.3	12	40.0	36.7
>35 years	13	43.3	12	40.0	41.7
Education					
Primary (SD/SMP)	7	23.3	5	16.7	20.0
Secondary (SMA)	14	46.7	19	63.3	55.0
Higher (D3/S1)	9	30.0	6	20.0	25.0
Gestational Age					
Trimester I	8	26.7	5	16.7	21.7
Trimester II	16	53.3	15	50.0	51.7
Trimester III	6	20.0	10	33.3	26.7

TABLE 2
Shapiro-Wilk Normality Test Results

Group	Variable	Statistic	p-value	Distribution
Video	Pre-Knowledge	0.922	0.031	Non-normal
	Post-Knowledge	0.735	<0.001	Non-normal
	Pre-Attitude	0.922	0.030	Non-normal
	Post-Attitude	0.756	<0.001	Non-normal
Leaflet	Pre-Knowledge	0.844	<0.001	Non-normal
	Post-Knowledge	0.864	0.001	Non-normal
	Pre-Attitude	0.890	0.005	Non-normal
	Post-Attitude	0.861	0.001	Non-normal

The normality test results presented in TABLE 2 showed p-values below 0.05 for all variables in both groups, indicating that the data were not normally distributed. In addition, Levene's test for homogeneity demonstrated no statistically significant differences in baseline sociodemographic characteristics between the video and leaflet groups (all $p > 0.05$), indicating comparable baseline characteristics before the intervention.

TABLE 3
Wilcoxon Signed Rank Test Results for Knowledge and Attitude (Pre- and Post-Test)

Variable	Group	Pre-Test Median (IQR)	Post-Test Median (IQR)	Z	p-value	Effect size (r)
Knowledge	Video	5.00 (3.25)	9.00 (1.00)	-4.806	<0.001	0.88
	Leaflet	5.00 (1.00)	9.00 (2.00)	-4.814	<0.001	0.88
Attitude	Video	25.00 (19.50)	37.50 (11.25)	-4.706	<0.001	0.86
	Leaflet	19.50 (10.50)	38.50 (11.25)	-4.704	<0.001	0.86

Based on TABLE 3, both educational media interventions produced statistically significant improvements in knowledge and attitudes. Knowledge scores in the video group increased from a median of 5.00 (IQR 3.25) at pretest to 9.00 (IQR 1.00) at posttest, while in the leaflet group knowledge increased from a median of 5.00 (IQR 1.00) to 9.00 (IQR 2.00). Attitude scores in the video group increased from a median of 25.00 (IQR 19.50) to 37.50 (IQR 11.25), while in the leaflet group attitude scores increased from a median of 19.50 (IQR 10.50) to 38.50 (IQR 11.25). Both Wilcoxon Signed Rank Tests returned $p < 0.001$ for knowledge ($Z = -4.806$ for video, $Z = -4.814$ for leaflet) and attitude ($Z = -4.706$ for video, $Z = -4.704$ for leaflet), with large effect sizes ranging from $r = 0.86$ to $r = 0.88$, confirming significant within-group improvement in both intervention arms.

TABLE 4
Mann-Whitney U Test: Post-Test Comparison Between Video and Leaflet Groups

Variable	Median Video	Median Leaflet	U	Z	p-value	Effect size (r)	95% CI Hodges-Lehmann
Knowledge Posttest	9.00 (1.00)	9.00 (2.00)	330.500	-1.888	0.059	0.24	0.000 to 1.000
Attitude Posttest	37.50 (11.25)	38.50 (11.25)	404.500	-0.681	0.496	0.09	-2.000 to 2.000

Based on TABLE 4, the Mann-Whitney U Test revealed no statistically significant difference between groups in post-test knowledge ($U = 330.500$, $Z = -1.888$, $p = 0.059$, $r = 0.24$) or post-test attitude scores ($U = 404.500$, $Z = -0.681$, $p = 0.496$, $r = 0.09$), with effect sizes indicating a small-to-negligible magnitude of difference between media types. The Hodges-Lehmann estimate of median difference for post-test knowledge was 0.000 (95% CI: 0.000 to 1.000), and for post-test attitude was 0.500 (95% CI: -2.000 to 2.000). Both confidence intervals include zero, indicating that the true median difference between groups cannot be distinguished from no difference at the 95% confidence level, and providing additional support for the interpretation of comparable short-term effectiveness between the two educational media.

IV. DISCUSSION

A. EFFECT OF VIDEO AND LEAFLET EDUCATION ON KNOWLEDGE OF MMS CONSUMPTION

The present study demonstrated that both video- and leaflet-based health education significantly improved pregnant women's knowledge regarding Multiple Micronutrient Supplement (MMS) consumption. In the video group, the median knowledge score increased from 5.00 (IQR = 3.25) before the intervention to 9.00 (IQR = 1.00) after the intervention. A similar improvement was observed in the leaflet group, in which the median score increased from 5.00 (IQR = 1.00) to 9.00 (IQR = 2.00). The Wilcoxon Signed-Rank Test demonstrated statistically significant changes in both groups ($p < 0.001$), with large effect sizes ($r = 0.88$). These findings indicate that exposure to structured educational information was associated with substantial immediate improvement in respondents' understanding of MMS consumption.

The improvement in knowledge may be explained by the fact that both interventions conveyed the same core educational content, including the definition, composition, benefits, consumption regimen, and consequences of non-adherence to MMS. Although the delivery formats differed, the thematic equivalence of the materials ensured that

participants in both groups received comparable information. The video was presented through participants' smartphones under researcher supervision, whereas the leaflet provided printed information that could be visually reviewed during and after the educational session. The standardized content therefore likely contributed more strongly to knowledge acquisition than the medium itself.

This interpretation is consistent with recent evidence demonstrating that nutrition education during pregnancy can substantially improve knowledge and supplementation-related outcomes. Engidaw et al. [30], in a systematic review and meta-analysis involving 53 peer-reviewed studies and 13,475 pregnant women, reported that nutrition education significantly improved iron–folic acid supplementation compliance and reduced anemia risk. The authors emphasized that education can address misconceptions, increase awareness of supplement benefits, and support behavioral change. Although the intervention in the present study focused specifically on MMS and measured knowledge immediately after exposure, the direction of the findings is consistent with the broader evidence that structured antenatal nutrition education can improve maternal understanding of supplementation.

The findings are also supported by Reshid and Anato [31], who reported significant improvements in knowledge and favorable attitudes toward iron–folic acid supplementation following community-based nutrition education among pregnant women. Their study demonstrates that education delivered within a community or antenatal-care context can improve maternal understanding of supplementation-related information. Similarly, Permatasari et al. [32] previously demonstrated that nutrition and reproductive health education among pregnant women in Indonesia could improve maternal knowledge and related health practices. Thus, the present findings extend existing evidence by showing that both video and printed education can produce marked immediate knowledge gains when the educational content is specifically structured around MMS consumption.

The video format may provide additional advantages because it combines visual and auditory information, potentially facilitating comprehension of sequential or procedural information. In the present study, the video lasted 7 minutes and 8 seconds and was delivered individually under researcher supervision. This controlled exposure ensured that participants received the complete intervention without interruption. Recent evidence on digital health interventions also indicates that technology-mediated approaches can positively influence supplementation-related outcomes. Shao, Meng, and Liang [33] found that digital interventions were associated with improved adherence to oral iron supplementation and increased hemoglobin levels among pregnant women compared with non-digital interventions. Nevertheless, the present study measured immediate knowledge rather than long-term adherence, and therefore the findings should not be interpreted as evidence that video education necessarily produces superior behavioral outcomes.

The leaflet intervention also produced a large improvement in knowledge. This finding suggests that printed educational materials remain relevant in antenatal health promotion, particularly when the information is concise, structured, and directly related to participants' needs. Unlike video, a leaflet can potentially be retained and reviewed independently after the educational session. This characteristic may be particularly useful for reinforcing information concerning dosage, consumption schedules, benefits, and management of possible side effects. However, because the present study assessed knowledge immediately after the intervention, the potential advantage of repeated leaflet exposure could not be evaluated.

B. EFFECT OF VIDEO AND LEAFLET EDUCATION ON ATTITUDES TOWARD MMS CONSUMPTION

In addition to knowledge, both educational interventions significantly improved attitudes toward MMS consumption. The video group demonstrated an increase in median attitude scores from 25.00 (IQR = 19.50) to 37.50 (IQR = 11.25), while the leaflet group increased from 19.50 (IQR = 10.50) to 38.50 (IQR = 11.25). Both changes were statistically significant ($p < 0.001$), with large effect sizes of $r = 0.86$. The improvement was particularly notable in the leaflet group because its baseline attitude score was lower than that of the video group, yet its post-intervention median slightly exceeded that of the video group.

The improvement in attitudes may indicate that the interventions did more than simply transmit factual information. Educational content concerning the benefits of MMS, appropriate consumption, and the consequences of non-adherence may have helped participants reassess their perceptions of MMS and develop more favorable views toward regular consumption. This interpretation is supported by Alfaqeeh et al. [34], who investigated knowledge, attitudes, and acceptance of MMS among women in Indonesia. Their nationwide study found that knowledge was significantly associated with attitude and acceptance, while gaps remained in women's understanding of MMS use and potential side effects. These findings emphasize the importance of improving maternal knowledge as part of the process of strengthening positive attitudes toward MMS.

The present findings are also consistent with Reshid and Anato [31], who reported a significant improvement in favorable attitudes toward supplementation following community-based nutrition education. This similarity suggests that educational interventions may influence both the cognitive and evaluative dimensions of supplementation. Nevertheless, attitude change should not automatically be interpreted as behavioral change. A participant may report a more favorable attitude immediately after receiving information but may still encounter practical barriers to consuming MMS consistently, such as side effects, forgetfulness, delayed initiation, or limited access.

This distinction is particularly important in the context of MMS adherence in Indonesia. Battung, Groen, and van der Beek [35] reported that overall adherence to the recommended MMS intake in a community-based program in Parepare was

53.9%. Earlier initiation of MMS was associated with better adherence, while delayed initiation was associated with substantially lower adherence. The study also identified side effects and other individual characteristics as factors influencing intake. Therefore, improving attitudes through educational media represents an important first step, but it should ideally be accompanied by continued counseling, monitoring, and support throughout pregnancy.

An important finding of the present study is that neither video nor leaflet education demonstrated a statistically significant advantage over the other. The Mann–Whitney U Test showed no significant difference in post-intervention knowledge between the video and leaflet groups ($p = 0.059$) and no significant difference in post-intervention attitude ($p = 0.496$). The effect sizes for between-group comparisons were small ($r = 0.24$ for knowledge and $r = 0.09$ for attitude), while the Hodges–Lehmann confidence intervals included zero. These findings suggest that both media produced comparable immediate improvements under the conditions of this study.

The absence of a significant difference is plausible because the two interventions were intentionally designed around the same thematic content. Consequently, the educational message itself may have been the dominant factor influencing the outcomes, whereas the difference in presentation format contributed less to immediate knowledge and attitude change. This interpretation is also consistent with the Indonesian MMS literature showing that contextual and individual factors influence knowledge and attitudes toward supplementation. Alfaqeeh et al. [34] found that demographic and pregnancy-related characteristics were associated with knowledge and attitudes, while knowledge itself was an important predictor of positive MMS perceptions.

However, the finding should be interpreted carefully. A non-significant p-value does not establish that video and leaflet interventions are statistically equivalent. The current study was not designed as an equivalence or non-inferiority trial, and the sample consisted of only 60 participants. Therefore, the appropriate interpretation is that no statistically significant difference was detected between the two educational media in immediate post-intervention outcomes, rather than that the two media are definitively equivalent. This distinction is important when translating the findings into recommendations for clinical practice.

C. LIMITATIONS, IMPLICATIONS, AND FUTURE DIRECTIONS

Several limitations should be considered when interpreting the findings. First, the post-test was administered immediately after the intervention. Consequently, the observed improvements primarily represent immediate changes in knowledge and attitudes and cannot establish whether the effects were retained over time. Knowledge may decline after the initial exposure, and positive attitudes may not necessarily translate into consistent MMS consumption. This limitation is particularly relevant because evidence from Indonesia indicates that actual MMS adherence remains influenced by timing of initiation, side effects, and other individual factors [35].

Second, the study used village-level allocation rather than individual randomization. Four villages were assigned to the video group and five villages to the leaflet group, with 30 participants in each intervention arm. This approach was selected to reduce the possibility of information contamination among participants from the same community; however, it introduces potential cluster-level differences between groups. In addition, the statistical analysis did not fully account for clustering at the village level. Therefore, the precision of the estimated intervention effects may be affected. Future studies should consider individual randomization or formally incorporate cluster-level effects into the statistical analysis.

Third, the study assessed only self-reported knowledge and attitudes and did not measure objective MMS adherence, tablet consumption, hemoglobin concentration, or maternal and neonatal outcomes. This limits the extent to which the findings can be connected to clinically meaningful outcomes. The distinction between educational impact and behavioral adherence is supported by Battung et al. [35], whose longitudinal findings demonstrate that actual MMS intake is influenced by multiple factors beyond exposure to information. Therefore, future studies should incorporate objective adherence indicators, such as tablet counts, supplementation records, or digital monitoring, together with longer follow-up periods.

Despite these limitations, the findings have practical implications for antenatal care. Both video and leaflet media can be considered feasible educational options for improving immediate knowledge and attitudes toward MMS consumption. The choice of medium may therefore be determined according to available resources, participant characteristics, digital access, literacy, and the workflow of the healthcare facility rather than assuming that one medium is universally superior. Video may be particularly useful when audiovisual demonstration and standardized delivery are prioritized, whereas leaflets may be advantageous when low-cost materials and repeated independent review are desired.

The findings also support the integration of structured nutrition education into routine antenatal services. Engidaw et al. [30] concluded that nutrition education can improve supplementation compliance and reduce anemia risk, while Shao et al. [33] demonstrated that digital approaches can improve supplementation adherence and hemoglobin outcomes. These findings suggest that future MMS programs could combine face-to-face counseling with appropriate digital or printed reinforcement rather than relying exclusively on a single educational medium.

Overall, the present study contributes evidence that both video- and leaflet-based health education can produce substantial immediate improvements in pregnant women's knowledge and attitudes toward MMS consumption. The large within-group effect sizes indicate that structured education is a potentially important component of antenatal nutrition promotion. However, the absence of a significant between-group difference should be interpreted as evidence of similar observed short-term effects, not proof of equivalence. Future research should use larger samples, individual randomization, cluster-adjusted analyses where appropriate, repeated follow-

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up assessments, and objective adherence and clinical outcomes to determine whether improvements in knowledge and attitudes are sustained and ultimately translated into consistent MMS consumption and improved maternal and neonatal health outcomes.

V. CONCLUSION

This study aimed to evaluate and compare the effectiveness of video- and leaflet-based health education in enhancing knowledge and attitudes regarding Multiple Micronutrient Supplement (MMS) consumption among pregnant women. Conducting a quasi-experimental trial involving 60 pregnant women assigned to either a video group (n = 30) or a leaflet group (n = 30), both educational interventions demonstrated statistically significant within-group improvements across all evaluated metrics immediately post-intervention. Within the video group, knowledge median scores improved significantly from 5.00 (IQR: 3.25) to 9.00 (IQR: 1.00) ($Z = -4.806$, $p < 0.001$, $r = 0.88$), while attitude median scores increased from 25.00 (IQR: 19.50) to 37.50 (IQR: 11.25) ($Z = -4.706$, $p < 0.001$, $r = 0.86$). Correspondingly, the leaflet group exhibited comparable improvements, with knowledge median scores rising from 5.00 (IQR: 1.00) to 9.00 (IQR: 2.00) ($Z = -4.814$, $p < 0.001$, $r = 0.88$) and attitude median scores increasing from 19.50 (IQR: 10.50) to 38.50 (IQR: 11.25) ($Z = -4.704$, $p < 0.001$, $r = 0.86$). Between-group comparisons utilizing the Mann–Whitney U test revealed no statistically significant differences in post-intervention knowledge ($U = 330.500$, $Z = -1.888$, $p = 0.059$, $r = 0.24$) or attitude scores ($U = 404.500$, $Z = -0.681$, $p = 0.496$, $r = 0.09$). Hodges-Lehmann median differences further supported these findings, yielding 0.000 (95% CI: 0.000 to 1.000) for knowledge and 0.500 (95% CI: 2.000 to 2.000) for attitude. These results indicate that audiovisual and print media offer comparable short-term educational efficacy in primary care settings, allowing healthcare providers flexibility in media selection based on institutional resources and patient demographics. Future works should incorporate longitudinal follow-up periods with delayed post-tests to assess long-term retention, employ individual randomization to eliminate cluster design effects, and evaluate long-term compliance, maternal hemoglobin levels, and neonatal health outcomes.

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DATA AVAILABILITY

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request, subject to applicable ethical and confidentiality requirements.

AUTHOR CONTRIBUTION

C.A.D. contributed to the conceptualization, methodology, investigation, data collection, data curation, formal analysis, and preparation of the original manuscript. A.S. contributed to study supervision, methodological guidance, interpretation of the findings, and critical revision of the manuscript. N.U. contributed to the development and implementation of the educational intervention, data interpretation, and manuscript review. T.E.H. contributed to supervision, validation, interpretation of the results, and critical review of the manuscript. All authors reviewed and approved the final manuscript and agreed to be accountable for all aspects of the work.

DECLARATIONS

ETHICAL APPROVAL

Ethical Approval and Informed Consent

The authors declare that this manuscript is an original work and has not been published previously or submitted simultaneously to another journal. All authors have participated substantially in the research and preparation of the manuscript, have reviewed and approved the final version, and agree to be responsible for the integrity and accuracy of the work. The study was conducted following applicable ethical principles and received ethical approval from the Ethics Committee of Poltekkes Kemenkes Surabaya (EA/4427/KEPK-Poltekkes_Sby/V/2026). Written informed consent was obtained from all participants, and participant information was handled confidentially.

CONSENT FOR PUBLICATION PARTICIPANTS

Consent for publication was given by all participants

COMPETING INTERESTS

The authors declare no financial, professional, or personal relationships that could have influenced the design, conduct, analysis, or reporting of this research.

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