nutrición clínica y Dietética Hospitalaria

Artículo Original

Nutr Clín Diet Hosp. 2025; 45(4):415-425
DOI: 10.12873/454effendi

Improving anemia prevention behavior through the Anemia-Free Integrated Network Approach (AFRINA) among prospective brides in Bengkulu, Indonesia

Afrina MIZAWATI[1,2], Nursyirwan EFFENDI[3], Delmi SULASTRI[4], Rozi SASTRA PURNA[5]

1 Doctoral Program of Public Health, Faculty of Medicine, Andalas University, Padang, West Sumatera, Indonesia.
2 Department of Midwifery, Poltekkes Kemenkes Bengkulu, Bengkulu, Indonesia.
3 Department of Anthropology, Faculty of Social and Political Sciences, Andalas University, Padang, West Sumatera, Indonesia.
4 Department of Nutrition, Faculty of Medicine, Andalas University, Padang, West Sumatera, Indonesia.
5 Department of Psychology, Faculty of Medicine, Andalas University, Padang, West Sumatera, Indonesia.

Recibido: 23/octubre/2025. Aceptado: 5/diciembre/2025.

ABSTRACT

Introduction: Anemia remains a major public health issue among women of reproductive age in Indonesia, particularly prospective brides. Fragmented health education, limited family involvement, and weak intersectoral collaboration have reduced the effectiveness of prevention programs. The Anemia-Free Integrated Network Approach (AFRINA) was developed as an integrated model combining digital health education, family engagement, and cross-sector collaboration to strengthen anemia prevention behavior.

Objective: This study evaluated the effectiveness of the AFRINA model in improving preventive behavior, family support, and motivation among prospective brides in Bengkulu, Indonesia.

Method: A quasi-experimental pretest–posttest control group design with non-random assignment was used involving 74 prospective brides recruited from five district religious offices in Bengkulu City. Participants were allocated into an intervention group receiving the AFRINA digital educational program and a control group receiving standard counseling. Validated questionnaires measuring preventive behavior, family support, and motivation were administered before and after the intervention. Data were collected from June to August 2025 and analyzed using the Wilcoxon signed-rank test and Mann–Whitney U test, with a significance level of $p < 0.05$.

Results: The AFRINA intervention significantly increased preventive behavior (mean difference = 9.81; $p<0.001$), family support (8.57; $p<0.001$), and motivation (8.17; $p<0.001$) compared to the control group. The improvements were higher in the intervention group, showing the model's effectiveness in enhancing behavioral and psychosocial determinants of anemia prevention.

Conclusion: The AFRINA model, integrating digital communication, family engagement, and intersectoral collaboration, effectively improves preventive behavior, family support, and motivation among prospective brides. This model offers an innovative, scalable framework to strengthen premarital health programs and reduce anemia risk among women of reproductive age.

KEYWORDS

Premarital health, digital educational intervention, preventive behavior, quasi-experimental study, Mobile health, female reproductive health.

INTRODUCTION

Anemia among women of reproductive age remains a significant public health problem globally and in Indonesia. The World Health Organization (WHO) estimates that approximately 30% of women of childbearing age suffer from anemia, contributing to adverse maternal and fetal outcomes such as low birth weight, preterm birth, and maternal mortal-

Correspondencia:
Afrina Mizawati
2230322006_afrina@student.unand.ac.id

ity[1]. In Indonesia, national data indicate that more than one-third of women aged 15–49 years are anemic, largely due to nutritional inadequacy and suboptimal health behavior[2]. In Southeast Asia, Indonesia ranks among countries with high prevalence: 31.2% of women of childbearing age in Indonesia were reported anemic in 2019, one of the highest in the region[3].

Anemia reflects nutritional deficiency and affects physical endurance, cognitive performance, and overall well-being. It occurs when hemoglobin levels fall below 12 g/dL, primarily due to iron deficiency, which reduces oxygen-carrying capacity and results in fatigue, low productivity, and impaired reproductive outcomes[4]. Among women of reproductive age, anemia also contributes to pregnancy complications and long-term risks such as stunting and low birth weight[3,5].

Recent national surveys indicate that more than one-third of Indonesian women of reproductive age experience anemia, with nutritional and behavioral factors being major contributors[2].Premarital women, particularly those preparing for marriage, represent a vulnerable group because many enter pregnancy soon after marriage with poor iron status and limited awareness of anemia prevention[6]. Despite national programs such as *Gerakan Nasional Aksi Bergizi* and mandatory premarital health screening, preventive efforts remain fragmented and lack contextual education, family engagement, and cross-sector collaboration[7,8]. Compliance with iron supplementation is another persistent challenge. Studies in Indonesia have shown that low motivation, poor knowledge, and limited family support significantly reduce adherence to iron tablet consumption[9,10]. These behavioral, familial, and informational determinants must be addressed through an integrated and participatory approach to achieve sustainable prevention outcomes. Behavioral, familial, and informational factors have been shown to significantly influence adherence to anemia prevention practices among women of reproductive age.

The Anemia-Free Integrated Network Approach (AFRINA) was developed as an innovative model that integrates digital health education, family involvement, and multi-sector collaboration through an interactive mobile application and structured learning modules. AFRINA aims to strengthen anemia prevention by improving knowledge, building motivation, and enhancing family support to strengthen preventive behavior against anemia. The model emphasizes early screening, balanced nutrition, and sustained adherence to iron supplementation through accessible and engaging educational media.

Given the limited evidence on the effectiveness of integrated digital interventions targeting premarital women, this study was designed to evaluate the effect of the AFRINA model on improving preventive behavior, family support, and motivation among prospective brides in Bengkulu, Indonesia. The findings are expected to contribute to the development of a scalable framework for strengthening premarital health programs and reducing anemia prevalence among women of reproductive age[11].

METHODS

This study employed a quasi-experimental design with a pretest–posttest control group design with non-random assignment and was conducted from June to August 2025 in five district religious offices (*Kantor Urusan Agama*) in Bengkulu City, Indonesia. The study population consisted of women of reproductive age registered as prospective brides. The inclusion criteria were women aged 19–35 years, registered for premarital counseling, willing to participate throughout the study, and completing both pretest and posttest questionnaires. The exclusion criteria included individuals who withdrew during the study, became pregnant during the data collection period, had a history of severe anemia (Hb < 8 g/dL), or reported chronic medical conditions that could affect motivation, participation, or anemia-related behavioral outcomes.

The sample size was determined using the hypothesis test formula for the mean difference between two independent groups, with an additional 10% to anticipate dropouts, yielding a total of 74 respondents—37 in the intervention group and 37 in the control group. Participants were recruited purposively and each of the five KUA offices (Gading Cempaka, Teluk Segara, Sungai Serut, Ratu Agung, and Ratu Samban) contributed participants to both intervention and control groups, although allocation was not randomized, which may introduce selection bias."The intervention group received health education through the Anemia-Free Integrated Network Approach (AFRINA), a model integrating structured digital education, family engagement, and multisector collaboration. The AFRINA model consisted of three main components:

1. Digital education via the AFRINA mobile application, containing interactive materials on anemia prevention, nutrition, and reproductive health.
2. Family involvement through guided discussion modules encouraging family members particularly spouses and parents to support iron supplementation adherence and healthy dietary practices.
3. Cross-sector collaboration involving midwives, community leaders, and local health offices to facilitate counseling and monitoring.

The intervention was conducted over four weeks and included educational sessions and interactive follow-ups through the AFRINA platform. Participants received notifications, quizzes, and reminder messages to reinforce learning and behavioral commitment. In contrast, the control group received conventional premarital health counseling following standard Ministry of Health guidelines without the AFRINA program.

Data collection was conducted before and after the intervention using validated questionnaires measuring preventive behavior, family support, and motivation related to anemia prevention. Each instrument consisted of Likert-scale items, with higher scores indicating better outcomes. All instruments were validated through pilot testing prior to data collection.

Preventive behavior, family support, and motivation toward anemia prevention were measured using structured Likert-scale questionnaires developed based on premarital health guidelines and prior studies. All items used a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree), with higher scores indicating better outcomes. Content validation showed that all items were valid with an Item-Content Validity Index (I-CVI) of 1.00, and reliability testing demonstrated excellent internal consistency, with Cronbach's alpha values of 0.85 for preventive behavior, 0.91 for family support, and 0.95 for motivation.

The preventive behavior scale consisted of 10 items assessing screening practices, iron tablet adherence, and preventive commitment, with a total score range of 10–50. The family support and motivation scales each contained 10 items, measuring emotional, motivational, and instrumental support, as well as willingness and perceived importance of engaging in anemia prevention behaviors. Both scales had score ranges of 10–50, where higher scores indicated stronger family support or greater motivation toward anemia prevention.

Ethical approval for this study was obtained from the Ethics Committee of the Faculty of Medicine, Universitas Andalas (Ref. No. 468/UN.16.2/KEP-FK/2024). Written informed consent was obtained from all participants after providing a full explanation of the study objectives and procedures.

Data were processed through editing, coding, and verification to ensure accuracy and completeness. The Kolmogorov Smirnov test was used to assess data normality. Since data were not normally distributed, the Wilcoxon signed-rank test was used to compare pretest and posttest scores within each group, while the Mann Whitney U test was used to compare differences between intervention and control groups. A *p*-value <0.05 was considered statistically significant. All analyses were performed using SPSS version 21.0

Table 1. Characteristics of prospective brides in the intervention and control groups

Variables	Treatment (n=37)		Control (n=37)	
	Total	%	Total	%
Age (years)				
< 21 or > 35	4	10.8	3	8.1
21-35	33	89.2	34	91.9
Education				
Low education	1	2.7	1	2.7
Higher education	36	97.3	36	97.3
Occupation (Employed)				
Unemployed	11	29.7	10	27.0
Employed	26	70.3	27	73.0
Income				
< Regional Minimum Wage	15	40.5	11	29.7
≥ Regional Minimum Wage	22	59.5	26	70.3
Access to health services				
Difficult	3	10.8	31	83.8
Easy	33	89.2	6	16.2
Family history of anemia				
Yes	6	16.2	22	59.5
No	31	83.8	15	40.5
Exposure to anemia information				
Unexposure	17	45.9	22	52.7
Exposure	20	54.1	15	47.3

RESULTS

Characteristics of respondents

A total of 74 prospective brides participated in the study, divided equally into the intervention group (AFRINA model) and the control group (conventional education). Most respondents were aged 21–35 years (89.2% and 91.9%, respectively) and had higher education (97.3%). More than two-thirds were employed, and the majority had an income above the regional minimum wage. Access to health services was generally better among the intervention group (89.2%) than the control (16.2%). The proportion of respondents with a family history of anemia was higher in the control group (59.5%) than in the intervention group (16.2%), while exposure to anemia-related information was slightly higher among the intervention group (54.1%).

The results indicate that both groups were comparable in terms of socio-demographic characteristics, except for access to health services and family history of anemia, which were slightly higher in the control group.

Preventive behavior

Table 2 presents the comparison of mean preventive behavior scores before and after the intervention in both groups. In the intervention group, the mean score increased substantially from 37.30 (SD = 6.72) before the implementation of the AFRINA model to 47.11 (SD = 2.93) after the intervention. In contrast, the control group showed only a modest increase from 36.92 (SD = 8.70) to 39.43 (SD = 7.75) after receiving conventional counseling.

The description of the trend of changes in values before and after in the intervention group is as follows:

In addition to looking at the trend of anemia prevention behavior scores in the groups, we can also see the difference in delta values in the intervention and control groups in the figure 2.

The boxplot above shows that the intervention group had higher levels of preventative behavior than the control group. This indicates that the intervention can improve anemia-preventive behavior among prospective brides and grooms.

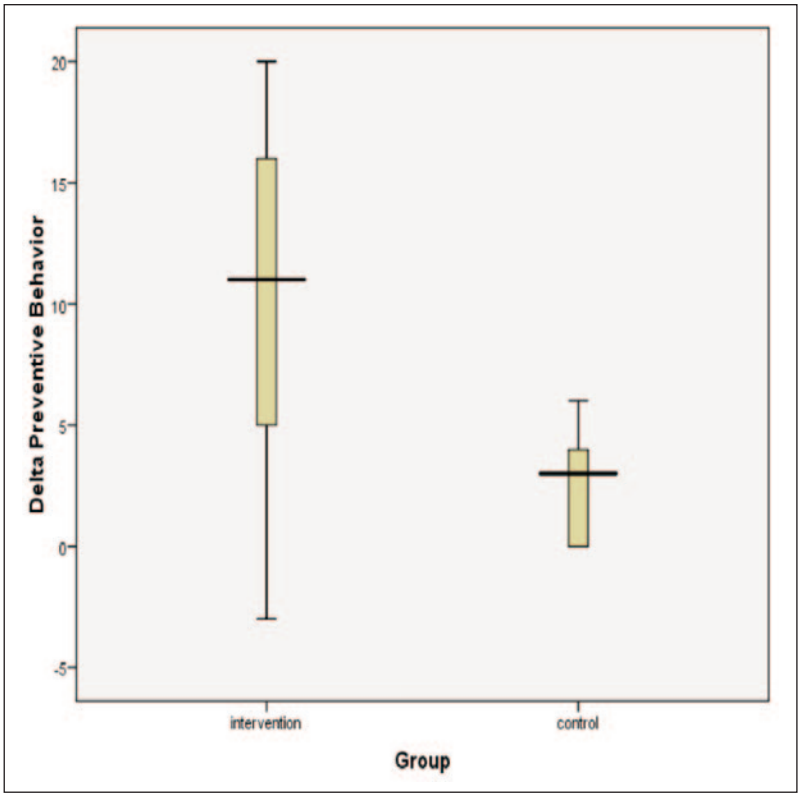

Figure 2. Comparison of preventive behavior scores between intervention and control groups

Table 2. Differences in preventive behavior scores before and after intervention

Variables	Treatment (n=37)			Control (n=37)		
	Min	Max	Mean ± SD	Min	Max	Mean ± SD
Preventive Behavior:						
Before Intervention	28	50	37.30 ± 6.72	22	50	36.92 ± 8.70
After intervention	40	50	47.11 ± 2.93	26	50	39.43 ± 7.75

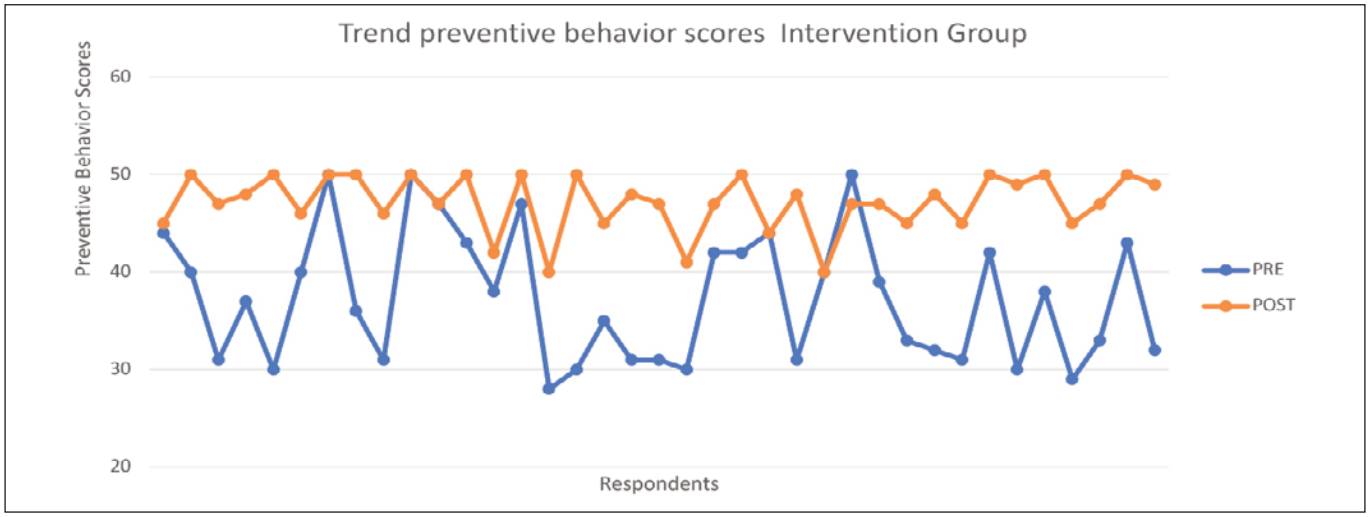

Figure 1. Trend of Preventive Behavior Scores in the Intervention Group

Family support

Table 3 shows the distribution of family support scores before and after the intervention in both groups. In the treatment group, the mean family support score increased from 38.81 ± 6.62 before the intervention to 47.38 ± 3.12 after receiving the AFRINA model intervention. Meanwhile, the control group showed a smaller improvement, with mean scores increasing from 38.41 ± 6.97 to 42.24 ± 6.46 after receiving conventional counseling.

Although both groups experienced increases, the post-intervention mean in the AFRINA group was higher and had a smaller standard deviation, indicating more consistent family engagement among participants.

The description of the trend of changes in values before and after in the intervention group is as follows:

In addition to looking at the trend of family support scores in the groups, we can also see the difference in delta values in the intervention and control groups in the figure 4.

The boxplot above shows that the intervention group had higher family support than the control group. This indicates that the intervention can increase the support of the bride and groom's families in preventing anemia.

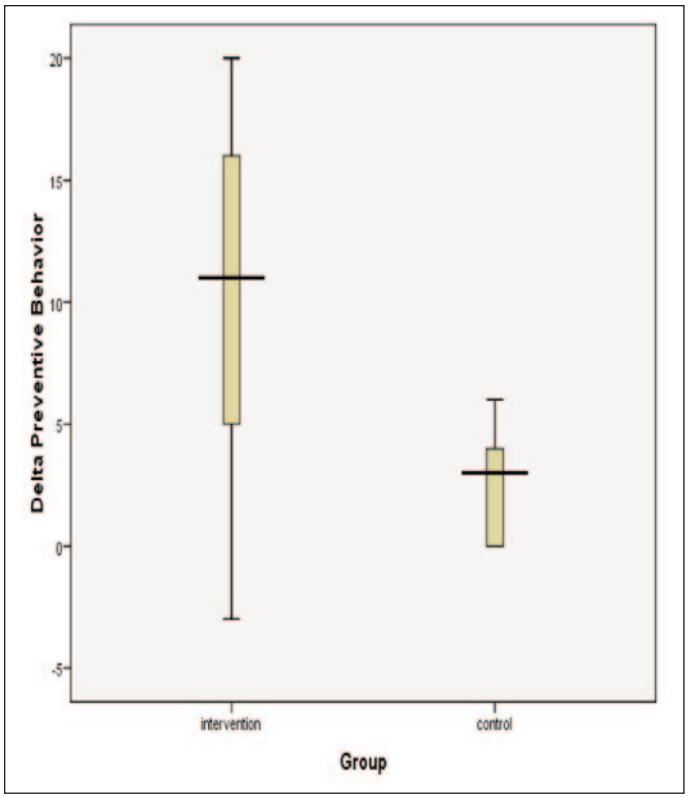

Figure 4. Comparison of Family Support Scores Between Groups

Table 3. Differences in family support scores before and after intervention

Variables	Treatment (n=37)			Control (n=37)		
	Min	Max	Mean ± SD	Min	Max	Mean ± SD
Family Support:						
Before Intervention	30	50	38.81 ± 6.62	26	50	38.41 ± 6.97
After intervention	40	50	47.38 ± 3.12	30	50	42.24 ± 6.46

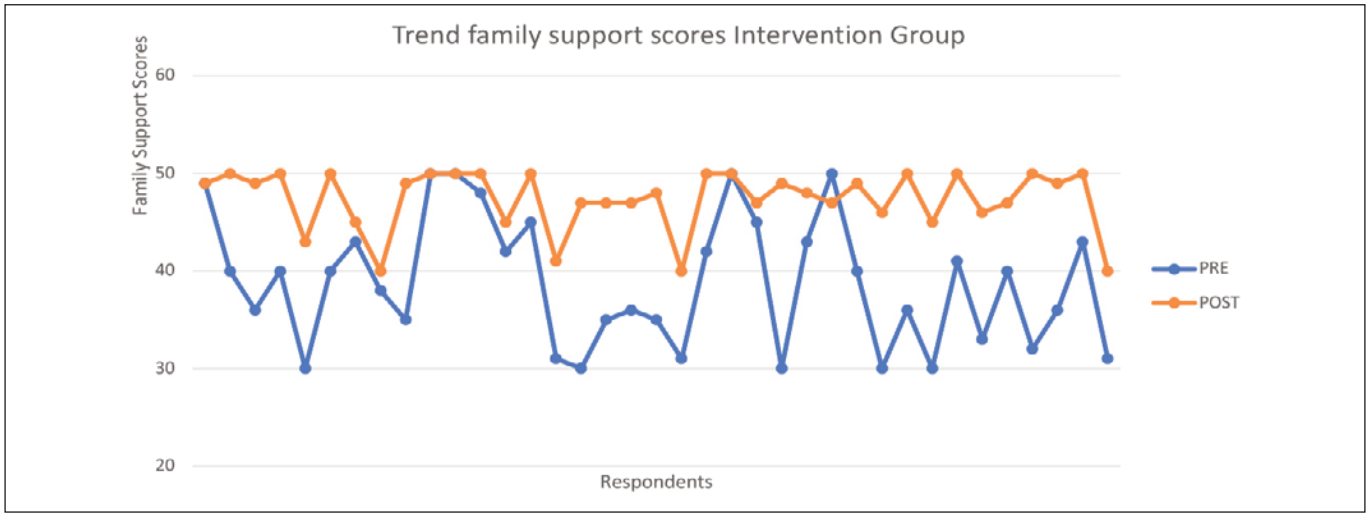

Figure 3. Trend of Family Support Scores in the Intervention Group

Motivation

Table 4 presents the mean motivation scores of prospective brides before and after the intervention in both groups. In the treatment group, the mean motivation score increased from 40.59 ± 5.70 before the intervention to 48.76 ± 2.08 after receiving the AFRINA model intervention. In contrast, the control group showed a relatively smaller improvement, with the mean score increasing from 34.16 ± 7.55 to 36.14 ± 7.15 after conventional counseling.

Although there was a slight increase, the mean score remained notably lower than that of the treatment group, reflecting that conventional education methods were less effective in motivating behavioral change.

The description of the trend of changes in values before and after in the intervention group is as follows:

In addition to looking at the trend of motivation scores in the groups, we can also see the difference in delta values in the intervention and control groups in the figure 6.

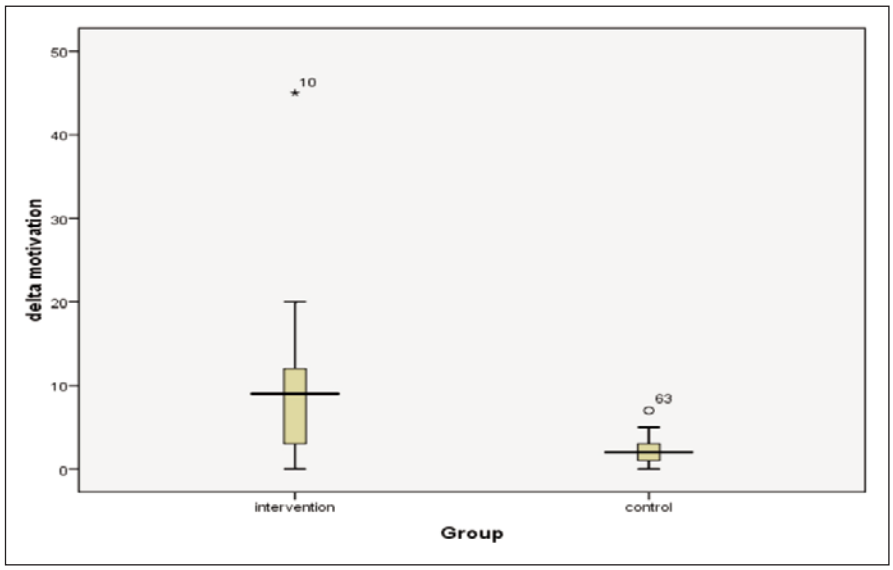

Figure 6. Comparison of Motivation Scores Between Groups

Table 4. Differences in motivation scores before and after intervention

Variables	Treatment (n=37)			Control (n=37)		
	Min	Max	Mean ± SD	Min	Max	Mean ± SD
Motivation:						
Before Intervention	30	50	40.59 ± 5.70	20	50	34.16 ± 7.55
After intervention	40	50	48.76 ± 2.08	22	50	36.14 ± 7.15

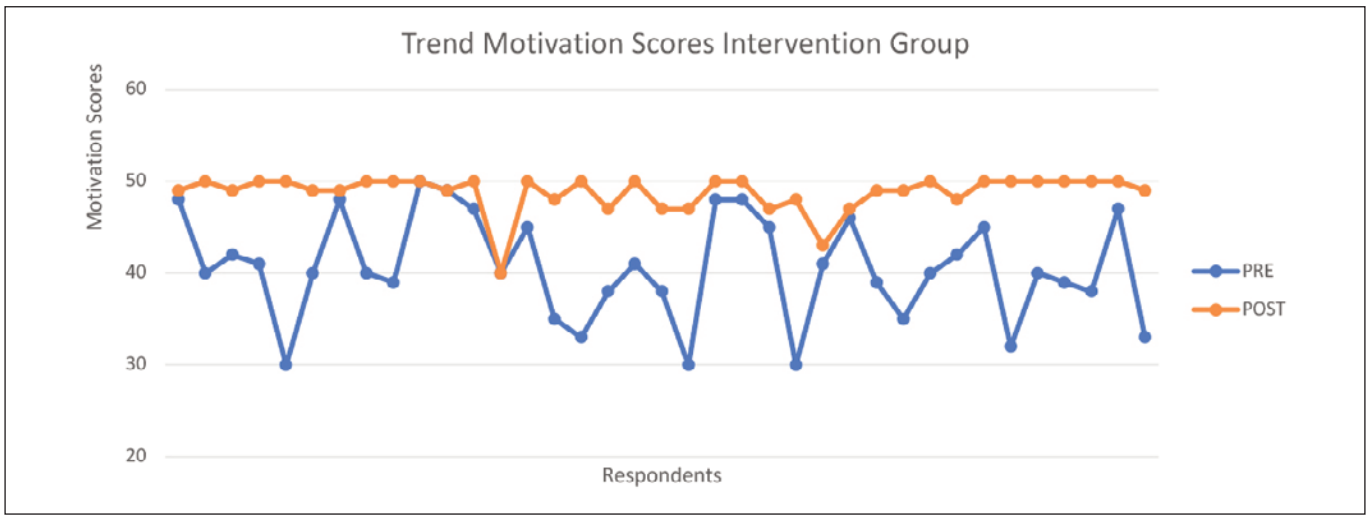

Figure 5. Trend of Motivation Scores in the Intervention Group

The boxplot above shows that the intervention group had higher motivation than the control group. This indicates that the intervention can increase the motivation of prospective brides and grooms to prevent anemia.

Bivariate

All three variables: preventive behavior, family support, and motivation showed statistically significant improvements after implementation of the AFRINA model ($p < 0.001$). The greatest improvement occurred in preventive behavior ($\Delta = 9.81$), followed by family support ($\Delta = 8.57$) and motivation ($\Delta = 8.17$).

These findings confirm the effectiveness of AFRINA in enhancing behavioral and psychosocial determinants of anemia prevention among prospective brides.

Conventional health education also resulted in modest but significant improvements in all three variables ($p < 0.05$). However, the magnitude of change was notably smaller than that observed in the AFRINA model group.

Comparison between AFRINA and conventional education

Further comparison using the Mann Whitney test showed that the AFRINA model was significantly more effective than conventional education across all outcome variables ($p < 0.001$), as shown in Table 7.

Comparative analysis clearly demonstrates that the **AFRINA model** had a significantly greater effect on all variables compared to conventional health education. The largest gain was observed in preventive behavior, followed by family support and motivation. These results affirm that AFRINA, which integrates structured education, family involvement, and cross-sector collaboration, is more effective in promoting anemia prevention behavior among prospective brides.

Table 5. Differences in preventive behavior, family support, and motivation before and after AFRINA model implementation

Variable	Group	*Mean*	Beda *Mean*	SD	Z	*P- Value*
Preventive Behavior	Before Intervention	37.30	9.81	6.995	-4.893	<0.001
	After Intervention	47.11		2.932		
Family Support	Before Intervention	38.81	8.57	7.009	-4.919	<0.001
	After Intervention	47.38		3.102		
Motivation	Before Intervention	40.59	8.17	6.077	-5.092	<0.001
	After Intervention	48.76		2.396		

* Wilcoxon test.

Table 6. Differences in Preventive Behavior, Family Support, and Motivation Before and After Conventional Health Education

Variable	Group	*Mean*	Beda *Mean*	SD	Z	*P- Value*
Preventive Behavior	Before Intervention	36.92	2.51	10.728	-4.565	<0.001
	After Intervention	39.43		5.132		
Family Support	Before Intervention	38.41	3.83	6.966	-4.955	<0.001
	After Intervention	42.24		6.633		
Motivation	Before Intervention	32.0	2.00	9.394	-4.916	<0.001
	After Intervention	34.0		4.684		

* Wilcoxon test.

Table 7. Comparison of mean score changes between AFRINA and conventional education groups

Variable	Group	*Mean*	*Median*	SD	*P- Value*
Preventive Behavior	Model AFRINA	9.81	11.00	6.591	<0.001
	Conventional	2.51	3.00	2.090	
Family Support	Model AFRINA	8.57	9.00	5.800	<0.001
	Conventional	3.84	4.00	2.328	
Motivation	Model AFRINA	9.38	9.00	8.301	<0.001
	Conventional	1.97	2.00	1.518	

* Mann whitney.

DISCUSSION

This study demonstrated that the Anemia-Free Integrated Network Approach (AFRINA) effectively improved preventive behavior, family support, and motivation among prospective brides in Bengkulu, Indonesia. The intervention group that received education through the AFRINA model showed a significantly higher increase in all outcome variables compared to those who received conventional education. These findings indicate that integrating digital health education, family engagement, and cross-sector collaboration provides a more comprehensive and sustainable strategy for anemia prevention among women of reproductive age[12].

The improvement in preventive behavior among participants reflects the central role of structured education and real-time digital communication in reinforcing health-promoting practices. Previous studies have emphasized that behavior change in anemia prevention is influenced not only by knowledge but also by accessibility of information and consistent reinforcement from health educators and family members[13]. The AFRINA model's use of interactive digital features—such as reminders, quizzes, and feedback—helped maintain participant engagement and adherence, consistent with findings from mobile health interventions that improve nutritional and reproductive health literacy[14,15].

Family support also increased significantly after the AFRINA intervention, highlighting the critical role of social and familial involvement in enhancing self-efficacy and adherence to preventive behaviors. In women's health programs, active participation of spouses and parents has been shown to strengthen motivation, emotional support, and compliance with recommended health practices[16]. The inclusion of spouses and parents through structured family modules facilitated emotional and instrumental support, improving adherence to iron supplementation, dietary modification, and health check participation. These findings are in agreement with studies showing that family-centered interventions enhance both motivation and behavioral outcomes in anemia prevention and maternal health[17].

Recent studies have demonstrated the effectiveness of preventive nutritional and behavioral interventions in reducing the risk of anemia. Weekly iron–folic acid (WIFA) supplementation has been shown to significantly improve knowledge and preventive behavior related to anemia, indicating that structured support and regular monitoring can enhance adherence and awareness[18].Video-based nutrition education also improved iron intake and dietary practices among young women, contributing to reduced anemia risk[19]. These findings support the results of the present study, emphasizing that prevention strategies integrating digital education, family engagement, and strengthened behavioral motivation—as implemented through the AFRINA model—can reinforce anemia prevention efforts among prospective brides.

In terms of motivation, the substantial increase observed in the AFRINA group highlights the importance of motivational components embedded in digital education and community interaction. Motivation, both intrinsic and extrinsic, is critical in sustaining preventive health behaviors. The AFRINA platform provided motivational content emphasizing the benefits of early anemia screening, consistent iron intake, and healthy dietary habits. These results are consistent with behavioral theories, including the Health Belief Model and Social Cognitive Theory, which underscore perceived benefits, cues to action, and social reinforcement as determinants of behavior change[20].

Compared with previous interventions that primarily relied on face-to-face counseling or supplementation programs, AFRINA offers an innovative and scalable framework that addresses the multi-level determinants of anemia. Its novelty lies in integrating technology-based education, family-centered engagement, and cross-sector coordination—elements rarely combined in conventional premarital health programs. By delivering messages through an accessible

digital platform, AFRINA reduces barriers related to distance, time, and access to health information, which are common challenges in community-based interventions. Digital health solutions have been shown to enhance healthcare access by overcoming geographical, economic, and infrastructural barriers, particularly in underserved populations[21].

The significant improvements in preventive behavior, family support, and motivation confirm the potential of AFRINA to serve as a complementary tool for existing national initiatives such as *Gerakan Nasional Aksi Bergizi* and premarital health screenings. Integrating AFRINA into routine counseling activities at religious offices (*Kantor Urusan Agama*) and community health centers could enhance outreach, especially among young women preparing for marriage and pregnancy[22].

However, this study has several limitations. First, the study period was relatively short, covering only three months, which may not fully capture long-term behavioral sustainability. Second, the self-reported nature of questionnaires may introduce response bias, particularly in motivation and family support measures. Third, although the AFRINA model incorporates digital accessibility, variations in participants' digital literacy may influence engagement levels. Future studies should consider longitudinal designs and incorporate objective behavioral indicators, such as actual iron tablet consumption and hemoglobin levels, to strengthen causal inference.

Despite these limitations, the findings of this study provide strong evidence that the AFRINA model can enhance behavioral and psychosocial determinants of anemia prevention among prospective brides. The integration of digital technology, family involvement, and sectoral collaboration provides a feasible and innovative direction for strengthening premarital and reproductive health programs in Indonesia.

IMPLICATIONS FOR PRACTICE AND POLICY

The findings of this study provide practical and policy-relevant evidence for strengthening anemia prevention efforts within Indonesia's premarital and reproductive health systems. The Anemia-Free Integrated Network Approach (AFRINA) demonstrated measurable improvements in preventive behavior, family support, and motivation; three key behavioral determinants often overlooked in conventional health education[23,24]. Previous qualitative research supporting the AFRINA framework revealed five major challenges in premarital anemia prevention, including limited exposure to anemia information, superficial understanding of anemia risks, inconsistent and weakly enforced screening policies, poor adherence to iron supplementation, and insufficient coordination and shared responsibility across health, religious, and community sectors. These findings informed the development of AFRINA as a structured model emphasizing systematic education, early detection and intervention, strengthened supplementation adherence, multisectoral collaboration, and coordinated referral mechanisms—elements that contribute to the effectiveness of the present intervention[25].

From a practical perspective, AFRINA offers an evidence-based and easily adaptable model that can be implemented within existing premarital health education frameworks managed by the *Ministry of Health* and the *Ministry of Religious Affairs*. Through its digital platform, AFRINA can reach a wider population of prospective brides, particularly those in rural or resource-limited areas, overcoming traditional barriers such as limited time, distance, and lack of health personnel[26]. Integration of the AFRINA application into premarital counseling at *Kantor Urusan Agama (KUA)* or *Puskesmas* could enhance early screening and reinforce iron supplementation adherence among women of reproductive age[27].

From a policy perspective, the results highlight the need for a shift from a purely biomedical approach toward a more integrated behavioral and social framework in anemia prevention. The AFRINA model can complement national initiatives such as *Gerakan Nasional Aksi Bergizi* and the *Program Kesehatan Reproduksi Remaja (KRR)* by embedding digital health education and family-centered engagement into policy implementation. Strengthening cross-sector partnerships between health institutions, education authorities, and local governments would further ensure that anemia prevention is addressed holistically across different life stages—from adolescence to pre-pregnancy[8].

In addition, adopting the AFRINA framework within the national health information system could improve data monitoring and decision-making related to anemia prevention. Policymakers can leverage the digital reporting features of AFRINA to identify gaps in service delivery and evaluate program effectiveness in real time.

Overall, AFRINA demonstrates how integrating digital innovation, behavioral change strategies, and family engagement can create a transformative approach to reducing anemia prevalence and promoting sustainable health outcomes for women of reproductive age.

CONCLUSION

The Anemia-Free Integrated Network Approach (AFRINA) effectively improved preventive behavior, family support, and motivation among prospective brides in Bengkulu, Indonesia. This integrated model, which combines digital health education, family engagement, and cross-sector collaboration, demonstrated greater effectiveness compared to conventional health education. The AFRINA framework provides an innovative, scalable, and sustainable strategy to strengthen premarital health programs and reduce anemia risk among women of reproductive age.

RECOMMENDATION

Integrating the AFRINA model into national premarital counseling programs and community health initiatives could enhance the reach and impact of anemia prevention efforts. Further longitudinal and multi-regional studies are recommended to assess long-term behavioral sustainability and scalability across diverse population settings.

ACKNOWLEDGEMENT

The authors would like to express their sincere appreciation to all participants and key informants who generously shared their time and insights during the data collection process. We gratefully acknowledge the enumerators who supported the fieldwork, and the Department of Midwifery, Poltekkes Kemenkes Bengkulu, for providing institutional support and granting study leave to the first author.

Our gratitude is also extended to the Bengkulu City Government and its respective offices for facilitating access to secondary data and allowing time and space for this research to be conducted. This article is part of the doctoral dissertation of Afrina Mizawati in the Doctoral Programme of Public Health, Faculty of Medicine, Universitas Andalas, Indonesia.

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