

Booklet and Whatsapp monitoring for iron supplementation: Adherence and hemoglobin among rural Indonesian girls

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ABSTRACT

Adolescent anemia remains a persistent public health problem despite widespread weekly iron supplementation, while evidence on integrated self-monitoring and digital adherence support in rural communities remains limited; this program evaluated a combined booklet and WhatsApp-based strategy. This community service program aimed to assess implementation of a TTD Monitoring Booklet integrated with a WhatsApp Group to support weekly iron supplementation adherence and improve hemoglobin status among adolescent girls in Dusun Bontopanno, Gowa Regency, Indonesia. A Community Development approach with a pretest-posttest design was implemented among 20 adolescent girls over 24 weeks. The intervention included anemia education, weekly tablet-consumption recording, WhatsApp reminders, motivational messages, interactive communication, and monitoring by facilitators and community health cadres. Adherence records showed that participants consumed 11–24 tablets during the intervention, with most consuming 17–23 tablets. Mean hemoglobin concentration increased from 11.83 ± 1.04 g/dL at baseline to 13.22 ± 0.90 g/dL after intervention ($p=0.003$). The proportion with hemoglobin <12.0 g/dL decreased from 45.0% to 5.0%. Integrating simple self-monitoring with accessible digital communication may provide a feasible, low-cost strategy for strengthening community-based weekly iron supplementation programs, particularly in rural and resource-limited settings.

ABSTRAK

Anemia pada remaja masih menjadi masalah kesehatan masyarakat yang persisten meskipun suplementasi zat besi mingguan telah diterapkan secara luas, sementara bukti mengenai integrasi pemantauan mandiri dan dukungan kepatuhan berbasis digital di komunitas perdesaan masih terbatas; program ini mengevaluasi strategi kombinasi buku pemantauan dan WhatsApp. Program pengabdian kepada masyarakat ini bertujuan untuk menilai penerapan Buku Pemantauan TTD yang terintegrasi dengan Grup WhatsApp guna mendukung kepatuhan konsumsi tablet tambah darah mingguan dan meningkatkan status hemoglobin pada remaja putri di Dusun Bontopanno, Kabupaten Gowa, Indonesia. Pendekatan Community Development dengan desain pretest-posttest diterapkan pada 20 remaja putri selama 24 minggu. Intervensi meliputi edukasi anemia, pencatatan konsumsi tablet mingguan, pengingat melalui WhatsApp, pesan motivasi, komunikasi interaktif, serta pemantauan oleh fasilitator dan kader kesehatan masyarakat. Catatan kepatuhan menunjukkan bahwa peserta mengonsumsi 11–24 tablet selama periode intervensi, dengan sebagian besar mengonsumsi 17–23 tablet. Rata-rata konsentrasi hemoglobin meningkat dari $11,83 \pm 1,04$ g/dL pada awal pengukuran menjadi $13,22 \pm 0,90$ g/dL setelah intervensi ($p=0,003$). Proporsi peserta dengan hemoglobin $<12,0$ g/dL menurun dari 45,0% menjadi 5,0%. Integrasi pemantauan mandiri yang sederhana dengan komunikasi digital yang mudah diakses dapat menjadi strategi yang layak dan berbiaya rendah untuk memperkuat program suplementasi zat besi mingguan berbasis komunitas, khususnya di wilayah perdesaan dan daerah dengan keterbatasan sumber daya.

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INTRODUCTION

Anemia remains one of the most common nutritional disorders among adolescent girls and continues to represent a major public health concern, particularly in low- and middle-income countries. Adolescence is a period of rapid physical growth accompanied by increased blood volume, the onset of menstruation, and higher iron requirements, all of which substantially increase the risk of iron deficiency anemia. The consequences extend beyond reduced hemoglobin levels and include impaired cognitive function, reduced physical capacity, poorer academic performance, and adverse reproductive outcomes later in life. Girls who enter pregnancy with inadequate iron stores are also more vulnerable to maternal anemia and unfavorable neonatal outcomes, thereby contributing to an intergenerational cycle of malnutrition. For these reasons, prevention of anemia among adolescent girls is closely aligned with the Sustainable Development Goals, the WHO Global Nutrition Targets, and broader maternal and child health strategies (WHO, 2016, 2024; Sari et al., 2022).

To address this burden, the World Health Organization recommends Weekly Iron and Folic Acid Supplementation (WIFAS) for menstruating adolescent girls in settings where anemia constitutes a public health problem. Indonesia has implemented this approach through the national *Tablet Tambah Darah* (TTD) program delivered through schools and primary healthcare services. However, persistent anemia among adolescent girls indicates that availability and distribution of iron tablets alone are insufficient. Previous studies have identified inadequate knowledge, misconceptions about iron supplementation, forgetfulness, fear of adverse effects, limited social support, and insufficient monitoring as major barriers to adherence (Silitonga et al., 2023; WHO, 2024; Yanisah & Widati, 2023). These findings indicate that improving program effectiveness requires not only commodity provision but also sustained behavioral support.

A key implementation problem in community-based iron supplementation programs is the absence of continuous mechanisms to monitor whether distributed tablets are actually consumed. Program performance may therefore be reflected more strongly by tablet distribution than by sustained adherence or biological outcomes. This gap is particularly relevant in rural communities, where follow-up resources may be limited and health workers cannot continuously supervise weekly tablet consumption. Digital health interventions offer a practical opportunity to overcome these limitations. The widespread use of smartphones among adolescents enables regular delivery of reminders, health information, and interactive support outside conventional health-service encounters. Systematic reviews have shown that mobile health interventions integrating reminders, self-monitoring, feedback, and social support can improve adherence and self-management, while Indonesian studies have also reported improvements in iron-folic acid supplementation adherence and hemoglobin concentrations following WhatsApp-based interventions (Eaton et al., 2024; Laurence et al., 2025; Septiana et al., 2025).

Self-monitoring represents an important behavioral strategy for improving adherence because documenting health behaviors can increase awareness, accountability, and self-regulation. Recording weekly iron tablet consumption may help adolescent girls recognize missed doses, reinforce routine formation, and increase personal responsibility for supplementation. When combined with reminder systems and supportive communication, self-monitoring may also strengthen self-efficacy and reduce forgetfulness. These mechanisms are particularly relevant among adolescents, whose health behaviors are strongly influenced by peer interaction, communication patterns, and digital engagement (Eaton et al., 2024; Laurence et al., 2025; Silitonga et al., 2023).

The integration of a monitoring booklet with WhatsApp-based communication therefore provides a theoretically and operationally appropriate intervention. The booklet functions as a structured self-monitoring tool, while the WhatsApp Group provides regular reminders, health education, reinforcement, and opportunities for interactive communication. This combined strategy may address both individual behavioral barriers and weaknesses in routine monitoring. Compared with one-time counseling or passive distribution of supplements, an integrated approach offers repeated contact and sustained reinforcement over the intervention period. Such a model is especially relevant for rural settings because it is relatively low-cost, requires limited additional

infrastructure, and can be incorporated into existing community and primary healthcare activities.

Community diagnosis conducted during the Community-Based Field Learning Program (*Pengalaman Belajar Lapangan*) in Dusun Bontopanno, Belabori Village, Parangloe District, Gowa Regency identified inadequate monitoring of weekly TTD consumption among adolescent girls as a priority public health problem. Although iron tablets were routinely distributed through existing health services, there was no structured mechanism for documenting consumption, providing regular reminders, or maintaining continuous communication between health workers and participants. This implementation gap may reduce the effectiveness of anemia prevention because successful distribution does not necessarily translate into regular consumption.

Although previous studies have demonstrated benefits from digital reminders or educational interventions, evidence remains limited regarding the integration of self-monitoring booklets with WhatsApp-based communication within routine community health services, particularly in rural areas. The novelty of this program lies in combining a TTD Monitoring Booklet and WhatsApp Group as complementary behavioral tools to strengthen adherence and monitor changes in hemoglobin status. Using a Community Development approach with a pretest-posttest design among 20 adolescent girls, the program integrated health education, weekly consumption recording, digital reminders, health messages, and interactive communication. Accordingly, this community service program aimed to evaluate the implementation of the integrated monitoring approach and assess changes in hemoglobin concentrations among adolescent girls in Dusun Bontopanno, Gowa Regency, Indonesia.

METHODS

Program Design and Setting

This community service program employed a Community Development approach with a pretest–posttest evaluation design. The approach emphasized active participation of adolescent girls, community leaders, village health cadres, and primary healthcare personnel throughout planning, implementation, monitoring, and evaluation. The program was conducted in Dusun Bontopanno, Belabori Village, Parangloe District, Gowa Regency, South Sulawesi, Indonesia, from October 2025 to April 2026. Prior to implementation, a community diagnosis was conducted to identify priority health problems. The Bryant priority-setting method was applied, and inadequate monitoring of weekly iron tablet consumption among adolescent girls was identified as one of the priority public health problems requiring intervention.

Participants and Recruitment

The target population consisted of adolescent girls residing in Dusun Bontopanno who were eligible to participate in the national Weekly Iron and Folic Acid Supplementation (WIFAS) program. A total of 20 adolescent girls participated in the intervention. Participants were recruited through collaboration with village authorities, community health cadres, and local community leaders. Eligible participants were adolescent girls residing in the program area, participating in weekly iron supplementation activities, willing to participate in the complete intervention, and able to undertake baseline and post-intervention assessments. Prior to implementation, advocacy and coordination meetings were conducted with relevant stakeholders to obtain community support, determine intervention schedules, and ensure alignment with existing adolescent health activities.

Intervention Procedures

The intervention was implemented over 24 consecutive weeks and integrated two complementary behavioral strategies: a TTD Monitoring Booklet and a WhatsApp Group. The booklet served as a self-monitoring tool in which participants recorded weekly iron tablet consumption. The WhatsApp Group functioned as a digital platform for weekly reminders, anemia-prevention education, motivational messages, and interactive communication between participants, facilitators, and community health cadres.

Implementation consisted of four stages. First, participants underwent orientation, registration,

baseline hemoglobin measurement, and health education covering anemia, the benefits of iron supplementation, potential side effects, and appropriate tablet-consumption practices. Second, participants received the TTD Monitoring Booklet and were instructed on how to document each weekly tablet consumed. Third, weekly monitoring was conducted for 24 weeks. During this period, reminder and educational messages were delivered through WhatsApp, while facilitators and cadres regularly reviewed monitoring records, provided feedback, and addressed barriers such as missed doses. Finally, post-intervention evaluation was performed through repeat hemoglobin measurement and review of completed monitoring booklets.

Hemoglobin Measurement

Hemoglobin concentration was assessed before and after the intervention using the HemoCue® Hb 201+ System (HemoCue AB, Ängelholm, Sweden). Capillary blood samples were collected by trained personnel according to the manufacturer's standard operating procedures. Hemoglobin values were expressed in grams per deciliter (g/dL). The portable analyzer enabled immediate quantitative hemoglobin assessment and was suitable for community-based field implementation.

Outcome Measures and Data Analysis

The primary outcome was adherence to weekly iron supplementation, measured by the total number of iron tablets consumed during the 24-week intervention based on records in the TTD Monitoring Booklet. The secondary outcome was change in hemoglobin concentration between baseline and post-intervention assessments. Descriptive statistics were used to summarize participant characteristics, tablet consumption, intervention participation, and hemoglobin status. Continuous data were presented using minimum, maximum, mean, and standard deviation, while categorical data were summarized as frequencies and percentages. Differences in hemoglobin concentrations before and after the intervention were analyzed using the Friedman test, with statistical significance established at $p < 0.05$. Findings were interpreted to assess the feasibility and effectiveness of integrating self-monitoring with WhatsApp-based behavioral support.

Ethical Considerations and Informed Consent

Participation was voluntary. Before the program commenced, participants and their parents or legal guardians received information regarding program objectives, procedures, measurements, confidentiality, and participation requirements. Written informed consent was obtained from all participants and their parents or legal guardians. Participant information and monitoring records were maintained confidentially and used solely for program evaluation and scientific reporting.

RESULTS AND DISCUSSION

Participant Characteristics

A total of 20 adolescent girls participated in the community service program and completed all intervention activities, resulting in a 100% retention rate. As presented in [Table 1](#), most participants were 12–15 years old (75.0%), while 25.0% were aged 16–19 years. All participants underwent baseline and follow-up hemoglobin measurements after completing the 24-week intervention program. with digital communication facilitated sustained participation throughout the intervention period.

Table 1
Characteristics of participants

Characteristics	n	%
Age (years)		
12–15	15	75
16–19	5	25
Completed intervention	20	100

Table 2

Distribution of Iron Tablet Consumption During the 24-Week Intervention by Educational Level

Number of Iron Tablets Consumed	Junior High School (n)	Senior High School (n)	Total n (%)
11	0	1	1 (5.0)
12	1	0	1 (5.0)
15	1	2	3 (15.0)
16	1	0	1 (5.0)
17	2	0	2 (10.0)
18	1	0	1 (5.0)
19	1	0	1 (5.0)
20	1	1	2 (10.0)
21	0	1	1 (5.0)
22	2	0	2 (10.0)
23	3	1	4 (20.0)
24	1	0	1 (5.0)
Total	14	6	20 (100.0)

Implementation of Community Service Activities

The community service program was implemented through an integrated strategy consisting of health education on anemia prevention, distribution of a TTD Monitoring Booklet, establishment of a WhatsApp Group for weekly reminders and communication, routine monitoring of iron tablet consumption, and hemoglobin assessments before and after the intervention. Community health cadres and facilitators provided continuous supervision throughout the 24-week intervention to encourage regular tablet consumption and maintain participant engagement. All participants completed the planned intervention activities and follow-up assessments.

Changes in Adherence to Iron Tablet Consumption

Adherence to weekly iron supplementation was evaluated using participants' TTD Monitoring Booklet records collected during the 24-week intervention. As shown in [Table 2](#), participants consumed between 11 and 24 iron tablets throughout the intervention period. The highest frequency of consumption was 23 tablets, achieved by four participants (20.0%), followed by 15 tablets consumed by three participants (15.0%). Two participants (10.0%) each consumed 17, 20, and 22 tablets, while the remaining consumption frequencies (11, 12, 16, 18, 19, 21, and 24 tablets) were each reported by one participant (5.0%).

Among participants with junior high school (SMP) education (n = 14), the highest frequency of consumption was 23 tablets (n = 3), followed by 17 tablets and 22 tablets (n = 2 each). Among participants with senior high school (SMA) education (n = 6), the highest frequency was 15 tablets (n = 2), whereas consumption of 11, 20, 21, and 23 tablets was each reported by one participant. Overall, most participants consumed 17–23 tablets, indicating good adherence to weekly iron supplementation throughout the intervention period.

Table 3

Distribution of Hemoglobin Status Before and After the Intervention

Hemoglobin Status	Hb I n (%)	Hb II n (%)
<12.0 g/dL	9 (45.0)	1 (5.0)
≥12.0 g/dL	11 (55.0)	19 (95.0)

Changes in Hemoglobin Levels

Hemoglobin assessment demonstrated a substantial improvement following the intervention. At baseline, 9 participants (45.0%) had hemoglobin concentrations below 12.0 g/dL, whereas 11

participants (55.0%) had normal hemoglobin concentrations (≥ 12.0 g/dL). Following the intervention, the number of participants with hemoglobin levels below 12.0 g/dL decreased to 1 participant (5.0%), while 19 participants (95.0%) achieved normal hemoglobin concentrations (see Table 3). These findings indicate a marked improvement in hemoglobin status after implementation of the TTD monitoring program.

Table 4

Comparison of Hemoglobin Concentrations Before and After the Intervention

Variable	n	Min	Max	Mean $\pm$ SD	p-value
Hb I	20	9.51	14.46	11.83 $\pm$ 1.04	0.003
Hb II	20	10.57	14.48	13.22 $\pm$ 0.90	

Further analysis demonstrated that the mean hemoglobin concentration increased from 11.83 $\pm$ 1.04 g/dL before the intervention to 13.22 $\pm$ 0.90 g/dL after the intervention. The minimum hemoglobin value increased from 9.51 g/dL to 10.57 g/dL, while the maximum value remained relatively stable (14.46 g/dL vs. 14.48 g/dL). Statistical analysis using the Friedman test revealed a statistically significant improvement in hemoglobin concentration following the intervention ($p = 0.003$) (see Table 4).

Overall, implementation of the community-based monitoring strategy integrating the TTD Monitoring Booklet and WhatsApp Group was associated with high participant adherence, a substantial reduction in the proportion of participants with anemia, and a significant increase in mean hemoglobin concentration. These findings suggest that combining self-monitoring with continuous digital communication is a feasible and effective strategy for supporting adherence to weekly iron supplementation and improving hemoglobin status among adolescent girls.

The present community-based intervention demonstrated that integrating a TTD Monitoring Booklet with a WhatsApp Group effectively improved hemoglobin status among adolescent girls in Dusun Bontopanno. Following the intervention, the prevalence of anemia (Hb < 12 g/dL) decreased from 45.0% to 5.0%, while the mean hemoglobin concentration increased significantly from 11.83 $\pm$ 1.04 g/dL to 13.22 $\pm$ 0.90 g/dL. These findings indicate that combining structured self-monitoring with continuous digital communication can substantially improve adherence to weekly iron supplementation and produce measurable improvements in hematological outcomes. Beyond providing iron tablets, interventions that actively encourage adolescents to adopt and maintain healthy behaviors appear to be essential for maximizing the effectiveness of anemia prevention programs.

The observed increase in hemoglobin concentration is consistent with evidence demonstrating that regular iron supplementation effectively improves iron status when adherence is maintained. A recent systematic review and meta-analysis reported that oral iron supplementation significantly reduced anemia and increased hemoglobin concentrations across different populations, emphasizing that intervention success depends not only on supplementation itself but also on adequate compliance with treatment schedules. Likewise, evidence among adolescents indicates that improved iron status contributes to better physical health, cognitive performance, and academic achievement, highlighting the broader public health benefits of successful anemia prevention programs (Zlotkin et al., 2023; Samson & Fischer, 2022).

Adherence represents one of the greatest challenges in implementing weekly iron supplementation programs among adolescents. Previous systematic reviews have consistently identified forgetfulness, limited knowledge, fear of side effects, inadequate supervision, and weak behavioral reinforcement as major barriers to regular tablet consumption. Conversely, interventions incorporating monitoring, supervision, and continuous follow-up demonstrate significantly higher adherence than routine tablet distribution alone. The monitoring booklet used in the present intervention likely addressed several of these barriers by encouraging participants to document weekly tablet consumption, thereby increasing accountability and reinforcing positive health behaviors (Silitonga et al., 2023; Feriyanti et al., 2022).

An important strength of this intervention was the incorporation of self-monitoring, which has been widely recognized as one of the most effective behavior change techniques. Self-monitoring enables individuals to evaluate their own progress, recognize missed doses, and establish consistent health-related routines. Digital and paper-based self-monitoring strategies have consistently been associated with improved adherence because they enhance self-regulation, personal responsibility, and motivation. Systematic reviews of digital health interventions further demonstrate that combining self-monitoring with personalized feedback and reminders produces stronger behavioral outcomes than educational interventions alone. Therefore, the monitoring booklet in this study functioned not only as a recording instrument but also as a practical behavior change tool that strengthened adherence throughout the intervention period (Aguar et al., 2022; Carpenter et al., 2022).

The addition of a WhatsApp Group further enhanced the intervention by providing regular reminders, continuous communication, and social support between participants and facilitators. Weekly reminders reduced forgetfulness, while interactive communication enabled participants to discuss tablet consumption, clarify misconceptions, and receive encouragement throughout the intervention. Mobile health platforms are particularly suitable for adolescent populations because they integrate health promotion into communication technologies already used in everyday life. Recent evidence from Indonesia demonstrated that WhatsApp-based reminders significantly improved adherence to weekly iron-folic acid supplementation and increased hemoglobin concentrations among adolescent girls. Similarly, broader reviews of mobile health interventions have shown that digital communication increases participant engagement, facilitates continuous behavioral reinforcement, and improves adherence to preventive health programs among adolescents and young adults (Laurence et al., 2025; Bond et al., 2022).

Health education also contributed substantially to the success of this intervention by improving participants' awareness regarding anemia prevention and the importance of regular iron supplementation. Educational interventions are known to increase knowledge, self-awareness, and motivation, thereby creating the foundation necessary for behavior change. However, evidence suggests that educational activities alone rarely produce sustained behavioral improvements unless accompanied by continuous monitoring and follow-up. Studies conducted among adolescent girls have demonstrated that combining educational media with behavioral reinforcement significantly improves compliance with iron tablet consumption compared with conventional health education alone. Community-based educational initiatives have similarly shown positive effects on adolescents' motivation and participation in anemia prevention activities (Septiana et al., 2025; Yanniarti et al., 2023).

The findings of this study can also be explained using the Health Belief Model, which proposes that preventive health behaviors are influenced by perceived susceptibility, perceived benefits, perceived barriers, self-efficacy, and cues to action. Educational sessions likely enhanced participants' understanding of anemia and the benefits of regular iron supplementation, while weekly WhatsApp reminders served as repeated external cues encouraging tablet consumption. Simultaneously, self-monitoring through the booklet strengthened self-efficacy by allowing participants to evaluate their own adherence and observe behavioral progress. Previous studies applying the Health Belief Model have similarly demonstrated that greater knowledge and positive health beliefs significantly improve preventive nutritional behaviors among adolescent girls, supporting the behavioral mechanisms observed in the present intervention (Verona et al., 2021; Aguair et al., 2022).

From a programmatic perspective, these findings have important implications for strengthening Indonesia's Weekly Iron and Folic Acid Supplementation (WIFAS) program. Current implementation primarily focuses on tablet distribution through schools and primary healthcare facilities, whereas systematic adherence monitoring remains inconsistent across many communities. The present intervention demonstrates that integrating a simple monitoring booklet with WhatsApp-based communication represents a feasible, low-cost, and scalable strategy that can easily be incorporated into routine adolescent health services without requiring sophisticated digital infrastructure. Such an approach may strengthen community participation, improve adherence, and

ultimately enhance the effectiveness of national anemia prevention efforts, particularly in rural and resource-limited settings (Feriayanti et al., 2022; Laurence et al., 2025).

Despite these encouraging findings, several limitations should be acknowledged. The intervention employed a pre-post design without a comparison group, limiting causal inference. The relatively small sample size and implementation within a single rural community may also restrict the generalizability of the findings to broader populations. In addition, adherence was primarily assessed through participant self-recording, which may be subject to reporting bias. Nevertheless, the inclusion of objective hemoglobin measurements provides robust evidence that the intervention produced measurable physiological improvements beyond self-reported behavioral outcomes. Future studies should employ randomized controlled or quasi-experimental designs involving larger populations and longer follow-up periods to determine the long-term sustainability of combining self-monitoring strategies with digital communication and to evaluate their integration into routine implementation of national adolescent anemia prevention programs.

CONCLUSION

The integration of a TTD Monitoring Booklet with a WhatsApp Group strengthened adherence to weekly iron supplementation and improved hemoglobin status among adolescent girls in Dusun Bontopanno. The intervention combined self-monitoring, continuous health education, digital reminders, and regular communication, thereby extending behavioral support beyond conventional tablet distribution. The marked reduction in participants with hemoglobin levels below 12.0 g/dL and the significant increase in mean hemoglobin concentration indicate meaningful physiological improvement following the program. These findings demonstrate that sustainable anemia prevention requires continuous adherence support and active participant engagement. Integrating simple monitoring tools with widely accessible digital communication platforms offers a practical, low-cost, and scalable strategy for strengthening the Weekly Iron and Folic Acid Supplementation program, particularly in rural and resource-limited settings. Future initiatives should involve schools, parents, teachers, and community health workers and should be evaluated through larger samples, longer follow-up, and assessment of sustainability, cost-effectiveness, and broader public health impact.

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AUTHORS' CONTRIBUTION

Sitti Raadhah supervised the community service program, contributed to the conceptualization of the study, provided methodological guidance, and critically reviewed the manuscript. Syamsul Alam conceptualized and designed the program, coordinated its implementation, analyzed and interpreted the data, and prepared the original manuscript. Nurfadila Nurfadila, Dwi Jayanti, Miftahul Jannah, Nurazizan Dirham, and Ananda Tiara Atthilah participated in data collection, health education activities, community intervention, monitoring, and data management. All authors contributed to manuscript revision, approved the final version, and agreed to be accountable for all aspects of the work.

COMPETING INTEREST

The author(s) declare no potential conflict of interest with respect to the research, authorship, or publication

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