Nutrition and Health Insights

**Literature Review**

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# The effectiveness of aoksigame cards in improving knowledge, attitudes, and practices of anemia among adolescent girls

## *Efektivitas kartu aoksigame dalam meningkatkan pengetahuan, sikap, dan praktik anemia di kalangan remaja perempuan*

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## Abstract

Anemia remains a public health problem among adolescent girls in Indonesia. A 2023 national survey reported that 15.5% of adolescents aged 15–24 years experience anemia. Knowledge and compliance with iron supplementation remain low, while conventional education methods are often perceived as less engaging by adolescents. This study aimed to evaluate the effectiveness of Aoksigame Card on improving adolescents' knowledge, attitudes, and practices in preventing anemia. A quasi-experimental study with a pretest-posttest control group design was conducted on 62 tenth-grade female students from two high schools in Yogyakarta, selected using simple random sampling. The intervention group received education using the Aoksigame Card, while the control group received PowerPoint slide education. Data on knowledge, attitudes, and practices were collected before and after the intervention using a validated and reliable questionnaire. Data were analyzed using SPSS with a significance level of p<0.05. The intervention group showed a significant improvement in knowledge (p=0.003), but not in attitudes (p=0.276) or practices (p=0.083). Intergroup comparison showed a significant difference in knowledge (p=0.017), but not in attitudes (p=0.956) or practices (p=0.232). Aoksigame Card is effective in increasing adolescents' knowledge of anemia.
**Keywords:** Anemia, adolescents, Aoksigame Card, knowledge, attitude, practice

## Abstrak

Anemia tetap menjadi masalah kesehatan masyarakat di kalangan remaja perempuan di Indonesia. Sebuah survei nasional tahun 2023 melaporkan bahwa 15,5% remaja berusia 15–24 tahun mengalami anemia. Pengetahuan dan kepatuhan terhadap suplementasi zat besi tetap rendah, sementara metode pendidikan konvensional sering dianggap kurang menarik oleh remaja. Penelitian ini bertujuan untuk mengevaluasi efektivitas Kartu Aoksigame dalam meningkatkan pengetahuan, sikap, dan praktik remaja dalam mencegah anemia. Studi kuasi-eksperimental dengan desain kelompok kontrol pretest-posttest dilakukan pada 62 siswi kelas sepuluh dari dua SMA di Yogyakarta, dipilih menggunakan simple random sampling. Kelompok intervensi menerima edukasi menggunakan Kartu Aoksigame, sedangkan kelompok kontrol mendapatkan edukasi slide PowerPoint. Data pengetahuan, sikap, dan praktik dikumpulkan sebelum dan sesudah intervensi menggunakan kuesioner yang divalidasi dan dapat diandalkan. Data dianalisis menggunakan SPSS dengan tingkat signifikansi p<0,05. Kelompok intervensi menunjukkan peningkatan pengetahuan yang signifikan (p=0,003), tetapi tidak dalam sikap (p=0,276) atau praktik (p=0,083). Perbandingan antarkelompok menunjukkan perbedaan pengetahuan yang signifikan (p=0,017), tetapi tidak dalam sikap (p=0,956) atau praktik (p=0,232). Kartu Aoksigame efektif dalam meningkatkan pengetahuan remaja tentang anemia.
**Kata kunci:** Anemia, remaja, Kartu Aoksigame, pengetahuan, sikap, praktik

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## Introduction

Calcium plays a fundamental role in the bone remodeling process, which is also influenced by nutrition, physical activity, estrogen, endogenous hormones, vitamin D, parathyroid hormone, tumor necrosis factor (TNF), and insulin-like growth factors I and II. Bone remodeling ceases and maintains its mass once linear growth and maximum bone volume are achieved. Bone mass is determined by the dynamic balance between bone formation and resorption processes.[1,2,3]

Bone tissue comprises three main cell types: osteoblasts, osteocytes, and osteoclasts. Osteoblasts are responsible for bone formation, mineralization, and parathyroid hormone receptor expression. Osteoclasts are multinucleated bone cells derived from hematopoietic precursors and contain lysosomal enzymes. Osteocytes, the most abundant bone cells, are small and flattened, embedded in the bone matrix, and responsible for translating mechanical stimuli into signals that induce remodeling aligned with mechanical load. Osteocytes are interconnected via canaliculi networks and undergo apoptosis or phagocytosis during osteoclastic resorption. Bone is composed of extracellular matrix and bone cells. The extracellular matrix consists primarily of organic components and a smaller portion of inorganic elements. The organic matrix includes type I collagen, proteoglycans, non-collagenous proteins (osteocalcin, osteonectin, osteopontin), thrombospondin, growth factors, and cytokines. The inorganic matrix primarily comprises calcium hydroxyapatite, which serves as a reservoir for calcium and phosphate ions.[4,5]

Osteoporosis is a systemic skeletal disorder characterized by low bone mass and microarchitectural deterioration, leading to bone fragility and increased fracture risk. It is most prevalent in the elderly. According to WHO, osteoporosis ranks among the top 10 global degenerative diseases. Contributing factors include aging, prior fracture history, family history of low bone mass, menopause, and prolonged corticosteroid use.[6,7] Calcium deficiency during bone growth is a major risk factor. Individuals with osteoporosis face a 18% higher total fracture risk and 43% pelvic fracture, adversely affecting mobility and quality of life.[8]

Calcium, a micronutrient, is essential in small amounts for human health. It contributes to hormone and enzyme synthesis involved in metabolism and digestion. Preventing osteoporosis involves adequate calcium intake throughout life, regular physical activity, non-smoking habits, and hormonal balance. Calcium's direct role strengthens bone growth via absorption, while indirectly preventing rickets due to vitamin D deficiency or calcium-phosphorus imbalance that disrupts bone mineralization. Achieving peak bone mass during growth phases is vital to preventing bone loss in adulthood.[8,9] Adequate calcium intake is essential for building optimal bone mass in the first three decades of life. In infants, children, and adolescents, calcium supports bone formation alongside dietary intake and protein sufficiency. Evidence shows that adult and elderly bone loss is influenced by peak bone mass achieved in earlier life stages.[10] Therefore, high calcium intake during growth is critical. Calcium-rich foods and proteins are necessary to achieve optimal peak bone mass and prevent osteoporosis. Dairy products, particularly milk, are the most common calcium sources consumed by the elderly. They are widely believed to reduce osteoporosis risk. This review aims to examine the benefits of consuming milk and dairy products in preventing osteoporosis among older adults.

## Methods

### Design and setting
This study was a quasi experimental research with a pretest-posttest control group design. The researchers used a quasi-experimental design as it was appropriate to evaluate the impact of interventions in real-school contexts, with limited control over external variables while maintaining internal validity. The research was carried out in February 2025 for three weeks in two different locations: SMAN 7 Yogyakarta school served as the experimental group, and SMAN 5 Yogyakarta served as the control group. The researchers chose the location based on data on the highest prevalence of anemia among high school students in Yogyakarta City, as well as the readiness of the institution to support the implementation of educational interventions for three weeks.

### Sampling
The population in this study consisted of all class X students in both schools. The sample included 62 individuals, with 31 respondents in the experimental group and 31 in the control group, who were selected using a simple random sampling technique. The researchers calculated the required sample size using Lemeshow's formula for two independent groups, referring to the research Nanik et al., 2021[14] with an increase in knowledge of 12.02 so that a minimum sample of 28 respondents per group. The sample calculation can be seen as follows:

$$n1 = n2 = \frac{2\sigma^2 (Z_{1-\frac{\alpha}{2}} + Z_{1-\beta})^2}{(\mu_1 - \mu_2)^2}$$

$$n1 = n2 = \frac{2 \times 144.49 (5+95)^2}{(12.02)^2} =$$

$$n1 = n2 = 28$$

The inclusion criteria included class X students who were willing to take part in the entire series of research activities and filled out a complete questionnaire. The exclusion criteria were students who were absent during the intervention or did not complete the instrument. The sample selection procedure was detailed in Figure 1.
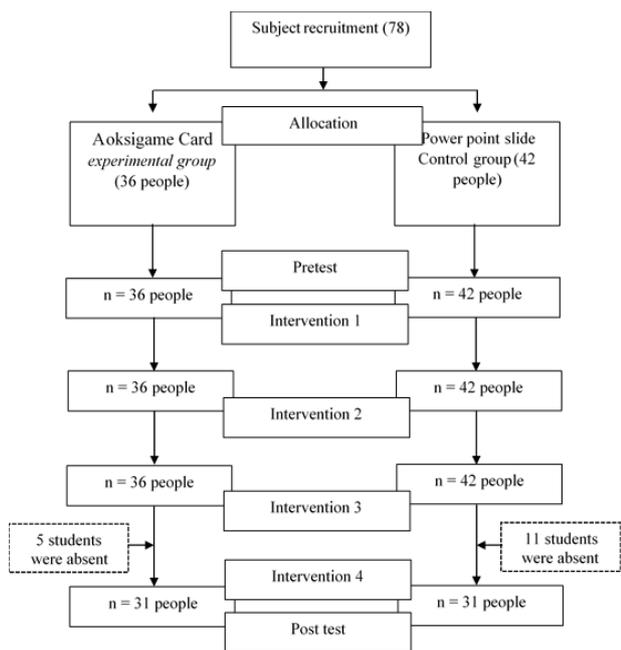


**Figure 1.** Research Consort Diagram

**Variables and data collection**
The independent variables were the intervention using Aoksigame cards and PowerPoint slides. Before being used as an instrument in research, Aoksigame cards were first tested based on assessment indicators that included aspects of appearance and material quality. In this process, two experts were involved as material evaluators: a nutritionist in the field of clinical nutrition and a high school teacher, along with two experts in graphic design who evaluated the display of Aoksigame cards. Based on the results of the assessment of the display aspect from the experts, a score of 3.9 was obtained. When compared to the cutoff of the assessment of the display aspect, which was 3, Aoksigame cards were included in the very good category. For the material aspect, it received a score of 3.8, also within the very good category, leading to the conclusion that Aoksigame cards were suitable for use as an educational medium.

The dependent variables included knowledge, attitudes, and practices about preventing anemia. Data on knowledge, attitudes, and practices regarding preventing anemia were collected using structured questionnaires developed by Putri, which had gone through validity and reliability tests (r=0.73 and r=0.86, respectively). Filling out the questionnaire was carried out in a structured manner and supervised directly by researchers in the classroom. Incomplete questionnaires (with more than 10% of blank items) were eliminated from the final analysis.

**Intervention**
The research procedure in both groups was carried out over 3 weeks. In the 1st week, the experimental group participated in a pretest, followed by education using PowerPoint slides, which ended with playing games using Aoksigame Cards, as seen in Figure 3. The game was conducted in small groups of 4-6 students and lasted for 30 minutes. In week 2, the intervention continued offline using Aoksigame Cards, and in week 3, the final intervention took place using Aoksigame Cards, followed by posttest data collection. Meanwhile, in the control group, week 1 involved pretest and educational activities using PowerPoint slides. In week 2, the intervention was continued through a WhatsApp group, which included delivering materials and discussions. In week 3, the online intervention continued, and post-test data collection was conducted. The flow of the intervention was illustrated in Figure 2.
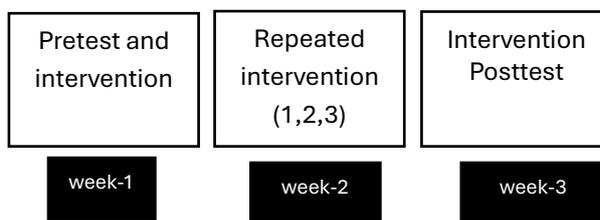


**Figure 2.** Intervention flow

**Instruments**
Data on knowledge, attitudes, and practices about preventing anemia were collected using structured questionnaires developed by Putri (14), which had undergone validity and reliability tests (r=0.73 and r=0.86, respectively).

The Aoksigame Card consisted of 35 cards with two main categories: knowledge questions and healthy action challenges. Each card was designed based on the principles of visual and interactive education that were relevant to the teenage age. The shape of the sample of the Aoksigame card could be seen in Figure 3.

**Analysis**
The primary data collected by this researcher was analyzed using SPSS, focusing on univariate analysis stages related to respondent characteristics, descriptive statistics, and variable distribution. The normality of the data was assessed using the Shapiro-Wilk test (applicable for n<50). For bivariate analysis of the pre-posttest differences in the knowledge

variable, the Wilcoxon test was employed given the non-normal distribution of the data. Conversely, for the attitude variable, a paired sample t-test was utilized as the data met normality assumptions. In the experimental group, the behavior variable was analyzed using a paired sample t-test, while the control group was assessed with the Wilcoxon test. To compare pre-posttest differences between groups for the knowledge variable, the Mann-Whitney U test was applied due to non-normal distribution, whereas the attitude and behavior variables were analyzed using the Independent Sample t-test, as those datasets were normally distributed. To evaluate the effectiveness of the Aoksigame Card, the mean difference test for the pre-posttests of knowledge, attitude, and behavior was conducted. This Research was approved by The Health Research Ethics Committee of the Health Polytechnic of the Ministry of Health of Yogyakarta No.DP.04.03/e-KEPK.1/053/2025. Informed Consent was signed by the respondent's parents.

| | | | |
|---|---|---|---|
| Truth card | APA SAJA SUMBER MAKANAN PROTEIN HEWANI YANG MENGANDUNG ZAT BESI? | PERILAKU SEPERTI APA YANG DAPAT MENGHAMBAT PENYERAPAN ZAT BESI DALAM TUBUH? | ANEMIA PADA REMAJA PUTRI DAPAR DICEGAH DENGAN CARA? |
| Dare card | SAYA AKAN MENAMBAHKAN SAYURAN SUMBER VITAMIN C SEPERTI BROKOLI, BAYAM, TOMAT, KANGKUNG KEDALAM MENU MAKAN SAYA SETIAP HARINYA | SAYA AKAN RAJIN MINUM TTD 1 TABLET SEMINGGU SEKALI | SAYA AKAN RAJIN MENGKONSUMSI MAKANAN SUMBER ZAT BESI SEPERTI HATI AYAM/DAGING MERAH MINIMAL 3X/MINGGU |

**Figure 3.** Aoksigame Card

## Result And Discussion

### Characteristics of respondents

This study involved grade 10 students from two public high schools in Yogyakarta, specifically SMAN 7 Yogyakarta, which served as the experimental group, and SMAN 5 Yogyakarta, which acted as the control group. The demographic characteristics of the respondents were presented in Table 1.

The characteristics of the respondents in this study showed that the majority of respondents were 16 years old, with a percentage of 87.1% in the experimental group and 74.2% in the control group. A small proportion of respondents were 15 years old (12.9% of the experiment; 16.1% of the controls) and 17 years of age (0% of the experiments; 9.7% of the controls).

The homogeneity test indicated no significant difference in age distribution between the two groups (p=0.792). Additionally, most of the respondents had received anemia education (93.54%), experienced signs and symptoms of anemia (41.93%), and prevented anemia (93.54%). Based on the results of the data homogeneity test, there was no significant difference between the experimental group and the control group (p>0.05).

**Table 1.** Characteristic of Respondent

| Characteristics | Experiment | | Control | | Total | | p-value |
|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | |
| Age | | | | | | | |
| 15 year | 4 | 12.9 | 5 | 16.1 | 9 | 14.5 | .792*a |
| 16 year | 27 | 87.1 | 23 | 74.2 | 50 | 80.6 | |
| 17 year | 0 | 0 | 3 | 9.7 | 3 | 4.8 | |
| Have received education related to anemia | | | | | | | |
| Ya | 28 | 90.32 | 30 | 96.77 | 58 | 93.54 | .301*a |

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|  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|
| No | 3 | 9.67 | 1 | 3.22 | 4 | 6.45 | |
| Have felt signs and symptoms of anemia | | | | | | | |
| Ya | 15 | 48.38 | 11 | 35.48 | 26 | 41.93 | .303*a |
| No | 16 | 51.61 | 20 | 64.51 | 36 | 58.06 | |
| Have done anemia prevention | | | | | | | |
| Ya | 29 | 93,54 | 29 | 93,54 | 58 | 93,54 | 1.000*a |
| No | 2 | 6,45 | 2 | 6,45 | 4 | 6.45 | |

The homogeneity of respondent characteristics, particularly age and educational background, was an important factor in the experimental research to minimize bias.[15] These results suggested that the two groups had a balanced baseline, so differences in intervention outcomes might have been more likely caused by treatment, an open demographic variable. The high percentage of respondents who had received anemia education aligned with the theory of the health belief model, where prior knowledge could influence the response to health interventions.

Similar findings were reported in studies on adolescent anemia education, where the control and experimental groups had homogeneous ages and early knowledge characteristics. However, those studies included respondents with a wider age range (15-18 years), leading to more varied impacts from the intervention.[16] Another study found that respondents with an educational history of anemia tended to be more responsive to interventions, although in their studies this did not significantly affect attitudes and behavioral outcomes.[17] The homogeneity of the characteristics of the respondents in this study strengthened the internal validity, particularly in testing the effect of the Aoksigame Card. However, the predominance of respondents being 16 years old and the high percentage of those with prior knowledge of anemia possibly limited generalizations to populations with different characteristics.

**The relationship between the timing of measurements and study outcomes across various intervention groups**

Changes in knowledge, attitudes, and practice before and after in the group are listed in Table 2.

**Table 2.** The relationship between the timing of measurements and study outcomes across various intervention groups.

| Variabel | To the | Post-tests | Pre-test vs post-test | |
|---|---|---|---|---|
|  | Average ± SD | | Δmeans | p-value |
| Experiment | | | | |
| Knowledge | 87.42±7.28 | 94.84±4.91 | 8.23 | 0.000** |
| Attitude | 69.19±8.34 | 67.48±6.93 | 6.35 | 0.273*** |
| Practing | 67.19±16.14 | 78.03±19.57 | 17.26 | 0.001*** |
| Control | | | | |
| Knowledge | 95.32±6.31 | 94.52±4.53 | 4.84 | 0.467** |
| Attitude | 66.29±6.68 | 67.39±6.74 | 4.90 | 0.318*** |
| Practing | 79.97±18.16 | 83.68±17.19 | 22.16 | 0.515** |

Table 2 demonstrated that interventions using Aoksigame Card were significantly successful in increasing adolescents' knowledge of anemia. The experimental group's average knowledge score increased significantly from a pre-intervention score of 87.42 to 94.84 after the intervention (Δ=8.23; p=0.000). Meanwhile, in the control group that only received education through PowerPoint slides, the increase did not signify much and tended to decrease from 95.32 before the intervention to 94.52 after the intervention, and it was statistically proven that the results were not significant (p=0.467). In the attitude variable, the results indicated that there was no significant improvement in attitude in both the experimental and control groups. In the experimental group that received the intervention using Aoksigame Card, the average attitude score increased from 69.19 to 67.48 but was not statistically significant (p=0.273). Similarly, in the control group that received education through PowerPoint slides, the increase from 66.29 to 67.39 also showed no significant difference (p=0.318). The results showed that there was a significant difference in behavior change in the experimental group using Aoksigame Card (p=0.001), with an increase in score from 67.19 to 78.03 (Δmean = 17.26). Meanwhile, in the control group using PowerPoint slides, there was no significant difference (p=0.515), although there was an increase in scores from 79.97 to 83.26 (average delta 22.16).

**The association between the intervention and study outcomes across different research teams**

Differences in knowledge, attitudes, and practing between groups are listed in Table 3. The difference in knowledge improvement between the

two groups listed in Table 3 showed that the experimental group was larger than the control group with statistically significant results (p>0.05). The use of Aoksigame Card was shown to be more effective in increasing the knowledge of the experimental group compared to the control group, which only used PowerPoint slides. This result aligned with the concept of the cone of experience from Edgar Dale, which stated that the more actively a person was involved in the learning process, the higher the absorption of information.

Aoksigame Card was interactive and combined visual, writing, and interactive elements that created a fun and meaningful learning process, thus strengthening cognitive learning outcomes. This research supported the findings of Du et al. who stated that game-based health education could significantly improve adolescents' knowledge[19]. A similar study by Dodd et al. also showed that participatory learning media tended to result in more

significant knowledge changes compared to one-way methods. Looking at the results obtained, the researcher believed that the use of Aoksigame Card was not only relevant but also promising as a more contextual and attractive educational approach for adolescents. In the context of health education, especially about anemia, which was often considered a simple issue by adolescents, conventional approaches such as lectures or PowerPoint presentations tended to be less able to arouse the interest and active involvement of participants. Aoksigame Card provided a more fun, competitive, and applicative learning experience. The significant increase in knowledge in the experimental group was evidence that educational methods needed to adapt to the development of modern learning styles. The advantages of Aoksigame Card as a tangible game-based educational media combined cognitive, affective, and even motor aspects simultaneously.

**Table 3.** The association between the intervention and study outcomes across different research teams

| Variabel | Experiment | Control | Delta | p-value |
|---|---|---|---|---|
| | Mean | | | |
| Knowledge | 8.23 | 4.84 | 3.39 | 0.016** |
| Attitude | 6.35 | 4.90 | 1.45 | 0.216*** |
| Practing | 17.26 | 22.16 | 4.9 | 0.216*** |

Differences in attitude improvement delta in Table 3, when compared between groups, also showed that the difference was not significant (p=0.216). This suggested that the educational interventions provided were not effective in influencing changes in adolescents' attitudes towards anemia prevention. This phenomenon could be explained through pre-proceed theory, a model of health program planning that explained that changes in attitudes were not only influenced by education but also by predisposing factors formed from individual beliefs, values, and perceptions. The interventions provided needed to consider the psychosocial context of the respondents, where the delivery of information that touched on the emotional and social dimensions was very necessary. These results aligned with Nurhidayah's[17] findings, which showed that increasing knowledge through education was not always followed by a change in attitude if it was not accompanied by a strategy that touched on the affective aspect of the respondents. Research conducted by Abdi and Simbar in 2023 also explained that information-based interventions tended to increase knowledge, but to change attitudes, additional strategies such as role-playing, group discussions, or reinforcement from the peer environment were needed. This suggested that attitudes were more complex and required a more in-depth approach than just one-way or one-sided education[20].

The researcher assessed that the characteristics of the respondents also affected the outcome of the intervention, especially in terms of attitudes. The majority of respondents were 16 years old, an age where attitudes were still strongly influenced by the social environment and were not yet fully stable. In addition, most of the respondents had also been educated about anemia, so the interventions given might not have been different or provocative enough to change pre-formed attitudes. Although Aoksigame Card was interactive, a one-time approach without social or emotional reinforcement tended to be less effective in shaping attitudes. Therefore, researchers suggested that future education should be adjusted to the age, knowledge background, and learning style of adolescents and be carried out gradually while involving elements of discussion or peer support.

However, the duration of the intervention was relatively short (3 weeks), so it was not enough to form a new habit. In addition, the context factor of peer influence and the limitations of group discussion sessions reduced the impact on daily attitudes and practice. Other results related to behavioral variables in this study showed that there was an increase in behavioral scores, as listed in Table 2, from 79.97 to 83.26 (average delta 22.16). However, when comparing the changes in behavior between groups in Table 3, there was no statistically significant

difference (p=0.216) between the experimental group and the control group.

Behavioral changes resulted from complex interactions between dispositions, driving factors, and reinforcing factors. In this study, Aoksigame Card played a role as a predisposing factor that could increase adolescents' motivation and involvement in learning about anemia. However, without simultaneous supporting and reinforcing factors, pre-formed practices were more difficult to change consistently. Therefore, the behavioral changes that occurred in the experimental group were still not significantly different compared to the control group.

The results of this study aligned with the research conducted by Ghadam.et.al [21], which evaluated the influence of digital game-based nutrition education to initiate behavioral changes in adolescents who were easily receptive to new technology, supporting the findings of this study that showed the effectiveness of Aoksigame Card in improving anemia prevention behavior. However, the results of this study did not align with other studies on the effects of Precede-based education on iron deficiency anemia in female students, which suggested that nutrition education interventions had a positive effect in improving iron deficiency anemia prevention practices in female students and that there were significant differences between groups[22]. The average increase in final behavior scores in the control group was higher compared to the experimental group, which might have been due to

higher levels of active participation in the control group during the intervention. Observations during the material delivery process showed that respondents in the control group were more enthusiastic in asking questions and providing feedback compared to the experimental group; the interactive activities allowed them to act as intrinsic reinforcement that strengthened the respondents' understanding and engagement, thus supporting more meaningful behavior improvements in the control group. Therefore, the effectiveness of educational media was not only determined by the form and method of delivery but also depended on the dynamics of participant involvement in the learning process.

**Impact of interventions on knowledge and attitudes**

The Impact of interventions seen from the delta pretest minus the post test is listed in Table 4.

Based on Table 4, the results of the study showed that Aoksigame Card was significantly more effective in increasing knowledge about anemia in adolescents compared to PowerPoint slides. However, for attitude and behavior variables, there was no significant difference in effectiveness between the two media. These findings indicated that Aoksigame Card had a particular advantage in the cognitive aspect of learning but did not demonstrate consistent excellence in all domains of health learning.

**Table 4**. Impact of interventions on knowledge and attitudes

| Variabel | Pretest | Postest | Delta | p-value |
|---|---|---|---|---|
| Knowledge | | | | |
| Aoksigame Card | 87.42 | 94.84 | 8.23 | .016* |
| Power Point Slide | 95.32 | 94.52 | 4.84 | |
| Attitude | | | | |
| Aoksigame Card | 69.19 | 67.48 | 6.35 | .216** |
| Power Point Slide | 66.29 | 67.39 | 4.90 | |
| Practing | | | | |
| Aoksigame Card | 79.97 | 83.68 | 22.16 | .142* |
| Power Point Slide | 67.19 | 78.03 | 17.26 | |

According to the Precede-Proceed theory, knowledge was one of the main predisposing factors that facilitated changes in health behavior. Game-based educational media acted as a supporting factor that created a conducive learning environment through an interactive and fun approach. The Precede-Proceed theory emphasized that the effectiveness of the intervention depended on the extent to which the media could comprehensively influence the determinants of behavior. Aoksigame Card successfully optimized the educational diagnosis component in the Precede phase, where the identification of learning needs and target

preferences of respondents was accommodated through a game approach.

The latest meta-analysis study showed that the effectiveness of digital education games in STEM learning had a moderate to large effect on students' academic performance[23]. The results of this study aligned with the research of Gui et al. (2023)[24] on game-based learning in medical education, which showed that game-based educational media was consistently more effective in increasing short-term knowledge retention. However, its effectiveness in changing attitudes and practice required longer exposure times and continuous reinforcement. Based on the characteristics of respondents, the

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effectiveness of Aoksigame Card in increasing knowledge could be explained through several factors. The majority of respondents were 16 years old (80.6%), belonging to the digital native generation, who were more familiar and responsive to technology-based and game-based learning approaches. This age group had a preference for interactive and visual learning, which was optimally facilitated through the media of card games. Although 93.54% of respondents had received anemia-related education before, the experimental group's pretest knowledge score (87.42) still showed room for improvement.

This indicated that previous conventional learning approaches had not been optimal in facilitating an in-depth understanding of anemia. Aoksigame Card managed to fill this gap through a more interesting and memorable learning approach. The advantage of Aoksigame Card lay in its ability to activate various learning channels through visual, tactile, and social interaction components. Card games facilitated active learning in which respondents not only passively received information but also engaged in the process of knowledge construction through gameplay mechanisms. The limited effectiveness in the domain of attitudes and practice suggested the need for modification of intervention design, and a longer duration of exposure and follow-up sessions was required to achieve meaningful changes in attitudes and practices.

## Conclusion

Aoksigame Card educational media proves effective in increasing adolescents' knowledge about anemia, but does not show significant effectiveness in changing attitudes and practices compared to PowerPoint slides. We recommend implementing this medium by extending the intervention duration to a minimum of 6 weeks and incorporating role-play activities and regular group discussions to reinforce material internalization. The involvement of parents or teachers as facilitators also enhances knowledge transfer into real-life practice within adolescent environments.

## Acknowledgments

## Author's Contribution

Design concept, method, data collection, analysis, drafting manuscript: HN, drafting and finalization: TS, methods, field supervision: LW, Analysis: WW

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