REVIEW ARTICLES

# Effectiveness of interventions to improve knowledge, attitudes, and practices regarding thalassemia prevention among women aged 15–49 in Cao Bang province in 2024

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## ABSTRACT

**Objective:** This study aimed to evaluate the effectiveness of interventions in improving knowledge, attitudes, and practices regarding thalassemia prevention among women aged 15–49 in Cao Bang Province.

**Methods:** A quasi-experimental study design was conducted from August 2023 to December 2024 with 531 women (265 in study group and 266 in control group). The intervention consisted of training for health staff, health education for women, individual counseling, workshops, and provision of educational materials.

**Results:** Before the intervention, the proportions of women with adequate knowledge, attitudes, and practices in the study group were 55.1%, 49.8%, and 19.2%, respectively. After the intervention, mean knowledge and attitude scores increased from 10.2 ± 4.8 to 12.9 ± 5.2 and from 3.5 ± 1.8 to 5.3 ± 1.6, with corresponding increases in adequate knowledge (70.6%) and correct attitudes (88.3%). Preventive practice scores improved among both women planning and not planning pregnancy, and the proportion with adequate practices increased to 37.4%. The highest intervention effectiveness index was observed for practices (94.8), followed by attitudes (77.31) and knowledge (21.13) ($p < 0.05$), while no significant changes were observed in the control group ($p > 0.05$).

**Conclusion:** The intervention was effective in improving knowledge, attitude, and practice, and thus, primary healthcare services may refer to this approach for Thalassemia prevention among women of reproductive age.

***Keywords:*** *Thalassemia, knowledge, attitude, practice, women aged 15–49, Cao Bang.*

## INTRODUCTION

Thalassemia is a hereditary disorder caused by impaired hemoglobin synthesis, leading to chronic anemia and severe complications. According to the World Health Organization, approximately 7% of the global population are carriers of thalassemia related genes, and an estimated 300,000–400,000 infants are born each year with severe hemoglobin disorders (1). The prevalence of the disease varies considerably across regions (2). It is particularly high in Southeast Asia, where the gene frequency of α-thalassemia reaches 30–40% and that of β-thalassemia ranges from approximately 1% to 9% (3). In Vietnam, approximately 13.8% of the population are carriers, with cases reported across all 54 ethnic groups (4). In addition, the cost of treating a patient with severe thalassemia from birth to 30 years of age may reach approximately 3 billion VND, while the total annual treatment cost is estimated to exceed 2,000 billion VND (5). This reality underscores the urgent need to strengthen preventive interventions and early

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screening in order to reduce disease incidence and the burden of thalassemia.

Cao Bang is a mountainous province in northeastern Vietnam with a population of over 530,000, more than 80% of whom are ethnic minorities. Geographic remoteness, limited education and health awareness, and consanguineous marriage in some ethnic groups increase the risk of thalassemia-affected births. Although several thalassemia prevention models have shown initial effectiveness nationwide, most remain localized and lack integrated coordination among health education, screening, and premarital counseling. In this context, health education for women of reproductive age (15–49 years) plays a pivotal role, as this population is directly related to pregnancy and childbirth and can substantially influence the reduction of the risk of giving birth to children affected by the disease. Based on this practical context, we conducted the present study in order to evaluate the effectiveness of an intervention aimed at enhancing knowledge, attitudes, and preventive practices regarding thalassemia among women of reproductive age (15–49 years) in Cao Bang province in 2024.

## METHOD

**Study design:** A quasi-experimental study design was applied in this study.

**Study setting and period**

**Study setting:** Cao Bang City, Hoa An District, and Ha Quang District, Cao Bang Province, Vietnam.

**Study period:** From August 2023 to December 2024.

**Study participants**

Women of reproductive age (15–49 years) residing in the study area.

***Inclusion Criteria***

Have not previously participated in any intervention program aimed at enhancing knowledge, attitudes, and preventive practices regarding thalassemia.

Willing to participate in the study.

***Exclusion Criteria:***

Unable to respond to the interview.

Not residing in the study area during the study period

**Sample size and sampling**

**Sample size:** The sample size was calculated using the formula

where:

$$n = 2\left(\frac{Z_{1-\alpha/2}+Z_{1-\beta}}{ES}\right)^2$$

$Z_{1-\alpha/2}$ = 1.96, corresponding to a two-sided type I error of 5%;

$Z_{1-\beta}$ = 0.842, corresponding to 80% statistical power;

ES represents the expected effect size.

The expected effect size was based on an increase in the proportion of women with adequate knowledge of thalassemia prevention from 10.8% at baseline (6) to 22% after the intervention, yielding a minimum sample size of 170 women per group. Given the cluster sampling design, the sample size was adjusted for the design effect using the formula DEFF = 1 + (m − 1)ρ, where the average cluster size (m) was 29 and the intracluster correlation coefficient (ρ) was assumed to be 0.02. Accordingly, the minimum sample size increased to 265 women per group. In total, 531 women were enrolled, including 266 in the control group and 265 in the study group.

**Sampling method:** A cluster sampling approach was applied in this study. First, three areas were purposively selected to represent central (Cao

Bang City), near-central (Hoa An District), and remote (Ha Quang District) settings. Within each selected area, three communes or wards were randomly selected. Subsequently, within each selected commune or ward, two hamlets or residential groups were randomly selected and allocated to either the intervention cluster or the control cluster. In the selected hamlets or residential groups, a list of women aged 15–49 was compiled and screened according to the inclusion criteria. From each cluster, at least 29 eligible women were randomly selected to participate in the study. A total of 531 women were enrolled, including 266 in the control group and 265 in the intervention group. Baseline demographic and socioeconomic characteristics of participants in the intervention and control groups were assessed and compared to ensure group comparability.

**Study Indicators**

The study assessed several key indicators to evaluate the impact of the intervention. These included the proportion of participants demonstrating correct knowledge, appropriate attitudes, and adequate practices both before and after the intervention. In addition, participants were classified according to levels of knowledge, attitudes, and practices pre- and post-intervention to examine changes in each domain.

**Intervention**

The intervention consisted of healthcare worker training and a six-month community-based health education program for women aged 15–49 years. Commune-level healthcare workers received structured training on Thalassemia prevention, OF test screening, counseling, and health communication, and only those meeting predefined competency criteria were permitted to deliver the community intervention. Trained healthcare workers conducted monthly group education sessions, while local radio broadcasts were aired twice weekly in repeated cycles. Individual counseling and OF test screening were provided at commune health stations upon women's request. Intervention delivery followed a standardized protocol across all clusters.

**Instruments**

Knowledge, attitudes, and practices regarding Thalassemia prevention were assessed using a structured questionnaire. Knowledge was classified as adequate (≥11/21 points) or inadequate; attitudes as adequate (≥4/8 points) or inadequate; and practices as adequate or inadequate based on predefined thresholds for women planning to have children (≥3/6 points) and those not planning to have children (≥2/4 points), as informed by prior literature (7). The instruments were validated through expert consultation and pilot-tested in 30 participants, demonstrating good reliability (Cronbach's alpha > 0.8).

**Data analysis**

Descriptive statistics (mean, standard deviation, and percentage) were used to summarize participant characteristics and KAP scores. Baseline characteristics between the intervention and control groups were compared using independent t-tests and chi-square tests. Pre–post changes within each group were assessed using paired t-tests for continuous variables and McNemar's tests for categorical variables. Between-group differences were evaluated based on post-intervention outcomes in relation to baseline values. The clustered sampling design was taken into account in the analysis and interpretation of results. Statistical significance was set at $p < 0.05$. Intervention effectiveness was assessed using the effectiveness index.

**Ethical Considerations**

The study was approved by the Ethics Committee of Thai Nguyen University of Medicine and Pharmacy, Vietnam (Official Letter No. 220/ĐHYD-HĐĐĐ, dated March 21, 2022).

## RESUTLS

Table 1 showed that the mean age of women was 32.7 ± 8.6 in the control group and 34.5 ± 8.1 in the study group, with the 30–39 age group accounting for nearly half of participants in both groups (48.1% and 46.0%, respectively). Regarding educational attainment, approximately 42–44% of women had completed high school, while the predominant occupation was farming (42.9% in the control group and 43.8% in the study group). There were no statistically significant differences in demographic characteristics between the study group and the control group.

**Table 1. General Characteristics of Women Participating in the Study**

| Characteristics \ Group | Control Group (n = 266) | Study Group (n = 265) | Total | p |
|---|---|---|---|---|
| ***Age group*** | | | | |
| < 30 | 79 (29.7%) | 63 (23.8%) | **142 (26.7%)** | > 0.05 |
| 30 - 39 | 128 (48.1%) | 122 (46.0%) | **250 (47.1%)** | |
| 40 - 49 | 59 (22.2%) | 80 (30.2%) | **139 (26.2%)** | |
| Mean | 32.7 ± 8.6 | 34.5 ± 8.1 | **33.6 ± 8.4** | |
| ***Educational level*** | | | | |
| Primary school | 08 (3.0%) | 06 (2.3%) | **14 (2.6%)** | > 0.05 |
| Secondary school | 49 (18.4%) | 45 (17.0%) | **94 (17.7%)** | |
| High school | 118 (44.4%) | 111 (41.9%) | **229 (43.1%)** | |
| College or higher | 91 (34.2%) | 103 (38.9%) | **194 (36.5%)** | |
| ***Occupation*** | | | | |
| Farmer | 114 (42,9%) | 116 (43,8%) | **230 (43,3%)** | > 0.05 |
| Homemaker | 12 (4,5%) | 11 (4,2%) | **23 (4,3%)** | |
| Worker | 48 (18,0%) | 49 (18,5%) | **97 (18,3%)** | |
| Self-employed | 26 (9,8%) | 30 (11,3%) | **56 (10,5%)** | |
| Public servant | 47 (17,7%) | 44 (16,6%) | **91 (17,1%)** | |
| Student | 19 (7,1%) | 15 (5,7%) | **34 (6,6%)** | |
| **Total** | **266** | **265** | **531** | |

Table 2 indicated that in the control group, knowledge about the disease and its complications increased only slightly (from 50.4% to 52.3% and from 10.9% to 13.5%, respectively), while other items showed no significant changes ($p > 0.05$). In contrast, in the study group, the proportion of women who were aware of the disease increased markedly from 52.8% to 97.7%, and knowledge of disease-related complications rose from 12.1% to 30.2%. Other knowledge items also demonstrated significant improvement, increasing from 15.5–50.2% before the intervention to 33.6–65.3% after the intervention ($p < 0.05$). Knowledge regarding treatment decreased slightly from 30.2% to 28.7%; however, this change was not statistically significant ($p > 0.05$).

**Table 2. Women's Correct Knowledge About Thalassemia Before and After Intervention**

| Item | Control Group (n = 266) | | | Study Group (n = 265) | | |
|---|---|---|---|---|---|---|
| | Before | After | p | Before | After | p |
| Be aware of the disease | 134 (50.4%) | 139 (52.3%) | > 0.05 | 140 (52.8%) | 259 (97.7%) | **< 0.05** |
| Mode of transmission | 126 (47.4%) | 130 (48.9%) | > 0.05 | 133 (50.2%) | 173 (65.3%) | **< 0.05** |
| Risk of child being affected if parents are carriers | 129 (48.5%) | 137 (51.5%) | > 0.05 | 122 (46.0%) | 166 (62.6%) | **< 0.05** |
| Risk of grandchild being affected if grandparents are carriers | 102 (38.3%) | 111 (41.7%) | > 0.05 | 109 (41.1%) | 128 (48.3%) | **< 0.05** |
| Risk of sibling being affected if cousins are carriers | 54 (20.3%) | 66 (24.8%) | > 0.05 | 41 (15.5%) | 86 (32.5%) | **< 0.05** |
| Clinical manifestations | 74 (27.8%) | 80 (30.1%) | > 0.05 | 76 (28.7%) | 100 (37.7%) | **< 0.05** |
| Tests required for diagnosis | 66 (24.8%) | 74 (27.8%) | > 0.05 | 69 (26.0%) | 89 (33.6%) | **< 0.05** |
| Treatment | 96 (36.1%) | 92 (34.6%) | > 0.05 | 80 (30.2%) | 76 (28.7%) | > 0.05 |
| Complications | 29 (10.9%) | 36 (13.5%) | > 0.05 | 32 (12.1%) | 80 (30.2%) | **< 0.05** |

As shown in table 3, in the control group, the proportion of women with correct attitudes regarding complications and diagnostic perspectives increased only slightly, from 61.3% to 65.8% and from 27.8% to 31.2%, respectively, while other items showed no significant changes. In contrast, in the study group, correct attitudes toward disease complications increased from 63.8% to 85.3%, and attitudes toward treatment improved from 28.3% to 42.2%. Other items also showed marked improvement, rising from 30.6%–52.5% before intervention to 52.5%–80.4% after intervention.

**Table 3. Women's Correct Attitudes/Agreement Regarding Thalassemia Prevention Before and After Intervention**

| Item | Control Group (n = 266) | | | Study Group (n = 265) | | |
|---|---|---|---|---|---|---|
| | Before | After | p | Before | After | p |
| Thalassemia is a disease that reduces the quality of offspring | 94 (35.3%) | 101 (38.0%) | > 0.05 | 86 (32.5%) | 139 (52.5%) | **< 0.05** |
| Consanguineous couples have a higher risk of having children with Thalassemia | 109 (41.0%) | 119 (44.7%) | > 0.05 | 127 (47.9%) | 210 (79.2%) | **< 0.05** |
| Thalassemia can be completely cured with current treatment | 83 (31.2%) | 95 (35.7%) | > 0.05 | 75 (28.3%) | 113 (42.6%) | **< 0.05** |

| Item | Control Group (n = 266) | | | Study Group (n = 265) | | |
|---|---|---|---|---|---|---|
| | Before | After | p | Before | After | p |
| Thalassemia causes many complications | 163 (61.3%) | 175 (65.8%) | > 0.05 | 169 (63.8%) | 226 (85.3%) | **< 0.05** |
| Thalassemia is a costly lifelong disease | 142 (53.4%) | 144 (54.1%) | > 0.05 | 134 (50.6%) | 173 (65.3%) | **< 0.05** |
| Thalassemia is a preventable disease | 105 (39.5%) | 107 (40.2%) | > 0.05 | 108 (40.8%) | 191 (72.1%) | **< 0.05** |
| If both parents are normal, testing for Thalassemia in the child is unnecessary | 74 (27.8%) | 83 (31.2%) | > 0.05 | 81 (30.6%) | 144 (54.5%) | **< 0.05** |
| Couples should undergo Thalassemia screening before marriage | 146 (54.9%) | 160 (60.2%) | > 0.05 | 139 (52.5%) | 210 (80.4%) | **< 0.05** |

As presented in table 4, in the control group, women's knowledge of counseling locations increased slightly (47.7% to 48.5%), and the proportion of women undergoing active screening remained unchanged at 7.7%, with other practices showing minimal, non-significant changes (25.2–36.1% to 26.3–39.5%). In the study group, awareness of counseling locations rose from 48.7% to 60.0%, active screening from 8.1% to 13.2%, and other practices improved markedly (from 26.8–38.9% before the intervention to 38.1–53.6% after the intervention) with statistically significant differences.

**Table 4. Women's Correct Practices in Thalassemia Prevention Before and After Intervention**

| Item | Control Group (n = 266) | | | Study Group (n = 265) | | |
|---|---|---|---|---|---|---|
| | Before | After | p | Before | After | p |
| Actively seeking information on where to undergo Thalassemia screening | 96 (36.1%) | 105 (39.5%) | > 0.05 | 103 (38.9%) | 142 (53.6%) | **< 0.05** |
| Actively seeking information on where to receive Thalassemia counseling | 127 (47.7%) | 129 (48.5%) | > 0.05 | 129 (48.7%) | 159 (60.0%) | **< 0.05** |
| Ever undergone Thalassemia screening | 17 (7.7%)* | 17 (7.7%)* | > 0.05 | 16 (8.1%)** | 26 (13.2%)** | **< 0.05** |
| Advising relatives to undergo Thalassemia screening | 71 (26.7%) | 77 (28.9%) | > 0.05 | 76 (28.7%) | 107 (40.4%) | **< 0.05** |
| Actively seeking information about Thalassemia | 67 (25.2%) | 70 (26.3%) | > 0.05 | 71 (26.8%) | 101 (38.1%) | **< 0.05** |
| Intending to undergo Thalassemia screening in the next pregnancy | 64 (29.1%)* | 68 (30.9%)* | > 0.05 | 65 (33,0%) | 85 (43.1%) | **< 0.05** |

**: Calculated among women planning to have children in the control group (n = 220)*
***: Calculated among women planning to have children in the study group (n = 197)*

Table 5 showed that in the control group, mean scores of knowledge, attitude, and practice showed no significant changes before and after the study ($p > 0.05$). In the study group, mean knowledge scores increased from 10.2 ± 4.8 to 12.9 ± 5.2, attitude scores from 3.5 ± 1.8 to 5.3 ± 1.6, and practice scores increased from 1.5 ± 1.0 to 2.0 ± 1.0 among women planning pregnancy and from 1.3 ± 0.9 to 1.7 ± 1.0 among those not planning pregnancy after the intervention. All changes were statistically significant ($p < 0.05$).

**Table 5. Mean Scores of Knowledge, Attitude, and Practice Before and After Intervention in Women**

| Mean | | Control Group (n = 266) | | | Study Group (n = 265) | | |
|---|---|---|---|---|---|---|---|
| | | Before | After | Before | After | Before | After |
| Knowledge | | 11.2 ± 4.7 | 11.3 ± 4.9 | > 0.05 | 10.2 ± 4.8 | 12.9 ± 5.2 | **< 0.05** |
| Attitude | | 3.4 ± 1.7 | 3.7 ± 1.7 | > 0.05 | 3.5 ± 1.8 | 5,3 ± 1.6 | **< 0.05** |
| Practice | Women planning pregnancy | 1.4 ± 1.0 | 1.4 ± 1.0 | > 0.05 | 1.5 ± 1.0 | 2.0 ± 1.0 | **< 0.05** |
| | Women not planning pregnancy | 1.3 ± 1.0 | 1.5 ± 1.1 | > 0.05 | 1.3 ± 0.9 | 1.7 ± 1.0 | **< 0.05** |

As shown in table 6, in the control group, the proportions of women with adequate knowledge, attitudes, and practices were 53.4%, 48.1%, and 19.2%, respectively, before the intervention. After the intervention, these figures were 57.1%, 53.4%, and 18.0%, with no statistically significant differences observed. In the study group, the proportion of women with adequate knowledge increased from 55.1% to 70.6%. Adequate attitudes rose markedly from 49.8% to 88.3%, while adequate practices increased from 19.2% to 37.4%. All observed changes were statistically significant.

**Table 6. Changes in knowledge, attitudes, and practices among women before and after the intervention**

| Classification | Control Group (n = 266) | | Study Group (n = 265) | | P |
|---|---|---|---|---|---|
| | Before (1) | After (2) | Before (3) | After (4) | |
| Adequate knowledge | 142 (53.4%) | 152 (57.1%) | 146 (55.1%) | 187 (70.6%) | $P_{1,2} > 0.05$, $\mathbf{P_{3.4} < 0.05}$<br>$P_{1,3} > 0.05$, $\mathbf{P_{2.4} < 0.05}$ |
| Adequate attitude | 128 (48.1%) | 142 (53.4%) | 132 (49.8%) | 234 (88.3%) | $P_{1,2} > 0.05$, $\mathbf{P_{3.4} < 0.05}$<br>$P_{1,3} > 0.05$, $\mathbf{P_{2.4} < 0.05}$ |
| Adequate practice | 51 (19.2%) | 48 (18.0%) | 51 (19.2%) | 99 (37.4%) | $P_{1,2} > 0.05$, $\mathbf{P_{3.4} < 0.05}$<br>$P_{1,3} > 0.05$, $\mathbf{P_{2.4} < 0.05}$ |

The effectiveness indices for knowledge, attitude, and practice were 28.13%, 77.31%, and 94.8%, respectively. The intervention effectiveness was 21.2% for knowledge, 66.3% for attitude, and 88.6% for practice.

**Table 7. Intervention Effectiveness Index**

| Variable | Effectiveness Index (%) | | Intervention Effectiveness (%) |
|---|---|---|---|
| | $EI_C$ | $EI_S$ | $EI_C - EI_S$ |
| Knowledge | 6.93 | 28.13 | 21.2 |
| Attitude | 11.02 | 77.31 | 66.3 |
| Practice | 6.25 | 94.8 | 88.6 |

$EI_C$: *Effectiveness index of the control group*

$EI_S$: *Effectiveness index of the study group*

## DISCUSSION

The study results showed that the mean age of women in the control and study groups was 32.7 and 34.5 respectively, with the 30–39 age group being the most prevalent. Selecting participants aged 15–49 was appropriate, as it corresponds to reproductive age and is relevant for the prevention of Thalassemia affected births. Regarding educational level, most women had completed high school, consistent with previous studies (7). The majority were married, and their main occupation was farming, accurately reflecting the characteristics of populations at risk of having children with genetic disorders. Overall, the sociodemographic characteristics of the two groups were comparable, with no significant differences, indicating that the sampling process was rigorously conducted, helping to control confounding factors and ensuring the accuracy of intervention effectiveness assessment.

The control group showed no statistically significant improvement in knowledge about Thalassemia, whereas the study group demonstrated substantial gains across all knowledge domains, including disease awareness, understanding of genetic risk, and recognition of complications. This increase reflects a positive shift in perception, which is a crucial prerequisite for changing screening and preventive behaviors, consistent with the principle that awareness of the severity and consequences of a health issue drives behavior change (8). Most other knowledge items also showed statistically significant improvements, indicating the comprehensive effectiveness of the communication model, which is consistent with findings from international studies (9, 10). However, in the present study, the proportion of women who were aware of available treatment options slightly decreased from 30.2% to 28.7% after the intervention, and this difference was not statistically significant ($p > 0.05$). Although women received educational materials and both direct and indirect health education, they may have focused more on information related to disease consequences and preventive interventions. Therefore, future interventions should provide clearer and more detailed guidance regarding treatment-related information.

The study results demonstrated that women in the study group exhibited significant improvements in attitudes toward thalassemia following the intervention. Specifically, the proportion of women with a correct attitude toward the statement "Thalassemia causes multiple complications" increased from 63.8% to 85.3%, and perspectives on disease prevention and risks associated with consanguineous marriage also improved markedly. These findings indicate that health education activities implemented directly, clearly, and in a locally relevant manner enhanced women's awareness and attitudes, particularly in ethnic minority areas with traditions of consanguineous marriage. In contrast, the control group showed no statistically significant changes, underscoring the necessity of culturally and socially tailored health education programs to promote positive attitudes toward Thalassemia prevention.

Following the intervention, preventive practices related to thalassemia in the study group improved significantly across all assessed items. Awareness of screening locations increased from 38.9% to 53.6%, and the intention to undergo screening in a subsequent pregnancy rose from 33.0% to 43.1%, demonstrating the positive effect of health education activities. In addition, the increased proportion of women actively seeking information and encouraging family members to be screened suggests a broader community-level impact of the intervention. These findings are consistent with a study conducted in Phnom Penh, in which screening uptake in the study group was significantly higher than in the control group (11). However, the proportion of women who actually underwent screening remained low, increasing only from 8.1% to 13.2%, reflecting challenges in translating awareness into action due to limited healthcare infrastructure and geographic distance from health centers. These factors highlight the necessity of strengthening primary healthcare capacity and supporting community access to services, particularly in mountainous regions such as Cao Bang.

The intervention program markedly improved knowledge, attitude, and preventive practices regarding Thalassemia in the study group. Following the intervention, mean knowledge scores increased from $10.2 \pm 4.8$ to $12.9 \pm 5.2$, attitude scores from $3.5 \pm 1.8$ to $5.3 \pm 1.6$, and practice scores increased among women planning to have children (from $1.5 \pm 1.0$ to $2.0 \pm 1.0$) and those not planning to have children (from $1.3 \pm 0.9$ to $1.7 \pm 1.0$), with all changes being statistically significant ($p < 0.05$). The proportions of women with adequate knowledge, attitudes, and practices also increased significantly, from 55.1% to 70.6%, 49.8% to 88.3%, and 19.2% to 37.4%, respectively, confirming the effectiveness of the health education program. These findings are consistent with previous studies, including those conducted by Cheng et al. (2018) in Cambodia (11) and Kia et al (2019) in Indonesia (12), indicating that health education helps enhance awareness and promotes preventive behaviors regarding Thalassemia. Our study highlights the crucial role of health education programs that are tailored to local contexts, particularly in Cao Bang, where infrastructure and access to health information remain limited.

The study demonstrated that the intervention had the greatest impact on women's preventive practices for Thalassemia (effectiveness index 94.8), followed by attitudes toward prevention (77.31), and knowledge about Thalassemia (21.13). These results indicate that the health education strategy not only enhances awareness but also promotes preventive behaviors within the community. The high effectiveness of the intervention can be attributed to its design strengths:

first, healthcare staff received direct training to improve their knowledge, counseling, and health education skills; subsequently, they implemented direct communication with women, ensuring accurate, relevant, and persuasive information. In addition, the women were provided with concise, easy to understand illustrative materials, including information on the severity, risks, health and economic impacts, and the effectiveness of preventive behaviors. The communication strategy combined direct (village meetings, women's groups) and indirect (thematic radio broadcasts, repeated daily) methods, which reinforced knowledge and attitudes while also promoting preventive practices. This multidimensional approach largely explains the high effectiveness of the intervention, consistent with previous studies showing that health education communication can simultaneously improve knowledge, attitudes, and practices within communities (13). This study has several limitations. The quasi-experimental design may be prone to selection bias; however, baseline characteristics between the study groups were comparable. The cluster sampling design may introduce intra-cluster correlation, which was addressed through sample size adjustment and considered in the interpretation of results. Outcomes were self-reported and may be subject to recall and social desirability bias; to mitigate this, standardized and pilot-tested instruments were used. The short follow-up period limits assessment of long-term sustainability. Future studies with randomized designs, longer follow-up periods, and multilevel analyses are warranted.

## CONCLUSION

The mean score for knowledge increased from 10.2 ± 4.8 to 12.9 ± 5.2, with the proportion of women with adequate knowledge rising from 55.1% to 70.6%. The attitude score increased from 3.5 ± 1.8 to 5.3 ± 1.6, with the proportion of women with a correct attitude rising from 49.8% to 88.3%. The practice score in the group planning to have children increased from 1.5 ± 1.0 to 2.0 ± 1.0, and in the group not planning to have children, it increased from 1.3 ± 0.9 to 1.7 ± 1.0, with the proportion of women with adequate practice increasing from 19.2% to 37.4%. The highest intervention effectiveness index was observed in practices (94.8), followed by attitudes (77.31) and knowledge (21.13). The intervention was effective in improving knowledge, attitude, and practice, and thus, primary healthcare services may refer to this approach for Thalassemia prevention among women of reproductive age.

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