



## THE ROLE OF NUTRITIONAL INTERVENTIONS IN ANEMIA PREVENTION AMONG ADOLESCENT GIRLS: A SCOPING REVIEW OF QUASI-EXPERIMENTAL STUDIES

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### ABSTRACT

Anemia among adolescent girls remains a major public health problem that may compromise future maternal and child health. It is influenced by inadequate intake of iron and micronutrients, poor dietary diversity, menstrual blood loss, and low adherence to iron folic acid tablet supplementation. Although various nutritional interventions have been implemented, evidence from quasi-experimental studies needs to be comprehensively mapped because this design is widely used in school and community based settings where randomization is often limited. This article aims to review and map the scientific evidence regarding the role of nutritional interventions in preventing anemia among adolescent girls based on quasi-experimental studies. A scoping review methodology was employed, with literature searches conducted through PubMed, Scopus, and ScienceDirect, and the selection process followed the PRISMA-ScR framework. The inclusion criteria comprised quasi-experimental studies published between 2020 and 2025 involving adolescent girls as research subjects. The data indicate that interventions such as iron supplementation or iron-folic acid tablets, food fortification, and school-based nutrition education can help increase hemoglobin levels and improve anemia status among adolescent girls. However, differences in study design, intervention duration, participant adherence, and outcome indicators show variations in methods and implementation across studies. These variations may affect the magnitude of intervention effects and the consistency of the findings. Therefore, an intervention may show effective results in one study condition but may not produce the same impact in another, particularly when implementation quality, participant adherence, and evaluation methods differ. Overall, Nutritional interventions have considerable potential to prevent anemia among adolescent girls, particularly through iron folic acid supplementation, food fortification, and school-based nutrition education. However, their effectiveness depends on intervention duration, participant adherence, implementation quality, and assessment of intervention outcomes.

Keywords: adolescent girls; anemia; nutritional interventions; quasi-experimental

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## INTRODUCTION

Anemia remains a major global public health and nutritional problem, especially in low- and middle-income countries (Fitariyani et al., 2025). Adolescent girls are highly vulnerable because rapid growth, menstrual blood loss, inadequate micronutrient intake, limited nutrition awareness, early pregnancy risk, and restricted access to nutrition education increase their anemia risk (Ghimire et al., 2024; Nasrul et al., 2025). Its impact extends beyond clinical health because anemia can affect school performance, development, reproductive health, and the health of future generations (Fitariyani et al., 2025). Nutritional interventions are key strategies for preventing anemia in adolescent girls. These interventions include iron and folic acid supplementation, food fortification,

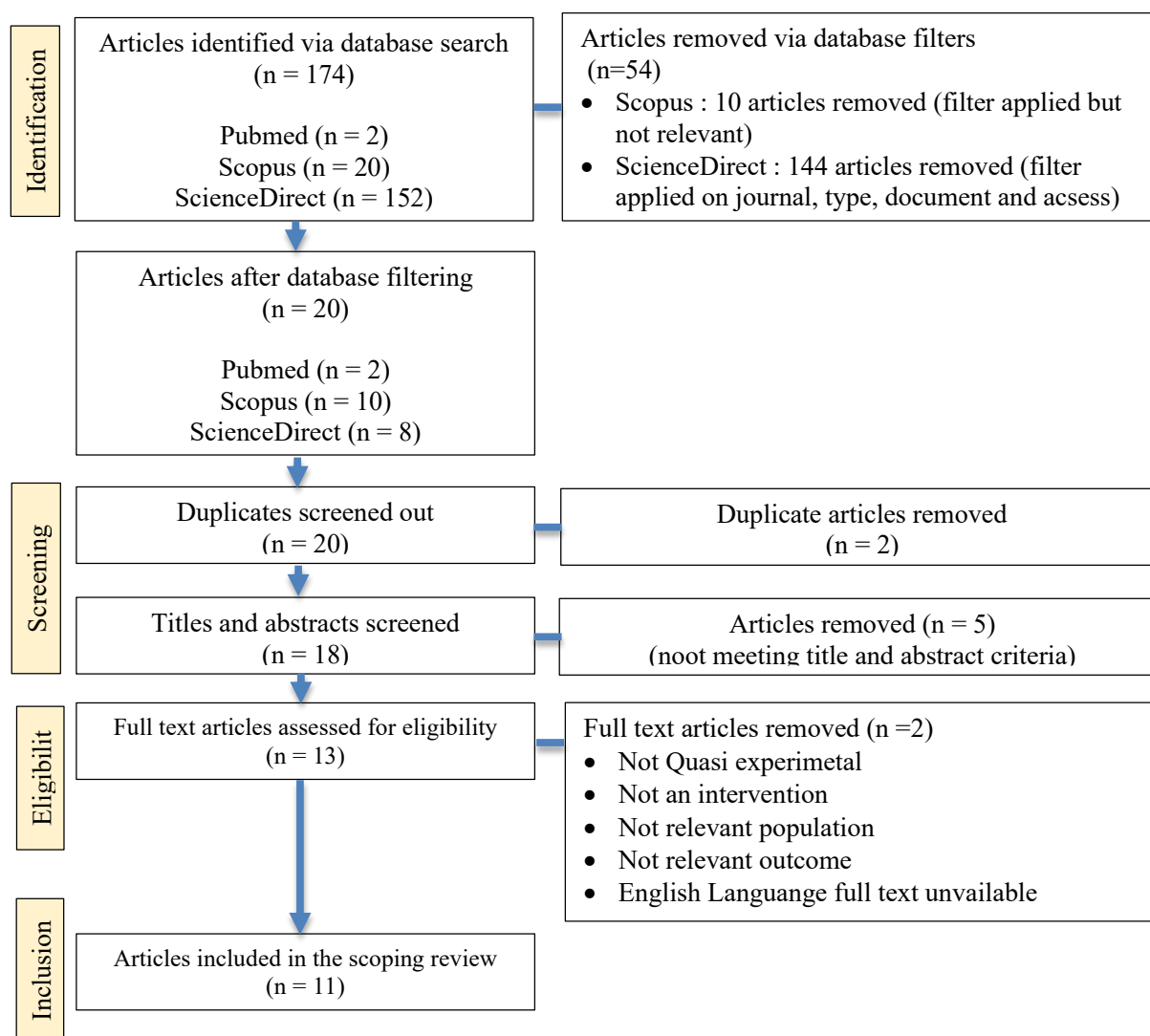
dietary diversification, nutrition education, promotion of iron-rich foods, and the use of vitamin C to enhance iron absorption (Nasrul et al., 2025). However, intervention success depends on context, duration, delivery method, and participant adherence (Gore et al., 2024). Quasi-experimental studies are important in anemia prevention research because they provide practical evidence from schools, communities, and public health settings where randomized controlled trials may be difficult to apply (Fitariyani et al., 2025). However, existing studies vary in intervention type, target population, setting, outcome measurement, duration, and reporting quality. This variation makes the evidence difficult to interpret consistently (Gore et al., 2024).

Current evidence synthesis remains limited, particularly in mapping quasi-experimental studies on nutritional interventions for anemia prevention among adolescent girls. There is still insufficient clarity regarding intervention models, participant characteristics, study settings, measured outcomes, methodological approaches, implementation duration, study limitations, and underexplored research areas (Fitariyani et al., 2025). Therefore, this scoping review aims to map evidence from quasi-experimental studies on nutritional interventions for preventing anemia among adolescent girls. It identifies intervention types, participant characteristics, study settings, outcome measures, methodological approaches, reported limitations, and research gaps. The findings are expected to support researchers, nutritionists, educators, school health stakeholders, and policymakers in designing context-responsive interventions to prevent anemia and improve adolescent health in Indonesia and other developing countries.

## **METHOD**

This study used a scoping review design to map evidence on nutritional interventions for preventing anemia among adolescent girls (Fitariyani et al., 2025). This design was selected because it can summarize intervention types, participant characteristics, study settings, outcome measures, and research gaps in the existing literature (Fitariyani et al., 2025). The review followed PRISMA-ScR principles and used the PICOS framework to define the research question, inclusion criteria, exclusion criteria, and key concepts (Tricco et al., 2018). The target population was adolescent girls aged 10 to 19 years. The interventions included iron supplementation, food fortification, and nutrition education, compared with no intervention or standard care. The main outcomes were hemoglobin concentration, anemia prevalence, iron status, and other nutritional indicator (Sari et al., 2025). Studies were included if they involved adolescent girls aged 10 to 19 years, evaluated nutritional interventions for anemia prevention, used a quasi-experimental, pre-post, or non-randomized controlled design, reported relevant anemia or nutrition outcomes, were published between 2020 and 2025, and were available in full text (Patimah & Idrus, 2023). Studies were excluded if they used animal models, were protocols without results, reviews, editorials, commentaries, conference abstracts, did not focus on adolescent girls or anemia, or had no accessible full text (Djati et al., 2025).

Articles were searched in PubMed, Scopus, and ScienceDirect using keywords such as “anemia,” “nutritional intervention,” “adolescent girls,” and “quasi-experimental.” Boolean operators AND and OR were applied, and the search was limited to studies published within the last five years, specifically from 2021 to 2025. Study selection was conducted in stages, beginning with title and abstract screening, followed by full-text review. The selection process was documented using a PRISMA flow diagram to ensure transparency (Kurniawan et al., 2024). Data were extracted using a charting form that included authors, year, setting, participant characteristics, sample size, intervention type, duration, outcome indicators, main findings, and study limitations (Kurniawan et al., 2024). Data were synthesized narratively by describing patterns in intervention types, study settings, measured outcomes, and reported effects on hemoglobin level, anemia prevalence, and nutritional status. Descriptive analysis was used to show the distribution of studies. Meta-analysis was not conducted because the review aimed to map the scope and characteristics of evidence rather than calculate pooled effect estimates (Rahman et al., 2025).



Picture 1. Search Method Based on the PRISMA Flow Diagram

## RESULT

As shown in the table below, 11 of the 20 uploaded articles met the inclusion criteria for this scoping review following the initial screening process. These studies examine the role of nutritional interventions in preventing anemia among adolescent girls, covering approaches such as nutrition education, mHealth application-based interventions, nutritional counselling, and food- or supplement-based strategies using locally available products, including Moringa capsules, moringa fish biscuits, sweet potato leaf beverages, red guava juice, and ferrous fumarate jelly sweets. Reported outcomes include improvements in knowledge, attitudes, practices, and behavioural intentions, as well as gains in anemia-related biomarkers, such as haemoglobin, ferritin, haematocrit, and mid-upper arm circumference, depending on the type of intervention implemented.

Table 1.

Characteristics of Articles Included in the Scoping Review

| Author, Year           | Method                                                                                                         | Intervention and Main Variables                                                                                                                      | Results                                                                                                                     | Conclusion                                                                                                    |
|------------------------|----------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| Abu Baker et al., 2021 | Quasi-experimental pre-test–post-test control group design; four schools; 363 female students aged 13–15 years | Intervention: a one-month nutrition education programme.<br>Variables: haemoglobin (Hb), knowledge, attitudes, and practices (KAP) relating to iron- | The intervention group showed a significant post-intervention increase in total KAP scores compared with the control group. | Structured nutrition education effectively improved KAP relating to anemia prevention among adolescent girls. |

| Author, Year                | Method                                                                                                                                                   | Intervention and Main Variables                                                                                                                                                  | Results                                                                                                                                                            | Conclusion                                                                                                                             |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
|                             |                                                                                                                                                          | deficiency anemia (IDA). Participants: girls in Grades 8–10.                                                                                                                     |                                                                                                                                                                    |                                                                                                                                        |
| Khani Jeihooni et al., 2021 | Quasi-experimental design; 160 female students, with 80 in the intervention group and 80 in the control group; 4 month follow-up                         | Intervention: six PRECEDE-based nutrition education sessions. Variables: PRECEDE constructs, anemia-preventive behaviours, Hb, haematocrit, and ferritin.                        | Preventive behaviour constructs improved significantly, and ferritin levels increased significantly following the intervention.                                    | PRECEDE-based education had a positive effect on anemia-preventive behaviour and selected biological indicators.                       |
| Rakhsani et al., 2025       | Quasi-experimental design; 160 female students aged 14–19 years; experimental and control groups; pre-test and four-month post-test                      | Intervention: six educational sessions based on the Theory of Planned Behaviour. Variables: attitude, subjective norms, perceived behavioural control, intention, and behaviour. | After the intervention, significant between-group differences emerged across all TPB constructs and behavioural outcomes.                                          | ETPB-based education effectively improved iron-deficiency anemia prevention behaviour among female secondary school students.          |
| Sari et.al., 2022           | Quasi-experimental pre-test–post-test design; WENTER application intervention versus booklet; 162 in the intervention group and 115 in the control group | Intervention: app-based mHealth education. Variables: knowledge, attitudes, and practices (KAP) relating to anemia. Participants: female students in rural Indonesia.            | Knowledge and attitudes improved significantly after three months; however, no significant difference in KAP was found between the application and booklet groups. | Digital education may strengthen knowledge and attitudes, but its advantage over printed media in changing practice remains uncertain. |
| Madestria et al., 2021      | Quasi-experimental pre-test–post-test control group design; 62 respondents in each group                                                                 | Intervention: video education combined with modified iron tablet packaging; control: video only. Variables: knowledge, attitude, and intention to consume iron tablets.          | Both groups improved, but the combined video and packaging modification produced a significant effect on knowledge, attitudes, and intentions.                     | Educational media combined with packaging modification may enhance acceptance-related behaviour towards iron supplementation.          |
| Jumiyati et al., 2024       | Quasi-experimental non-randomised control group pre-test–post-test design; 30 in the intervention group and 30 in the control group                      | Intervention: nutritional counselling. Variables: knowledge and attitudes towards anemia prevention. Participants: adolescent girls in junior secondary schools in Bengkulu.     | The intervention group demonstrated a significant increase in knowledge, and attitudes also changed following the intervention.                                    | Nutritional counselling was effective as a promotive and preventive strategy for anemia prevention.                                    |
| Jubaedah et al., 2024       | Quasi-experimental one-group pre-test–post-test design without a control group; 52-day intervention among adolescent girls aged 10–19 years              | Intervention: a functional drink made from sweet potato leaves. Variables: Hb, anemia status, adherence, and                                                                     | Median Hb increased from 11 to 12 g/dL, with a statistically significant difference ( $p < 0.001$ ).                                                               | A sweet potato leaf-based functional drink may improve haemoglobin levels in adolescent girls.                                         |

| Author,<br>Year              | Method                                                                                                                                                                                                | Intervention and<br>Main Variables                                                                                                   | Results                                                                                                                                                    | Conclusion                                                                                                                           |
|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
|                              |                                                                                                                                                                                                       | nutritional status.                                                                                                                  |                                                                                                                                                            |                                                                                                                                      |
| Megawati<br>et.al.,<br>2023  | Quasi-experimental pre-test–<br>post-test control group<br>design; adolescent girls in<br>junior secondary schools in<br>Tasikmalaya                                                                  | Intervention: salak–<br>banana jelly sweets<br>fortified with ferrous<br>fumarate using<br>nanotechnology.<br>Variable: Hb.          | The study was<br>designed to assess the<br>effect of fortification<br>on increasing Hb<br>levels in adolescent<br>girls.                                   | Innovative food<br>fortification may<br>offer an alternative<br>food-based approach<br>to anemia<br>intervention.                    |
| Fatmawati<br>et.al.,<br>2023 | Quasi-experimental design;<br>36 participants in the<br>intervention group and 36 in<br>the control group; conducted<br>in coastal schools in Kendari                                                 | Intervention:<br>Moringa biscuits<br>blended with sori<br>fish flour. Variable:<br>Hb. Participants:<br>anaemic adolescent<br>girls. | Mean Hb in the<br>intervention group<br>increased from 10.51<br>to 12.45; the<br>independent t-test<br>showed statistical<br>significance ( $p = 0.000$ ). | Moringa–sori fish<br>biscuits were<br>effective in<br>increasing Hb<br>among anaemic<br>adolescent girls.                            |
| Nugraheni<br>et.al, 2025     | Quasi-experimental pre-test–<br>post-test control group<br>design; 102 female students<br>aged 13–15 years; 51 in the<br>intervention group and 51 in<br>the control group; six-month<br>intervention | Intervention: 300 mg<br>Moringa oleifera<br>capsules taken twice<br>weekly. Variables:<br>Hb and MUAC.                               | Hb increased<br>significantly from<br>$11.58 \pm 0.87$ to $13.65 \pm 0.89$ g/dL, and<br>MUAC also improved<br>significantly.                               | Moringa capsules<br>effectively improved<br>both haemoglobin<br>levels and basic<br>nutritional status<br>among adolescent<br>girls. |
| Tirtawati<br>et.al.,<br>2024 | Quasi-experimental pre-test–<br>post-test design with a<br>control group; total of 30<br>respondents, with 15 in the<br>intervention group and 15 in<br>the control group                             | Intervention: red<br>guava juice.<br>Variable: Hb.<br>Participants:<br>adolescent girls in<br>junior secondary<br>school.            | Hb levels in the<br>treatment group<br>increased significantly,<br>whereas the control<br>group showed no<br>meaningful<br>improvement.                    | Red guava juice<br>may serve as a<br>promising local<br>food-based<br>intervention to<br>support anemia<br>prevention.               |

## DISCUSSION

The literature search was done in PubMed, Scopus, and ScienceDirect, and it found 174 initial records. There were 2 records from PubMed, 20 from Scopus, and 152 from ScienceDirect. After screening, 10 records from Scopus and 8 from ScienceDirect were kept for further review. After removing duplicates and checking for eligibility, 11 quasi-experimental studies that were relevant to preventing anemia in teenage females were included in the final analysis. The majority of the research included were done in educational environments, both in urban and rural contexts, and concentrated on adolescent females aged 10 to 19 years. The number of people in the samples ranged from 30 to over 150. Most of the research were done in Indonesia, however a few were done in Iran and Jordan. Across the literature reviewed, school-based treatments were the predominant strategy. These approaches encompassed nutrition education, food fortification, iron supplementation, and integrated techniques that incorporated both instructional elements and product change. Over the last five years, more scholarly work has been published on how to prevent anemia in teens. This is because more people are aware of the risks of anemia and the importance of reproductive health for teenage girls.

The interventions identified in the reviewed studies can be broadly classified into nutrition education, functional foods and food fortification, Moringa oleifera supplementation, and combined interventions. Nutrition education was delivered through various media, including mHealth applications, videos, booklets, and nutritional counselling. These approaches were generally associated with significant improvements in adolescent girls' knowledge and attitudes toward anemia prevention. However, their effects on dietary practices and anemia-related biological markers were not consistently observed across studies (Jumiyati et al., 2024; Putu et al., 2021).

Food-based interventions also demonstrated promising outcomes. Several studies used locally available ingredients to develop functional foods and fortified products, including Moringa biscuits

enriched with fish flour, nanotechnology-based jelly sweets, sweet potato leaf beverages, and red guava juice. These interventions were reported to increase haemoglobin levels among adolescent girls, indicating that locally sourced foods may provide an accessible and culturally appropriate approach to anemia prevention (Fatmawati et al., 2023; Jubaedah & Hisyam, 2024; Megawati & Sudargo, 2023). In addition, the administration of *Moringa oleifera* capsules twice weekly was associated with improvements in haemoglobin levels and basic indicators of nutritional status, supporting the potential effectiveness of supplementation-based strategies for adolescent girls (Nugraheni et al., 2025).

Some studies implemented combined interventions by integrating educational components with modifications to iron tablet packaging. These modifications were intended to increase adolescents' intention, acceptance, and adherence to iron supplementation. The findings suggest that multi-component interventions may be more effective than approaches that rely on a single strategy because they simultaneously address knowledge, motivation, dietary intake, and physiological iron requirements (Putu et al., 2021). Overall, nutritional interventions generally improved haemoglobin levels, knowledge, attitudes, and behavioural intentions related to anemia prevention. Among the interventions reviewed, strategies combining nutrition education, food fortification, and supplementation produced the most consistent outcomes, with several studies reporting significant increases in haemoglobin levels among adolescent girls (Fatmawati et al., 2023; Jubaedah & Hisyam, 2024; Nugraheni et al., 2025).

Most of the included studies employed quasi-experimental pre-test–post-test designs. Some studies included control groups, while others evaluated only one intervention group. Although quasi-experimental designs are valuable for assessing interventions in real-world school and community settings, several methodological limitations were identified. These included small sample sizes, short intervention periods, reliance on self-reported behavioural data, and inconsistent measurement of biological indicators. Such limitations reduce the strength of causal conclusions and restrict the extent to which the findings can be generalised to broader populations.

The available evidence nevertheless indicates that nutritional interventions have considerable potential to prevent anemia among adolescent girls. Their effectiveness may be influenced by the type and duration of the intervention, implementation quality, participant adherence, and the social and cultural context in which the intervention is delivered. Supplementation and food fortification generally produce more direct physiological effects on haemoglobin levels, whereas nutrition education and dietary diversification are more likely to encourage sustained behavioural changes. Therefore, combined interventions may provide a more comprehensive response by addressing both the immediate biological causes of anemia and the behavioural factors influencing dietary intake and supplement adherence (Nugraheni et al., 2025).

Preventing anemia during adolescence is particularly important because adolescent girls experience rapid growth, menstruation, and increased micronutrient requirements. Anemia prevention at this stage may improve current health, learning capacity, and daily functioning while also supporting future reproductive health. Effective nutritional interventions may improve iron status before pregnancy and reduce the risk of maternal and intergenerational health complications later in life (Jubaedah & Hisyam, 2024; Megawati & Sudargo, 2023). However, the successful implementation of these interventions depends on consistent participation, operational feasibility, adequate resources, and the availability of appropriate local foods (Fatmawati et al., 2023; Putu et al., 2021).

Despite the promising findings, several research gaps remain. Most of the included studies were conducted in Indonesia and Iran, resulting in limited geographical representation. Evidence concerning the long-term effects of nutritional interventions is also scarce, particularly regarding sustained adherence, behavioural maintenance, and changes in anemia status after the intervention has ended. Few studies have directly compared nutrition education, food fortification,

supplementation, and combined approaches. Furthermore, adherence and long-term behavioural changes have not been measured consistently, while biological outcomes such as ferritin levels, iron intake, and other indicators of iron status have not been assessed using fully standardised methods across studies (Nugraheni et al., 2025; P. Sari et al., 2022).

Future research should therefore employ multi-site designs with larger and more diverse samples to improve the generalisability of the findings. Researchers should use standardised and comprehensive measurements of both biological and behavioural outcomes, including haemoglobin, ferritin, dietary iron intake, knowledge, adherence, and sustained dietary practices. Comparative studies are also required to determine the relative effectiveness of nutrition education, food fortification, supplementation, and integrated strategies. Greater attention should be given to long-term outcomes, intervention sustainability, participant adherence, operational feasibility, and cost-effectiveness. Studies conducted across broader geographical and socioeconomic settings would also provide a better understanding of local factors and the adaptations required for effective anemia-prevention programmes (Fatmawati et al., 2023; Megawati & Sudargo, 2023; Nugraheni et al., 2025).

## **CONCLUSION**

Nutritional interventions based on Quasi experimental research have shown that anemia in adolescent girls can be prevented by iron–folic acid supplementation, food fortification and school based nutrition instruction. The value of quasi-experimental research is their capacity to examine interventions in real schools and communities, where it is often impossible to randomise. The results however are varied across research because of variation in duration of intervention, compliance of participants, quality of execution and evaluation methodologies . Therefore, future quasi-experimental research should include more organised designs, clearly defined outcome measures, and consistent evaluation to improve the evidence base for anemia prevention initiatives.

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