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REVIEW ARTICLE

Effectiveness of fertility education interventions in adolescents: A systematic review and meta-analysis protocol

Eficácia das intervenções de educação para a fertilidade em adolescentes: Protocolo de revisão sistemática e meta-análise

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Abstract

Objective: This systematic review and meta-analysis protocol was designed to evaluate the effectiveness of fertility education interventions for adolescents aged 12 to 19. The primary aim is to assess their impact on fertility-related knowledge, attitudes, and behaviors. **Method**: This review will include randomized controlled trials examining educational programs focused on fertility and reproductive health in adolescents. Eligible studies must report outcomes related to knowledge, attitudes, or behavioral intentions/actions and include a clearly identifiable fertility-focused component. A systematic search will be conducted in CENTRAL, APA PsycInfo, MEDLINE, and Web of Science Core Collection (SCIE and SSCI). Studies published between January 2010 and November 2024 will be included, reflecting the period during which school-based fertility education interventions became more widely implemented. The search will be rerun before publication. Studies published in English, Portuguese, and Spanish will be eligible. Two independent reviewers will screen studies, extract data, and assess methodological quality using the Effective Public Health Practice Project Quality Assessment Tool. Data will be synthesized through meta-analysis, where appropriate, using random-effects models; standardized mean differences will be used for continuous outcomes and risk/odds ratios for dichotomous outcomes. Between-study heterogeneity will be quantified (I^2 and τ^2), and prespecified subgroup and sensitivity analyses will explore this heterogeneity. **Conclusions**: The systematic review will provide evidence on the effectiveness of fertility education for adolescents. Findings are expected to support the development of educational and public health strategies aimed at improving reproductive health literacy and informed decision-making among young people. **Ethics and dissemination**: Ethics approval is not required because this review will synthesize published, aggregate data only; findings will be disseminated via a peer-reviewed publication. **Registration**: PROSPERO CRD42024611088.

Keywords: Adolescence; Fertility; Health literacy; Randomized controlled trials; Reproductive health; Systematic review.

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Resumo

Objetivo: Este protocolo foi concebido para avaliar a eficácia de intervenções de educação para a fertilidade em adolescentes de 12 a 19 anos. O objetivo principal é avaliar o impacto no conhecimento, atitudes e comportamentos relacionados com a fertilidade. **Métodos**: Esta revisão incluirá ensaios controlados aleatorizados que examinem programas educativos centrados na fertilidade e na saúde reprodutiva em adolescentes. Os estudos elegíveis deverão reportar resultados sobre conhecimento, atitudes ou intenções/ações comportamentais e incluir uma componente de fertilidade explícita. Será realizada uma pesquisa sistemática na CENTRAL, APA PsycInfo, MEDLINE e Web of Science Core Collection (SCIE e SSCI). Serão incluídos estudos publicados entre janeiro de 2010 e novembro de 2024, período em que estas intervenções se tornaram amplamente implementadas em contexto escolar. A pesquisa será repetida antes da publicação. Serão elegíveis estudos em inglês, português e espanhol. Dois revisores independentes procederão à triagem, extração de dados e avaliação da qualidade metodológica com o Effective Public Health Practice Project Quality Assessment Tool. Os dados serão sintetizados por meta-análise, quando apropriado, com modelos de efeitos aleatórios, serão utilizadas diferenças médias padronizadas para resultados contínuos e razões de risco/odds ratio para resultados dicotómicos. A heterogeneidade entre estudos será quantificada (I^2 e τ^2), e análises de subgrupos e de sensibilidade pré-especificadas explorarão essa heterogeneidade. **Conclusões**: A revisão sistemática fornecerá evidência sobre a eficácia da educação para a fertilidade em adolescentes, apoiando o desenvolvimento de estratégias educativas e de saúde pública dirigidas à melhoria da literacia em saúde reprodutiva e da tomada de decisões informadas dos jovens. **Ética e disseminação**: Não é necessária aprovação ética, pois este protocolo sintetizará apenas dados publicados e agregados; os resultados serão disseminados através de publicação com revisão por pares. **Registo**: PROSPERO CRD42024611088.

Palavras-Chave: Adolescência; Ensaios controlados aleatorizados; Fertilidade; Literacia em saúde; Saúde reprodutiva; Revisão sistemática.

Introduction

Despite ongoing efforts, fertility awareness remains insufficient among both men and women globally (Martins et al., 2024; Pedro et al., 2018). Educational efforts to improve fertility knowledge are essential to equip individuals with the tools necessary to make informed reproductive decisions (Alfaraj et al., 2019). To address this gap, we developed a protocol for a systematic review and meta-analysis to identify the most effective fertility education and awareness interventions for adolescents. The review will synthesize evidence on the effectiveness of existing interventions for fertility awareness and infertility prevention, while providing insights for refining future interventions. This review will also contribute to knowledge on fertility awareness levels in adolescents, the types and characteristics of current interventions, and their effectiveness and influence on reproductive health-related behaviors.

Before delving into existing interventions focused on fertility awareness, it is important first to establish the broader background of infertility and fertility awareness. *Infertility* is defined as the failure to achieve pregnancy after 12 months or more of regular, unprotected intercourse (Zegers-Hochschild et al., 2017). It affects approximately one in six adults worldwide (World Health Organization [WHO], 2023).

Moreover, the age-standardized prevalence of infertility has increased globally from 1990 to 2021 (Liang et al., 2025). In parallel with this rising prevalence, the postponement of childbearing has become a widespread trend, driven by various sociocultural and economic factors (Fauser et al., 2024). This shift highlights the urgent need for individuals to understand the biological realities of age-related fertility (Okine et al., 2023). Furthermore, changes in family and societal norms emphasize the critical importance of developing and implementing fertility education interventions (Martins et al., 2024).

However, despite the recognized significance of such education, research on fertility awareness interventions remains limited (Okine et al., 2023), as the field is still relatively nascent (Ren et al., 2023). *Fertility awareness* is broadly defined as understanding fecundity, fecundability, reproduction, and related individual and non-individual risk factors (Zegers-Hochschild et al., 2017). This definition also includes knowledge of cultural and societal factors that affect options for meeting family-building needs and reproductive family planning. Fertility awareness has been conceptualized as a continuous educational process that enables informed reproductive decisions across the life course (Knight, 2016). Low levels of fertility awareness have been associated with delayed care-seeking for infertility (Swift & Liu, 2014) and an increased likelihood of engaging in risk-taking behaviors (Knight, 2016).

Adolescence is a pivotal stage for introducing fertility education. Widespread and accessible fertility education, starting in adolescence, is crucial for fostering realistic reproductive expectations and supporting timely reproductive decision-making consistent with individuals' goals (Delbaere et al., 2020), as well as promoting access to evidence-based information on sexual and reproductive health and rights (Ragnar et al., 2025). Research also suggests that adolescents and younger populations are more receptive to fertility education interventions, underscoring the importance of age-appropriate content delivery (Bodin et al., 2023). Early fertility education can mitigate misconceptions, reduce decision-making uncertainty, and increase the likelihood of timely care-seeking for infertility (Koert et al., 2020). Adolescents, in particular, benefit from tailored interventions that account for their developmental stage, cultural context, and evolving attitudes toward parenthood (Martins et al., 2024). During this developmental period, foundational knowledge can shape future reproductive decisions and behaviors. However, existing sexual education curricula often neglect fertility education, focusing instead on preventing sexually transmitted infections and unintended pregnancies (Harper et al., 2021). Consistent with the World Health Organization's (WHO, 2025) recent emphasis on infertility prevention and the integration of fertility-related care within national health strategies, this gap underscores the need to strengthen fertility education as part of broader public health and educational approaches. This omission highlights a significant gap in current reproductive health education, as acknowledged by the World Health Organization, which recently emphasized the urgent need to integrate fertility education into public health strategies (Martins et al., 2024).

Building on this framework, the review seeks to identify and evaluate the most effective fertility education interventions for adolescents through a systematic review and meta-analysis with randomized controlled trials. By synthesizing the available evidence, the review aims to inform policymakers, educators, and healthcare professionals about best practices for improving fertility awareness (Pedro et al., 2022). Evidence to date supports the need to develop and test educational interventions to improve fertility awareness (Pedro et al., 2022). Components such as online educational content (Herzberger et al., 2022) and interactive, visually engaging tools appear to be effective (Martins et al., 2024). The findings of the review will contribute to the development of tailored, evidence-based interventions that empower adolescents to make informed reproductive decisions and enhance fertility literacy on a global scale.

Method

The protocol for the systematic review was established according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA-P) 2015 guidelines (Moher et al., 2015; Shamseer et al., 2015) and registered with the International Prospective Register of Systematic Reviews (PROSPERO, Registration no. CRD42024611088). The completed PRISMA-P checklist is available in Appendix A. Any amendments to the protocol will be reported in the final publication, with justification. We aim to determine the most effective fertility education and awareness interventions for adolescents. Specifically, the systematic review will address the following key questions:

1. What is the baseline level of fertility knowledge among adolescents reported in the included trials?
2. What interventions have been implemented to enhance fertility awareness and prevent infertility in this population?
3. What are the essential components of these interventions?
4. How effective are these interventions in improving fertility awareness and influencing reproductive health-related behaviors?

Following the PICO framework, the review will consider: Population (P) – adolescents aged 12–19; Intervention (I) – fertility awareness interventions; Comparison (C) – standard education or no intervention; Outcome (O) – fertility awareness, including knowledge, attitudes, and behaviors.

Data Sources

Preliminary searches of electronic databases and platforms, including CINAHL, MEDLINE, APA PsycInfo, the Cochrane Database of Systematic Reviews, the Cochrane Central Register of Controlled Trials (CENTRAL), Web of Science Core Collection (SCIE, SSCI), and Communication and Mass Media Complete (via EBSCOhost), will be performed by two members of the research team. Relevant articles will be noted for testing the final search sequence. The reference lists of existing systematic reviews on related topics were combed for primary research studies relevant to the objective of the current review. Based on this exercise, the team will refine the final search strategy, retaining only the most productive databases to improve efficiency without compromising comprehensiveness.

Accordingly, the systematic search will be conducted in CENTRAL, APA PsycInfo, MEDLINE, SCIE, and SSCI. The search will include studies published between January 1, 2010, and November 10, 2024, reflecting the period in which contemporary school-based fertility education interventions became more widely implemented, and searches will be rerun prior to publication to identify newly indexed studies. Articles written in English, Portuguese, and Spanish will be included.

Because grey literature and unpublished studies do not typically undergo rigorous, independent peer or scientific review (Mantovani et al., 2024), they will not be considered, in order to prioritize high-quality, peer-reviewed evidence for the meta-analysis; the potential implications of this decision for publication bias will be considered when interpreting the findings (Paez, 2017). Backward and forward citation

searches will be conducted for all articles selected for data extraction. This process aims to identify additional relevant studies and uncover unexplored controlled vocabulary and keywords that may enhance the comprehensiveness of the review.

Appendix B outlines the search strategy developed for PsycInfo via EBSCOhost. This strategy was subsequently tailored for use in other databases by referencing the thesauruses specific to each database to ensure the inclusion of appropriate controlled vocabulary terms. Detailed search strategies for all databases can be provided by the first author upon request.

Participants

The review will include studies focusing on adolescents aged 12–19 years from general (non-clinical) populations (e.g., school- or community-based samples). Studies focusing on adolescents recruited because of a medical condition or treatment with direct implications for fertility (e.g., fertility preservation in oncology or clinically indicated reproductive conditions) will be excluded. The WHO defines adolescence as 10–19 years (WHO, 2021); however, participants aged 10–11 years will be excluded because they fall at the lower boundary of adolescence (Hu et al., 2017), and fertility education interventions are commonly designed for older adolescents. This decision also acknowledges that pubertal timing varies and that early adolescence encompasses heterogeneous developmental stages (Dahl et al., 2018). All sexes/genders will be eligible; studies including only girls or only boys will not be excluded but will be considered in subgroup/sensitivity analyses if sufficient data are available. Eligibility for "non-clinical" status will be determined at the study level, based on the recruitment setting and sample description reported in each trial.

Ethical Statement

This study will be conducted using data extracted exclusively from previously published primary studies. Because the review will analyze only published, aggregated data and will not involve contact with participants or access to identifiable individual-level information (no individual participant data will be requested), ethical approval is not required.

Interventions

The review will focus on educational interventions aimed at improving fertility awareness and fertility-related decision-making among adolescents. Eligible interventions must include an explicit fertility-focused component (e.g., fertility facts, age-related fertility changes, reproductive planning, and/or fertility-related risk factors), delivered as stand-alone programs or as a clearly identifiable module within broader sexual/reproductive health education. Interventions may include classroom or workshop-based education, digital or app-based programs, peer-led approaches, healthcare professional-led education, or multicomponent strategies delivered in school, community, or healthcare settings, provided they target general (non-clinical) adolescent populations. Interventions delivered primarily as clinical counselling

for fertility preservation (e.g., oncology-related preservation) or programs targeted to adolescents recruited because of a fertility-related diagnosis/treatment will be excluded. Where available, intervention characteristics (content, duration/dose, delivery mode, provider, setting, and fidelity) will be extracted to support interpretation and planned subgroup analyses.

Types of Studies to be Included

Randomized Controlled Trials (including individually randomized and cluster-randomized controlled trials) will be included to support causal inference regarding intervention effectiveness. Non-randomized designs (e.g., observational, quasi-experimental, and pre–post studies without random allocation) will be excluded. Eligible comparators may include: (i) no intervention/passive control (no fertility-focused education), (ii) standard education/usual care (general health, sexual, or reproductive health education without a targeted fertility component), and (iii) alternative active interventions (fertility-related programs differing in format, intensity, or content focus). For multi-arm trials, relevant intervention and comparator arms will be handled using prespecified methods to avoid double-counting (e.g., combining comparator groups or selecting the most appropriate comparator).

Context

We will consider studies reporting on fertility education interventions delivered to adolescents in any setting (e.g., school, community, or healthcare), provided that the target population is a general (non-clinical) adolescent sample and the intervention is primarily educational in nature. No restrictions will be applied by country or region.

Main Outcomes

The primary outcome is fertility awareness. Eligible studies must report at least one measurable domain of fertility awareness, including fertility-related knowledge, attitudes (e.g., perceived importance, beliefs, or self-efficacy), and intentions and/or behavioral outcomes relevant to fertility awareness. To guide categorization, the definition of fertility awareness proposed by Zegers-Hochschild et al. (2017) will be operationalized into prespecified domains, and outcomes will be grouped accordingly. Outcomes will be extracted at the earliest post-intervention assessment and, where available, at the longest follow-up. For meta-analysis, outcomes will be organized as continuous or dichotomous within each domain; effect sizes will be computed using available descriptive data (e.g., means/standard deviations, event counts).

Screening

Prior to screening, the review team will conduct a calibration training session to standardize title/abstract screening decisions and to operationalize the inclusion and exclusion criteria (without changing the review question) (Polanin et al., 2019). Two reviewers will independently screen titles and abstracts for

potential eligibility. Full texts will then be retrieved and independently assessed by the two same reviewers. Disagreements at this stage will be resolved through discussion and, if needed, consultation with a third reviewer. When full texts are not accessible, study authors will be contacted; if the full text cannot be obtained, the record will be excluded and documented as "full text unavailable." Reasons for exclusion at the full-text stage will be recorded.

Data Extraction

Records will be managed in EndNote 20 to support organization and deduplication, and then uploaded to Covidence (Veritas Health Innovation, 2025) to facilitate screening and data extraction. A standardized data extraction form will be piloted on a subset of included studies and implemented in a pre-piloted Microsoft Excel worksheet to code study characteristics and outcome data. Two reviewers will independently extract data, with discrepancies resolved by consensus or by a third reviewer.

Extracted items will include study characteristics (e.g., country, setting, recruitment, sample size), participant characteristics (e.g., mean age, sex/gender distribution, school grade), intervention and comparator characteristics (e.g., format, duration/dose, provider/facilitator, delivery setting), and outcome measurement details (instrument, scoring, and assessment time points), and explanatory variables (e.g., socio-demographic variables). Outcome data will be extracted in a form suitable for effect size computation (e.g., means/standard deviations and sample sizes for continuous outcomes; event counts and denominators for dichotomous outcomes). When necessary, effect estimates will be derived from other reported statistics (e.g., confidence intervals, p values, t/F statistics) using prespecified conversion methods. For incomplete reporting, study authors will be contacted to request missing information.

Risk of Bias Assessment

Two reviewers will independently assess methodological quality using the Effective Public Health Practice Project Quality Assessment Tool for Quantitative Studies (Effective Public Health Practice Project [EPHPP], 2010). The EPHPP evaluates studies across key domains, including selection bias, study design, confounders, blinding, data collection methods, withdrawals and dropouts, intervention integrity, and analyses, and yields an overall global rating of strong, moderate, or weak based on prespecified criteria. Disagreements will be resolved through discussion or adjudication by a third reviewer. Studies will not be excluded based on EPHPP ratings; however, ratings will be incorporated into interpretation and prespecified sensitivity analyses (e.g., excluding studies rated "weak," if sufficient studies are available) (Armijo-Olivo et al., 2012; EPHPP, 2010). When at least 10 studies are available within a meta-analysis for a given outcome/domain, funnel plots and, where appropriate, tests of funnel plot asymmetry will be used to explore small-study effects. Evidence of small-study effects will be considered when judging certainty of evidence and may contribute to rating down for publication bias. If asymmetry is observed, potential publication bias will be considered in the interpretation of the findings.

Strategy for Data Synthesis

All search steps and the study selection process will be documented in line with PRISMA-P reporting guidelines (Moher et al., 2015; Shamseer et al., 2015). Methodological quality will be assessed using the EPHPP Quality Assessment Tool (EPHPP, 1998; Thomas et al., 2025).

If the included studies are sufficiently homogeneous in terms of population, intervention, comparator, and outcome measures, a meta-analysis will be conducted to quantitatively synthesize the data. The meta-analysis will be performed using the MetaAnalysisOnline (Fekete & Győrffy, 2025). A random-effects model will be used, and statistical heterogeneity will be quantified using I^2 and τ^2. Where sufficient data are available, subgroup analyses will be conducted to explore factors such as intervention type (e.g., digital vs. in-person), gender, or geographical region. Sensitivity analyses will also be performed by excluding studies with a high risk of bias to assess the robustness of the findings.

Planned subgroups include intervention type (e.g., digital vs. in-person), participant gender, geographic region, country income classification (high-income vs. low- and middle-income countries), age group (early adolescence [12–14 years] vs. late adolescence [15–19 years]), and intervention intensity/duration. If sufficient data are available, meta-regressions will be performed to investigate the influence of study- and intervention-level characteristics on intervention effects. Interaction tests will be used to assess whether subgroup differences are statistically significant. Where appropriate, subgroup-specific pooled estimates will be presented to facilitate comparison across categories. When quantitative synthesis is not feasible for a given subgroup or outcome domain, findings will be summarized narratively to describe patterns and contextual differences.

The results will be presented as pooled effect sizes with 95% confidence intervals. For continuous outcomes, mean differences or standardized mean differences will be calculated (as appropriate to measurement scales). For dichotomous outcomes, risk ratios or odds ratios will be used. Synthesized data will be cross-checked for consistency against extracted data to ensure accuracy. Forest plots will be generated for meta-analyses.

For outcomes where meta-analysis is not feasible (e.g., due to heterogeneity or insufficient data), a narrative synthesis will be performed. Key characteristics and findings of included studies will be summarized in tables and discussed thematically. Data presentation will consist of tables and/or graphs summarizing the characteristics of the included studies, interventions, and outcomes.

Dissemination Plans

Findings from this systematic review will be synthesized in a manuscript and submitted to a peer-reviewed journal. Results will also be disseminated through presentations at academic conferences and, where appropriate, through stakeholder-oriented summaries to support educational and public health practice.

Results

No results are available at this stage, as this manuscript reports a systematic review protocol.

Discussion

Fertility education and social policies must be employed to safeguard future parenthood for the younger generation (Salazar et al., 2023). Although the importance of fertility education is increasingly recognized, most research has focused on young and emerging adults (Martins et al., 2023), and some studies suggest that increasing fertility knowledge may be associated with heightened anxiety in certain groups (Maeda et al., 2016). To effectively promote fertility awareness, multifaceted approaches across the life course have been recommended, including delivery beginning in adolescence (Sylvest et al., 2024).

Education and information on reproductive health issues are still not available to the majority of adolescents (Maqbool et al., 2019). However, targeting these populations has often elicited negative public feedback (Bhana et al., 2024; Tripathi & Sekher, 2013), as issues related to sexuality and reproductive health are particularly sensitive during adolescence and youth (Maqbool et al., 2019). In this context, adolescents' awareness of reproductive health can be hampered by cultural and social norms (Wahyuningsih et al., 2024).

Despite recent recommendations to integrate fertility education into the broader reproductive health framework at earlier ages (Boivin et al., 2018; Maqbool et al., 2019), evidence syntheses focusing specifically on fertility education interventions in adolescents remain limited, and the effectiveness of these interventions has not been conclusively quantified across randomized trials. Assessing the current state of knowledge in this area (Capotosto, 2021) and determining the most effective ways to teach young people about fertility is therefore essential (Heywood et al., 2016; Hviid Malling et al., 2022). This protocol outlines methods to address this gap through a systematic review and, where appropriate, meta-analysis.

A high degree of heterogeneity is expected in studies of outcome assessment. In accordance with the findings of Vincent and Krishnakumar (2022), such heterogeneity may hinder the conduct of statistical analyses, thereby hindering the advancement of knowledge in this domain. Furthermore, heterogeneity is expected to manifest across domains, including geographical location, intervention content, delivery methods, implementation settings, and other components. This diversity may pose challenges for isolating the most efficacious components, particularly when insufficient numbers of studies are available to support subgroup analyses.

Conclusion

This article presents a protocol for a systematic review of randomized controlled trials designed to identify the most effective components of fertility education interventions targeted at adolescents. The findings are expected to contribute to a deeper understanding of best practices and features for the development

of future interventions focusing on fertility awareness. This protocol will provide a foundation for the development of fertility education practices, support public policy decision-making, and promote reproductive health literacy among adolescents.

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Conflicts of interest: The authors report no potential competing interests.

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Contributions: **MVM:** Conceptualization; Methodology; Formal Analysis; Investigation; Resources; Writing - Review and Editing**. FBN:** Formal Analysis; Investigation; Resource; Writing - Original Draft**;** Writing - Review and Editing. **FN:** Writing - Review and Editing. **RM:** Writing - Review and Editing.

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