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Cost-effectiveness of long-acting versus short-acting contraception in adolescents: A systematic review

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ABSTRACT

Child marriage remains a global reproductive health concern, placing adolescents at high risk of early pregnancy and obstetric complications. The selection of effective and cost-efficient contraceptive methods is essential to prevent unintended pregnancies among this vulnerable population. This systematic review aimed to identify and compare the cost-effectiveness of long-acting reversible contraception (LARC) versus short-acting reversible contraception (SARC) among married adolescents. Following PRISMA 2020 guidelines with the PICO framework, we systematically searched PubMed, ScienceDirect, and Google Scholar for studies examining married adolescents aged 10–19 years using LARC methods (IUDs and implants) compared to SARC methods (oral pills, injectables, and condoms). Articles were screened using Rayyan and quality assessed using the CHEERS checklist. Data were narratively synthesized based on parameters including cost-effectiveness, cost-utility, cost-benefit, ICER, ACER, and QALY.

Of 471 articles identified, six met the inclusion criteria. Most studies employed Markov or decision tree models for economic evaluation. The findings consistently demonstrated that LARC methods were more cost-saving compared to SARC across different settings. In Indonesia, IUDs showed an ICER of USD 0.84 per pregnancy averted compared to USD 3.76 for oral pills and USD 5.18 for injectables. In India, etonogestrel implants achieved an ICUR of USD 232 per QALY, well below the national willingness-to-pay threshold. Kenya reported the lowest cost per couple-year of protection for IUDs at USD 4.87. Overall, LARC was shown to prevent more unintended pregnancies at substantially lower costs than SARC, supporting their prioritization in family planning policies to improve access and utilization among married adolescents globally.

1. Introduction

The persistently high prevalence of child marriage remains a critical challenge in global reproductive health. According to UNICEF, approximately 12 million girls worldwide are married each year before reaching the age of 18, and around 640 million adult women today were first married during childhood. Furthermore, 1 in 5 young women (aged 20–24) were married before the age of 18, placing them at increased risk of pregnancy and childbirth complications due to inadequate physical, emotional, and social readiness (UNICEF-USA, 2024).

This phenomenon underscores the urgent need for safe, effective, and sustainable contraceptive services for married adolescents. Adolescents who marry at a young age are vulnerable to early pregnancies without adequate support, making the provision of appropriate contraceptive services crucial to safeguard their reproductive health.

Within the context of married adolescents, the choice of contraceptive method plays a pivotal role in preventing unintended pregnancies and supporting healthy family planning. Short-acting reversible contraceptives (SARC) such as oral pills and injectables are commonly used due to their accessibility, yet they carry higher risks of non-compliance and reduced effectiveness (Allison et al., 2024; Beckham & Cohen, 2023; Saloranta et al., 2022). In contrast, long-acting reversible contraceptives (LARC), such as implants and intrauterine devices (IUDs), have demonstrated superior performance. A study in Finland reported that LARC use was associated with a reduced incidence of abortion compared to short-acting methods (Saloranta et al., 2022), while economic analyses in adolescents indicated that LARC is more cost-effective and reduces unintended pregnancies (Marmett et al., 2024). One notable advantage of LARC is its practical "set and forget" feature, wherein the device is inserted once and provides long-term effectiveness without requiring ongoing user action. This characteristic enables LARC to achieve higher pregnancy prevention rates compared to short-acting methods that demand strict adherence, such as daily oral pills or periodic injections (Durante et al., 2023).

Cost-effectiveness studies further reveal that long-acting methods, such as implants and IUDs, offer greater economic benefits than short-acting methods, particularly when used over extended periods. A recent review on adolescents found that LARC was more effective and cost-saving because it prevented more unintended pregnancies and had lower discontinuation rates (Marmett et al., 2024). In Brazil, a five-year comparison demonstrated that LARC methods such as implants or IUDs were more economical than oral contraceptives, largely due to their higher effectiveness and reduced need for frequent replacement or daily adherence (Farah et al., 2022). Additional research in 2023 reaffirmed that LARC reduces unintended pregnancies and generates substantial savings for health systems (Marmett et al., 2024). The United Nations Population Fund (UNFPA, 2022) reported that investments in family planning programs, including LARC, yield substantial economic returns—every USD 1 allocated to such programs can produce multiple savings, particularly through reduced demand for costly maternal and newborn care associated with unintended pregnancies.

Despite global evidence supporting the clinical effectiveness and cost-efficiency of LARC, studies specifically comparing the cost-effectiveness of LARC and SARC among married adolescents remain scarce. A health technology assessment (HTA) study by Suwantika et al. (2021) in Indonesia demonstrated that LARC methods such as implants and IUDs were more cost-effective than SARC methods, with the cost of preventing one pregnancy using LARC estimated at approximately USD 1.25, compared to USD 4.58 for short-acting methods. This cost difference became more pronounced after the implementation of the national health insurance system (BPJS Kesehatan) (Suwantika et al., 2021). However, the study did not explicitly target married adolescents as the primary population, leaving a gap in economic evidence. Other research across various countries has confirmed that LARC is more effective and efficient than SARC, particularly when used for more than one year (Moray et al., 2022). In Indonesia, the uptake of LARC remains low, accounting for only around 21% of all contraceptive users, despite evidence indicating that its adoption is strongly influenced by spousal support and contextual factors such as social norms and healthcare accessibility (Kurniatin et al., 2023).

Therefore, a systematic HTA review is warranted to synthesize current evidence on the cost-effectiveness of LARC use among married adolescents, with the aim of informing policy recommendations that are responsive to local needs. This systematic review seeks to identify and synthesize the latest evidence on the cost-effectiveness of LARC compared to SARC among married adolescents, providing a scientific basis for more equitable and efficient family planning policies and programs.

2. Method

2.1 Study Design

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (Page et al., 2022). The research question was formulated using the Population, Intervention, Comparison, and Outcome (PICO) framework. The population comprised married adolescents aged 10–19 years; the intervention was long-acting reversible contraception (LARC), including subdermal implants and intrauterine devices (IUDs); the comparison group was short-acting contraception (SARC) such as oral pills, injectables, and condoms; and the measured outcome was health economic evaluation.

A comprehensive literature search was conducted across three databases: PubMed, ScienceDirect, and Google Scholar. Search strategies employed Boolean operators (AND, OR, NOT) and truncation to broaden or narrow search results. Keywords were adapted from Medical Subject Headings (MeSH) and included combinations such as: adolescent OR adolescen* OR teen* OR youth AND copper intrauterine devices OR Long-Acting Reversible OR Contraception Intrauterine OR intrauterine device migration OR drug implants OR implant* AND cost effectiveness analysis OR cost effectiveness OR Health technology assessment OR cost benefit analyses OR cost savings OR health resources OR resource allocation OR Cost effective* OR Cost benefit*.

2.2 Inclusion Criteria

Eligible studies were those involving married adolescents aged 10–19 years, comparing long-acting contraceptive methods such as IUDs and implants with short-acting methods such as oral pills, injectables, and condoms. Included studies were required to report outcomes of health economic evaluations, including cost-effectiveness, cost-utility, cost-benefit, Incremental Cost-Effectiveness Ratio (ICER), Average Cost-Effectiveness Ratio (ACER), Quality-Adjusted Life Years (QALY), or Disability-Adjusted Life Years (DALY). Only primary research or original articles published within the last ten years (2015–2025) in either Indonesian or English, and available as free full-text, were considered to ensure completeness of data and transparency of analysis.

2.3 Exclusion Criteria

Studies were excluded if they were commentaries, editorials, opinion pieces, or literature reviews without primary data. Conference abstracts without full-text availability were also excluded. Articles that did not meet the predefined criteria for population, intervention, or outcomes, as well as those rated as low quality (Grade C) based on the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) checklist, were excluded to maintain the validity and reliability of the review findings.

2.4 Operational Definition of Variables

The following definitions were applied within the context of cost-effectiveness analysis of long-acting versus short-acting contraception in adolescents:

Long-Acting Reversible Contraception (LARC): Contraceptive methods that provide pregnancy protection for more than one year without requiring routine user maintenance. LARC in this review includes subdermal implants and intrauterine devices (IUDs). These methods are reversible, have high efficacy, and are not dependent on daily user compliance.

Short-Acting Contraception (SARC): Contraceptive methods requiring repeated or periodic use over a shorter interval (daily, weekly, or monthly). SARC in this review includes combined oral contraceptives, progestin-only pills, hormonal injections, and condoms. Their effectiveness is highly dependent on user adherence to regular use as prescribed.

Adolescents: Individuals aged 10–19 years, as defined by the World Health Organization (WHO), who, in this study, are married and within the early reproductive age range.

Cost-Effectiveness: An economic evaluation comparing the total cost of a health intervention to the clinical outcomes or benefits achieved, such as prevention of unintended pregnancy, improvement in QALY, or reduction in DALY. In this review, cost-effectiveness was assessed through reported parameters including cost-effectiveness, cost-utility, cost-benefit, ICER, and ACER in the selected studies.

2.5 Study Instrumens

The study employed the PRISMA 2020 flow diagram to illustrate the article selection process. Screening and selection of articles were conducted using Rayyan, with independent review by three researchers. Duplicate records were removed, and disagreements were resolved through discussion. Quality assessment was performed using the CHEERS checklist, which comprises 28 criteria to evaluate reporting standards for health economic evaluations. Each criterion was scored "yes" (1 point) or "no" (0 points). Studies scoring 24–28 points were graded as A (excellent), 18–23 as B (good), and below 18 as C (low). Articles graded C were excluded from further analysis.

2.6 Data Analysis

Data extraction was performed for studies meeting the inclusion criteria, covering study characteristics, population, intervention, type of economic evaluation, and reported outcomes. Extracted data were summarized in tables and analyzed narratively to compare the cost-effectiveness of long-acting and short-acting contraception among married adolescents. The analysis also identified patterns, trends, and knowledge gaps to inform policy recommendations and reproductive health service practices.

3. Results and Discussion

A. Results

A comprehensive literature search was conducted through *PubMed, ScienceDirect, and Google Scholar* using *Medical Subject Headings (MeSH)*-adapted keywords. The search yielded a total of 471 articles relevant to the specified keywords. The retrieved records were then screened using the Rayyan AI tool by all researchers. During the duplication check, 72 duplicate articles were identified and removed, leaving 435 unique records. Each researcher subsequently performed title screening in accordance with the *systematic review* theme, resulting in the exclusion of 381 articles that did not meet the eligibility criteria, leaving 54 articles. Abstract screening was then conducted, during which 45 articles were excluded for irrelevance to the research theme. The remaining 9 articles proceeded to full-text screening, where 3 were excluded for not aligning with the research objectives. Ultimately, 6 articles met all inclusion criteria and were included in this systematic review. The article selection process is illustrated in the PRISMA Flowchart adapted from The Joanna Briggs Institute (JBI) (Figure 1).

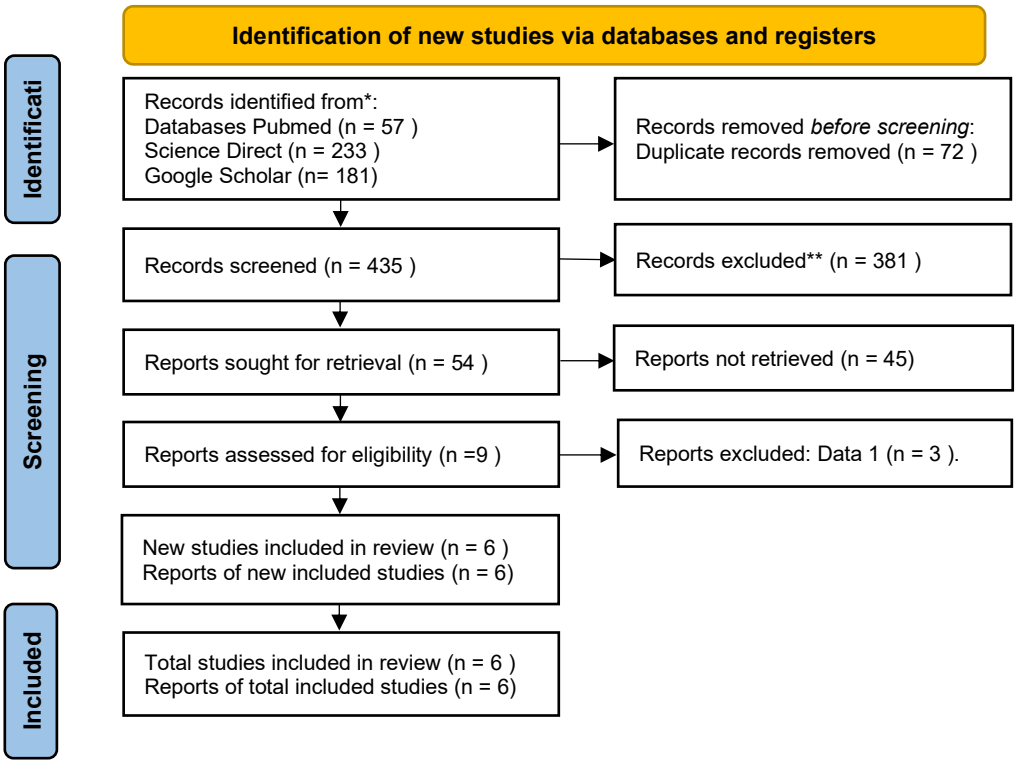

Fig. 1. PRISMA Flowchart

Table 1. Characteristics of the Reviewed Articles

No.	Author(s) (Year)	Country (Income Level)	Study Design	Type of Economic Evaluation	Population	Intervention vs. Comparator
1.	Henry et al. (2015)	Swedia (High Income)	Markov Model (3 years).	Cost-Effectiveness & Cost-Utility Analysis.	Women aged 15–44 years, users of reversible contraception.	Women aged 15–44 years, users of reversible contraception.
2.	Linet et al. (2021)	France (High-Income)	Markov Model (6 years).	Cost-Effectiveness Analysis.	Sexually active reproductive-age women in France, not intending to become pregnant.	Etonogestrel implant vs. IUDs (copper & hormonal), COC, POP, injectables.
3.	Ngacha & Ayah (2022)	Kenya (Lower-Middle-Income)	Cross-Sectional Study + Activity-Based Costing (ABC).	Cost-Effectiveness Analysis.	Users of family planning services at Kiambu County Hospital, reproductive-age women.	IUCD vs. implants (one-rod & two-rod) vs. DMPA vs. pills (based on CYP & costs).
4.	Suwantika et al. (2021)	Indonesia (Upper-Middle-Income).	Decision Tree Model	Cost-Effectiveness Analysis.	Women aged 15–49 years receiving family planning services (from BPJS data 2014–2017).	LARC (IUD, implant) vs. SARC (injectables, condoms, pills) vs. no contraception.
5.	Harun & Ahmed (2023)	Malaysia (Upper-Middle Income).	Markov Model (5 years).	Cost-Effectiveness Analysis.	83,500 women aged 20–25 years, family planning users in public clinics.	IUCD vs. implant vs. DMPA injectables vs. pills.
6.	Joshi et al. (2020)	India (Lower-Middle Income).	Markov Model (31 years).	Cost-Utility & Budget Impact Analysis.	Adolescent females aged 15 years through menopause within the public health system.	Current national family planning scenario vs. new scenario including etonogestrel implant.

In Table 1, this systematic review presents the characteristics of six health economic evaluation studies. The six analyzed articles originated from countries with varying income levels, ranging from High-Income Countries (HICs) such as the study by Henry et al. (2015) conducted in Sweden and the study by Linet et al. (2021) conducted in France to Upper-Middle-Income Countries (UMICs), represented by the study of Suwantika et al. (2021) in Indonesia and the study of Harun & Ahmed (2023), and to Lower-Middle-Income Countries (LMICs), including the study of Ngacha & Ayah (2022) in Kenya and the study of Joshi et al. (2020) in India.

Most studies employed a mathematical modeling approach, including Markov models and decision tree models, while one study applied a cross-sectional design combined with an activity-based costing approach. The Markov model was utilized in the studies by Harun & Ahmed (2023), Henry et al. (2015), Joshi et al. (2020), and Linet, Lévy-Bachelot, et al. (2021), which is particularly suited for analyzing recurrent and chronic processes over extended time horizons. Notably, the study by Joshi et al. (2020) employed a 31-year time horizon.

The interventions compared varied substantially. Henry et al. (2015) compared LNG-IUS 13.5 mg with oral contraceptives and a hormonal market mix. Linet et al. (2021) evaluated etonogestrel implants against various methods, including hormonal and copper IUDs, combined oral contraceptives, progestin-only pills, and injections. Meanwhile, Ngacha & Ayah (2022) compared multiple methods—IUCD, implants, injections, and pills—based on cost per Couple Year of Protection (CYP), rather than QALY or DALY as in utility-based evaluations. Suwantika et al. (2021) compared LARC (IUDs, implants), SARC (injections, condoms, pills), and a no-contraception scenario using national health insurance (BPJS) data, providing strong local contextual relevance. Joshi et al. (2020) compared the current national family planning scenario with an alternative scenario

incorporating etonogestrel implants into public health services. Harun & Ahmed (2023) evaluated four contraceptive interventions: IUCD, implants, injections, and pills.

Five of the six studies reported results as cost-effectiveness analyses (CEA), while one study by Joshi et al. (2020) combined cost-utility analysis (CUA) with budget impact analysis. The economic outcomes evaluated included indicators such as cost per pregnancy averted, cost per Couple Year of Protection (CYP), and QALY and ICER values as additional effectiveness parameters. Two studies from high-income countries (Henry et al., 2015; Linet et al., 2021) presented dominance-based results and utility gains, whereas studies from UMICs and LMICs (Harun & Ahmed, 2023; Suwantika et al., 2021) emphasized the direct cost-effectiveness of family planning programs using actual local data.

Overall, the findings consistently indicated that long-acting reversible contraceptives (LARC), particularly IUDs and implants, provide superior clinical effectiveness and cost efficiency compared with short-acting methods such as pills, injections, and condoms, from the perspectives of healthcare providers, payers, and society.

Table 2. Characteristics of the Reviewed Studies and Sensitivity Analyses Conducted

No.	Author(s) (Year)	Time Horizon	Perspective	Discount Rate	Probabilistic Sensitivity Analysis	One Way Sensitivity Analysis	Scenario Analysis	Model Validation
1.	Henry et al. (2015)	3 years	Societal Perspective	3%	Yes	Yes	Yes	No
2.	Linet et al. (2021)	6 years	Societal Perspective	2,5%	Yes	Yes	Yes	Yes
3.	Ngacha & Ayah (2022)	1 year	Service Provider Perspective	Not reported	No	No	No	No
4.	Suwantika et al. (2021)	4 years	Payer Perspective	Not reported	No	Yes	Yes	No
5.	Harun & Ahmed (2023)	5 years	Service Provider Perspective	3%	No	Yes	No	Yes
6.	Joshi et al. (2020)	31 years	Societal Perspective	3%	Yes	Yes	Yes	Yes

Table 2 demonstrates notable differences in the characteristics of the reviewed articles. Three studies Henry et al. (2015), Joshi et al. (2020), and Linet et al. (2021) adopted a societal perspective, encompassing both direct and indirect cost components from the viewpoints of users and the broader social system. The remaining three studies Ngacha & Ayah (2022), Suwantika et al. (2021), and Harun & Ahmed (2023) employed a provider or payer perspective, focusing on the actual operational costs within healthcare institutions or public financing schemes.

The analytical time horizons varied substantially. Ngacha & Ayah (2022) utilized a one-year horizon in accordance with their empirically driven approach based on real-world service data, whereas Joshi et al. (2020) employed a 31-year horizon to capture the entire reproductive cycle from adolescence to menopause. Other studies adopted intermediate time spans of 3–6 years, aligning with the effective duration of the respective contraceptive methods under evaluation.

Regarding the application of discounting, four studies explicitly reported annual discount rates ranging from 2.5% to 3%, consistent with global pharmacoeconomic practice. However, the studies by Ngacha & Ayah (2022) and Suwantika et al. (2021) did not specify the use of discounting, which may affect the accuracy of long-term cost estimates and limit cross-study comparability in economic validity.

One-way sensitivity analysis was employed in five out of six studies as a primary approach to assess the impact of parameter variation on model outcomes. Ngacha & Ayah (2022) was the only study that did not report sensitivity analysis, consistent with its non-simulation-based design. Furthermore, scenario analyses were conducted in four studies to evaluate the influence of variations such as user age, contraceptive method type, and duration of use on economic outcomes. Probabilistic sensitivity analysis (PSA), which tests the robustness of findings against parameter uncertainty in a comprehensive manner, was reported in three studies Henry et al. (2015), Joshi et al. (2020), and Linet

et al. (2021). These studies utilized Monte Carlo simulation–based PSA, thereby enhancing the credibility of their economic results. Model validation was explicitly reported only in the studies by Harun & Ahmed (2023), Joshi et al. (2020), and Linet et al. (2021).

Table 3. Cost and Effectiveness Outcomes from Reviewed Articles

No.	Author (s) / Year / Country	Effectiveness Outcome	Incremental Effectiveness	Increme-ntal Cost	ICER/ACER/ICUR	Summary of Findings
1.	Henry et al. / 2015 / Sweden	Unintended pregnancies prevented.	239.66 per 1,000 women.	-€ 311,350.21	ICER: LNG-IUS dominant; QALY gain: 1.35; ACER for OC: €3,502 per pregnancy prevented.	The 13.5 mg LNG-IUS yielded a cost saving of approximately €311,000, prevented 239 unintended pregnancies, and increased QALYs by 1.35 compared with oral contraception (OC) among 1,000 women.
2.	Linet et al. / 2021 / France	Unintended pregnancies prevented.	0.755–3.53 per person (depending on comparator).	€ 2,221	ICER: Copper IUD €2,221; IUD (5 years) €7,551; IUD (3 years) strictly dominated by implant; Combined oral contraceptive (COC) gen-2 €984; COC gen-3 and mini-pill strictly dominated.	The etonogestrel implant prevented 0.75%–3.53% of unintended pregnancies annually compared with copper IUDs and second-generation COCs.
3.	Ngacha & Ayah / 2022 / Kenya	Couple Years of Protection (CYP).	IUCD: $4.87; Two-rod implant: $6.36; DMPA: $23.68; Combined pill: $38.60 (per year).	Not reported	ACER: IUCD $4.87; Two-rod implant $6.36; One-rod implant $9.50; COC $23.68; Mini-pill $38.60.	IUCD was the most cost-efficient method, followed by implants, while oral contraceptives were the least efficient.
4.	Suwantika et al. / 2021 / Indonesia.	Pregnancies prevented	IUD: $0.84; Implant: $1.67; Pill: $3.76; Condom: $4.80; Injectable: $5.18 (per pregnancy prevented).	Not reported.	ICER: Implant $1.67; IUD $0.84.	IUD was the most cost-saving and effective method, supporting LARC as the primary choice.
5.	Harun & Ahmed / 2023 / Malaysia	Pregnancies prevented	63 per 83,500 women	MYR 6,736.57	ACER: IUCD MYR 43.77; ICER: Implant MYR 6,736.57	Implant was the most efficient and cost-effective in preventing pregnancies.
6.	Joshi et al. / 2020 / India	QALYs gained	1.35 QALYs	INR 16,475 (USD 232)	ICUR: INR 16,475 per QALY (USD 232).	Highly cost-effective; reduced unintended pregnancies and maternal mortality.

Table 3 presents the economic evaluation results from six distinct studies assessing the cost-effectiveness and efficiency of various contraceptive methods across diverse country contexts, ranging from integrated healthcare systems in Sweden to public financing schemes in Indonesia, India, and Kenya. Each study employed specific analytical approaches, including the Incremental Cost-Effectiveness Ratio (ICER), Average Cost-Effectiveness Ratio (ACER), and Incremental Cost-Utility Ratio (ICUR), enabling cross-method comparisons based on incremental costs and key health outcomes such as pregnancies averted or improvements in quality-adjusted life years (QALYs).

In the study by Henry et al. (2015), the LNG-IUS 13.5 mg demonstrated high effectiveness, preventing 239 pregnancies per 1,000 women over three years of use, while generating cost savings of up to €311,350. Compared with oral contraceptives (OCs), its additional effectiveness was reflected

in a QALY gain of 1.35. In the cost-effectiveness analysis, LNG-IUS emerged as a dominant method, being both more effective and less costly than Ocs, with the ACER for Ocs reaching €3,502 per pregnancy averted. This underscores that long-acting reversible contraceptives (LARCs) not only offer superior clinical benefits but also deliver substantial fiscal advantages.

Similarly, Linet et al. (2021) reinforced the advantages of etonogestrel implants in real-world settings. Using a six-year Markov model combined with probabilistic analysis, the results indicated that implants could prevent up to 3.53% of unintended pregnancies annually, depending on the comparator method. Although the ICER versus copper IUDs reached €2,221, implants remained within the optimal efficiency threshold, particularly when the French societal willingness-to-pay value was set at €10,000 per pregnancy averted. Third-generation oral contraceptives and progestin-only pills were found to be strictly dominated, indicating they are neither technically nor economically competitive with LARCs. The strength of this study also lies in its use of actual clinical data from national databases, enhancing its practical relevance.

From a low-income country context, the study by Ngacha and Ayah (2022) offered a provider perspective. The IUCD recorded a cost per couple-year of protection (CYP) of only USD 4.87, making it the most cost-efficient method compared with injectables at USD 23.68 and oral pills at USD 38.60. Although the study did not report explicit ICER or QALY measures, the efficiency rationale remains strong as IUCDs and two-rod implants provide high effectiveness, are independent of daily user adherence, and are suitable for populations with limited healthcare access.

In Indonesia, a decision-tree model from the payer perspective (National Health Insurance/JKN) again highlighted the dominance of IUDs, with an ICER of USD 0.84 per pregnancy averted, followed by implants at USD 1.67. Pills and injectables were more costly, at USD 3.76 and USD 5.18 respectively, revealing a gap between user preferences and health system efficiency. These findings confirm that LARCs are not only more cost-effective but should also be prioritized in national financing and educational strategies.

Harun and Ahmed (2023) reported that implants demonstrated high effectiveness, preventing a total of 352,994 pregnancies among 83,500 women, albeit at a substantial total cost of MYR 44,999,788. The ICER of MYR 6,736 per pregnancy averted remained within the efficient category. While IUCDs prevented slightly fewer pregnancies, their ACER of MYR 43.77 indicated optimal cost efficiency. Injectables and oral contraceptives were classified as dominated, being more expensive and less effective.

Joshi et al. (2020) presented the most comprehensive approach, with a 31-year time horizon. The use of etonogestrel implants from age 15 until menopause yielded an ICUR of only INR 16,475 per QALY (USD 232), far below the national willingness-to-pay threshold of INR 137,945. In a hypothetical population, implant use was projected to prevent more than 7.34 million unintended pregnancies, 4.23 million births, 37,000 abortions, and 59 maternal deaths. This study was the only one to explicitly integrate clinical, fiscal, and social outcomes within a national budgetary framework.

Table 4. *Checklist consolidated health economic evaluation reporting standars* (CHEERS).

No.	Author(s)	Henry et al., (2015)	Linet et al., (2021)	Ngacha & Ayah, (2022)	Suwantika et al., (2021)	Harun & Ahmed, (2023)	Joshi et al., (2020)
1.	Title	1	1	1	1	1	1
2.	Abstract	1	1	1	1	1	1
3.	Background and objectives	1	1	1	1	1	1
4.	Health economic analysis plan	0	1	0	0	1	1
5.	Study population	1	1	1	1	1	1
6.	Setting and location	1	1	1	1	1	1
7.	Comparators	1	1	1	1	1	1
8.	Perspective	1	1	1	1	1	1
9.	Time horizon	1	1	0	1	1	1
10.	Discount rate	1	1	0	0	1	1
11.	Selection of outcomes	1	1	1	1	1	1
12.	Measurement of outcomes	1	1	1	1	1	1
13.	Valuation of outcomes	1	1	1	1	1	1
14.	Measurement and valuation of resources and costs	1	1	1	1	1	1
15.	Currency, price date, and conversion	1	1	1	1	1	1

16.	Rationale and description of model	1	1	0	0	0	0
17.	Analytics and assumptions	1	1	1	1	1	1
18.	Characterizing Heterogeneity	1	1	1	1	1	1
19.	Characterizing distributional effects	0	0	0	0	0	0
20.	Characterizing uncertainty	1	1	1	1	1	1
21.	Approach to engagement with patients and others affected by the study	0	1	0	0	1	1
22.	Study parameters	1	1	1	1	1	1
23.	Summary of main results	1	1	1	1	1	1
24.	Effect of uncertainty	1	1	1	1	1	1
25.	Effect of engagement with patients and others affected by the study	0	1	0	0	0	0
26.	Study findings, limitations, generalizability, and current knowledge	1	1	1	1	1	1
27.	Source of funding	1	1	1	1	1	1
28.	Conflicts of interest	1	1	1	1	1	1
	TOTAL	**24 Excellent**	**27 Excellent**	**18 Good**	**21 Good**	**23 Good**	**24 Excellent**

Studies were classified into three quality grades: Grade A (excellent), Grade B (good), and Grade C (low). Studies fulfilling 24–28 checklist items were assigned Grade A, those meeting 18–23 items were assigned Grade B, and those meeting fewer than 18 items were assigned Grade C.

B. Discussion

Assessing the Cost-Effectiveness of Long-Acting and Short-Acting Contraception in Adolescents

Adolescents often face complex challenges in managing their reproductive health, ranging from emotional instability to inadequate economic and social readiness. Unplanned pregnancies in adolescents pose high medical and psychosocial risks, making the choice of effective and efficient contraceptive methods crucial. Long-acting reversible contraceptives (LARC), such as implants and intrauterine devices (IUDs), demonstrate significant advantages over short-acting reversible contraceptives (SARC). Multiple global studies have confirmed that although LARC involves higher initial costs, its long-term effectiveness in preventing pregnancy makes it considerably more cost-effective. For example, Henry et al. (2015) reported savings of €311,350 per 1,000 LNG-IUS users compared to oral contraceptives. Similarly, Linet et al. (2021) found that the etonogestrel (ENG) implant is more effective for younger age groups, including married adolescents(Henry et al., 2015; Linet, Lévy-Bachelot, et al., 2021).

Evidence from developing countries also supports the cost-effectiveness of LARC. In Kenya, the IUD required only USD 4.87 per couple-year of protection (CYP) (Ngacha & Ayah, 2022), while in Indonesia, the cost per pregnancy averted was as low as USD 1.25—substantially more economical than other methods (Suwantika et al., 2021). Malaysia and India reported long-term efficiency of implants, with cost savings amounting to billions of local currency units and substantial reductions in unintended pregnancy rates (Harun & Ahmed, 2023; Joshi et al., 2021).

Economic Evaluations Comparing LARC and SARC in Adolescents

Henry et al. (2015) combined cost-effectiveness analysis (CEA) and cost-utility analysis (CUA) in a three-year model to project the effectiveness and costs of LNG-IUS compared to oral contraceptives (OC). This evaluation considered not only direct costs such as device prices but also indirect costs, including productivity losses from unplanned pregnancies, thus offering a realistic and comprehensive decision-making framework (Henry et al., 2015). Linet et al. (2021) integrated real-world data from the national health insurance system into a population-level model of women of reproductive age, analyzing seven reversible contraceptive methods with detailed effectiveness and cost parameters (Linet, Lévy-Bachelot, et al., 2021).

In Kenya, Ngacha and Ayah (2022) adopted a micro-costing, context-specific approach by conducting direct facility observations and interviewing healthcare providers to estimate activity-based costs (Ngacha & Ayah, 2022). In Indonesia, Suwantika et al. (2021) utilized local data from the National Health Insurance (JKN) system and constructed a decision tree model to compare the cost-

effectiveness of LARC and SARC in the context of public health financing. This study is particularly important as it provides nationally relevant evidence to inform health policy(Suwantika et al., 2021). Similarly, Joshi et al. (2020) developed a Markov model with a 31-year horizon, from age 15 to menopause, incorporating epidemiological, service cost, and quality of life (QALY) data to assess the long-term effectiveness of the ENG implant (Joshi et al., 2020). This aligns with Amalia et al. (2023), who concluded that IUDs are more cost-effective than implants in global analyses (Amalia et al., 2023). Despite methodological variations, all these studies converge on the economic justification for prioritizing LARC in high-risk populations such as adolescents.

Cost-Effectiveness Outcomes: Cost per QALY or Cost per Case Averted

International studies consistently highlight the superiority of LARC in terms of both effectiveness and cost-efficiency. Henry et al. (2015) found that although the QALY gain from LNG-IUS use was modest (2,467.61 vs. 2,466.25), the lower total costs yielded substantial impact at the population level. Linet et al. (2021) showed that ENG implants were more effective in preventing pregnancies than second-generation pills and copper IUDs, with ICER values of €2,221 and €984 per pregnancy averted, respectively.

Efficiency advantages are also clear in low- and middle-income countries. In Kenya, IUDs cost only USD 4.87 per CYP, far below DMPA injections (USD 23.68) and oral pills (USD 38.60) (Ngacha & Ayah, 2022). In Indonesia, the average cost per pregnancy averted using LARC was USD 1.25—with IUDs at USD 0.84 and implants at USD 1.67—compared to pills (USD 3.76), condoms (USD 4.80), and injections (USD 5.18) (Suwantika et al., 2021). In Malaysia, Harun and Ahmed (2023) reported the lowest average cost-effectiveness ratio (ACER) for IUDs at MYR 43.77 per pregnancy averted. In India, Joshi et al. (2020) found that the ENG implant had an ICER of INR 16,475 (USD 232) per QALY—well below the national willingness-to-pay threshold—making it highly cost-effective in public health settings.

ICER Comparison Between Long- and Short-Acting Contraception

The incremental cost-effectiveness ratio (ICER) is a key determinant in identifying the most efficient contraceptive method. A low ICER indicates that a method delivers substantial additional health benefits at an acceptable—or even reduced—additional cost. LNG-IUS emerged as a dominant strategy, offering greater health benefits at lower total costs compared to OC (Henry et al., 2015). Linet et al. (2021) further reinforced this finding, noting a 79.5% probability that the ENG implant is the most cost-effective option at a €10,000 willingness-to-pay threshold per pregnancy averted.

While Ngacha and Ayah (2022) did not explicitly calculate ICERs, their CYP-based cost data suggest that IUDs and implants are far more efficient than SARC. For example, in Indonesia, the ICER for IUDs was USD 0.84 per pregnancy averted compared to USD 5.18 for DMPA injections (Suwantika et al., 2021). Even in cases where ICER values were relatively high, such as MYR 6,736.57 for implants versus IUDs in Malaysia, they remained well within the national willingness-to-pay threshold of MYR 50,000 (Harun & Ahmed, 2023). Similar stability was observed in India, where Monte Carlo simulations confirmed the ENG implant's robustness as a cost-effective intervention (Joshi et al., 2021). In the United States, Trussella et al., (2015) demonstrated that IUDs and implants had substantially lower ICERs than oral contraceptives, often emerging as dominant strategies.

Long-Term Economic Impact and Policy Implications

The cost-effectiveness of LARC carries economic and social implications far beyond QALY or ICER values. Unplanned adolescent pregnancies are associated with multi-dimensional consequences, including school dropout, intergenerational poverty, and increased maternal and infant mortality. Henry et al. (2015) emphasized that LNG-IUS use could reduce both direct healthcare costs and productivity losses, contributing to sustainable development. Linet et al. (2021) projected an additional 8,000 unintended pregnancies annually if ENG implant use declined among adolescents, with significant fiscal and social repercussions.

Ngacha and Ayah (2022) highlighted that long-term funding allocation for adolescent contraception aligns with principles of social equity. In Indonesia, LARC is recommended within the JKN scheme to reduce high-cost deliveries and pregnancy-related complications (Suwantika et al., 2021). Malaysia and India underscore the importance of subsidies and education in maximizing LARC effectiveness (Harun & Ahmed, 2023; Joshi et al., 2020). The integration of LARC into public service

delivery in India required less than 1% of the national health budget while potentially saving up to USD 1 billion.

Both Henry et al. (2015) and Linet et al. (2021) demonstrated that LNG-IUS and ENG implants are consistently more cost-effective than oral contraceptives and other short-acting methods in high-income settings. In Kenya, Kungu et al., (2024) reported that every USD 1 invested in LARC generated USD 6 in reproductive healthcare savings. This underscores LARC's high return on investment across both high- and middle-income countries. Evidence from Indonesia (Suwantika et al., 2021) and India (Joshi et al., 2020) supports the prioritization of LARC over SARC in national financing schemes. Similarly, Santiago & Novais, (2023) showed that a multi-pronged intervention in Brazil combining sex education, community services, and LARC provision improved distribution efficiency and reduced adolescent pregnancies by 45%. Collectively, these findings affirm that integrating LARC into public health systems is both an economically sound and socially impactful strategy across diverse settings.

4. Conclusion

Long-acting reversible contraceptives are more cost-effective than short-acting methods among married adolescents, supporting their prioritization in family planning policies to improve access and utilization.

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