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Systematic Review of Integrated Weed Management Strategies in Maize (*Zea mays* L.) Cultivation

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ABSTRACT

Weeds are a major constraint in maize cultivation, causing global yield losses averaging about 37%, with reported ranges of 20% to 80% depending on weed pressure and management.
Effective weed control is therefore critical, particularly during the vulnerable period between 4 to 7 weeks after sowing. This systematic review aims to evaluate and synthesize current approaches to Integrated Weed Management (IWM) in maize cultivation to support farmers, researchers, and agricultural specialists in identifying sustainable and effective weed control strategies. Although various weed control methods exist, comprehensive comparisons of their effectiveness, sustainability, and long-term impacts on soil health and productivity in maize-based systems remain limited. A systematic search was conducted across major scientific databases including Google Scholar, Web of Science, Scopus, and PubMed using keywords such as "Integrated Weed Management," "biological methods," "chemical weed control," "mechanical methods," "cultural practices," and "herbicide risks." Articles were screened based on relevance and methodological quality. The findings show that although chemical herbicides are widely used due to efficiency and lower labor requirements, excessive reliance can result in herbicide resistance, soil degradation, and environmental harm. In contrast, IWM strategies integrating crop rotation, mechanical control, cover crops, bio herbicides, and precision agriculture offer more sustainable outcomes. The review also highlights the potential of herbicide-resistant maize cultivars and natural herbicides in reducing dependence on synthetic chemicals. Future research should focus on optimizing IWM strategies for specific agro ecological zones and enhancing adoption of sustainable practices at the farm level.

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INTRODUCTION

Maize (Zea mays L.) is one of the world's most important cereal crops, ranking third after rice and wheat, and is often referred to as the "Miracle crop" or the "Queen of cereals" due to its high genetic yield potential (Krishnaprabhu, 2020). It plays a vital role as a staple food for humans, feed for livestock, and a raw material for multiple industrial applications, thanks to its rich nutritional profile comprising 28% to 80% starch, 10–15% protein, 5–6% fat, 9–15% fiber, and essential vitamins and minerals (Krishnaprabhu, 2020). Despite its global importance, maize productivity is significantly limited by weed infestation, which competes with the crop for essential resources such as water, nutrients, and sunlight, and can also harbor pests and diseases (Arvadiya et al., 2012). Such pressures can lead to yield reductions up to 82–84% during the growing season.

In Afghanistan, maize cultivation faces similar challenges. According to FAOSTAT, in 2022 the harvested area for maize was about 0.139 million ha, with a yield of approximately 2.24 t ha^{-1}, resulting in a total production of roughly 0.312 million tons. This is well below the global average (~5.8 t ha^{-1}), indicating a substantial yield gap, primarily due to limited use of improved hybrids, suboptimal agronomic practices, and socio-environmental constraints (FAO, 2022). Poor weed management, high weed pressure, and improper planting methods are among the main factors contributing to low productivity, as wide row spacing increases vulnerability to early-stage weed competition, causing yield losses of 27%–60% (Kumar & Reddy, 2000).

Historically, weed control relied on manual labor and simple mechanical tools such as hand hoes or bullock-drawn implements, which were labor-intensive and time-consuming. The advent of chemical herbicides improved efficiency, with pre-emergence herbicides such as atrazine, when combined with timely cultural practices and hand weeding, effectively reducing weed pressure in maize fields (Hanke et al., 2010; Jat & Gaur, 2000; Singh et al., 1991). However, increased reliance on herbicides has led to the emergence of herbicide-resistant (HR) weed species. To date, 383 HR weed biotypes have been reported across 208 species worldwide, with glyphosate resistance found in 23 species in over 20 countries (Igrc & Maceljski, 1993).

These trends highlight the urgent need for alternative and more sustainable weed control strategies. Integrated Weed Management (IWM), which combines chemical, cultural, biological, and mechanical methods, has gained increasing attention as a viable solution. IWM offers multiple advantages, including reduced herbicide reliance, environmental protection, labor efficiency, and sustainable long-term productivity. Nevertheless, challenges such as extreme heat during manual weeding (June–August) and continued herbicide use, which can lead to resistance development, species shifts, and pollution, remain.

The specific objectives of this review are to:

- Critically evaluate the effectiveness of different IWM approaches in maize cultivation.
- Assess the practicality and sustainability of cultural, mechanical, chemical, and biological weed control methods.
- Identify research gaps and limitations in current IWM studies.
- Provide evidence-based recommendations to enhance sustainable weed management and policy development.

METHODS AND MATERIALS

This systematic review was conducted following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure methodological rigor and transparency in reporting. The study aimed to identify, evaluate, and synthesize relevant literature on integrated weed management (IWM) in maize (Zea mays L.).

Search Strategy

A comprehensive literature search was conducted across Google Scholar, Web of Science, Scopus, and PubMed databases to identify relevant studies. Boolean operators (AND/OR) were used to combine keywords related to three main categories:

1. Core concepts: "Integrated Weed Management," "Weed Control," "Maize," "Chemical control," "Cultural practices."
2. Regional context: Studies conducted in global maize-producing regions.
3. Outcomes/mechanisms: "Weed density," "Yield response," "Environmental impact."

Publications from 1982 to 2021 were considered. After deduplication, the initial search yielded 410 records.

Inclusion and Exclusion Criteria

The review included studies that specifically investigated IWM strategies in maize, encompassing field trials and experimental studies. Articles were included if they reported weed control efficiency, yield performance, or integrated management approaches. Exclusion criteria were:

- Non-maize crops
- Narrative reviews or conference abstracts without full texts
- Studies lacking clear methodological description
- Duplicate publications

Study Selection

After title and abstract screening, 250 irrelevant studies were excluded. Full-text review of 160 articles resulted in 110 exclusions due to methodological weaknesses, irrelevance to maize, or focus on other crops. Finally, 65 studies met the inclusion criteria and were included in the qualitative synthesis.

Data Extraction and Analysis

Data were systematically extracted using a standardized form, including:

- Study location and experimental design
- Types of weed management interventions

- Measured outcomes (weed density, yield, environmental impact)
- Key findings and conclusions

Given the heterogeneity of study designs and outcomes, a qualitative synthesis was conducted.

Quality Assessment

All included studies were critically appraised for credibility, methodological transparency, coverage comprehensiveness, and relevance to ensure high-quality evidence and minimize bias.

FINDINGS

This section presents the key findings of the systematic review, highlighting the multifaceted challenges posed by weeds in maize cultivation. Weeds are a major biotic constraint affecting crop growth and yield, and their management requires a comprehensive understanding of their definitions, species diversity, and competitive interactions with crops. The review also examines the potential risks associated with herbicide use and the resulting yield losses due to weed infestation. Furthermore, different weed management strategies, including chemical, cultural, biological, and mechanical approaches, as well as integrated weed management, are explored to provide insights into sustainable and effective control practices.

To provide a detailed overview of the dominant weed species reported across studies, the following section presents Table 1, which summarizes the major weed species identified in maize cultivation under diverse agro-ecological conditions.

A comprehensive understanding of weed flora composition is fundamental for developing effective and sustainable weed management strategies in maize cultivation. Weed species composition and dominance are influenced by agro-climatic conditions, cropping history, soil type, and management practices, which collectively determine the nature and intensity of crop–weed competition. Variations in weed communities across regions and seasons often result in differing responses to control measures. In this context, summarizing dominant weed species reported in previous studies provides valuable insights into commonly occurring and problematic weeds in maize-based cropping systems. Therefore, Table 1 presents an overview of the major weed species identified across different studies conducted under diverse locations, seasons, and experimental conditions.

Table 1. *Dominant weed species in maize cultivation across different studies*

Weed Type	Dominant Weed Species	Location / Season	Author(s) & Year
Grass, Sedge, Broadleaf	*Cynodon dactylon, Cyperus rotundus, Amaranthus viridis, Chenopodium album, Parthenium hysterophorus*	Experimental site	Laitinen, Sari, & Siimes, 2007
Grass, Sedge, Broadleaf	*Cynodon dactylon, Cyperus rotundus, Parthenium hysterophorus, Chenopodium album*	Field experiment	Babiker et al., 2013

Grass, Broadleaf	*Phalaris minor, Poa annua, Chenopodium album*	Winter season	Sutton et al., 2002
Grass, Sedge, Broadleaf	*Cynodon dactylon, Cyperus rotundus, Amaranthus viridis, Parthenium hysterophorus*	Kharif season	Kamble et al., 2005
Grass, Sedge, Broadleaf	*Polygonum spp., Cyperus rotundus, Cynodon dactylon, Digitaria ciliaris*	Field	Mukherjee & Rai, 2015
Grass, Sedge, Broadleaf	*Cynodon dactylon, Echinochloa spp., Cyperus rotundus, Parthenium hysterophorus*	Experimental field	Swetha, 2015
Grass, Sedge, Broadleaf	*Trianthema portulacastrum, Cynodon dactylon, Cyperus rotundus*	Experimental maize field	Klopfenstein et al., 2013
Grass, Sedge	*Cyperus rotundus, Cynodon dactylon, Digitaria sanguinalis*	Experimental field	Malviya et al., 2012
Grass, Sedge, Broadleaf	*Trianthema portulacastrum, Cynodon dactylon, Cyperus rotundus*	Maize field	Rasool & Khan, 2016
Grass, Sedge	*Cyperus rotundus, Echinochloa colona, Digitaria sanguinalis*	Field	Sanodiya et al., 2013
Grass, Sedge, Broadleaf	*Cynodon dactylon, Cyperus rotundus, Parthenium hysterophorus*	Field experiment	Paradkar & Sharma, 1993
Grass, Sedge	*Echinochloa colona, Digitaria sanguinalis, Cyperus rotundus*	Field study	Sreenivas & Satyanarayana, 1996
Grass, Broadleaf	*Phalaris minor, Chenopodium album*	Experimental field	Chopra & Angiras, 2008
Grass, Broadleaf	*Cynodon dactylon, Dactyloctenium aegyptium, Amaranthus viridis*	Maize field	Kumar & Reddy, 2000
Broadleaf, Sedge	*Trianthema portulacastrum, Digera arvensis, Cyperus rotundus*	Field experiment	Pandey et al., 2001
Grass, Broadleaf	*Parthenium hysterophorus, Cynodon dactylon, Commelina benghalensis*	Field trial	Ramesh & Nadanassababady, 2005
Grass, Broadleaf	*Phalaris minor, Chenopodium album*	Field condition	Thakur & Sharma, 1996
Grass, Sedge	*Echinochloa spp., Digitaria spp., Cyperus rotundus*	Field experiment	Saikia & Pandey, 1999
Grass, Broadleaf	*Trianthema portulacastrum, Cynodon dactylon*	Experimental maize field	Singh et al., 2015
Grass, Broadleaf	Mixed weed flora	Field observation	Evans et al., 1997

The data summarized in Table 1 reveal that maize fields are typically infested by a complex and heterogeneous weed community consisting of grasses, sedges, and broadleaf weeds. Grassy weeds such as *Cynodon dactylon*, *Digitaria spp*., *Setaria spp*., and *Echinochloa spp*. were repeatedly reported across multiple studies, indicating their strong adaptability and competitive potential in maize cropping systems. Sedges were predominantly represented by *Cyperus rotundus*, which appeared consistently across most locations, highlighting its widespread distribution and persistent nature. In addition, aggressive broadleaf weeds including *Parthenium hysterophorus*, *Amaranthus viridis*, *Trianthema portulacastrum*, and *Digera arvensis* were frequently observed, further intensifying weed pressure. The diversity and recurrence of these weed species across studies suggest that maize cultivation faces multifaceted weed challenges, underscoring the necessity of integrated and site-specific weed management strategies rather than reliance on a single control approach.

Table 2 presents a comparative overview of different weed management strategies in maize production systems. Effective weed management is crucial for maintaining maize productivity, as uncontrolled weeds compete with crops for nutrients, moisture, light, and space. Various strategies—including chemical, cultural, mechanical, biological, and integrated approaches—have been evaluated under diverse agro-ecological conditions. Each approach differs in effectiveness, cost, labor requirement, and environmental impact.

Table 2 summarizes the key findings from the literature regarding the performance of these strategies in suppressing weeds and improving maize yield.

Table 2. *Yield impact and effectiveness of different weed management strategies in maize*

Weed Management Strategy	Key Findings	References
Chemical control (herbicides: atrazine, pendimethalin, paraquat, glyphosate, nicosulfuron)	Effective in reducing weed biomass, flexible, labor-saving; overuse can lead to resistance and environmental concerns	Paradkar & Sharma, 1993; Sreenivas & Satyanarayana, 1996; Chopra & Angiras, 2008; Bhowmik et al., 1992; Kumar & Reddy, 2000; Pandey et al., 2001; Laxmi Praveen & Bhanu Murthy, 2005
Cultural control (hand weeding, hoeing, intercropping, mulching)	Manual weeding twice at critical stages increased grain yield; intercropping and mulching improved weed suppression and crop competitiveness	Ramesh & Nadanassababady, 2005; Thakur & Sharma, 1996; Saikia & Pandey, 1999; Sharma et al., 2000; Kamble et al., 2005; Tripathi et al., 2003
Biological control (allelopathy, phytophagous organisms)	Allelopathic mulches and corn gluten meal inhibited weed germination; grazing and bioagents reduced weed pressure	Gough & Carlstrom, 1999; Intodia et al., 1996; Madhavi et al., 2013; Gowtham & Thalkar, 2020
Mechanical control (hoe, harrow, brush weeder, tractor implements)	Efficient weed removal, increased maize yield, particularly when combined with interculturing; high labor requirement	Sinha et al., 2003; Sreenivas & Satyanarayana, 1994; Saikia & Pandey, 1999; Singh et al., 2015
Integrated Weed Management (IWM)	Combining herbicides, hand weeding, intercropping, mulching, and cultural practices maximized yield and weed suppression; reduced chemical dependency	Krishnaprabhu, 2020; Naher et al., 2019; Sanodiya et al., 2013; Verma et al., 2009; Ehsas et al., 2016; Paradkar & Sharma, 1993; Rasool & Khan, 2016

As illustrated in Table 2, chemical weed control methods, particularly the use of pre- and post-emergence herbicides, were generally effective in reducing weed biomass and improving maize yield while offering flexibility and reduced labor requirements. However, several studies reported concerns related to herbicide resistance, environmental contamination, and long-term sustainability associated with repeated herbicide use. Cultural practices such as hand weeding, hoeing, intercropping, and mulching showed substantial improvements in weed suppression and crop yield, especially when implemented during critical stages of crop–weed competition, although these methods were often labor-intensive. Mechanical weed control methods also contributed positively to yield enhancement but required appropriate equipment and operational costs. Biological control approaches exhibited variable effectiveness and were mainly supplementary in nature.

Notably, integrated weed management strategies consistently resulted in superior weed control and higher maize yields by combining chemical, cultural, and mechanical methods, thereby reducing sole dependence on herbicides and promoting more sustainable maize production systems.

Table 3 summarizes reported maize yield losses attributed to weed infestation under different management scenarios. Weed infestation is widely recognized as one of the most significant constraints to maize production worldwide, particularly when control measures are delayed or inadequately implemented. Quantifying yield losses associated with weed interference is essential for demonstrating the economic significance of effective weed management and for guiding management decisions.

Table 3. *Yield loss due to weed infestation in maize*

Study / Source	Weed Infestation Scenario	Yield Loss (%)
Heap, 2012	Fields with mixed weed species	33–50
Evans et al., 1997	Delay in weed control beyond critical period	up to 65
Shrestha et al., 2018	Prolonged weed infestation	28–100
Saini & Angiras, 1998; Saini et al., 2013	Extended weed presence	28–100
FAO, 2021	General observations on maize yield losses	~37 (global average)

The results presented in Table 3 clearly indicate that weed infestation can cause considerable reductions in maize yield, ranging from moderate losses to complete crop failure under severe conditions. Delayed weed control beyond the critical period of crop–weed competition was identified as a major factor contributing to extreme yield losses, sometimes exceeding 60%. Prolonged weed interference throughout the growing season was also associated with yield losses approaching 100% under high weed density. Global assessments suggest that weeds account for an average maize yield reduction of approximately 37%, emphasizing the widespread impact of weed competition on productivity. These findings underscore the critical importance of timely and integrated weed management strategies to minimize yield losses and ensure sustainable maize production.

SUMMARY OF FINDINGS

This review summarizes evidence on weed diversity, crop–weed competition, and weed management in maize systems. Results show that weed pressure varies by region and growth stage and can cause severe yield losses if not controlled. Timely weed control during critical periods is essential for protecting maize yield. Integrated weed management emerged as the most effective and sustainable approach across studies.

Weed Diversity in Maize Fields

The systematic review identified a total of 76 weed species associated with maize, including 26 grassy weeds, 45 broadleaf weeds, and 5 sedges (Laitinen, Sari, & Siimes, 2007; Babiker, Salah, Siraj, & Mukhtar, 2013; Sutton et al., 2002; Kamble et al., 2005; Mukherje & Rai, 2015;

Swetha, 2015; Klopfenstein et al., 2013; Madhavi et al., 2014; Malviya et al., 2012; Ravisankar et al., 2013; Rasool & Khan, 2016; Sanodiya et al., 2013; Arvadiya et al., 2012). The dominant species varied seasonally and regionally, with Cynodon dactylon, Cyperus rotundus, Parthenium hysterophorus, and Chenopodium album appearing frequently across studies.

Crop-Weed Competition and Yield Loss

Weeds compete with maize for nutrients, water, light, and space, significantly affecting growth and yield. Critical periods of weed competition occur between 15 to 45 days after planting, during which uncontrolled weeds can cause yield losses ranging from 28% to 100% (Kumar et al., 2015; Arvadiya et al., 2012; Evans et al., 1997; Shrestha et al., 2018; Saini et al., 2013; Heap, 2012; FAO, 2021).

Chemical Weed Control

Chemical herbicides, including atrazine, pendimethalin, nicosulfuron, oxyfluorfen, and glyphosate, have been widely applied to manage weeds effectively. Pre- and post-emergence applications reduce weed density and biomass, ultimately improving maize yield (Sutton et al., 2002; Paradkar & Sharma, 1993; Sreenivas & Satyanarayana, 1996; Chopra & Angiras, 2008; Bhowmik et al., 1992; Dale Monks et al., 1996; Kumar & Reddy, 2000; Pandey et al., 2001; Laxmi Praveen & Bhanu Murthy, 2005).

Cultural and Mechanical Weed Control

Manual weeding, hoeing, intercropping, mulching, and crop rotation are highly effective in reducing weed biomass and increasing maize yield. Hand weeding at critical growth stages (15–40 DAS) consistently produced higher grain yields, sometimes comparable or superior to pre-emergence herbicides (Ramesh & Nadanassababady, 2005; Thakur & Sharma, 1996; Saikia & Pandey, 1999; Kakade et al., 2016; Sharma, Toor, & Sur, 2000; Kamble et al., 2005; Tripathi, Tewari, & Prasad, 2003; Sinha et al., 2003; Sreenivas & Satyanarayana, 1994; Ishrat et al., 2012; Singh et al., 2015).

Biological Weed Control

Biological approaches, including the use of phytophagous organisms, plant pathogens, and allelopathy, provide sustainable long-term weed suppression. Examples include eucalyptus leaf mulch and corn gluten meal, which inhibit germination and early growth of weeds (Gough & Carlstrom, 1999; Intodia, Yadav, & Tomar, 1996; Madhavi et al., 2013; Gowtham & Thalkar, 2020; Numata, 1982).

Integrated Weed Management (IWM)

Combining chemical, cultural, mechanical, and biological methods under IWM frameworks consistently improved weed control efficiency, crop growth, and yield. Strategies such as herbicide application followed by hand weeding, intercropping with legumes, mulching, and mechanical weeding reduced weed biomass and enhanced maize productivity (Swanton & Weise, 1991; Krishnaprabhu, 2020; Naher et al., 2019; Sanodiya, Jha, & Shrivastava, 2013;

Verma, Tewari, & Dhermi, 2009; Goeden, 1988; Mathukia et al., 2014; Ehsas et al., 2016; Paradkar & Sharma, 1993; Bhuvaneswari, Muthusankaranarayanan, & Avudaithai, 2002; Reddy, Sundari, & Kumar, 2002; Mundra, Vyas, & Maliwal, 2002; Pandey, Prakash, Singh, & Mani, 2001; Saha & Srivastava, 1992; Deshmukh, Jathore, & Raskar, 2008; Abdullahi, Ghosh, & Dawson, 2016; Rasool & Khan, 2016; Kumar et al., 2015; Kumar, Prasad, Mandal, & Kumar, 2017; Mathukia et al., 2014; Sanodiya, Jha, & Shrivastava, 2013).

DISCUSSION

The findings of this systematic review demonstrate that an integrated approach to weed management in maize cultivation is more effective and sustainable than relying on a single method, directly addressing the study's primary objective of evaluating IWM strategies. Chemical weed control remains the most widely adopted method globally due to its convenience, rapid action, and reduced labor input (Sutton et al., 2002). However, prolonged and unregulated use of herbicides—particularly glyphosate—has led to significant concerns, including herbicide resistance, soil degradation, and potential human health risks (Myers et al., 2016; Hawaldar & Agasimani, 2012). These findings align with previous studies, highlighting both the efficiency and the limitations of sole chemical control methods.

Mechanical and cultural practices, such as hand weeding, hoeing, intercropping, mulching, and green manuring, have shown considerable promise in reducing weed biomass and enhancing maize yields, particularly when applied at critical growth stages (Kamble et al., 2005; Sharma et al., 2000; Krishnaprabhu, 2020). By combining mechanical or cultural methods with chemical strategies, IWM systems exploit complementary mechanisms: suppressing weed emergence, conserving soil moisture, and improving soil fertility. This integrative approach addresses a critical research objective of assessing the practicality and sustainability of multiple weed management methods.

Although less commonly adopted in commercial agriculture, biological control contributes to long-term sustainability by utilizing natural enemies or allelopathic interactions to limit weed growth (Madhavi et al., 2013). Examples such as corn gluten meal or eucalyptus mulch demonstrate that integrating allelopathic strategies can provide effective pre-emergence weed suppression (Gowtham & Thalkar, 2020). These findings extend previous research by showing how biological methods, when incorporated into IWM, enhance ecological balance and reduce dependency on herbicides.

Several studies confirm that combining pre-emergence herbicides with manual or mechanical weeding, such as atrazine application followed by hand weeding at 30–45 DAS, consistently improves maize yield and economic returns (Ehsas et al., 2016; Ramesh & Nadanassababady, 2005; Abdullahi et al., 2016). Furthermore, IWM approaches incorporating intercropping systems—such as maize with green gram or soybean—create dense canopy cover that limits light availability for weed germination, improving biodiversity and long-term soil health (Sanodiya et al., 2013; Verma et al., 2009). These results confirm that site-specific, multi-strategy approaches offer both ecological and agronomic advantages.

Despite these benefits, the adoption of IWM remains limited in many regions due to lack of awareness, insufficient training, and restricted access to bioherbicides or mechanical tools. Recognizing these limitations is crucial for guiding future research and extension efforts. Localized IWM models tailored to specific agro-ecological zones and active farmer education programs are essential to facilitate widespread implementation and sustainable maize production.

In conclusion, this review reinforces that a paradigm shift from herbicide-dominated weed control to integrated, multi-strategy approaches is essential. By combining cultural, mechanical, biological, and chemical strategies in a site-specific manner, IWM effectively addresses the complex challenges of weed management, advances sustainable agricultural practices, and safeguards environmental and human health.

CONCLUSION

Weeds significantly reduce maize productivity by competing for water, nutrients, and light, causing global yield losses estimated at around 37%, with reported local reductions ranging from 20% to 80% depending on infestation intensity and crop growth stage. Evidence suggests that relying on a single control method is insufficient for sustainable management. Integrated Weed Management (IWM), which combines chemical, biological, mechanical, and cultural strategies, provides a more holistic and effective approach.

Adopting IWM not only reduces dependence on chemical herbicides—thereby minimizing environmental contamination and protecting soil fertility—but also lowers production costs and enhances long-term agricultural sustainability. Incorporating bio herbicides, crop rotation, cover crops, and the development of herbicide-resistant maize cultivars can further strengthen weed control while mitigating environmental risks.

Future research should focus on locally adapted IWM strategies, long-term field evaluations, and optimization of combined management practices. Implementing comprehensive and integrated approaches enables farmers to achieve higher productivity, reduce yield losses, maintain environmental health, and ensure sustainable maize production over time.

AUTHORS CONTRIBUTIONS

The author solely conceptualized, conducted the literature search, analyzed the data, and wrote the manuscript. The author reviewed and approved the final version of the manuscript.

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CONFLICT OF INTEREST STATEMENT

The author declares that no financial, personal, or professional conflicts of interest exist regarding the publication of this manuscript.

DATA AVAILABILITY STATEMENT

The data supporting the findings of this review are derived from the literature and are available through the cited publications. No original data were created.

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