



Conservation of the Endemic *Lilium philippinense*: A Systematic Review

John Michael A. Guerzon¹, Anne Christine M. Cabrera², Christine Mae D. Casayuran³, Gian Vincent V. Castro⁴, Sophia F. Lindawan⁵, Jamie N. Tabia⁶

Department of Biology, School of Nursing, Allied Health, and Biological Sciences, Saint Louis University, Baguio City, Philippines 2600¹

 jmaguerzon@slu.edu.ph

RESEARCH ARTICLE INFORMATION	ABSTRACT
Received: January 10, 2026 Reviewed: May 9, 2026 Accepted: June 10, 2026 Published: June 30, 2026  Copyright © 2025 by the Author(s). This open-access article is distributed under the Creative Commons Attribution 4.0 International License.	<i>Lilium philippinense</i>, commonly known as Benguet lily, is an endemic plant species that is native to the Cordillera Administrative Region (CAR) of Northern Luzon in the Philippines. Despite its status as a high-priority endemic plant species, the conservation status of this species remains a major concern due to its declining population caused by anthropogenic activities and intrinsic biological constraints. This study aimed to systematically synthesize existing research on the threats to and conservation of <i>Lilium philippinense</i> and identify study gaps to support future conservation planning and research. This analysis used a systematic review that followed the PRISMA guidelines to gather and analyze five peer-reviewed studies published from 2010 to 2025. A total of 42 records were screened, and after applying the inclusion criteria, five articles met the final requirements for the synthesis. This study reveals that the survival of <i>Lilium philippinense</i> is impacted by land development that is primarily attributed to urbanization and unregulated plant collection practices. Although there are conservation efforts in place, it was reported that there is low reproductive success in both <i>in situ</i> and <i>ex situ</i> methodologies, consistently demonstrating poor growth and low survival rates. This study highlights the need to apply research findings to future conservation plans and actions by strengthening policies that protect their habitat, improving propagation techniques, and addressing ecological knowledge gaps to enhance the long-term survival of <i>Lilium philippinense</i>.

Keywords: *Lilium philippinense*, Benguet lily, conservation, systematic literature review, biodiversity

Introduction

Lilium philippinense Baker is an endemic species in the Cordilleras of Northern Luzon, Philippines. It is commonly known as “Benguet lily”. It is a perennial herbaceous plant with trumpet-shaped white to pale pink flowers, long lanceolate leaves, and a bulbous underground structure typical of the genus *Lilium* (Li et al., 2013). It has recently been classified as “vulnerable” due to its narrow distribution and exposure to stresses from human activities. Similar threats have been observed among other native and endemic plant species in the Philippines, where habitat disturbance and human activities continue to affect plant diversity and long-term conservation efforts (Tasani & Barcellano, 2024). As a result, interest in its conservation has grown, leading to several studies exploring its biological, ecological, and anatomical aspects. However, existing studies remain dispersed across different research areas, limiting a comprehensive understanding of the species’ overall conservation status, and have yet to be critically evaluated in a consolidated framework.

Prior studies have emphasized the significance of both *in situ* and *ex situ* conservation strategies. In the study by Ampaguey et al. (2002), *in vitro* micropropagation was used to conserve *Lilium philippinense*, and the technique facilitated the mass production of identical plant clones in a laboratory setting. Using a similar *in vitro* approach, Alipio and Ladilad (2005) reported that bulb-scale propagation, together with low-temperature stratification and rooting hormone treatments, has enhanced shoot and root development of this species. These results are the basis for the practical approaches applied in *in situ* and *ex situ* propagation to conserve the *Lilium philippinense*. Despite this success, the number of studies remains limited to propagation and lacks extensions to conservation planning.

The work of Balangcod (2009) corroborates these findings, citing several propagation challenges and noting conservation efforts for *Lilium philippinense* in Northern Luzon, such as vegetative propagation and seed-based methods. Despite their potential as a conservation tool, the results of their study showed inconsistencies due to environmental factors and a lack of a standardized protocol. The study provided valuable data by mapping the species’ limited geographic range, primarily in high-altitude grassland habitats. The study primarily focused on identifying conservation priority areas.

Building on these findings, Balangcod (2011) conducted another study to investigate the geographic range of *Lilium philippinense*. This time, they identified 15 natural sites within the Cordilleras (statutorily designated as the Cordillera Administrative Region, or CAR). Most populations were found above 1,000 meters in elevation, primarily in Benguet, Mountain Province, and adjacent areas. These species were observed as small, isolated, and fragmented clusters, making them highly susceptible to genetic erosion. This study emphasized the need for localized conservation strategies due to these spatial patterns.

Additionally, this study also noted the insufficiency of active protection and documentation in many of these sites. These findings further indicate that *Lilium philippinense* is highly habitat-specific, restricted to high-elevation forest and grassland ecosystems in the CAR. Despite this, integration of spatial distribution data with ecological and conservation management studies remains limited.

Anatomical and morpho-developmental studies were conducted to understand the growth mechanisms and developmental stages of this species. For instance, Paltayan-Bugtong et al. (2023) described the anatomical and morphological traits of *Lilium philippinense* under both field and laboratory conditions. Despite providing general knowledge about this species, the study did not test how different environmental variables, such as light intensity and elevation, can affect anatomical development, as it focused solely on the species' anatomy and morphology rather than the factors surrounding it and their effects on development. Moreover, the absence of comparative analyses with related *Lilium* species limits their generalizability and the advancement of species-specific cultivation protocols. This results in an incomplete ecological interpretation of species development.

Additionally, the medicinal and phytochemical potential of *Lilium* species has been examined in broader studies, including those listed in Wang et al. (2025). While most focus on other *Lilium* species in China and Korea, their study offered clues to possible applications of *Lilium philippinense* in future pharmacological research. For example, this study has shown antimicrobial, anti-inflammatory, and antioxidant activities in related species, yet no such biochemical investigation has been conducted specifically on *Lilium philippinense*. This indicates a gap in the ethnobotanical exploration of the species, which could have implications for its sustainable use, conservation value, and potential medicinal applications.

A taxonomic perspective was presented in a study by Paltayan-Bugtong et al. (2023), in which *Lilium philippinense* was discussed alongside other Southeast Asian lilies. The study noted that the species is morphologically distinct but underrepresented in regional botanical collections. It emphasized the species' rarity and horticultural value, while highlighting the lack of long-term conservation programs targeting endemic *Lilium* species in the Philippines. It also identified the need for further fieldwork and herbarium documentation to preserve genetic and morphological diversity.

Collectively, the reviewed studies reflect an expanding but fragmented body of knowledge on *Lilium philippinense*, encompassing research on geographic distribution, cultivation techniques, morpho-anatomical development, and taxonomic identification. While these studies provide valuable individual insights, there is no comprehensive synthesis that critically assesses the scope, trends, and limitations of the existing literature. This gap reflects a lack of integration across disciplines, in which anatomy, ecological distribution, and phytochemical potential are studied independently rather than as interconnected components of species conservation. This fragmentation limits the ability to correlate and incorporate evidence across studies, resulting in a weak foundation for conservation planning, population management strategies, and habitat prioritization efforts for the species.

Therefore, a systematic review is necessary to synthesize existing studies, carefully evaluate current knowledge, and produce an integrated, evidence-based study that can guide effective conservation efforts and research priorities for *Lilium philippinense*. In line with this, the study sought to systematically review the existing literature on current conservation efforts and ecological research findings related to *Lilium philippinense* to identify insights to guide future protection and management practices in CAR, address fragmentation in research, and support a more integrated understanding of the species.

Methods

A systematic literature review was primarily used to identify the research articles, evaluate them, and synthesize their findings, focusing on the conservation of *Lilium*

philippinense. The Sample, Phenomenon of Interest, Design, Evaluation, and Research type (SPIDER) framework was employed to establish preliminary inclusion and exclusion criteria (see Table 1) based on the study's objectives (Methley et al., 2014). This was used as a guide to identify the initial sample of research articles to be screened. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (Page et al., 2021) were the primary reference used in the review. This is composed of a 27-item checklist that screens the number of research articles included in the review.

Google Scholar was also used as the primary database for this study due to its broad coverage of multidisciplinary scholarly literature. A Boolean search strategy was employed to identify relevant studies on *Lilium philippinense* with the primary search terms: “*Lilium philippinense*” OR “Benguet Lily” AND “conservation” OR “ecology” OR “distribution” OR “habitat” OR “propagation”. The search was limited to studies published from 2010 to 2025 to capture recent research relevant to the conservation of *L. philippinense*. The literature search was conducted on July 14, 2025.

Table 1. Inclusion and Exclusion Criteria

Criteria Type	Inclusion Criteria	Exclusion Criteria
Time Frame	Research articles published from 2010 to 2025	Research articles published between 2010 and 2025
Topic Relevance	Studies must focus on <i>Lilium philippinense</i> (Benguet Lily)	Studies on other <i>Lilium</i> species or unrelated plants
Geographic Focus	Research conducted in the Philippines, specifically in the Cordillera	Studies outside the Philippines
Type of Research	Primary research articles that are published in peer-reviewed journal publications	Review papers, conference abstracts, or non-peer-reviewed articles.
Language	English (or Filipino with English abstract/full translation)	Non-English/Filipino papers with no available translation
Database	Research articles in Google Scholar	Research articles that are not in Google Scholar

Figure 1 shows the flow of the screening and selection process performed in this systematic review. The screening process and the presentation of the flow diagram were based on the published work of Abutin et al. (2026) and modified to reflect the procedures employed in the present study. A total of 44 articles were retrieved after the initial search. Two (2) articles were removed after duplicate checks using Zotero. Afterward, 32 articles were further screened out after a closer assessment using the inclusion and exclusion criteria and the PRISMA checklist. Also, two (2) additional articles were removed after full-text assessment because they were relevant to the research topic and satisfied the eligibility criteria. Finally, five (5) research articles were included for analysis. The small sample size already reflects the limited number of peer-reviewed research studies currently available on *Lilium philippinense*.

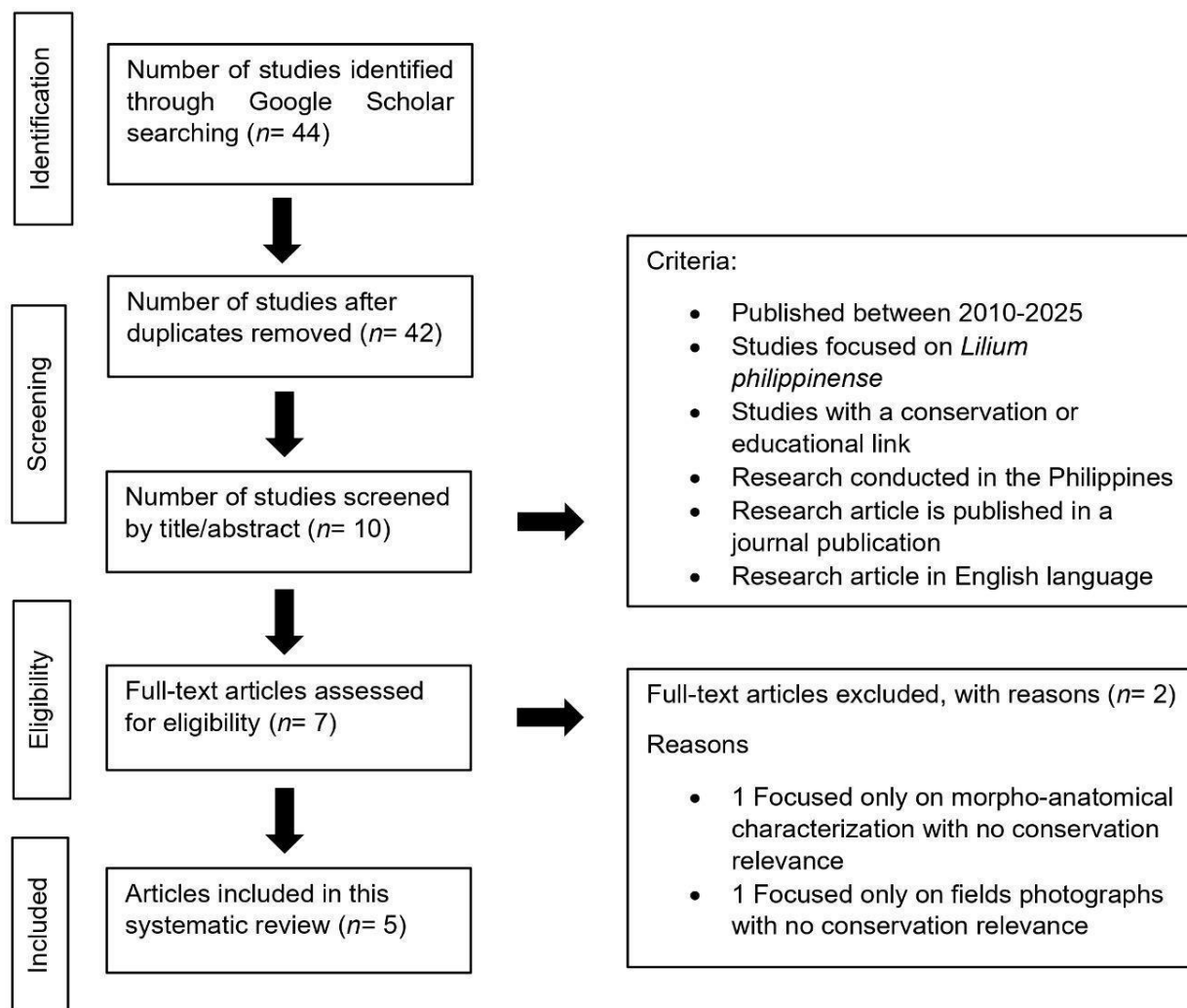


Figure 1. Research Article Screening Process

The relatively small number of included studies reflects the limited peer-reviewed research available on *Lilium philippinense*. Nevertheless, these studies represent the relevant and currently available evidence for identifying conservation priorities and research gaps.

The extracted information from the five included studies was organized to facilitate comparison across studies. Based on the reported findings, the studies were organized into four major themes: (1) geographic range and habitat characteristics, (2) human-induced threats, (3) *in situ* and *ex situ* conservation practices, and (4) gaps in research coverage. These themes provided a structured framework for presenting and discussing the current state of knowledge on the conservation of *Lilium philippinense*. The findings were then examined to identify patterns, areas of agreement, and knowledge gaps that could contribute to future research and conservation efforts.

Ethical Considerations

This systematic review primarily used secondary data from open-access research articles. This means that there were no plants, animals, or humans involved in the data collection process. The reference materials were all cited and acknowledged in

accordance with a recognized citation format. Academic integrity is ensured by not fabricating data that is grounded in the research articles screened.

Results and Discussion

Distribution Patterns of *Lilium philippinense*

In terms of geographic range and habitat characteristics, *Lilium philippinense* occurs within a limited, discontinuous range in the Cordillera Central of Luzon Island. Balangcod et al. (2011) documented 118 natural populations located along the southwestern slopes of Benguet and Mountain Provinces at elevations ranging from 754 to 2,155 meters. These populations were commonly found in steep, grassy habitats on well-drained highland slopes that experience minimal human disturbance. Using Geographic Information System (GIS) tools, they identified additional areas that may be suitable for the species. They showed that factors such as elevation, soil characteristics, and organic matter play important roles in determining its distribution. Paltayan-Bugtong et al. (2023) further reported that the species possesses unique structural characteristics that may contribute to its ability to survive in mountainous environments. Likewise, Alipio-Ayban et al. (2019) observed that although the species could be cultivated under greenhouse conditions, successful growth still depended on maintaining environmental conditions similar to those in its natural habitat, underscoring the importance of considering the plant species' habitat characteristics.

From these, it can be understood that *Lilium philippinense* is highly dependent on specific habitat conditions, making the species particularly susceptible to environmental changes and habitat disturbance. It is consistently shown across the reviewed studies that the species thrives under a narrow set of environmental requirements, meaning a high level of habitat specialization. In conservation biology, species with specialized habitat requirements are often more sensitive to environmental change because their ability to adjust to new or altered conditions is limited. In addition, the fragmented distribution may contribute to population isolation and the gradual loss of genetic diversity, both of which can negatively affect the long-term persistence of the species.

Major Threats Affecting *Lilium philippinense*

Evidence from the reviewed studies indicates anthropogenic threats which accentuate that human activities are among the primary factors contributing to the decline of *Lilium philippinense*. Land-use changes, such as road construction, agricultural expansion, and the collection of plants from natural populations, were frequently identified as threats that reduce both the availability and quality of suitable habitats for the species. Balangcod (2011) further demonstrated, using Geographic Information System (GIS) modeling, that areas capable of supporting *Lilium philippinense* have decreased over time due to continued human development.

Apart from habitat-related threats, several studies also highlighted biological challenges that may hinder the species' recovery. Propagation efforts have generally been limited by low germination rates and slower plant growth under controlled conditions compared with those observed in natural habitats. These findings suggest that the conservation of *Lilium philippinense* is complicated not only by external pressures from human activities but also by biological characteristics that limit its natural recovery. In general, the available evidence indicates that the combined effects of habitat loss and inherent biological constraints drive the species' decline. As suitable

habitats continue to shrink, the species faces fewer opportunities for establishment and survival, while low germination rates and slow growth further reduce its capacity to rebuild populations. If these factors continue to act simultaneously, they may increase the likelihood of population decline and place the species at greater risk of local extinction.

Conservation Strategies: Current Insights and Challenges

***In Situ* Conservation Efforts**

The studies included in this review consistently highlighted the importance of *in situ* conservation, which aims to protect *Lilium philippinense* within its natural habitat. Balangcod et al. (2011) recommended prioritizing the protection of areas where existing wild populations remain. Using Geographic Information System (GIS) modeling, Balangcod (2011) also identified additional locations that may be suitable for future conservation or reintroduction efforts. Paltiyon-Bugtong et al. (2023) noted that certain anatomical characteristics of the species can serve as useful markers for field identification. Proper identification can help minimize the unintentional collection of the species and improve monitoring activities in natural populations.

Correct identification of *Lilium philippinense* may also support conservation by distinguishing it from surrounding vegetation and by helping locate reproductive individuals that are important for maintaining population stability. Such information can support more effective habitat management, monitoring, and conservation planning. Although the reviewed studies provided several recommendations for protecting the species, none of them documented an existing conservation program specifically dedicated to *Lilium philippinense*. This indicates that, despite the growing body of knowledge on the species' ecology, distribution, and propagation, relatively few efforts have translated these findings into on-the-ground conservation actions. Bridging the gap between scientific research and practical conservation remains an important step toward ensuring the long-term survival of the species. To strengthen conservation efforts, local and national stakeholders may consider developing coordinated management programs that build upon existing scientific recommendations and research findings.

***Ex Situ* Propagation Challenges and Opportunities**

In addition to *in situ* conservation, studies have explored *ex situ* approaches such as greenhouse cultivation and laboratory-based propagation. Despite these efforts, success has remained limited. Balangcod et al. (2011) reported that *Lilium philippinense* seeds and bulbs exhibited low germination rates, while plants grown from seeds required long periods before reaching maturity. Similarly, Alipio-Ayban et al. (2019) found that plants propagated *in vitro* grew more slowly than those grown under natural conditions. These findings indicated that laboratory-based propagation alone cannot fully overcome the challenges associated with maintaining and increasing populations of the species. The difficulties encountered in *ex situ* propagation are largely linked to poor germination, slow growth, and the challenge of recreating the environmental conditions required for healthy development outside the species' natural habitat.

Despite these limitations, some studies have identified approaches that may improve propagation efforts. Paltiyon-Butong et al. (2023) developed mathematical models relating plant height to reproductive potential, providing a practical tool for selecting individuals with higher propagation value. While such methods may enhance

ex situ conservation efforts, the available evidence suggests they are unlikely to prevent the decline of wild populations when used alone. Additional studies emphasized that the *ex situ* conservation method, particularly through germplasm collection and plant propagation, can help protect endemic plant species. According to Madrid's (2023) study, he used these specific methods to support efforts to conserve the declining population of endemic fruit plants in Isabela. Likewise, the same *ex situ* method could be applied to conserve *Lilium philippinense* and preserve its genetic diversity. For this reason, protecting natural populations and their habitats remains a key aspect of conserving *Lilium philippinense*. At the same time, *ex situ* approaches can complement these efforts by producing planting materials and safeguarding genetic resources. Rather than being treated as separate or competing strategies, *in situ* and *ex situ* conservation are most effective when applied together. Combining both approaches allows conservation programs to maintain natural ecological processes in the wild while also supporting population reinforcement and genetic preservation through propagation efforts.

Gaps in Research and Future Research Directions

Gaps in Research Coverage

One common issue across all studies is the limited geographic scope of research. Most studies were conducted in Benguet and Mountain Provinces, while other areas within the Cordillera Central Range, such as Abra, Apayao, Kalinga, and Ifugao, have received little research attention. As a result, additional populations or suitable habitats may remain undocumented. Another important gap is the absence of long-term monitoring studies that examine population survival growth trends over extended periods.

The literature also provided limited information on the reproductive biology of *Lilium philippinense*, particularly regarding pollination and seed dispersal under natural conditions. This lack of information makes it difficult to develop well-informed conservation strategies and evaluate whether future interventions will effectively support the long-term persistence of the species. These research gaps further restrict the development of conservation plans grounded in scientific evidence. Without a clearer understanding of population dynamics, reproductive ecology, and habitat requirements, identifying priority conservation areas and implementing appropriate recovery measures becomes more challenging.

Another concern is the relatively small number of studies that specifically focus on *Lilium philippinense*. Due to the limited evidence available, meaningful comparisons across research areas remain difficult, and broad conclusions should be approached with caution. The findings presented in this review, therefore, represent the current state of knowledge but would benefit from validation through additional studies. Despite these limitations, the existing literature points to several important directions for future ecological, reproductive, and conservation research. Differences in research methodology also present challenges when comparing findings across studies. The reviewed literature included GIS-based habitat modeling, greenhouse and *in vitro* propagation experiments, and morpho-anatomical investigations, each addressing different aspects of the species. While these approaches contribute valuable insights, variations in study design and objectives limit direct comparisons and emphasize the need for more integrated research efforts in the future.

Conclusion and Future Works

The limited amount of published research on *Lilium philippinense* suggests that this endemic species has not received the level of scientific attention needed to support its long-term conservation. As a result, important aspects of its biology, ecology, and population status remain poorly understood, making conservation planning more difficult. The limited number of studies available for review also points to a broader concern in Philippine biodiversity research: many endemic plant species remain understudied despite increasing pressures on their natural habitats.

The conservation of *Lilium philippinense* depends not only on generating new research but also on putting existing knowledge into practice. Local government units, conservation organizations, academic institutions, and relevant government agencies can play a greater role in turning scientific findings into conservation programs and management plans. Protecting habitats affected by land conversion, infrastructure development, and unregulated plant collection remains essential. In contrast, continued research on reproduction, population dynamics, and habitat management can provide information needed for more effective conservation decisions. Beyond the species itself, the situation of *Lilium philippinense* reflects the challenges faced by many endemic plants in the Philippines. It emphasizes the importance of continued efforts to study and protect the country's biological diversity.

Future research would benefit from exploring areas of the Cordillera Central Range that have received little scientific attention, as additional populations of *Lilium philippinense* may remain undocumented. Long-term field studies are also needed to better understand changes in population size, survival, and growth over time. Further improvements in propagation techniques, particularly the development of more efficient and reliable tissue culture methods, may help strengthen ongoing conservation efforts. In addition, Geographic Information System (GIS) mapping could be used to identify habitats that warrant priority protection and potential restoration. Another area is the application of research findings to conservation practice. Examining how ecological and biological information can be incorporated into local management strategies and conservation policies may help bridge the gap between research and implementation. Closer integration between scientific studies and conservation planning could contribute to more effective habitat protection and improve the long-term survival of wild populations.

The involvement of multiple stakeholders, including local communities, researchers, and government agencies, is equally important for the success of conservation initiatives. Collaborative efforts can increase public awareness, encourage habitat stewardship, and support the sustainable management of remaining populations. Ultimately, the available studies point to the need for stronger coordination among research, conservation, and policy sectors to ensure the continued protection of *Lilium philippinense* and the habitats on which it depends.

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Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Artificial Intelligence (AI) Declaration Statement

The authors acknowledge the use of OpenAI's ChatGPT for formatting and structural suggestions during the preparation of this manuscript. Additionally, Grammarly AI was used to assist with language refinement, and Scribbr was used to ensure adherence to APA citation formatting standards.

These tools were used solely for technical and editorial support. They were not involved in the study design, data collection, data analysis, interpretation of results, or the development of the manuscript's original scientific content. All outputs generated with these tools were critically reviewed, validated, and revised by the authors. The authors take full responsibility for the content of this manuscript and affirm its accuracy, originality, and academic integrity.