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Review

Management of Municipal Solid Waste: A Comparative Analysis between Togo and Brazil

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Abstract: Given the increasing generation of municipal solid waste (MSW) in developing countries, this study compares MSW management systems in Brasília (Brazil) and Lomé (Togo), focusing on institutional structures, collection systems, regulations, and operational challenges. Although several studies discuss the environmental impacts of waste, there remains a significant research gap regarding the comparative role of municipal authorities and governance structures in waste management systems across developing countries. This study adopts a qualitative comparative case study approach, based on document analysis of 37 institutional, legal, and scientific sources published between 2010 and 2025. The findings reveal major disparities between the two cities. In Brazil, the municipal recycling rate reached 4.5% in 2025, while Brasília recorded operational improvements of 5.6% in waste collection, 4.3% in street-cleaning services, and 43.3% in reverse logistics. In contrast, in Lomé, annual waste generation exceeds 350,000 tons, while less than 35% is properly collected, and approximately 83.5% remains inadequately managed nationwide. Informal waste pickers account for nearly 55% of collection operators in Lomé, underscoring the reliance on informal systems. The study demonstrates that Brasília benefits from more advanced regulatory frameworks and institutional coordination. In contrast, Lomé faces severe limitations in infrastructure, financing, informality, and the lack of specific waste management legislation. The study concludes that strengthening governance mechanisms, integrating informal workers, investing in technological innovation, and promoting circular economy policies are essential for improving waste management systems in developing countries. Future studies should prioritize empirical investigations involving residents, waste pickers, and municipal authorities better to understand behavioral and institutional barriers to sustainable waste management.

Keywords: municipal solid waste; waste management; circular economy; developing countries; public policy

JEL: Q53; O13; Q56

1. Introduction

Municipal solid waste (MSW) management has become one of the most pressing environmental and public health challenges in developing countries, particularly in rapidly urbanizing regions of Sub-Saharan Africa and South America. According to the United Nations Environment Program [1], global waste generation is expected to increase significantly in the coming decades, while inadequate collection, treatment, and disposal systems continue to affect low disproportionately- and middle-income countries. It emphasizes that inefficient governance

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structures, insufficient financial investment, weak institutional coordination, and limited technological capacity remain among the principal barriers to sustainable waste management in developing economies [2].

Recent comparative studies have demonstrated that municipalities play a central role in coordinating waste collection systems, implementing environmental regulations, integrating informal waste pickers, and promoting circular economy practices [3–5]. In Sub-Saharan Africa, waste management systems are frequently characterized by fragmented governance, informality, insufficient infrastructure, and low collection coverage, particularly in peripheral urban areas [6,7]. Similarly, in South America, despite important regulatory advances such as Brazil's National Solid Waste Policy, major challenges persist regarding selective collection, recycling rates, technological modernization, and policy continuity [8,9].

Although the literature has substantially advanced in its discussion of environmental impacts, circular economy strategies, and technological solutions for municipal solid waste management, important research gaps remain. First, there is still limited comparative research examining how local governance structures and municipal institutional capacities influence the effectiveness of waste management systems across developing countries. Second, comparative studies of African and Latin American urban contexts remain scarce, particularly regarding the interactions among formal institutions, informal actors, and public policies [10]. Third, recent global reports, including UNEP (2024) [1], call for more context-specific analyses that can identify operational, institutional, and financial barriers to sustainable waste governance.

In this context, comparing Brasília (Brazil) and Lomé (Togo) offers an important opportunity to analyze how different institutional arrangements, regulatory frameworks, and operational capacities shape municipal solid waste management outcomes in two developing-country capitals with distinct governance trajectories [11].

Therefore, this study aims to compare municipal solid waste management systems in Brasília and Lomé, focusing on collection systems, regulatory frameworks, institutional governance, participation of informal actors, operational challenges, and public policy implementation. The study also seeks to identify structural limitations and opportunities for improving sustainability, circular economy practices, and environmental governance in developing urban contexts.

2. Challenges in Solid Waste Management in Developing Countries

Rapid industrialization, accelerated urbanization, and population growth have significantly increased the challenges of solid waste management in developing countries. These issues reveal a series of structural and institutional deficiencies, underscoring the serious risks that inadequate waste management poses to the environment and public health. According to Rashid et al. [5], in Pakistan, for example, 90% of waste is left untreated.

The difficulties are multifactorial, involving socio-cultural, economic, and administrative factors [12], which exacerbate environmental impacts. This dynamic clearly demonstrates the need for tailored solutions adapted to local conditions, as well as public policies that promote integrated management systems, sustainable financing, and accessible technologies.

The textile waste sector presents even more acute challenges. Sanjrani et al. [13] note that, due to the absence of specific policies and the scarcity of infrastructure, developing countries often resort to incineration and landfilling, thereby increasing environmental risks and reducing the recovery of valuable materials. As these unsustainable practices persist, they have serious consequences for human health and natural resources [10].

It is important to note that numerous non-governmental organizations are engaged in the collection of municipal solid waste, including plastics, steel, iron, aluminum, electronic waste, and organic residues, in countries such as South Africa, Uganda, Ethiopia, Kenya, Zimbabwe, Nigeria, Ghana, Togo, and Benin, among others. However, a significant gap remains in the recycling and valorization of materials through advanced technologies in developing countries, particularly in African nations. Although a substantial portion of solid waste is collected, it comprises diverse materials that often require differentiated treatment processes. Moreover, there is a lack of specific and adequate treatment for recovered waste streams [14].

Greenhouse gas emissions from municipal solid waste management activities are particularly pronounced in most Sub-Saharan African countries compared with many developed nations. In addition, waste across much of Africa is commonly disposed of directly on land, limiting effective control over greenhouse gas emissions. Furthermore, only a limited number of sustainable development projects have been effectively implemented and formally registered in the region [15].

With the growing dissemination of circular economy (CE) initiatives in developed countries in recent years, African nations are expected to benefit increasingly from circular models that transform both avoidable and unavoidable food waste into valuable resources. Such models could significantly mitigate environmental impacts while simultaneously addressing food insecurity [2].

A similarly critical situation can be observed in Latin America. Despite regulatory advances, such as Brazil's National Solid Waste Policy (Law No. 12.305/2010) [16] and national strategies adopted in Argentina, open dumpsites persist, and heavy-metal contamination of soil and groundwater remains a serious concern [8]. The difficulty in effectively implementing legal frameworks reflects the absence of robust fiscal and financial mechanisms to support the rehabilitation of degraded areas [11].

Galavote et al. [3] emphasize that municipal waste management in developing contexts must address specific operational challenges, including low levels of source segregation, high moisture content, heterogeneous waste composition, and limited sorting and processing capacity. Additionally, the informal recycling sector, although economically significant, often operates at the margins of regulatory systems, complicating the implementation of sustainable waste management models.

Rapid, uneven urbanization further excludes peripheral communities from access to formal waste collection and management services, as observed by Arya and Shukla [4]. In these areas, informality frequently emerges as the only available alternative, albeit constrained by logistical limitations, lack of equipment, and weak institutional support. This scenario underscores the urgency of integrated strategies that reconcile social inclusion, economic viability, and environmental protection [17].

In low-income urban areas, waste collection and processing rates are significantly lower, thereby intensifying public health and sanitation risks. According to [7], the composition of waste, characterized by high organic content and low calorific value, limits the adoption of waste-to-energy technologies, thereby hindering the transition toward more advanced circular solutions.

Despite these challenges, solid waste also represents a considerable opportunity. Heidari-Maleni et al. [18] highlight the potential for energy recovery and resource reutilization through composting, anaerobic digestion, and biofuel production. However, realizing this potential requires integrated public policies, adequate infrastructure investment, public awareness initiatives, and the promotion of technological innovation.

Finally, as noted by Rashed [19], only through coordinated efforts among governments, the private sector, and civil society will it be possible to overcome structural barriers and establish environmentally sustainable, economically viable, and socially just solid waste management systems in developing countries.

3. Methods

This study adopts a qualitative comparative case study approach to analyze solid waste management systems in Brasília (Brazil) and Lomé (Togo). The research design follows a most-different systems comparative logic [20], since the two capitals present distinct institutional capacities, governance structures, socioeconomic contexts, and regulatory frameworks, while facing similar challenges related to rapid urbanization, environmental degradation, informality, and municipal waste management.

The study combines qualitative document analysis and comparative content analysis to investigate institutional arrangements, collection systems, public policies, governance structures, and operational challenges associated with municipal solid waste management in both cities.

3.1 Data Sources and Document Selection

The empirical corpus consisted of 37 documents published between 2010 and 2025, including scientific articles, government reports, legislation, municipal plans, institutional reports, and publications from international organizations. The documents were retrieved from Sage, Google Scholar, Scopus, Springer, IPEA, government repositories, and institutional databases.

The following search strings were used in English, Portuguese, and French: "municipal solid waste management" AND "Brazil" AND "governance"; "municipal solid waste" AND "Togo"; "waste governance" AND "developing countries"; "circular economy" AND "municipal waste"; "solid waste policy" AND "Lomé"; "solid waste policy" AND "Brasília"; "informal waste sector" AND "Africa" AND "Latin America".

The document selection process followed four operationalized criteria: (i) Thematic relevance: documents needed to explicitly address municipal solid waste management, public policies, recycling systems, informal waste pickers, environmental governance, or circular economy practices; (ii) Geographic relevance: documents had to focus on Brazil, Togo, Sub-Saharan Africa, South America, or comparative developing-country contexts; (iii) Institutional credibility: preference was given to peer-reviewed articles, official legislation, government reports, institutional publications, and reports from international organizations such as UNEP; (iv) Temporal relevance: priority was assigned to documents published between 2020 and 2025, while seminal references published before 2020 were retained when theoretically relevant.

Documents were excluded when they: (a) focused exclusively on hazardous or industrial waste; (b) lacked full-text availability; (c) did not address governance or management dimensions; or (d) presented duplicated information.

The complete list of analyzed documents is available in Table 1.

Table 1. Documents analyzed in the study.

No.	Document/Reference	Type	Year	Country/Scope	Database/Source
1	[21]	Institutional Report	2024	Brazil	ABREMA
2	[22]	Government Report	2024	Brazil	Senado Federal
3	[23]	Scientific Article	2021	Brazil	Google Scholar
4	[4]	Scientific Article	2025	International	Scopus
5	[24]	Methodological Book	2011	International	Book
6	[25]	Scientific Book	2021	Brazil	Institutional Publication
7	[26]	Scientific Chapter	2015	Togo	Scopus
8	[27]	Institutional Report	2014	Africa/Caribbean	Institutional Repository
9	[16]	Federal Legislation	2010	Brazil	Government Repository
10	[28]	Government Plan	2025	Brazil	Ministry Repository
11	[29]	Institutional Report	2019	Brazil	CNI
12	[30]	Scientific Chapter	2019	International	Google Scholar
13	[31]	Methodological Book	2011	International	Sage
14	[32]	District Legislation	2013	Brazil	SINJ/DF
15	[33]	Scientific Article	2025	Brazil	Google Scholar
16	[34]	Institutional Report	2017	International	EMF
17	[3]	Scientific Article	2025	Developing Countries	Scopus
18	[35]	Institutional Report	2011	International	GIZ
19	[18]	Scientific Article	2023	Iran	Scopus
20	[36]	Institutional Report	2025	Brazil	Institutional Website
21	[37]	Government Report	2020	Brazil	IPEA
22	[7]	Scientific Article	2024	Developing Countries	Scopus
23	[38]	Scientific Article	2014	Togo	Google Scholar
24	[39]	Scientific Article	2021	Togo	Google Scholar
25	[14]	Thesis	2011	Togo	University Repository
26	[6]	Scientific Article	2019	Togo	Google Scholar
27	[8]	Scientific Article	2024	Latin America	Scopus
28	[40]	Scientific Article	2021	International	Scopus
29	[41]	Government Report	2020	Brazil	Government Repository
30	[42]	Scientific Article	2023	Developing Countries	Scopus
31	[43]	Scientific Chapter	2020	Brazil	Springer
32	[44]	Government Plan	2018	Brazil	Government Repository
33	[5]	Scientific Article	2025	Pakistan	Scopus
34	[45]	Institutional Report	2024	Brazil	SLU
35	[46]	Thesis	2019	Togo	University Repository
36	[1]	International Report	2024	Global	UNEP
37	[47]	Scientific Article	2022	International	Scopus

Table 1 presents the complete list of analyzed documents, including source, document type, year, and country of origin.

3.2 Content Analysis Procedures

The analysis followed Bardin's [24] content analysis framework, operationalized in three stages: (i) pre-analysis and corpus organization; (ii) coding and thematic categorization; and (iii) interpretation and comparative synthesis.

A coding protocol was developed to ensure analytical consistency across documents. The analysis was structured into five analytical categories and corresponding subcategories:

1. Legal and institutional frameworks
    - environmental legislation
    - regulatory enforcement
    - governance structure
2. Collection and operational systems
    - selective collection
    - transport infrastructure
    - waste treatment technologies
3. Informal sector participation

- waste picker integration
- labor conditions
- social inclusion mechanisms

4. Public policies and financing
   - municipal investments
   - international cooperation
   - public-private partnerships
5. Operational and environmental challenges
   - infrastructure deficiencies
   - irregular disposal
   - environmental and health impacts

Coding was conducted manually using a comparative matrix developed by the authors. To improve analytical reliability, the coding process was reviewed twice at different stages of the analysis, comparing interpretations and the consistency of category allocation. Divergences in coding interpretation were reassessed through iterative review procedures and triangulation between institutional reports, legislation, and scientific literature.

Although the coding protocol was reviewed iteratively to improve analytical consistency, the study did not employ formal inter-rater reliability procedures involving multiple independent coders. Future studies may strengthen methodological robustness by incorporating inter-coder validation techniques and software-assisted qualitative analysis.

Methodological triangulation was adopted to strengthen validity by comparing normative documents, institutional reports, and peer-reviewed scientific studies. This procedure reduced interpretive bias and enhanced the robustness of comparative findings.

3.3 Comparative Case Study Rationale

The selection of Brasília and Lomé was guided by theory rather than merely by pragmatism. The two capitals represent contrasting governance and institutional configurations within developing countries. Brasília presents relatively advanced waste governance structures, formalized recycling systems, and consolidated environmental legislation. In contrast, Lomé is characterized by fragmented governance, high informality, weak institutional regulation, and limited infrastructure capacity.

Despite these differences, both cities face common structural pressures stemming from urban population growth, rising waste generation, and environmental vulnerability. This contrast allows identification of how institutional capacity, regulatory frameworks, and governance arrangements influence municipal solid waste management outcomes in developing-country contexts.

4. Results and Discussion

4.1 Institutional Governance and Regulatory Capacity

The comparative analysis reveals substantial differences in institutional governance and regulatory capacity between Brasília and Lomé. In Brasília, municipal solid waste management operates within a relatively consolidated institutional framework supported by the National Solid Waste Policy (Law No. 12.305/2010) [16], district regulations, and the operational coordination of the Urban Cleaning Service (SLU). The existence of formalized governance structures enables the implementation of selective collection systems, reverse logistics initiatives, and partnerships with waste picker cooperatives.

Recent operational reports indicate measurable institutional advances in Brasília. According to SLU (2023) [48], waste collection activities increased by 5.6%, while reverse logistics operations expanded by 43.3% between January and March 2023. These improvements reflect not only investments in infrastructure but also stronger institutional coordination and regulatory enforcement mechanisms. Nevertheless, important structural challenges remain, particularly regarding operational efficiency, technological modernization, and the continuity of public policies across political cycles.

In contrast, waste governance in Lomé remains highly fragmented and institutionally fragile. Although environmental policies and climate-related strategies exist at the national level, the absence of a specific and integrated solid waste management policy limits the effectiveness of municipal actions. Institutional responsibilities remain poorly coordinated, and waste collection services rely heavily on temporary arrangements involving private companies, community associations, and informal operators.

The comparative findings suggest that regulatory existence alone does not guarantee effective waste governance. Rather, the effectiveness of municipal solid waste management depends on institutional continuity, stable financing mechanisms, monitoring capacity, and coordination among public, private, and informal actors. This finding aligns with recent studies emphasizing governance quality as a central determinant of sustainable waste management outcomes in developing countries [3,5].

4.2 Waste Collection Systems and Operational Infrastructure

Important operational differences were identified between the waste collection systems of Brasília and Lomé.

Table 2 summarizes the key comparative indicators between Brasília and Lomé in waste collection systems, recycling performance, operational coverage, and informal sector participation.

Table 2. Comparative indicators between Brasília and Lomé.

Indicator	Brasília	Lomé	Source
Recycling rate	4.5%	Data unavailable	[36]
Waste collection coverage	High urban coverage	<35%	[46]
Reverse logistics growth	+43.3%	Data unavailable	[48]
Informal sector participation	Formalized cooperatives	~55% informal operators	[14]
Annual waste generation	Official SLU monitoring system	>350,000 tons/year	[45,46]
Governance structure	Formalized and regulated	Fragmented and weakly coordinated	[16]
Selective collection systems	Present	Limited	[6,44]

Source: Authors based on institutional reports and scientific literature.

Brasília presents a relatively structured waste collection network coordinated by SLU and supported by contracted companies, transfer stations, sorting facilities, and selective collection programs. Approximately 58% of collected waste passes through transfer stations before final disposal, while selective collection initiatives increasingly incorporate waste picker cooperatives into official management systems [44,45].

Technological infrastructure also contributes to operational efficiency in Brasília. Collection systems use optimized routes, mapping technologies, and voluntary drop-off points for electronic waste, oils, batteries, and construction residues. Although recycling rates remain modest at approximately 4.5% nationally in 2025, Brasília demonstrates important progress regarding reverse logistics and integration of circular economy principles into waste management strategies.

In Lomé, however, operational infrastructure remains severely limited. Waste collection coverage remains below 35%, and approximately 83.5% of waste is still inadequately managed nationwide [46]. Collection activities rely heavily on manual labor, small-scale pre-collection systems, and informal transportation. In peripheral urban areas, waste often accumulates in open spaces due to insufficient collection capacity and weak logistical coordination.

These operational disparities reflect broader inequalities in municipal investment capacity, technological modernization, and institutional organization between the two cities. The findings demonstrate that waste collection efficiency in developing countries is closely associated with infrastructure investment, governance integration, and long-term public financing mechanisms.

4.3 Informality and the Role of Waste Pickers

The role of informal waste pickers emerged as one of the most significant comparative dimensions between Brasília and Lomé. In Brasília, waste pickers increasingly operate through cooperatives formally integrated into municipal waste governance systems. This integration contributes to selective collection, recycling activities, and social inclusion policies supported by public authorities.

Although challenges related to labor conditions and operational infrastructure persist, Brasília demonstrates gradual progress toward formalization and institutional recognition of waste picker activities. Public policies under the National Solid Waste Policy have helped improve access to equipment, infrastructure, and organizational support for cooperatives.

In contrast, the informal sector dominates waste recovery activities in Lomé. According to Koledzi [14], itinerant waste pickers represent approximately 55% of collection and recovery operators. Informality functions simultaneously as a survival strategy and as a substitute for insufficient municipal waste services. However, the absence of institutional protection exposes waste pickers to unsafe working conditions, low remuneration, and environmental health risks.

The comparative analysis indicates that informal waste sectors should not be interpreted solely as governance failures but also as adaptive socio-economic responses to institutional limitations. Nevertheless, sustainable waste

governance requires greater integration of informal actors into formal municipal systems through training programs, cooperative structures, and social protection mechanisms.

4.4 Comparative Governance Challenges between Brasília and Lomé

Despite important contextual differences, Brasília and Lomé face common governance challenges associated with rapid urbanization, increasing waste generation, and environmental vulnerability. In both cities, operational sustainability depends on stronger coordination among municipal authorities, private companies, waste picker organizations, and civil society actors.

However, the nature of governance challenges differs substantially between the two cases. Brasília faces difficulties related primarily to operational optimization, bureaucratic complexity, technological modernization, and policy continuity. In Lomé, governance challenges are more structural, involving insufficient infrastructure, weak institutional regulation, fragmented service provision, and financial limitations.

The comparison also reveals significant disparities regarding data availability and monitoring systems. Brasília benefits from institutional reporting systems that generate operational indicators and management statistics. In contrast, updated empirical data on waste management in Lomé remain scarce, limiting evidence-based policy planning and institutional evaluation.

This asymmetry in data production itself constitutes an important governance issue. Weak monitoring systems reduce transparency, hinder long-term planning, and constrain the formulation of effective public policies. Future empirical research involving field surveys, interviews, and quantitative monitoring systems is therefore essential to strengthen municipal waste governance in low-income urban contexts.

4.5 Implications for Circular Economy and Sustainable Waste Governance

The findings also reinforce the relevance of Triple Bottom Line perspectives in municipal solid waste governance [17]. Environmental sustainability depends on reducing pollution and improving waste recovery systems; social sustainability involves integrating informal waste pickers into formal governance structures; and economic sustainability requires long-term financing mechanisms and operational efficiency. The comparative analysis demonstrates that weaknesses in any of these three dimensions compromise the overall sustainability of municipal waste management systems.

The findings demonstrate that the transition toward circular economy models in developing countries depends not only on technological innovation but also on the quality of governance, institutional coordination, and social inclusion mechanisms. Brasília presents early institutional advances in integrating circular economy principles through selective collection systems, reverse logistics programs, and cooperative participation. Nevertheless, recycling rates remain low, indicating the need for greater investment in material recovery infrastructure and public environmental awareness.

In Lomé, circular economy practices remain predominantly informal and economically vulnerable. Despite the absence of integrated regulatory systems, informal waste pickers and small-scale recycling initiatives already contribute significantly to material recovery and waste valorization. This suggests that circular economy transitions in low-income contexts may initially emerge through informal adaptive practices rather than formal institutional planning.

The study also highlights the importance of international cooperation and policy transfer between developing countries. Brazilian experiences involving cooperative integration, selective collection, and environmental regulation may provide useful institutional references for strengthening waste governance systems in Togo. However, policy transfer must consider local socio-economic conditions, institutional capacity, and infrastructure limitations.

Finally, the study demonstrates that sustainable municipal solid waste management requires an integrated approach that combines environmental regulation, technological modernization, financial investment, social inclusion, and institutional continuity. Without these interconnected dimensions, waste governance systems remain vulnerable to operational fragmentation and environmental degradation.

5. Conclusions

This study compared municipal solid waste management systems in Brasília (Brazil) and Lomé (Togo), focusing on governance structures, operational systems, regulatory frameworks, and the role of informal actors in developing-country urban contexts. The findings demonstrate that differences in waste management performance are strongly associated with institutional capacity, governance coordination, regulatory continuity, and infrastructure investment rather than solely with waste collection technologies.

The study contributes to the literature by addressing an important research gap concerning comparative analyses of municipal waste governance between Sub-Saharan Africa and South America. While previous studies

have predominantly emphasized environmental impacts or technological dimensions of waste management, this research highlights the importance of governance structures, institutional fragmentation, and informal-sector integration in shaping waste-management outcomes in developing cities.

The comparative analysis revealed that Brasília benefits from relatively consolidated institutional arrangements, selective collection systems, and formal integration of waste picker cooperatives into municipal management structures. In contrast, Lomé faces persistent challenges, including fragmented governance, insufficient infrastructure, weak regulatory enforcement, limited financial resources, and heavy reliance on informal waste recovery systems.

The study also demonstrates that informal waste pickers play a strategic environmental and socio-economic role in both contexts. However, their level of institutional integration differs substantially. In Brasília, cooperatives increasingly participate in formal governance systems, while in Lomé, informal waste collection largely compensates for limitations in municipal service provision.

Despite these findings, the study presents important limitations. The analysis relied predominantly on documentary sources and institutional reports, particularly regarding Lomé, where updated empirical data remain scarce. Furthermore, the absence of standardized quantitative indicators limited more advanced statistical comparison between the two cities.

Future research should therefore prioritize empirical fieldwork involving interviews, surveys, and direct observation with municipal authorities, waste pickers, private companies, and residents. Comparative studies using standardized indicators for collection coverage, recycling rates, governance efficiency, and informal-sector participation would further strengthen understanding of municipal solid waste governance in developing countries.

Author Contributions

O.O.-S.: conceptualization, methodology, data curation, visualization, supervision, writing—original draft and writing—review & editing; H.R.R.: resources, visualization, writing—original draft and writing—review & editing. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement

The original contributions presented in the study are included in the article; further inquiries can be directed to the corresponding author.

Conflicts of Interest

The authors declare no conflict of interest.

Use of AI and AI-Assisted Technologies

No AI tools were utilized for this paper.

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