Analyzing X mentions to uncover micro-clusters interfering in political campaigns: a case study during the Spanish elections

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Introduction: Coordinated influence campaigns on social networks pose a growing threat to democratic discourse, especially during electoral periods. This study investigates such efforts within political conversations during the Spanish regional elections of May 2023.

Methods: We analyzed a dataset of 345,000 messages posted on X (formerly Twitter) by 17,074 unique users. Using advanced quantitative techniques, we focused on the analysis of mentions to detect coordination patterns. We identified micro-clusters—groups of users engaging in synchronized messaging strategies—by tracking distribution lists and repeated amplification behaviors.

Results: Our findings reveal patterns of coordinated activity targeting political figures, journalists, and other influential actors. The Gephi-generated network maps visualize these micro-clusters and expose homophilic behavior and feedback loops that enhance the virality of messages.

Discussion: These results demonstrate the sophistication of digital tactics employed to manipulate political discourse. The study highlights the urgent need for effective detection mechanisms and regulatory frameworks to protect the integrity of public debate during electoral campaigns.

1 Introduction

1.1 Dark PR and political communication

Dark Public Relations (Dark PR), also known as Black PR, is a set of covert strategies designed to manipulate public opinion and discredit opponents through deceptive tactics. Unlike traditional PR, which relies on transparency and trust-building, Dark PR operates in the shadows of media ecosystems, leveraging misinformation, fabricated scandals, and even deepfake technology to achieve its objectives (Rodríguez-Fernández, 2023; García-Ull, 2021). The stakes in political communication make it an attractive arena for such tactics, where influencing public perception can have far-reaching consequences for democratic processes.

Dark PR campaigns exploit digital platforms, which provide the immediacy and reach necessary to execute highly targeted disinformation campaigns. These campaigns frequently employ bots and automated tools to amplify false narratives, ensuring their widespread dissemination. For instance, during high-stakes political events like elections or referenda, fabricated scandals are propagated at an accelerated pace, leaving minimal opportunity for fact-checking or rebuttal (Woolley and Howard, 2018; Bastos and Mercea, 2018).

A particularly insidious aspect of Dark PR is astroturfing—the orchestration of seemingly grassroots movements that are, in reality, artificial campaigns engineered to influence public opinion. By creating the illusion of widespread support or dissent, these campaigns manipulate both media narratives and voter sentiment. Studies indicate that bots and fake accounts often work in tandem with Dark PR strategies to bolster the credibility of these movements, embedding them deeply into online discourse (Bessi and Ferrara, 2016; Woolley and Howard, 2016).

Beyond reputation sabotage and misinformation, Dark PR has evolved into a highly professionalized industry. Specialist agencies now offer a range of services, including competitor suppression and search engine manipulation, to guarantee the visibility of damaging content. These practices often operate in legal grey areas, making them difficult to regulate or trace back to their originators (Rodríguez-Fernández, 2023).

The ethical implications of Dark PR are profound, as these tactics undermine the principles of transparency and accountability essential to democratic governance. By fostering distrust and confusion, these campaigns erode the foundation of informed decision-making and diminish the public's ability to engage critically with political discourse (Lazer et al., 2018). The increasing prevalence of these practices has prompted scholars to advocate for stricter regulatory frameworks and technological tools to mitigate their impact. Enhanced detection mechanisms, transparency in political advertising, and digital literacy programs are critical to countering the growing influence of Dark PR in political communication (Tufekci, 2017; Woolley and Howard, 2018).

1.2 Coordinated amplification and Dark PR

Bots, short for "robots," are automated programs that perform online tasks at a scale and speed beyond human capability. Initially developed for benign purposes such as automating mundane tasks or delivering updates, bots have become indispensable tools for executing Dark PR strategies. In the context of political communication, bots amplify disinformation, skew public opinion, and disrupt meaningful discourse, often operating as silent propagators of manipulative agendas (Woolley and Howard, 2016).

In Dark PR campaigns, bots and automated tools are primarily utilized to create an illusion of widespread support or opposition—what scholars term computational propaganda. These automated accounts can generate coordinated responses, drive hashtags to trend, and manipulate the visibility of specific messages, thereby influencing public narratives. During the 2016 U.S. presidential election, bots were responsible for a substantial portion of politically charged tweets, many of which were aimed at polarizing audiences through the dissemination of false or inflammatory content (Bessi and Ferrara, 2016).

A particularly insidious application of bots in Dark PR is manipulating trust networks. Bots frequently impersonate real users or fabricate personas to infiltrate social groups, disseminating false information within echo chambers. This tactic was observed during the Brexit referendum, where bot activity not only amplified anti-European Union rhetoric but also reinforced ideological silos, deepening societal divisions (Bastos and Mercea, 2018).

Recent advancements in artificial intelligence (AI) have made coordinated strategies more sophisticated, enabling them to produce human-like content and respond contextually to interactions. These developments have given rise to adaptive bots—programs capable of generating text, engaging in nuanced conversations, and even mimicking emotional expressions. Such capabilities allow bots to evade detection and manipulate discourse more effectively, making them integral to modern Dark PR operations (Cresci et al., 2017).

Bots also play a disruptive role by targeting influential accounts, such as journalists and policymakers, with coordinated disinformation campaigns. By spamming mentions or replies, bots redirect public attention to specific narratives, amplifying their reach and perceived legitimacy. This tactic, known as mention-bombing, has been used in electoral campaigns worldwide to dominate political discourse and drown out opposing voices (Bradshaw and Howard, 2018).

As bot technology continues to evolve, so too does its capacity to influence political outcomes. Beyond amplifying disinformation, bots have been observed deploying misattribution tactics, where they post polarizing content that appears to originate from rival groups. This creates confusion and mistrust, further destabilizing democratic processes. Addressing these challenges requires collaboration between policymakers, researchers, and technology platforms to develop more effective detection mechanisms and ethical standards (Yang et al., 2019; Bessi and Ferrara, 2016).

The use of social networks in political campaigns has increasingly involved coordinated amplification efforts to manipulate narratives and influence public opinion. These efforts can manifest through both automated systems, such as bots, and manual but orchestrated actions by groups of users. For example, groups may use synchronized distribution lists to amplify content in unison, mimicking bot-like behavior through human intervention. These actions can target key political figures, journalists, or influential personas to boost specific narratives or disrupt opposing ones.

Such coordination creates the appearance of widespread support or dissent, skewing the perception of public opinion. The distinction between automated and manual coordination is critical, as both types of efforts leverage homophilic behavior within tightly connected clusters to achieve their goals. This study aims to identify and analyze these coordinated amplification efforts, whether automated or human-driven, to better understand their impact on political discourse.

1.3 Bots in communication campaigns

Recent studies have demonstrated the significant impact of bots on political discourse. For instance, during the 2016 U.S. presidential election, bots were responsible for a substantial portion of political content on Twitter, effectively amplifying misinformation and polarizing public opinion (Bessi and Ferrara, 2016). Similarly, in the context of the Brexit referendum, bots played a crucial role in spreading both supportive and opposing narratives, thereby influencing the online political debate (Bruno et al., 2021).

The advancement of artificial intelligence has given rise to a new generation of bots capable of producing highly realistic and contextually relevant content. These "sleeper social bots" can remain dormant for extended periods and activate to disseminate disinformation strategically, making detection and mitigation more challenging (Doshi et al., 2023). Additionally, bots also contribute to computational propaganda by manipulating public sentiment through coordinated activities. They can artificially inflate the popularity of specific narratives, create the illusion of consensus, and suppress

dissenting opinions. This manipulation undermines the democratic process by distorting the authentic public discourse (Woolley, 2020).

The integration of bots into political communication strategies has transformed the dynamics of information dissemination. Their ability to operate at scale and speed allows malicious actors to execute disinformation campaigns with unprecedented efficiency. For example, during the COVID-19 pandemic, bots were utilized to spread false information about the virus, contributing to public confusion and mistrust (Ferrara et al., 2020). Despite the growing body of research on bots, there is a pressing need for studies that integrate network analysis techniques to elucidate their role in political communication. Analyzing interaction patterns offers a promising avenue for detecting bot activity and understanding their influence within online discourse (Shao et al., 2018).

1.4 Influence of automated tools on political communication

Automated tools have transformed political communication, serving as powerful instruments for shaping public narratives and amplifying strategic messaging. In the context of Dark PR campaigns, these technologies extend the reach of disinformation efforts, leveraging speed, scalability, and precision to influence electoral outcomes, disrupt political discourse, and manipulate public opinion (Woolley and Howard, 2016).

One of the primary ways bots influence political communication is through their ability to amplify divisive or polarizing content. By targeting trending topics and strategically engaging with hashtags, bots can elevate disinformation to prominence, ensuring its widespread visibility. Research into the 2017 German federal elections demonstrated that automated accounts accounted for a disproportionate share of interactions around politically charged topics, creating artificial momentum for certain narratives (Keller and Klinger, 2019). This phenomenon artificially inflates the popularity of specific ideas or candidates, misleading users about the broader public consensus.

Another critical aspect of bot influence is their role in undermining trust in democratic institutions. During electoral campaigns, bots have been deployed to spread disinformation targeting the credibility of voting systems, candidates, and media outlets. For instance, during the 2020 U.S. presidential election, botnets propagated false claims about mail-in voting, eroding public confidence in the electoral process (Bradshaw and Howard, 2018). By exploiting existing societal anxieties, these campaigns amplify skepticism and polarize communities, making it more difficult to foster meaningful debate.

Automated tools also enable the creation of feedback loops, wherein disinformation is continually reinforced within ideological echo chambers. Bots strategically target users with similar political inclinations, ensuring that they are exposed repeatedly to the same narratives. This process not only deepens ideological divides but also entrenches individuals within information silos, where opposing viewpoints are rarely encountered or considered (Woolley and Guilbeault, 2017). Such feedback loops are particularly damaging in electoral contexts, where the ability to engage with diverse perspectives is critical for informed decision-making.

Beyond their ability to amplify content, bots serve as conduits for targeted harassment campaigns, a tactic frequently used in Dark PR

operations. By flooding high-profile accounts with inflammatory mentions or replies, bots disrupt genuine discourse and redirect attention to specific narratives. These campaigns can be used to intimidate journalists, researchers, and political figures, silencing dissent and reinforcing the dominance of manipulative messaging (Bastos and Mercea, 2018).

The scalability of bots and automated tools also allows for micro-targeting, wherein disinformation is tailored to specific demographic groups. By analyzing user data, bots can craft messages designed to exploit vulnerabilities, fears, or biases within targeted communities. This tactic was observed during the 2019 Indian general elections, where bots disseminated false information tailored to regional issues, amplifying tensions along religious and ethnic lines (Bradshaw and Howard, 2018).

While the ethical implications of bot usage in political communication are well-documented, addressing their influence remains a significant challenge. As these technologies continue to evolve, their role in disinformation campaigns will likely grow, necessitating advancements in detection tools and stronger regulatory oversight. Scholars have emphasized the need for comprehensive international frameworks to curb the misuse of bots, particularly in politically sensitive contexts (Yang et al., 2019; Cresci et al., 2017).

1.5 Leveraging mention for coordinated activity detection

This study examines the use of X mentions to detect coordinated clusters activity during the Spanish regional elections in May 2023. By analyzing patterns in user mentions, this approach identifies coordinated groups employing automated tools to manipulate political discourse. Recent research emphasizes the importance of interaction-based detection methods, with the TwiBot-22 benchmark demonstrating how graph-based techniques can uncover coordinated activity through user interactions (Zhang et al., 2022). Similarly, community-aware detection models, such as those proposed in the BotMoE framework, highlight the efficacy of analyzing user behavior within clustered groups to expose sophisticated bot networks (Zhou et al., 2023). By focusing specifically on mention patterns, this research contributes to the growing body of literature on bot detection, providing novel insights into the dynamics of automated influence in political contexts.

2 Materials and methods

2.1 Research design

This study adopts a quantitative approach, focusing exclusively on the analysis of mentions on X (formerly Twitter) to uncover patterns of discourse surrounding political discussions. Using a structured social listening methodology, the study monitors and evaluates public mentions related to specific keywords and accounts, ensuring comprehensive coverage of relevant conversations. The geographic scope is Spain, incorporating the nation's linguistic diversity by analyzing mentions in Spanish, Catalan, Basque, and Galician. The dataset comprises 345,584 mentions from 17,074 unique authors, representing a broad and

diverse snapshot of online discourse. Data was retrieved using the Twitter API, with the extraction process conducted during the first week of October 2023

2.2 Study period and context

The Spanish political ecosystem is characterized by a diverse and decentralized structure, shaped by its parliamentary monarchy and autonomous regional governments. Spain operates as a multi-party democracy, with major national parties such as the Spanish Socialist Workers' Party (PSOE) and the People's Party (PP) often dominating the political landscape. In recent years, smaller parties like Unidas Podemos, Ciudadanos, and Vox have gained prominence, reflecting growing ideological diversity and regional interests.

Regional politics play a crucial role, with autonomous communities such as Catalonia and the Basque Country influencing national debates through their distinct political agendas and calls for increased self-governance. These dynamics often lead to polarization and tension in public discourse, particularly during election periods. Political fragmentation, combined with issues like economic disparity, immigration, and historical memory, further complicates coalition-building and policymaking in Spain, creating a rich but complex political environment for analysis.

The study focuses on the period from May 1 to May 31, as this timeframe aligns with a significant increase in political polarization and heightened public debate during the 2023 Spanish regional elections. This period was marked by intense discourse and social division, particularly surrounding the inclusion of 44 candidates who had previously been convicted for their involvement in ETA, a terrorist organization in the Basque region. The resulting surge in online activity and public discussions created a highly polarized environment, providing an optimal context for examining the dynamics of bot activity and its influence on public discourse. This specific timeframe enables a focused analysis of automated agents within an environment of notable political tension, facilitating insights into their role in amplifying polarization and shaping online narratives.

2.3 Data collection

The data collection process was designed to identify coordinated behavior patterns across various account types. This approach enables the detection of group dynamics, including both automated and human-driven efforts, that exhibit synchronized messaging and amplification strategies. Data was gathered from X (formerly Twitter) by capturing mentions involving EH Bildu and associated keywords. A Boolean search strategy was employed to ensure precise and relevant data collection, focusing exclusively on mentions within the public discourse.

Two key Boolean search configurations were applied:

1. **General Mentions of EH Bildu:** The first configuration combined the term "Bildu" with keywords like "ETA," "list," "terrorist," and "terrorism," while excluding direct mentions of the official EH Bildu account (@ehbildu). This setup captured broad public discussions about the party without interference from official communications.

2. **Mentions of the Official EH Bildu Account:** The second configuration incorporated the @ehbildu handle alongside the same keywords. This approach focused on public interactions with or referencing the official account, providing insights into how mentions of the party intersected with specific themes.

2.4 Frequency analysis of mentions

The frequency analysis of mentions is a quantitative method used to identify and understand patterns in the data. The process involved several steps: data collection, data processing, frequency counting, and filtering and indexing. These results were presented both in tabular format and as a cluster network using Gephi software.

To analyze modularity in the cluster network, the following parameters and results were used:

- **Parameters:**
  - Randomize: On
  - Use edge weights: On
  - Resolution: 1.0
- **Algorithm:**
  - Vincent D Blondel, Jean-Loup Guillaume, Renaud Lambiotte, Etienne Lefebvre, Fast unfolding of communities in large networks, in Journal of Statistical Mechanics: Theory and Experiment, 2008 (10), P1000 (Blondel et al., 2008).
  - R. Lambiotte, J.-C. Delvenne, M. Barahona, Laplacian Dynamics and Multiscale Modular Structure in Networks, 2009 (Lambiotte et al., 2009).

This method allowed the creation of a table highlighting the most frequently mentioned accounts in discussions about the Basque left, as well as the graphical representation of these mentions as a cluster network. The network visualization provides additional insights into the structure and dynamics of the discourse.

2.5 Analytical techniques

- **Quantitative mentions analysis:** The dataset was analyzed to measure the volume, frequency, and patterns of mentions over the study period. This included evaluating spikes in activity, the prominence of specific keywords, and temporal trends in discourse.
- **Cluster detection:** A quantitative network analysis was conducted using Gephi to identify clusters of mentions. This method helped detect patterns of coordinated activity, highlight influential accounts, and map the interactions between users and themes.

2.6 Data accuracy

The Boolean search strategy minimized irrelevant or ambiguous mentions, ensuring a high level of precision in the collected dataset. The focus on mentions provided a detailed and quantifiable representation of public discourse during a politically charged period. This approach highlights the role of mentions as a

critical component in understanding political communication dynamics.

3 Results

3.1 Introduction to Results

This section presents the findings from the analysis of mentions on X (formerly Twitter) during the Spanish regional elections of May 2023. The analysis focuses on uncovering patterns of engagement, ideological polarization, and the role of automated accounts in shaping political discourse. Using cluster detection and network visualization techniques, the study identifies key communities, influential nodes, and strategic behaviors of bot clusters within the conversation.

3.2 Cluster network analysis

3.2.1 Mention clusters and visualization

Using a dataset of 345,584 mentions from 17,074 unique authors, the study reveals 7,624 nodes (unique accounts) and 50,901 edges (mentions between accounts). Using Gephi software, a cluster map was generated to visualize these relationships and uncover patterns of engagement and influence.

The network visualization provides insights into the structure and dynamics of political discourse during the analyzed period. Nodes represent individual accounts, with larger nodes indicating greater centrality or prominence, often reflecting higher frequencies of mentions or interactions. Proximity between nodes reflects the strength of their connections, with closer nodes indicating higher levels of interaction or engagement within the network.

Clusters, represent distinct modularity classes or communities of discourse. These clusters highlight ideological or thematic groupings, with dense intra-cluster connections emphasizing homophilic interactions, where accounts primarily engage within their own community. For example:

- **@ehbildu and @ArnaldoOtegi cluster:** This cluster represents left-leaning or pro-independence discussions. Larger nodes, such as @ehbildu and @ArnaldoOtegi, signify their prominence in shaping conversations related to Basque independence. Mentions frequently connect with other prominent accounts like @PSOE and @PabloIglesias, reflecting overlapping interests within Spain's progressive political spectrum. The dense intra-cluster connections highlight strong ideological cohesion.
- **@ppopular and @NunezFeijoo cluster:** This cluster captures the activity of the Partido Popular (PP). The presence of a noticeable sub-cluster around @IdiazAyuso underscores regional political dynamics within the broader conservative discourse. The proximity of these nodes within the cluster reflects frequent interaction, reinforcing the party's regional and national presence.
- **@vox_es cluster:** Far-right discussions center around @vox_es, with notable engagement from accounts aligned with leftist discourse, reflecting ideological contention. The node's moderate size and proximity to opposing ideological clusters highlight

reciprocal interactions and its strategic role in polarizing narratives.

The size of nodes indicates their relative influence or importance within the network, with larger nodes, such as @ehbildu, @PSOE, and @ppopular, serving as focal points for interaction. The edges connecting nodes represent mentions or interactions, with denser connections within clusters reinforcing the presence of ideological silos. The visualization underscores the fragmented nature of the network, where clusters maintain strong internal cohesion but limited cross-cluster interaction, reflecting the polarization and segmentation of political discourse.

The key metrics describing the network structure are presented as follows. The modularity score evaluates the degree of division within the network, with values closer to 1 indicating a highly fragmented structure and minimal interaction between clusters. The community count reflects the total number of distinct clusters, illustrating the granularity of the segmentation in the analyzed discourse. Additionally, metrics such as diameter, radius, and average path length (Brandes, 2001) and PageRank parameters (Page et al., 1999) provide further insights into the overall connectivity and structure of the network.

- **Modularity score:** 0.776, indicating a highly fragmented structure where communities operate in echo chambers.
- **Community count:** 473 distinct clusters were identified, demonstrating the granularity of ideological segmentation.
- **Diameter:** 14, representing the longest shortest path within the network. This indicates that, at most, 14 steps are required to connect the two most distant nodes, reflecting the reachability within the network.
- **Radius:** 0, highlighting the presence of peripheral nodes or disconnected components that do not contribute to the core connectivity of the network.
- **Average Path Length:** 3.8468, showing the average number of steps required to connect any two nodes in the network. This value suggests a moderately connected structure, where most nodes can reach one another within a small number of steps.
- **PageRank Parameters:**
  - **Epsilon:** 0.001, representing the convergence threshold for the iterative process, ensuring computational efficiency and precision.
  - **Probability (Damping factor):** 0.85, indicating that 85% of the time, interactions follow existing connections, while 15% involve random jumps. This parameter ensures a fair distribution of influence and prevents rank sinkholes.

These metrics collectively reveal a network characterized by significant fragmentation (as indicated by the high modularity score) and moderate connectivity (evidenced by the average path length). The diameter and radius further underscore the disparities in connectivity, with some nodes being peripheral or isolated, while others are part of a more integrated network core. This fragmentation aligns with the presence of polarized and homophilic clusters, where coordinated users amplify divisive narratives by operating within tightly knit communities. The limited interaction between clusters, reflected in the high modularity and peripheral

placement of coordinated clusters, highlights their role in reinforcing ideological silos and exacerbating polarization within the discourse (Figure 1).

3.2.2 Betweenness and influence

Figure 2 showcases the accounts with the highest betweenness centrality scores, highlighting their role as critical bridges within the network during the May 2023 Spanish regional elections. Betweenness centrality measures the extent to which an account facilitates connections between otherwise fragmented parts of the network. The account @ehbildu ranks highest, reflecting its pivotal role in linking pro-independence and left-leaning narratives. Similarly, accounts like @PSOE and @sanchezcastejon exhibit high scores, indicating their centrality in bridging discourse between diverse ideological clusters. Media accounts such as @eldiarioes and @elmundoes appear prominently, underscoring their influence in disseminating information across fragmented communities (Figure 3).

The PageRank analysis measures the relative importance of nodes within the network, based on their connections and how often they are referenced by others. In the context of the political discourse network, nodes with higher PageRank values are those that receive significant attention and influence through repeated interactions. The account @ehbildu ranks the highest (0.024433), indicating its central role in shaping conversations within the network. Other influential nodes include @PSOE (0.010497) and @sanchezcastejon (0.009444), reflecting their prominence in driving political discussions and

engaging multiple clusters. Media outlets such as @eldiarioes also appear in the results, highlighting their role in amplifying narratives and acting as information hubs (Figure 4).

The segmentation of mentions into ideological communities demonstrates the fragmented nature of online political discourse. Most interactions occur within clusters, with limited cross-cluster engagement (Figure 5).

3.2.3 Role of coordinated micro-clusters

Three major clusters were identified at the periphery of the network. These clusters were characterized by low connectivity with user accounts but high activity in targeted messaging. Key features include:

- **Low external interactions:** Micro-clusters demonstrated minimal engagement with other users, focusing instead on amplifying specific narratives.
- **Targeted messaging:** Coordinated clusters directed mentions to key political figures, media outlets, and high-visibility accounts, reflecting deliberate strategies to influence discourse.
- **Strategic alignment**:
  - Far-right micro-cluster engage predominantly with accounts near @vox_es, amplifying far-right messaging and targeting political opponents.
  - Far-left and Catalan independence micro-cluster focus their activity around mentions of @PSOE and frequently interact
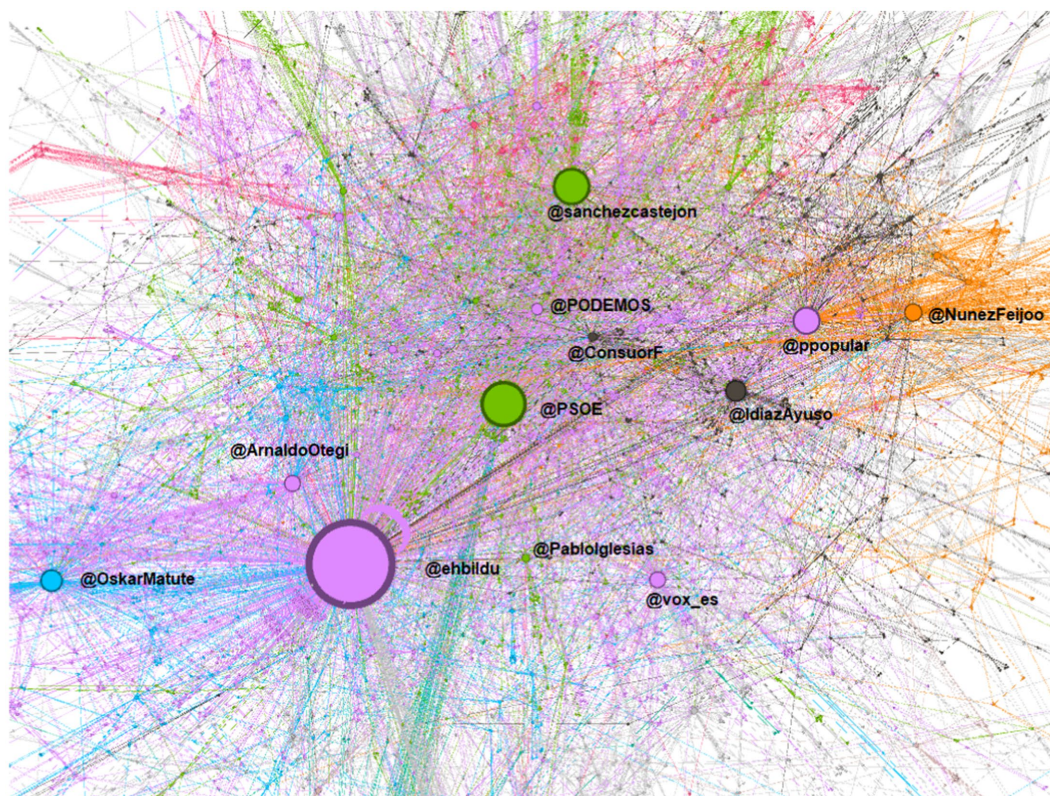

FIGURE 1
Cluster network of mentions on X reflecting political alignments and communication dynamics during the May 2023 Spanish elections. Source: Own elaboration.

Id	Betweenness Centrality ∨
@ehbildu	19211728.71816
@PSOE	6551461.374701
@sanchezcastejon	4819805.419628
@ppopular	4032256.430705
@IdiazAyuso	2727503.729576
@OskarMatute	2668245.785557
@vox_es	1851205.479614
@eldiarioes	1829000.43485
@NunezFeijoo	1653204.189942
@elmundoes	901613.853103

FIGURE 2
Betweenness centrality of key accounts in political discourse. Source: Own elaboration.

Id	PageRank ∨
@ehbildu	0.024433
@PSOE	0.010497
@sanchezcastejon	0.009444
@ppopular	0.006575
@OskarMatute	0.006533
@IdiazAyuso	0.005503
@vox_es	0.004199
@NunezFeijoo	0.003882
@eldiarioes	0.003655
@ArnaldoOtegi	0.00339

FIGURE 3
PageRank scores of key accounts in political discourse. Source: Own elaboration.

with media accounts like @eldiarioes, reflecting an agenda rooted in leftist discourse.

○ Basque independence micro-cluster is closely aligned with mentions of @ehbildu and @eajpnv, supporting narratives associated with Basque political autonomy.

The behavior of these micro-clusters aligns with findings by Pericàs et al. (2014), who documented similar patterns in ideologically cohesive networks. The deliberate placement of coordinated users at the network periphery underscores their strategic role in amplifying divisive narratives (Figure 6).

The far-right cluster, identified through modularity-based community detection, provides a compelling example of coordinated behavior and homophily within the broader social media ecosystem. This cluster demonstrates high levels of connectivity and interaction among accounts with similar ideological leanings, forming a dense and well-defined network. For instance, accounts such as @FilipidesE, which exhibits the highest PageRank value in the cluster, act as central hubs, amplifying messages and coordinating the dissemination of content. Other accounts, like @BernaldoDQuiros and @unculemadrid, also hold significant positions within the network.

The cohesiveness of this cluster is further highlighted by its shared patterns of engagement, such as recurring use of similar hashtags, identical phrasing in tweets, and synchronized posting times. This behavior reflects not only a strong alignment in messaging but also a level of coordination that goes beyond organic interaction. Homophily is evident as these accounts primarily interact with one another, reinforcing shared narratives and limiting exposure to opposing viewpoints.

Figure 7 illustrates the structure of a far-right coordinated network. On the left, the broader network overview highlights various clusters, each representing distinct groups with shared thematic or ideological focus. On the right, a detailed zoom-in reveals a densely connected far-right cluster characterized by high interconnectivity and tightly knit relationships between accounts. This structure indicates homophilic tendencies, where accounts preferentially interact with like-minded entities, and coordinated behavior, as evidenced by the uniformity in message amplification and interaction patterns. The zoomed view showcases the systematic nature of these interactions, which contribute to the cluster's influence within the broader network.

The interactions within certain clusters on X reveal a clear pattern of coordinated communication, as demonstrated by the frequent tagging of multiple profiles in a single tweet (Figure 8). For example, a tweet tagging over 40 accounts fosters interconnected discussions and amplifies visibility within the network. This behavior reflects a deliberate strategy to engage ideologically aligned users, creating a tightly knit community that reinforces shared narratives. The tagged accounts often participate in similar conversations, using consistent language and focusing on specific political topics, which illustrates a
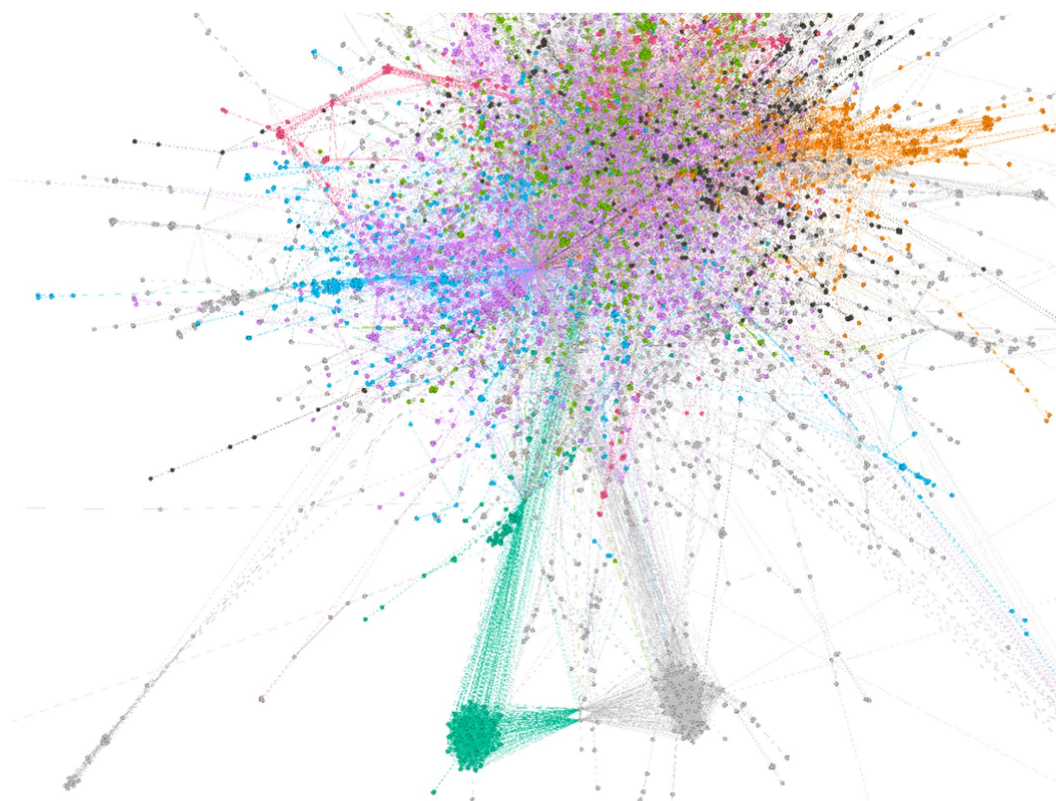
FIGURE 4
Panoramic view of the cluster map, showing micro-clusters interacting with the overall conversation network. Source: Own elaboration.

high degree of homophily within the cluster. This alignment of values and messaging contributes to an echo-chamber effect, where ideas are reiterated and amplified without external scrutiny. Such interactions highlight the organized and collective nature of these networks, enabling the rapid dissemination of their messages while strengthening internal cohesion.

While this analysis focuses on the far-right cluster as an example, it is important to note that similar patterns of coordination and homophily can be observed across other ideological or thematic groups within the network. The use of quantitative metrics such as PageRank and modularity class enables a systematic examination of these dynamics, shedding light on the mechanisms that drive influence and communication within tightly-knit digital communities.

3.3 Polarization and political silos

3.3.1 Minimal dialog between opposing clusters

The network analysis reveals limited interaction between ideologically opposing groups. For example, clusters representing Partido Popular (right-leaning) and EH Bildu (left-leaning) networks show minimal engagement with one another. This segmentation reflects the prevalence of echo chambers in online discourse, where interactions reinforce existing beliefs rather than foster dialog.

3.3.2 Fragmentation within left-wing discourse

The analysis highlights internal divisions within left-wing networks, particularly between:

- **@PSOE (Pedro Sánchez)**: Focused on institutional and governmental narratives, reflecting the role of the ruling party.
- **@PabloIglesias**: Despite stepping down from formal roles, his account remained central in discussions, engaging with activist-driven and oppositional discourse, emphasizing grassroots and alternative perspectives.

This fragmentation weakens the coherence of the progressive narrative, revealing competing priorities within the left-leaning ideological spectrum.

3.3.3 Prominence of central nodes

Despite fragmentation, @PSOE emerges as the most mentioned account, occupying a central position in the network. As the ruling party, it attracts significant attention from both supporters and opponents. This centrality underscores the party's pivotal role in shaping political debate during the election period.

4 Discussion

This study introduces a highly visual and intuitive method for identifying coordinated activity through the analysis of mentions on X (formerly Twitter). By leveraging network visualization tools like Gephi, the analysis detects clusters of automated accounts and their interaction patterns within political conversations. This methodology represents a novel approach to bot detection, emphasizing mentions as a primary data point and offering significant advantages over traditional, less transparent techniques.

FIGURE 5
Three micro-clusters interacting with the broader conversation. Source: Own elaboration.
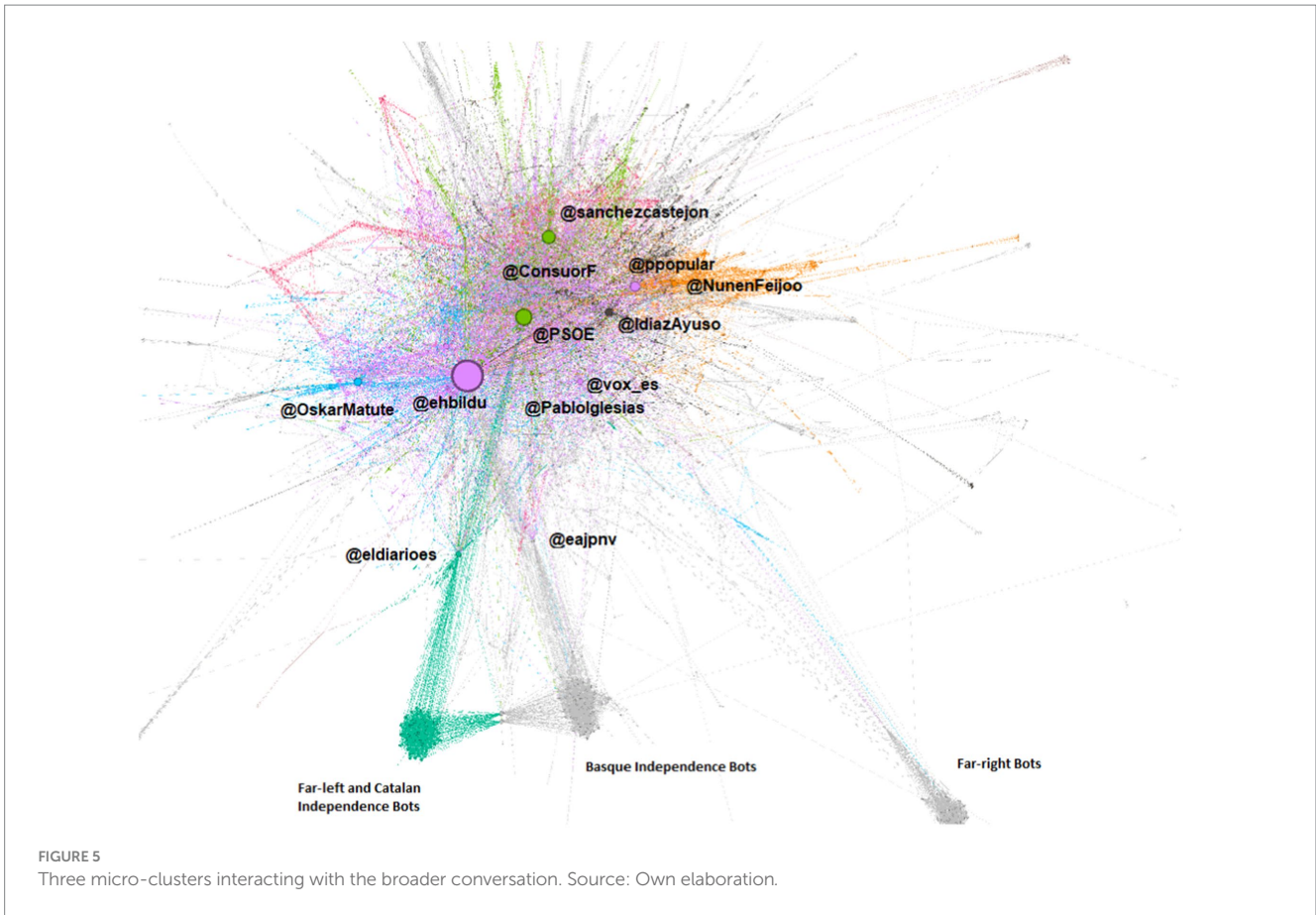
Id	PageRank
@FilipidesE	0.000297
@BernaldoDQuiros	0.000217
@unculemadrid	0.000217
@DazRos2	0.000209
@bvbrumbeck	0.000241
@ChusDark	0.000209
@silent_hacker1	0.00024
@ElMonoSabio2	0.000177
@Mister_A_aa	0.000177
@MiguelGTormo	0.000177
@Pollo27570	0.000177
@javilsantos	0.000177
@CincaJorgeJ	0.000177
@old_spinster	0.000177
@cuevas_dawson	0.000177
@Pienso_existo19	0.000177
@baldonauta	0.000177
@anxbltr	0.000177
@ZI_UR	0.000177
@alvaroh1408	0.000177

FIGURE 6
List of users identified in the far-right micro-cluster. Source: Own elaboration.

4.1 Comparison with previous studies

Previous research on coordinated and automated strategies detection has relied heavily on algorithmic techniques, often criticized for their lack of transparency and interpretability. For example, studies like Ferrara et al. (2016) and Shao et al. (2018) have identified bots as key actors in political discourse but focused on algorithmic detection models, frequently functioning as "black boxes." While these methods excel in precision, they lack accessibility and fail to provide intuitive insights into the structure of bot-driven interactions.

In contrast, this study introduces a visually driven methodology that maps mentions to uncover homophilic patterns and cluster dynamics. For instance, visualizations reveal the peripheral positioning of micro-clusters and their strategic engagement with key political accounts such as @vox_es, @PSOE, and @ehbildu. This transparency and visual clarity set the proposed methodology apart from existing approaches.
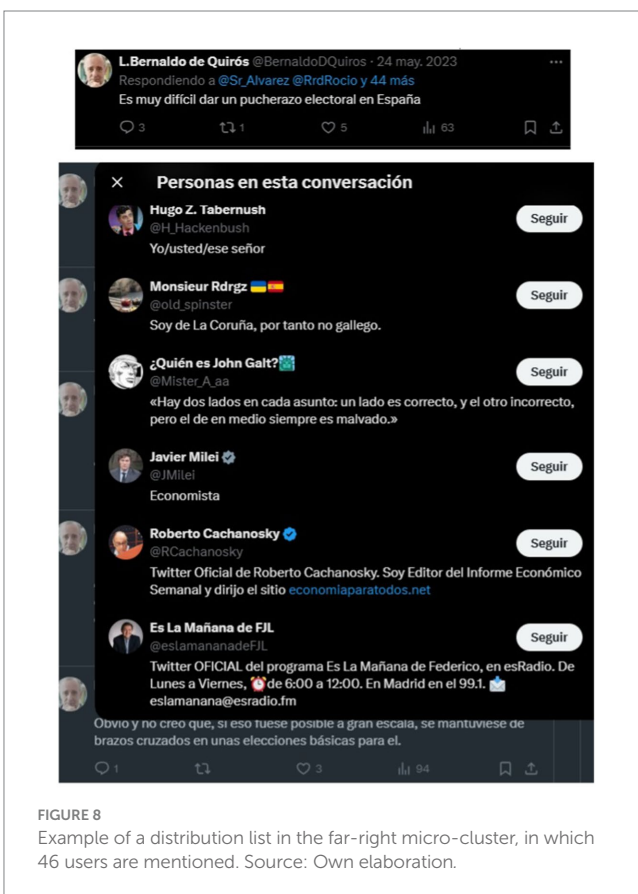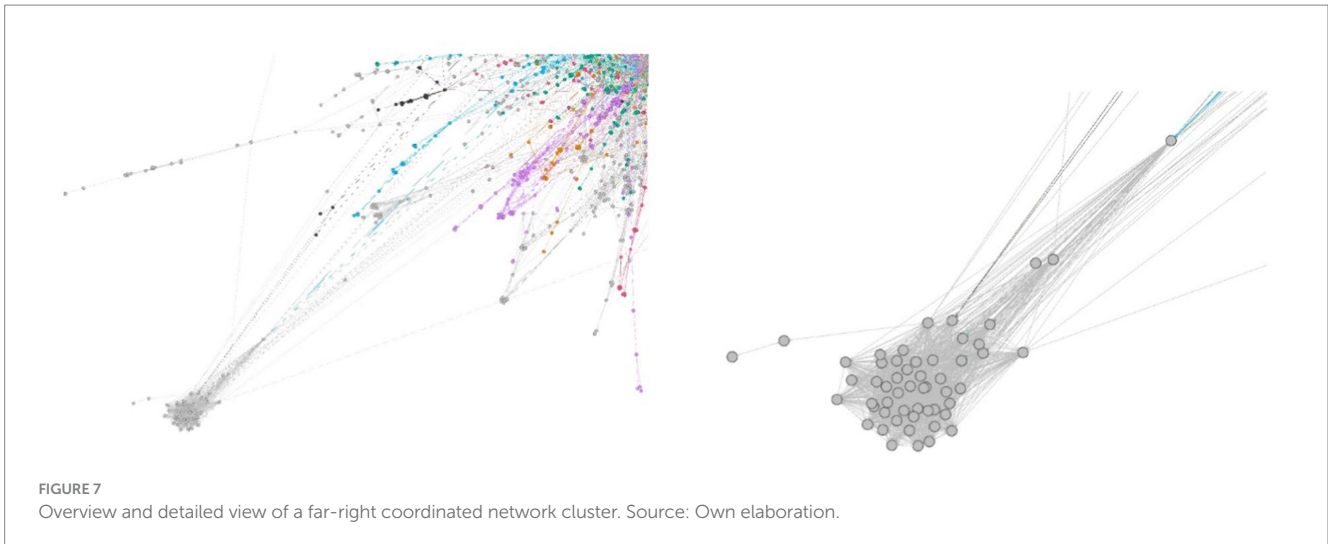
4.2 Advantages of the proposed methodology

The visual mapping of mentions highlights three major strengths of this approach:

1. **Clarity of identification:**
   The resulting cluster networks provide an immediate understanding of automated behaviors. Coordinated groups frequently appear as isolated, homophilic clusters with minimal interaction with real accounts. This distinct visual representation makes the method effective for researchers and policymakers seeking to analyze political conversations.
2. **Targeted behavior detection:**

FIGURE 7
Overview and detailed view of a far-right coordinated network cluster. Source: Own elaboration.

FIGURE 8
Example of a distribution list in the far-right micro-cluster, in which 46 users are mentioned. Source: Own elaboration.

This approach identifies targeted messaging strategies, where coordinated users interact with key political nodes (e.g., @PSOE, @NunezFeijoo, @ehbildu) to amplify divisive narratives or disrupt authentic discourse. For instance, the strategic alignment of bots with far-right or pro-independence clusters underscores their role in driving polarization.

3. **Transparency and reproducibility:**
   Unlike black-box algorithms, the visual methodology provides clear network maps that allow researchers to visually validate and reproduce findings. This transparency enhances the reliability of results and offers a complementary approach to traditional techniques.

4.3 Summary of key findings

- **Fragmentation and Echo Chambers**: The network analysis reveals a highly fragmented structure, with interactions largely confined to ideological clusters.
- **Distribution lists detection**: Coordinated messages at the network periphery amplify divisive narratives, demonstrating the ability of mentions to highlight coordinated behavior.
- **Polarization**: Polarization dominates the conversation, limiting meaningful engagement between opposing groups. Mentions serve as clear markers of echo chambers and ideological silos.

These findings demonstrate the potential of mentions as a critical analytical tool for detecting bot activity, revealing patterns of polarization, and mapping influence within online conversations.

4.4 Limitations of the study

While effective, several limitations must be acknowledged:

1. **API access limitations**:
   The study relies on data collected through X's API, which imposes restrictions on the volume and granularity of accessible data. These limitations may hinder the retrieval of complete datasets, particularly during periods of heightened activity, potentially affecting the comprehensiveness of the findings.
2. **Bot camouflaging and sophistication**:
   Advances in bot technology, particularly those leveraging artificial intelligence, allow bots to mimic human behavior with increasing sophistication. This camouflaging complicates detection, especially when bots are embedded within larger organic networks.

4.5 Emerging alternatives: transparent networks

In response to the challenges posed by platforms like X, new social networks such as Bluesky offer promising alternatives. These platforms prioritize decentralized frameworks, traceability, and user control. Unlike traditional platforms, Bluesky emphasizes open protocols, allowing for greater scrutiny of interactions and reducing the ability of automated accounts to operate undetected.

By fostering an environment resistant to disinformation and automated manipulation, these networks represent a forward-looking solution to the challenges highlighted in this study. Their emphasis on transparency and accountability promises to empower researchers, regulators, and users to better understand and combat the influence of coordinated campaigns.

5 Conclusion

This study provides a comprehensive analysis of coordinated influence efforts within political discourse on social media during the Spanish regional elections of May 2023. By examining a large dataset of mentions on X, we identified micro-clusters of users engaging in synchronized amplification efforts, often facilitated through distribution lists and other structured mechanisms. These coordinated behaviors, characterized by homophilic patterns and feedback loops, were strategically designed to amplify targeted narratives and shape public perception.

Our findings emphasize the importance of moving beyond simplistic classifications of influence efforts to a broader understanding of coordinated user behaviors. By analyzing mentions and their contextual patterns, we demonstrate that both manual and semi-automated actions play a crucial role in propagating political messaging. This nuanced approach sheds light on the orchestrated nature of influence within digital platforms.

To address these challenges, fostering greater transparency in social media algorithms and data practices is essential. Collaboration among researchers, policymakers, and social media companies can help create open frameworks to detect and counteract coordinated influence efforts. By prioritizing accountability and access to information, it is possible to better protect democratic processes and counter evolving tactics of manipulation.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical approval was not required for the study involving human data in accordance with the local legislation and institutional requirements. Written informed consent was not required, for either participation in the study or for the publication of potentially/ indirectly identifying information, in accordance with the local legislation and institutional requirements. The social media data was accessed and analyzed in accordance with the platform's terms of use and all relevant institutional/national regulations.

Author contributions

FG-U: Conceptualization, Data curation, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing. BB-D: Conceptualization, Funding acquisition, Investigation, Resources, Supervision, Writing – review & editing. JL-P: Conceptualization, Formal analysis, Investigation, Validation, Writing – original draft.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The authors declare that Gen AI was used in the creation of this manuscript. Generative AI was used to organize information and double-check references. All content has been carefully reviewed and verified to ensure accuracy and originality.

Publisher's note

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