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A Sexual Affiliation Network of Men Who Have Sex With Men Practicing Risk Sexual Behaviors and Chemsex: A Two-Mode Approach

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ABSTRACT

Background: Dating apps for men who have sex with men (MSM) have facilitated unprotected sexual encounters and practices. In addition, drug use during such encounters is widespread among MSM. Traditionally, these populations have been studied in order to relate these facts to their socioeconomic characteristics and not from the perspective of the structure of their relationships, an aspect included in all nursing metaparadigms.

Aim: Describe the structure of the MSM affiliation network and their dating apps.

Methods: This was a descriptive cross-sectional study with 32 participants recruited online through the apps. The data used by this article come from the same sample and the same questionnaires as a previously conducted study; full details are provided in the Methods section.

Results: MSM demonstrated varying degrees, engaging with 1–5 applications (normalized degree: 0.200–0.494), while venue popularity spanned from 1 to 32 (normalized degree: 0.031–0.500). The core of the network, including two applications and 16 central MSM units, exhibited a higher density, that is, a high number of connections (0.593), compared to the periphery (0.050), indicating significant centralization.

Conclusion: The sexual affiliation network of MSM forms a cohesive, extensive network, with higher app usage affinity seen among individuals who use drugs, are from different birth countries, engage in group sex, or identify with nonhomosexual orientations.

1 | Introduction

The escalating incidence of human immunodeficiency virus (HIV) infection among men who have sex with men (MSM) is a matter of concern across the Americas, Europe, and Asia (ONUSIDA 2023). Over 1.3 million new HIV infections occur annually, with the majority affecting MSM (ONUSIDA 2023).

Prevailing attitudes, such as safe sex fatigue, treatment optimism, recreational drug use, and the practice of serosorting, have been identified as contributing factors to changes in behavioral practices among MSM (Perry et al. 2016).

Numerous studies have substantiated the significant association between engagement in chemsex and the transmission of HIV

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and sexually transmitted infections (STIs) among MSM (Frankis et al. 2018; González-Baeza et al. 2018). Chemsex is characterized by the use of drugs in a sexualized context, aimed at facilitating, prolonging, enhancing sexual performance, and improving the overall sexual experience (Giorgetti et al. 2017). The prevalence of chemsex among MSM has witnessed a temporal increase and geographic expansion (Drückler et al. 2018; Lim et al. 2018). High prevalence rates have been reported in France (55%), Australia (54%), the United States (43%), the United Kingdom (32%), the Netherlands (18%–29%), as well as in Asia Pacific countries such as China (28%), Thailand (18%), Vietnam (14%), and Malaysia (7%) (Drückler et al. 2018; Lim et al. 2018). Among HIV-diagnosed MSM, the prevalence of chemsex engagement has been reported as high as 30% in places, such as Spain (González-Baeza et al. 2018), indicating the potential for population mixing of HIV-positive and -negative MSM within the same chemsex event.

Commonly used drugs in the MSM community for chemsex include gamma-hydroxybutyric acid (GHB), mephedrone, methamphetamine, erectile dysfunction agents (EDAs), and alkyl nitrites (poppers/rush) (Giorgetti et al. 2017). This practice is frequently associated with risk-prone health behavior, such as multiple sex partners, condomless sex, and group sex (Giorgetti et al. 2017).

Several studies indicate that MSM engaged in chemsex are more likely to undergo HIV testing (Frankis et al. 2018), suggesting potential benefits in enrolling them in HIV prevention services. At a community level, chemsex events have emerged as activities fostering connections among MSM, with participation linked to a heightened risk of HIV infection and STIs (Frankis et al. 2018; González-Baeza et al. 2018). Moreover, MSM within the same social network tend to share similar levels of risk-prone health behavior (Young et al. 2020).

The increasing use of the internet is transforming communication patterns in human society. Seeking sexual partners through the internet has been associated with unprotected intercourse and a higher number of partners (Acharya et al. 2023). Importantly, the rising transmission of HIV in MSM does not appear to be universally applicable, as the risk may vary depending on specific exposure settings. Situational exposure risks, such as higher chances of infection in the presence of drug use or when a sex partner is acquainted through cyberspace, contribute to the complexity of HIV transmission dynamics (Acharya et al. 2023).

Over the years, there has been a growing utilization of social network analyses in research focused on MSM. Numerous studies have underscored the pivotal role of sexual network characteristics in predicting HIV risk, providing valuable insights for guiding preventive interventions (Marqués-Sánchez et al. 2023; Smith et al. 2023). Fundamentally, network analysis offers tools for mapping social structures and analyzing the relationships within those structures (Sönmez et al. 2023). This analytical approach can identify structural patterns, contributing to evidence-based implementation strategies (Valente et al. 2015).

Studies typically treat the sexual network as a one-mode network, encompassing only one type of node—individual people. Full-network approaches, necessitating data collection from

all connections within the population, are resource-intensive. Alternative methods have been employed to better understand network configurations (Borgatti and Everett 1997; Lee et al. 2017). Investigations of one-mode sexual networks have demonstrated that the spread of STIs and the identification of individuals at the highest risk are contingent upon both the network structure and the group composition (Smith et al. 2023). This analysis is based on the idea of the “duality of people and groups” (Breiger 1974), which means that people who participate in the same activities or frequent the same places tend to be more connected to each other. In this case, MSM who engage in similar high-risk sexual behaviors and use the same venues are more likely to be linked within the social network. This perspective helps to map the structure of MSM networks and to compare different types of drug use and levels of involvement in chemsex.

These venues can be conceptualized as sexual affiliation networks, which are two-mode networks comprised of the following two distinct sets of nodes: one set representing the MSM and another set representing the venues with which they affiliate (Niekamp et al. 2013). Advanced two-mode network analysis techniques can be employed to analyze affiliation networks, such as the sexual networks of MSM (Niekamp et al. 2013). The analysis of sexual affiliation networks can complement traditional epidemiological methodologies and offer a unique contribution to the knowledge necessary for developing STI prevention strategies.

An essential consideration concerning the overall network structure is the degree of cohesion. Network cohesion, defined as the extent to which people in the sexual network are connected to each other, can impact the speed and magnitude of STI spread (Burt 1987). A more cohesive sexual affiliation network may facilitate the rapid dissemination of STIs. Specifically, when the network comprises unconnected groups (components in network terms), an outbreak of an STI in one group may not reach other groups (Burt 1987). Additionally, a shorter average distance between individuals within the network may accelerate the spread of STIs.

Centrality, indicating an individual’s position in the network, is another crucial aspect (Wasserman and Faust 1994). Being central in a sexual network, with numerous direct and indirect ties to other individuals, enhances both the risk of contracting an STI and the probability of transmitting it to others. In the context of an affiliation network, active individuals, those affiliating with numerous venues, are at a higher risk of infection, especially if these venues are frequented by individuals with a central network position (Niekamp et al. 2013). To identify these active individuals, degree centrality is employed. Less active individuals with a less central network position can still have a heightened risk of STI infection when closely connected to other people in central network positions (De et al. 2004). This concept can be translated to sexual affiliation networks, wherein MSM frequenting only one venue may still face a high risk of acquiring an STI if this venue is also frequented by MSM attending several other venues.

Homophily, as a guiding principle, suggests that individuals with similar characteristics tend to interact more frequently than those with dissimilar traits (McPherson et al. 2001). This

pervasive phenomenon underscores that cultural, behavioral, genetic, or material information transmitted through social networks tends to cluster within specific groups. Consequently, homophily implies that differences in social attributes directly influence the distance within a network, quantified as the number of relationships necessary for information to bridge between two individuals (McPherson et al. 2001). Furthermore, homophily determines that people who share the same place tend to have the same habits, implying that MSM who frequent the same physical places share the same risky behaviors (Buzi et al. 2021).

We systematically investigate the presence and significance of attribute effects on the structural configuration of the sexual affiliation network through the application of two-mode analysis (Wang et al. 2013). The utilization of a two-mode approach provides the distinct advantage of amalgamating attribute-based considerations with the network's structural aspects. This allows us to scrutinize whether the delineated structural characteristics of the network persist after accounting for the influence of attributes.

The primary objective of this study is to describe the structure of the MSM affiliation network and their dating apps. Additionally, the structure of the network is going to be described through the following: (a) analyzing network's cohesion, (b) describing the centrality of the network, and (c) determining the homophily of MSM based on risky sexual relations.

2 | Methods

2.1 | Study Overview

The current study adopts a descriptive cross-sectional design, relying on self-reported data from men who have sex with men. Participants provided responses to inquiries regarding their interpersonal networks involving sexual virtual spaces, as well as their health behaviors and engagement in chemsex within these relationships.

2.2 | Participants

The study encompasses MSM utilizing mobile dating applications, meeting the criteria of being of legal age and possessing the capability to provide informed consent. The sample comprises 32 MSM residing in various districts of Madrid, Spain. Participation in the study was contingent upon participants signing an informed consent form.

2.3 | Measures

The present study incorporated the examination of several variables as follows: demographic variables: These were utilized to characterize the study sample and included age, district of residence, sexual orientation (bisexual, homosexual, predominantly homosexual, although with sporadic heterosexual contacts, or predominantly heterosexual, although with sporadic homosexual contacts), gender (cisgender person, fluid gender, transgender person), educational level (university graduate, high school,

higher grade VET or intermediate VET), and monthly income and civil status (single, married, in a couple or separated). Risky sexual behaviors: group sex, chemsex, and unprotected anal and oral sex. Networks: centrality (degree, normalized degree, eigenvector, coreness score) (Wasserman and Faust 1994), cohesion (size, density, and geodesic distance) (Niekamp et al. 2013), and homophily (Hanneman and Riddle 2005).

For the affiliation data, participants were queried about the applications where they encountered or spent time with friends and members of their sexual networks. These networks illustrated the connections between individuals and locations, particularly in the context of virtual venues (mobile applications). Participants provided data on their sexual affiliations by disclosing the venues they frequented in the preceding 6 months. The questionnaire offered a list of fixed venue options, comprising the most popular locations in the region. For the purposes of this analysis, emphasis was placed on virtual venues explicitly designed for MSM and predominantly frequented by this demographic. Furthermore, these affiliation networks were converted into one-mode networks, facilitating the examination of relationships among individuals (Hanneman and Riddle 2005).

2.4 | Recruitment and Procedure

The data were acquired through the questionnaire outlined in the study conducted by Marqués-Sánchez et al. (2023), and this recruitment method was implemented in accordance with the recommendations provided in other studies, such as those by Hill et al. (2019).

2.5 | Analysis Plan

Statistical processing of the obtained data was conducted using SPSS v.26.0 software. The comparison of mean scores between groups was performed using Student's *t*-test. The UCINET tool, version 6.679 (Borgatti et al. 2002), was employed for calculating Social Network Analysis (SNA) measures—an exploratory software tool for network data analysis and visualization (Borgatti et al. 2002), and Gephi (Bastian et al. 2009) to represent graphs. The statistical significance level was set at 0.05.

2.6 | Ethical Considerations

The information gathered for this study underwent processing in strict adherence to the stipulations set forth in Organic Law 3/2018, dated December 5, regarding the Protection of Personal Data and the Guarantee of Digital Rights. Additionally, compliance was maintained with the Regulations of the Ethics Committee of Universidad de León, and due respect was accorded to the principles outlined in the Helsinki Declaration. Prior to the initiation of data collection, an affirmative report was sought from the Ethics Committee of the University of León, following established procedures for this purpose, and it was duly granted. Participants signed informed consent forms for participation and data publication, as outlined in [Supporting Material S1](#). To safeguard confidentiality, all information collected via questionnaires was electronically protected, limiting access

exclusively to the principal investigators of the study. Rigorous anonymization procedures were applied to all obtained data. Furthermore, participants were provided with the opportunity to contact the research team for clarification of any queries arising during the research process.

3 | Results

3.1 | Network's Cohesion and Centrality

A total of 32 MSM and five applications were obtained. All MSM utilized at least one of the virtual spaces. Grindr was nominated by all individuals. All nodes are interconnected. The average distance was 2, and the diameter was 3.

With respect to the units that are central in the network and therefore should be targeted in an intervention, we next consider both the degree centrality and the coreness of the MSM and venues (Table 1). The activity (degree) of the MSM varied between the attendance of 1 and 5 different applications (normalized degree: 0.200 to 0.494). The popularity (degree) of the venues varied between 1 and 32 (normalized degree: 0.031–0.500).

Moreover, the sexual affiliation network had a clear core-periphery structure, with a core of highly connected MSM ($n = 20$) and venues ($n = 4$) (Figure 1). This core has a density of 0.593, whereas the periphery has a density of 0.050. Although the network consists of one component, both the range for the degree centrality and the core-periphery structure indicate a high level of centralization, that is, the extent to which some MSM and events are more central than others. The coreness scores varied between 0.516 and 0.081 for MSM and between 0.597 and 0.146 for venues. In Figure 1, these coreness scores are represented by different node sizes. Table 1 and Figure 1 both show that the venues in the core of the affiliation network are all applications. The applications Grindr and Wapo and 16 MSM units form the core of the affiliation network.

The obtained data show statistical significance regarding certain centrality metrics, having children, and some sexual habits. The results indicate that individuals who consume alcohol exhibit higher levels of closeness ($p = 0.026$) and betweenness ($p = 0.015$). Generally, individuals who engage in chemsex show higher levels of normalized degree ($p = 0.006$), betweenness ($p = 0.02$), and eigenvector ($p = 0.005$). MSM who have children, in addition to the aforementioned, show a higher degree centrality ($p = 0.073$). Both MSM who engage in group sex and those who consume poppers exhibit higher levels of centrality (Table 2).

3.2 | Homophily Attributes of MSM

To examine the importance of the attributes of the MSM, we first explored the associations between their attributes and the applications and the total number of virtual venues used (Supporting Material S2). MSM attributes were generally not significantly associated with the number of applications, except for the following characteristics: birth country ($p = 0.003$), sexual orientation ($p = 0.029$), group sex ($p = 0.025$), and drug use ($p = 0.041$). This association can also be visualized in Figure 2.

TABLE 1 | Centrality measures of MSM and venues, sorted in descending sequence of coreness score.

MSM	Degree	Normalized degree	Coreness score
1	1	0.2	0.516
3	1	0.2	0.348
4	1	0.2	0.242
17	5	0.5	0.236
30	4	0.494	0.172
29	4	0.494	0.169
7	4	0.494	0.168
28	4	0.494	0.163
23	4	0.494	0.161
14	4	0.494	0.159
2	1	0.2	0.155
31	3	0.425	0.143
27	3	0.425	0.139
26	3	0.425	0.137
24	3	0.425	0.132
22	2	0.356	0.131
21	3	0.425	0.129
9	2	0.356	0.127
16	3	0.425	0.127
19	2	0.356	0.126
11	2	0.356	0.125
10	3	0.425	0.125
20	2	0.356	0.124
25	2	0.356	0.123
15	2	0.356	0.121
13	2	0.356	0.116
12	2	0.269	0.112
32	2	0.356	0.108
8	2	0.356	0.106
18	2	0.356	0.105
5	1	0.2	0.084
6	1	0.2	0.081

Application	Degree	Normalized degree	Coreness score
Grindr	32	0.5	0.597
Wapo	25	0.45	0.499
Scruff	10	0.256	0.353
Romeo	11	0.25	0.285
Hornet	1	0.031	0.146

TABLE 2 | Statistical significances of centrality measures of MSM and other variables (Student's *t*-test).

	Degree	Normalized_degree	Closeness	Betweenness	Eigenvector
	<i>p</i>	<i>p</i>	<i>p</i>	<i>p</i>	
Alcohol	—	—	0.026	0.015	—
Popper	0.012	0.032	—	—	0.031
Chemsex	—	0.006	—	0.020	0.005
Group sex	0.011	0.017	—	—	0.019
Child	0.073	—	0.000	0.000	—

TABLE 3 | Statistical significances of applications and other variables (Student's *t*-test).

	Number of app	Romeo	Scruff	Wapo
	<i>p</i>	<i>p</i>	<i>p</i>	<i>p</i>
Gender identity	—	0.044	—	—
Sexual orientation	0.029	—	—	—
Birth country	0.003	—	—	—
HIV status	—	—	0.025	—
Chemsex	0.041	0.005	—	—
Group sex	0.025	—	—	0.013
Mephedrone	—	—	0.044	—
Popper	—	0.005	—	—

Note: Hornet app is not included due to the small sample size, and Grindr is not included due to all participants nominating it.

Regarding the study of homophily through applications, the existence of a tendency to use certain applications according to their risky sexual habits has been demonstrated. For example, MSM who contact through the Romeo application show higher drug consumption ($p = 0.005$) (OR: 0.18, 95% CI: 0.04–0.73), especially poppers ($p = 0.005$) (OR: 0.11, 95% CI: 0.01–0.79). Among users of the Scruff application, MSM who consume mephedrone stand out ($p = 0.044$) (OR: 1.22, 95% CI: 0.93–1.62), as well as those who are HIV-positive ($p = 0.025$) (OR: 0.84, 95% CI: 0.62–1.14). Regarding homophily according to applications, it is worth noting that users of the Wapo application show a statistically significant relationship with participating in group sex encounters ($p = 0.013$) (OR: 2.08, 95% CI: 1.34–3.13) (Table 3).

4 | Discussion

The analysis of sexual affiliation networks stands out as a crucial contributor to the knowledge essential for the development of effective strategies in preventing STIs, thereby holding significant added value for the field of STI epidemiology. Unlike traditional epidemiological approaches, which tend to focus on individual-level factors and may overlook the complex social and spatial interactions among individuals who frequent shared venues, the network analysis perspective offers a more integrated understanding of context-specific health-related behaviors and affiliations. This methodological approach captures the structural and relational dimensions that are often critical for designing effective public health interventions (Latkin and Knowlton 2015).

Moreover, our findings underscore a noteworthy pattern wherein all MSM were integral components of a unified network, tightly connected within a confined geographical proximity. In the subsequent discussion, these results are going to be meticulously examined in accordance with the predefined objectives, maintaining alignment with the theoretical framework established earlier. This comprehensive analysis aims to illuminate the intricate dynamics within sexual affiliation networks and their implications for shaping targeted STI prevention strategies and advancing our understanding of STI epidemiology.

Our research centered on scrutinizing sexual affiliation networks among MSM and their virtual platforms utilized for sex partner recruitment. The primary objective of this research was to describe the structure of the MSM affiliation network and their dating apps.

Within the purview of this study, we focused on addressing two pivotal research questions. The intent was to conduct a rigorous examination of analyze network's cohesion and describe the centrality of the network. The conclusive sexual affiliation network encompassed 32 MSM and five venues, constituting a sample size slightly smaller than comparable studies, particularly in the realm of applications (Niekamp et al. 2013; Patel et al. 2018).

It is noteworthy that all MSM unanimously designated Grindr as the most central application, serving as the nexus linking all individuals and applications within the network. Consequently, in principle, the potential for STI dissemination throughout the

1	1				
3	1				
4	1				
17	1	1	1	1	1
30	1	1			1
29	1	1	1	1	
7	1	1	1	1	
28	1	1	1	1	
23	1	1	1	1	
14	1	1	1	1	
2	1				
31	1	1			1
27	1	1			1
26	1				1
24	1		1		1
22	1				1
21	1	1			1
9	1				1
16	1		1		1
19	1				1
11	1				1
10	1	1			1
20	1				1
25	1	1	1		1
15	1				1
13	1				1
12	1		1		
32	1				1
8	1				1
18	1				1
5	1				
6	1				

FIGURE 1 | Core-periphery structure of the affiliation network. The numbers are referring to the MSM. Affiliation network graphs with MSM attributes, the size of nodes is based on coreness score. In the case of the country of birth, the pink circles are Spain, and the red circles are other countries. In the genre, the pink circles are the homosexuals, and the pink circles are others.

entire network is evident. However, the velocity of this spread may hinge on the geographical proximity between network nodes. The calculated average distance between two nodes within the affiliation network was notably compact, underscoring a high degree of interconnectedness, a pattern observed to a lesser extent in previous studies (Niekamp et al. 2013).

Given the singular, highly interconnected component of the network, an STI outbreak originating at one venue is likely to transcend the confines of that specific locale and extend to other venues. This observation emphasizes the broader implications of STI transmission dynamics within the network, with ramifications for targeted preventive interventions extending beyond isolated venues.

Furthermore, the sexual affiliation network exhibited a discernible core-periphery structure, characterized by a highly connected core, yielding density metrics surpassing those reported in other studies (Patel et al. 2018). The densely connected core functions as a facilitator for the rapid transmission of STIs among core members and subsequently, albeit at a slower pace, to the periphery. Given the elevated risk profile associated with core members in terms of both acquiring and disseminating STIs, directing STI prevention strategies toward this central cohort may prove more efficacious than analogous efforts aimed at peripheral members (Niekamp et al. 2013). Notably, since all core venues were identified as being associated with Grindr, interventions should be particularly tailored towards individuals engaging with this application.

Despite the geographic dispersion of the 32 MSM across different districts, the sexual affiliation network formed a cohesive single component, as observed in prior studies (Buzi et al. 2021). This means that, regardless of physical distance or administrative boundaries, all individuals were indirectly connected through shared app usage and sexual practices, forming a single, unified network. Such cohesion suggests the presence of central actors or popular venues that act as bridges between otherwise disconnected subgroups, facilitating the spread of behaviors and potentially also of infections. This finding highlights the importance of analyzing relational structures beyond geography, as network cohesion may have greater implications for public health than spatial proximity alone.

The structural configuration of the sexual affiliation network implies a potential for the widespread transmission of STIs across all individuals within the network (Malandain and Thibaut 2025). Findings from both average geodesic distance and core-periphery analyses indicated a moderate overall interconnectedness with a notably interconnected core. The heightened degree centrality observed among specific MSM suggests an increased potential for STI propagation throughout the entire network, including less active individuals. MSM who engage with a diverse array of virtual venues for partner recruitment are anticipated to have a broader spectrum of potential sexual partners, thereby enhancing the likelihood of STI transmission. Consequently, for optimal efficacy, interventions aimed at preventing STIs should be directed towards core members rather than those on the periphery. It is worth noting that conventional STI prevention interventions typically target specific characteristics and

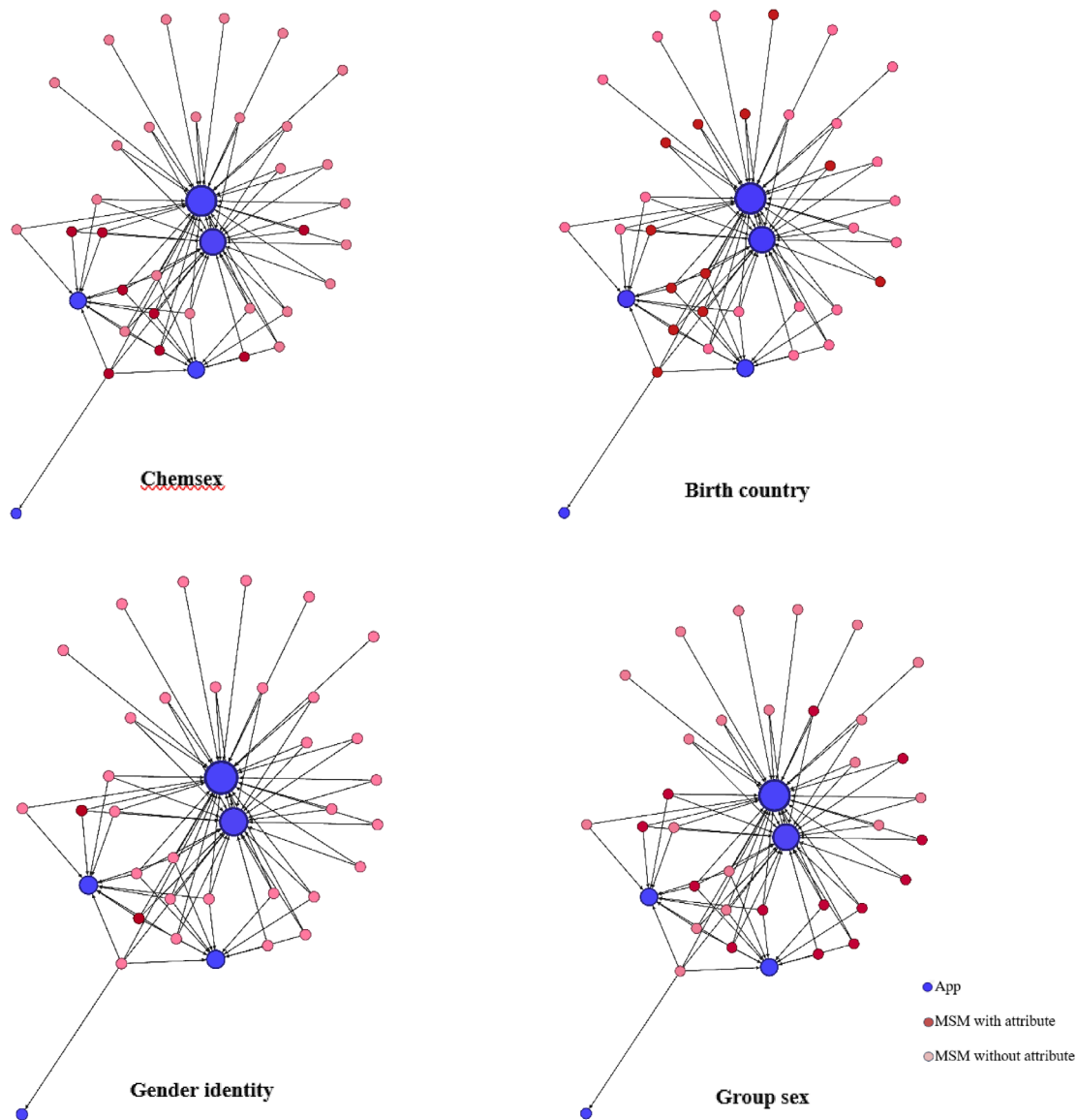


FIGURE 2 | Affiliation network graphs with MSM attributes, the size of nodes is based on coreness score. In the case of the country of birth, the pink circles are Spain, and the red circles are other countries. In the genre, the pink circles are the homosexuals, and the pink circles are others. [Color figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1111/phn.70058)]

risk-prone health behaviors associated with elevated STI transmission rates, such as the use of condoms or substances.

Therefore, the second research query centered on determining the homophily of MSM based on risky sexual relations, given that certain attributes are correlated with an elevated risk of STI transmission, the identification of venues characterized by a higher prevalence of such behaviors assumes paramount significance in determining the focal points for targeted interventions. The elucidation of associations between individual attributes and the structural dynamics of the affiliation network aids in refining the strategic focus of interventions, ensuring a more nuanced and effective approach to STI prevention within specific venue contexts (Garga et al. 2025).

The findings underscored discernible distinctions in venue attendance patterns, with certain venues predominantly attracting

drug users while others catered primarily to nondrug users, aligning with earlier research findings (Niekamp et al. 2013). A more nuanced exploration, considering the interplay between attributes of MSM and venue types, revealed that this divergence is rooted in the observation that MSM engaged in drug use frequented a significantly higher number of applications, as demonstrated by Wong et al. (2020). This correlation extended to MSM with a gender identity differing from homosexuality, as they too exhibited a propensity to frequent a greater number of applications.

Consequently, a discernible preference in venue selection emerged based on the characteristics of MSM and the venues themselves. Specifically, MSM engaging in drug use tended to gravitate towards central venues, such as Romeo or Scruff, as elucidated by Wong et al. (2020). This insight assumes paramount importance in refining the strategic focus of STI prevention

strategies, as it highlights the need for targeted interventions catering to the specific characteristics and behaviors prevalent within these central venues, thereby enhancing the overall effectiveness of STI prevention initiatives (Garga et al. 2021).

Additionally, the country of origin appears to be correlated with the number of applications utilized by MSM. MSM born in a different country demonstrate a higher frequency of application usage compared to those born in Spain, a trend consistent with the findings presented in studies conducted by Patel et al. (2018). This association between country of birth and application usage underscores a noteworthy dimension in the behavioral disparities among MSM, necessitating a nuanced approach in tailoring interventions to address the distinct preferences and characteristics associated with individuals from diverse national backgrounds.

The outcomes revealed pronounced homophily effects among MSM engaging in the consumption of specific drugs such as mephedrone or poppers, as evidenced by their shared attendance at identical venues (Wong et al. 2020). When concentrating on distinct behaviors, the option to pinpoint specific applications becomes viable. However, directing attention towards core venues proves to be a valuable strategy. Acknowledging the existence of homophily in risk behaviors suggests that preventive efforts should not only target core venues but also concentrate on clusters of MSM exhibiting high-risk behaviors congregating at specific locales. Graph visualizations can serve as instrumental tools in identifying these specific venues that attract individuals with heightened risk behaviors. It is noteworthy that, unlike observations in other studies (Lee et al. 2009), no discernible homophily or elevated centrality levels have been identified in relation to HIV status.

These findings resonate strongly with the metaparadigms of nursing, person, health, environment, and nursing practice, by illustrating how structural and social determinants, such as digital connectivity and spatial proximity, shape sexual health behaviors (Fawcett 2005). The identification of core venues and tightly connected subgroups within MSM sexual affiliation networks underscores the importance of understanding patients not merely as individuals, but as actors embedded within dynamic social systems (Valente 2010). For community health nurses, this insight enables geographically targeted outreach efforts (Rafferty and Traynor 2004). For family and public health nurses, it reinforces the need for culturally sensitive and structurally informed strategies that account for intersectionality, geolocation, and digital environments. Integrating network-based knowledge into nursing care supports the development of holistic interventions that align with the nursing discipline's commitment to promoting collective well-being and preventing disease within diverse populations (Latkin and Knowlton 2015).

5 | Limitations

The analysis is predicated upon a convenience sample rather than comprehensive network data. Obtaining complete network data poses a substantial challenge, given that MSM utilizing contact applications represent a concealed population that is inherently elusive. This inherent difficulty in reaching and collecting data

from the entirety of the network underscores the pragmatic constraints associated with this study. Additionally, self-reported data introduce potential recall bias and social desirability bias, as participants may unintentionally misreport or underreport sensitive behaviors, such as drug use or sexual practices. These biases may affect the accuracy of the reported affiliations and behaviors within the network. The exploration of longitudinal data provides a promising avenue for unravelling these intricate mechanisms.

While the use of complete network data is deemed essential for a nuanced interpretation of statistical network analysis results, the current study's reliance on a convenience sample necessitates careful consideration of potential implications. The sampling method employed raises pertinent questions concerning network boundary specifications within the affiliation network, the observed network structure, and the subsequent interpretation of the analytical findings. Given the inherent limitations stemming from the lack of complete network data, any extrapolation of the results to practical STI prevention should be approached with caution.

To enhance the practical utility of this analysis and its applicability to STI prevention strategies, it is recommended that future research endeavors prioritize the collection of complete network affiliation data. This strategic shift would contribute to a more comprehensive understanding of the dynamics at play within the sexual affiliation networks of MSM who use contact applications, thereby fostering more robust and informed public health interventions.

6 | Conclusion

This study highlights the utility of two-mode network analysis in examining sexual affiliation networks among MSM. The analysis revealed that the network constitutes a cohesive and highly interconnected structure in which individuals who use drugs, identify with sexual orientations other than homosexuality, were born outside the country, or participate in group sex, tend to cluster around specific apps. These apps function as central nodes within the network, suggesting their strategic importance for STI prevention.

One key finding is the presence of homophilic clustering related to drug use and length of time in the network. This indicates that certain venues and applications not only attract users with similar traits but may also reinforce risk-prone health behaviors. The dynamic nature of this affiliation network, particularly how new MSM integrate and how behaviors evolve over time, warrants further exploration in future longitudinal studies. Our results re-affirm the added value of the two-mode network analysis approach in STI epidemiology and in the design of more targeted prevention strategies.

Based on these findings, it is essential to develop a comprehensive STI prevention and health promotion strategy aimed at MSM who use mobile dating applications. This should include specific interventions addressing drug use, informing users about the risks, available detoxification resources, and how to respond in case of intoxication. Furthermore, the national chemsex strategy

developed by the Ministry of Health should be promoted and implemented across all relevant sectors, including primary care, substance abuse centers, LGBTQ+ organizations, MSM meeting places, and the apps themselves. In this context, community nurses have a vital role and should lead the development of effective health education programs that reduce these practices and their consequences.

Given the increasing complexity of sexual behaviors mediated by mobile applications, especially among MSM populations, nursing practice must adapt through evidence-based and context-sensitive interventions. Community, family, and public health nurses should incorporate structured assessments into routine clinical care that include questions on app usage, sexual affiliation patterns, and drug use. These assessments should be supported by nursing theories to ensure that interventions are grounded in a holistic, person-centered approach.

In addition, the scope of nursing action must expand beyond the traditional HIV/AIDS response. Clinical and public policy strategies should also address emotional regulation, social support networks, digital health literacy, and self-care, critical domains affecting MSM in digital contexts. These expanded roles require not only nursing care but also advocacy for inclusive and affirmative health services.

As a practical and feasible example, community nurses can collaborate with LGBTQ+ organizations, app developers, and public health agencies to create geolocated educational content within dating apps, offer digital risk-reduction counseling, and coordinate referrals to testing and detoxification services. These interventions should take into account global diversity in terms of context, resources, and policy, and should be guided by a global health perspective that connects public health nursing to international strategies and cross-border learning. This approach fosters a culturally sensitive and scalable care model that reflects the evolving nature of sexual health in a digitally connected world.

Author Contributions

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Conflicts of Interest

The authors declare no conflicts of interest. This article is an original work and is not presently under consideration for publication elsewhere.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.

Supporting File 1: phn70058-sup-0001-SuppMat.docx.

Supplementary Material 2: *Sociodemographic variables between applications.*