# Interplay of activity space and HIV transmission among men having sex with men in Aizawl City, India

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***Abstract*—This study examines the spatial dimensions of HIV vulnerability among Men Who Have Sex with Men (MSM) in Aizawl City, Mizoram—one of India's highest HIV prevalence settings. Using a cross-sectional exploratory design, data were collected from 52 MSM registered under the Zoram Drivers Ramthim Board's Targeted Intervention program between January and March 2021. A semi-structured questionnaire captured socio-demographic characteristics, substance use, sexual behavior, and self-reported HIV status, while GIS-based activity space mapping analyzed spatial mobility patterns. Results revealed that MSM in Aizawl lead spatially constrained lives, with mean core and peripheral activity spaces measuring 0.4 km² and 1.86 km² respectively. Social stigma and moral regulation by institutions such as the Church and the Young Mizo Association limited participation in public life, driving social and sexual interactions into hidden or semi-private settings. Substance use, particularly alcohol, was prevalent (80.77%) and often coincided with unprotected sexual encounters. HIV prevalence stood at 25%, with most transmissions occurring through unprotected sex in private residences. Only 37.5% of reported HIV transmission sites overlapped with mapped activity spaces, indicating that some risk behaviors occur beyond routine mobility zones. The findings underscore that HIV risk among MSM in Aizawl city is not merely behavioral but spatially produced emerging from the intersection of stigma, restricted mobility, and concealed social networks. Interventions must therefore integrate spatial understanding with stigma-informed and community-based strategies to enhance HIV prevention, testing, and care within this marginalized population.**

***Index Terms*—Activity space, Men Who Have Sex with Men (MSM), HIV risk, Spatial behavior, Marginalized populations, GIS, Risk environment**

## 1.Introduction

Men Who Have Sex with Men (MSM) bore a disproportionate burden of HIV infection, with prevalence rates several times higher than those of the general population (Alvy et al., 2011). High rates of condomless anal intercourse and alcohol- or drug-facilitated sex increased HIV risk among MSM (Alvy et al., 2011; Bruce et al., 2013). However, these behavioral risks are not evenly distributed in space. They are embedded in the social and physical environments where MSM live, work, and interact.

Stigma, rejection, and surveillance restrict MSM's freedom of movement and limit access to safe social spaces (Garofalo et al., 2015; Savin-Williams, 1994). As Bell & Valentine (2003) and Johnston & Longhurst (2010) observed, the spatial regulation of sexuality within urban contexts often confines non-heteronormative identities to specific, hidden, or transient places. Consequently, risk behaviors are shaped not only by individual choice but also by spatial constraints and opportunities within the city. Understanding these psychosocial and behavioral factors was critical for mapping MSM activity spaces as potential hotspots for HIV transmission (Vaughan et al., 2017). A qualitative study of young urban MSM further supported this link, showing that psychological distress directly raised the likelihood of HIV exposure (Mustanski, 2008).

Understanding where and how people moved through their daily environments was essential for identifying hotspots of HIV transmission. The concept of 'activity space,' defined as the set of locations an individual routinely visits, offered a way to capture where people lived, worked, socialized, and engaged in risk environments (VanDevanter et al., 2011; Cassels et al., 2023; Cassels et al., 2017; Deane et al., 2010; Coffee et al., 2007). This approach is grounded in Lefebvre's notion of the 'production of space,' which views space as socially constructed through everyday practices and power relations. In this study, activity spaces were thus interpreted not only as physical movement patterns but also as expressions of how stigma, mobility, and visibility shape the lived experience of MSM in urban Aizawl.

By mapping activity spaces, researchers could reveal spatial patterns of risk and target interventions more effectively in high-burden settings. Moreover, spatial mobility such as migration and daily commuting connected different risk environments and shaped patterns of HIV vulnerability. Previous studies expanded understanding of how spatial and psychosocial factors influenced HIV risk among MSM.

For instance, Gesink et al. (2020) demonstrated that MSM in Toronto tended to select partners within their habitual activity spaces, even as mobile applications decentralized traditional meeting venues. Broader analyses connected various forms of spatial mobility such as daily commuting, migration, and local travel to localized HIV transmission across diverse contexts (Shaw et al., 2019; Cassels et al., 2023; Cassels & Camlin, 2016). In urban settings, the built environment and anonymity facilitated both substance use and sexual networking among MSM, but these also amplified vulnerability in contexts of stigma and surveillance (Aldrich, 2013; Anacker & Morrow-Jones, 2005; Johnston & Longhurst, 2010). Therefore, understanding the spatial dimensions of activity space was essential for identifying the dynamics of HIV transmission and for planning effective interventions to address it.

However, no Indian study to date had examined how specific characteristics of MSM activity spaces influence HIV risk. Accordingly, the present study aimed to investigate how spatial behavior and activity spaces intersected with HIV vulnerability among Men Who Have Sex with Men (MSM) in Aizawl City, Mizoram. It specifically explored the influence of social stigma, substance use, and spatial mobility on patterns of HIV risk. Through this analysis, the study sought to determine whether HIV transmission among MSM primarily occurred within their defined activity spaces or extended beyond them, thereby contributing to a spatial understanding of HIV vulnerability in Aizawl.

## 2.METHODOLOGY

### 2.1 STUDY AREA

Aizawl City, the capital of Mizoram, was the primary setting of this study. Despite a gradual decline in new HIV infections, Mizoram continued to record one of the highest HIV prevalence rates in India and was still considered to be in the midst of an

epidemic (NACO, 2025). Aizawl, in particular, reported an adult HIV prevalence of 2.73%, which was more than thirteen times the national average of 0.2% (NACO, 2025). The main modes of HIV transmission included heterosexual and homosexual intercourse, injecting drug use, blood transfusion, and mother-to-child transmission.

The Mizoram State AIDS Control Society (MSACS, 2024) reported that the prevalence of HIV among Men Who Have Sex with Men (MSM) was 1.9%. Although this figure appeared lower than that of other high-risk groups such as Injecting Drug Users (IDU) and Female Sex Workers (FSW), MSM remained a socially marginalized group with limited visibility and restricted access to prevention services. Social stigma surrounding homosexuality and conservative religious norms often discouraged open expression of sexual identity, rendering MSM a hidden and hard-to-reach population within the city.

Aizawl City was also one of the most urbanized and densely populated cities in northeastern India, characterized by rapid urban growth within a limited hilly terrain. Its built form followed the contours of steep hill ridges, resulting in linear settlements, narrow roads, and compact residential clusters. The city's high level of urbanization, combined with its spatial constraints, made Aizawl a crucial setting for examining how activity space, mobility, and social stigma intersected to influence HIV vulnerability. These spatial and social features provided an ideal context for examining how daily mobility patterns relate to HIV vulnerability.

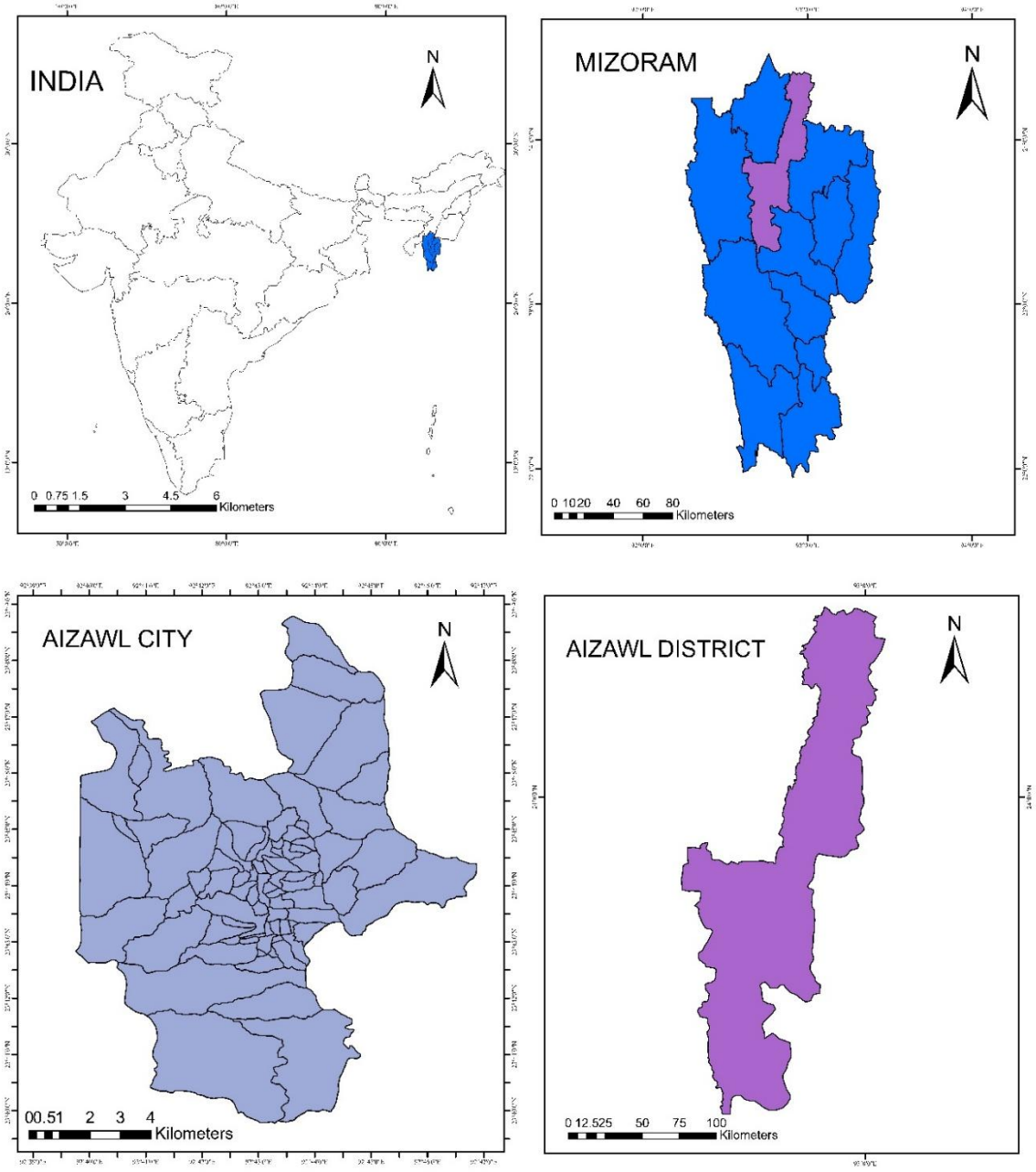


Fig 1: Map of the study area

### 2.1.1 SOCIOCULTURAL CONTEXT

Cultural perceptions of gender and sexuality in Mizoram added further complexity to MSM identities. Locally, individuals whose behavior or appearance deviated from traditional masculine norms and aligned more closely with feminine traits were referred to as '*Tuai*'. These individuals might or might not engage in anal intercourse with other males. In contrast, '*Mawngkawhur*' referred to males who engaged in anal sex. Such local terminologies reflected the diversity of gender expression and sexual roles within the MSM community and indicated how sexual identity was understood in local cultural terms.

Despite these internal distinctions, the broader social environment in Mizoram remained largely conservative and shaped by strong religious values. Public discussion of sexuality was often discouraged, and same-sex relationships were heavily stigmatized. As a result, many MSM concealed their identities and social interactions. Ralte & Kannan (2021) noted that the scarcity of research and documentation on MSM in Mizoram, stemming from such stigma, had constrained the development of effective HIV prevention programs and outreach strategies for this group. These sociocultural constraints also influenced where MSM could meet or socialize, thereby shaping the geography of their activity spaces.

### 2.2 SAMPLING

Given the hidden nature of the MSM population, convenience sampling through a trusted community-based organization was deemed most appropriate for exploratory spatial mapping. This exploratory study employed a cross-sectional design among Men Who Have Sex with Men (MSM) registered under the Targeted Intervention (TI) program implemented by the Zoram Drivers Ramthim Board (ZDRB) in Aizawl. The TI, initiated by the National AIDS Control Organisation (NACO), provides prevention, care, and support services for key high-risk populations through community-based Non-Governmental Organisations (NGOs).

A total of 52 respondents were interviewed, representing 7.53% of the 690 MSM registered under the program as of January 2021. Eligibility criteria included being a biological male aged 18 years or older and reporting sexual contact with another male. Recruitment was conducted through peer referrals and telephone contact, and interviews were held in private rooms at the drop-in center to ensure confidentiality. Written informed consent was obtained from all participants, and each was compensated INR 100 for participation.

### 2.3 DATA COLLECTION

Data collection was conducted between January and March 2024 using a semi-structured questionnaire administered at the ZDRB drop-in center. The questionnaire captured socio-demographic characteristics (age, education, income, occupation), substance use patterns, sexual behavior, participation in social or religious groups, and self-reported HIV status.

To supplement the survey, in-depth interviews were conducted with participants who voluntarily shared detailed narratives about mobility, stigma, and access to services. Confidentiality was maintained by omitting personal identifiers and obtaining additional verbal consent for sensitive questions related to HIV status.

To capture activity space, participants listed the localities they routinely visited during the past six months in relation to their daily activities. Four categories of locations were recorded: place of residence, workplace, hangout areas, and hotspots visited for sexual or social interaction. These spatial data were central to understanding how everyday mobility intersected with HIV risk environments. These localities were geocoded and later used in GIS-based spatial analysis to map individual activity spaces and examine overlaps with potential HIV risk zones. The activity space mapping reflected participants' routine and regularly visited locations; therefore, non-routine or sporadic movements (e.g., one-time encounters or out-of-area events) were not captured in the GIS dataset.

### 2.4 DATA ANALYSIS

Data were analyzed using both quantitative and spatial statistical approaches. Descriptive statistics were used to summarize socio-demographic, behavioral, and mobility-related characteristics.

Quantitative findings informed spatial interpretation, allowing integration of behavioral variables with mapped activity spaces. Spatial analysis was conducted in ArcGIS 10.2 to visualize the spatial extent and distribution of each respondent's activity space. Using the Standard Deviation Ellipse (SDE) method in ArcToolbox, one- and two-standard-deviation ellipses were generated for each individual. The 1-SD ellipse represented the core activity space (approximately 68% of visited locations), while the 2-SD ellipse delineated the peripheral or extended space (around 95%). Ellipses were centered around the mean center (centroid) of all the individual's activity locations.

For confidentiality, exact residential addresses were not mapped; instead, a single representative point was assigned to each named locality. Composite maps were then produced to visualize the overlap of individual ellipses, allowing identification of zones of concentrated mobility and potential HIV exposure areas.

## 3. RESULTS AND ANALYSIS

### 3.1 SOCIO-DEMOGRAPHY OF MSM

All respondents in the study were residents of Aizawl City, Mizoram. The median age was 25 years, with 92% falling between 18 and 43 years of age, reflecting a predominantly young and economically active population. The majority (61.54%) were single, and 38.46% were in informal or committed relationships—consistent with the absence of legal recognition for same-sex unions in India.

Educational attainment among respondents was relatively high, with over two-thirds completing higher secondary or tertiary education; however, 38.42% reported dropping out of school, often citing stigma, bullying, or financial hardship as reasons (Table 1). Occupationally, the largest group (34.62%) worked with non-governmental organizations, primarily as Outreach Workers or Peer Educators under the Zoram Drivers Ramthim Board (ZDRB). Others were employed in the service sector—such as salon work, hospitality, and small businesses—indicating a concentration in informal or semi-formal urban employment.

Table 1: Socio-Demography of MSM (n=52)

| Variable (n=52) | % |
|---|---|
| **Age** | |
| 18 – 23 | 28.85 |
| 24 – 29 | 63.46 |
| 30 – 35 | 5.77 |
| 35 above | 1.92 |
| **Marital Status** | |
| Single | 61.54 |
| In a relationship | 38.46 |
| **Highest Educational level attained** | |
| High School | 30.76 |
| Higher Secondary | 36.54 |
| UG | 30.77 |
| PG | 1.93 |
| **Occupation** | |
| Business | 15.38 |
| Govt. Service | 5.77 |
| Daily Labourer | 1.92 |
| Service Provider | 21.15 |
| NGO | 34.62 |
| Unemployed | 21.16 |
| **Monthly Income (INR)** | |
| 5000 – 20000 | 46.94 |
| 20001 – 35000 | 18.37 |
| 35001 – 50000 | 18.37 |
| 50001 above | 16.33 |

Source: Primary survey, 2021

A significant proportion of MSM lived outside their parental homes—21% resided with friends or alone, while 32% had migrated from other districts of Mizoram to Aizawl. About 15% had changed their residence within the past six months (Table 2). Such residential mobility, combined with independent living, offers greater privacy but may also facilitate hidden or risk-prone sexual networks due to reduced familial oversight.

Table 2: Migration and Housing Patterns of MSM

| Variable (n=52) | % |
|---|---|
| Migrated from other districts to Aizawl | 32 |
| Living with friends, cousins, or alone | 21.15 |
| Shifted locality in the past 6 months | 15.38 |

Source: Primary Survey, 2021

Overall, the socio-demographic profile indicates that MSM in Aizawl are largely young, urban, and economically active but socially fragmented. Their high educational levels contrast with precarious employment and housing conditions, reflecting structural vulnerability. Independent living and intra-urban mobility—while enabling privacy and freedom—also create distinct spatial patterns of daily movement that shape the geography of social interaction and potential HIV exposure. This pattern is further reinforced by the high proportion of migrants from outside Aizawl, many of whom relocate to the city in search of anonymity, employment, and greater social acceptance. These demographic conditions therefore contextualize the limited social integration discussed in the following section.

### 3.2 SOCIAL INTEGRATION

Mizo society is characterized by strong social cohesion, largely structured around two key institutions: the Church and the Young Mizo Association (YMA). Membership in both organizations is nearly universal among the Mizo population and represents an important marker of social belonging. However, MSM respondents reported significantly lower levels of participation in these institutions compared to the general population. As shown in Table 3, only 50% reported involvement in YMA activities and 48% in Church-related programs.

Table 3: Involvement of MSM in NGO and Church Activities

| HRG | Percentage of participants involved |
|---|---|
| **NGO** | 50% |
| **Church** | 48.08% |

Source: Primary Survey, 2021

This reduced participation reflects the heteronormative and gendered expectations embedded within community life. Traditional YMA activities, such as hnatlang (community work) or thlanlaih (burial preparation), emphasize physical labor and masculine roles, which many MSM found socially uncomfortable or stigmatizing. Similarly, church participation—typically viewed as a moral obligation—was hindered by the perception that homosexuality violated religious norms. Several respondents described feelings of guilt or exclusion, with some avoiding church entirely due to internalized stigma.

Such exclusion from central community spaces restricts MSM's social visibility and reinforces their marginalization. In Lefebvre's terms, these institutions represent conceived spaces—socially regulated environments that define moral belonging and spatial participation. As MSM withdraw from these public spaces, their social interactions become confined to more private or hidden settings, reshaping their activity spaces and limiting access to community support. This spatial and social isolation contributes to psychological distress and may indirectly heighten vulnerability to HIV risk behaviors. Such withdrawal into private settings forms the backdrop against which substance use and sexual risk-taking unfold.

### 3.3 SUBSTANCE USE

Substance use emerged as a significant behavioral and psychosocial concern among MSM in Aizawl City, with 80.77% of respondents reporting some form of substance use (Table 4). The high prevalence reflects the psychological stress of negotiating sexual identity within a conservative and religiously rigid society. Many respondents described substance use as a coping mechanism to manage stigma, loneliness, or emotional distress.

Table 4: Substance abuse among MSM in Aizawl City

| **Type of Substance Abuse (n=52)** | % |
|---|---|
| Alcohol Only | 67.3 |
| Alcohol and Marijuana | 3.85 |
| Marijuana and Pills | 3.85 |
| Pills Only | 1.92 |
| Alcohol and Pills | 1.92 |
| Alcohol, Pills, Heroin | 1.92 |
| **Regularity of Substance Abuse (n=52)** | |
| Regular Use (2 – 7 times a week) | 38.10 |
| Only in Parties/Events/Weekends | 61.90 |

Source: Primary Survey, 2021

Alcohol was the most used substance, often consumed during private social gatherings or small group events held discreetly within homes or secluded venues. Sleeping pills and anxiety medications were also misused by several respondents, typically to manage emotional stress or sleep disturbances.

In-depth interviews further revealed that substance use often served as a catalyst for sexual activity. Several bisexual or questioning respondents admitted engaging in same-sex encounters only while intoxicated, suggesting that alcohol or drugs temporarily suppressed internalized stigma and fear of social judgment. These moments of lowered inhibition frequently coincided with unprotected sex, underscoring the complex intersection of emotional distress, substance use, and sexual risk-taking.

Substance use also delineated specific spatial and social environments within MSM activity spaces. Private homes, rented rooms, and hidden party venues settings for both drinking and sexual interaction. These gatherings offered a temporary sense of community and safety but also normalized intoxication and risk behavior. In Lefebvre's spatial terms, these spaces represent lived spaces informal, hidden arenas where MSM negotiate identity, intimacy, and social belonging outside normative public life. While these hidden gatherings offered a sense of community and temporary relief from stigma, they also normalized intoxication and sexual risk-taking, creating environments where substance use and unsafe sex frequently intersect (Harawa et al., 2008).

Ultimately, substance use among MSM in Aizawl is both a symptom of social exclusion and a spatial practice shaped by it. The tendency to gather in concealed or semi-private environments reinforces patterns of isolation and secrecy, limiting access to health interventions and heightening vulnerability to HIV transmission.

### 3.4 SEXUAL BEHAVIOR AND RISK

MSM in Aizawl City exhibit a spectrum of sexual behaviors that heighten their vulnerability to HIV and other sexually transmitted infections. As shown in Table 5, 73.07% of respondents reported engaging in anal intercourse within the past six months, and more than half (51%) reported having casual sexual partners. Condom use during these encounters was low—71% of those with casual partners admitted to rarely or never using condoms. Among bisexual respondents, 19.22% reported inconsistent condom use, typically using protection with male partners but not with female partners, revealing a potential route for HIV transmission bridging different sexual networks.

Table 5: Sexual Attributes of MSM

| **Variable (n=52)** | Percentage % |
|---|---|
| **Sexual Role (N=50)** | |
| Bottom | 16 |
| Top | 22 |
| Versatile | 62 |
| **Sexual Preference** | |
| Male only | 44 |
| Both Male and female | 56 |
| **Number of Sexual Partners in the Last 6 Months** | |
| 1 – 2 | 73.68 |
| 3 – 4 | 10.53 |
| 5 and above | 15.79 |
| **Type of Sexual Partners** | |
| Casual Sex Partner | 51.35 |
| Regular partner | 48.65 |

Source: Primary Survey, 2021

Source: Primary survey, 2021

The majority of respondents identified as versatile (62%), meaning they assumed both insertive (“top”) and receptive (“bottom”) roles during anal intercourse, while smaller groups identified exclusively as tops (22%) or bottoms (16%). Versatility often corresponds to a higher probability of unprotected sex, as individuals alternate between higher-risk receptive and insertive acts without consistent condom use. Importantly, sexual identity does not always align with behavior at each encounter; event-level versatility was common, reflecting situational dynamics rather than fixed sexual roles. Studies have shown that versatile MSM report higher frequencies of unprotected receptive sex, which carries greater biological risk for HIV acquisition (Rasic et al., 2011; Pereira, 2021).

These behavioral patterns are influenced by the social and spatial context of MSM life in Aizawl. Fear of stigma and exposure discourages open expressions of sexuality, pushing many encounters into private or hidden spaces—homes, rented rooms, or secluded outdoor areas where negotiation around condom use or consent is limited. Such spatial constraints, rooted in societal and religious conservatism, thus amplify individual-level risk behaviors.

In addition to physical spaces, MSM in Aizawl increasingly rely on digital environments particularly social media and gay-specific mobile applications such as Grindr and Blued to find sexual partners. These virtual platforms provide anonymity and accessibility in a conservative setting, effectively extending MSM activity spaces into digital realms. However, they also blur the line between safe and risky interactions, as online communication often leads to private offline meetings where alcohol use, secrecy, and unequal power dynamics can undermine condom use. Consequently, both digital and physical spaces form interconnected layers of MSM activity space, each shaped by stigma, limited visibility, and uneven access to health resources.

Overall, sexual behavior among MSM in Aizawl reflects a complex interplay between individual agency and spatial constraint. Patterns of casual partnerships, low condom use, and digital partner-seeking highlight the spatialized nature of HIV vulnerability where social invisibility and restricted mobility intersect with risk behavior within confined urban environments. Sexual behaviors among MSM in Aizawl are not only patterned by individual agency but by where and how they navigate social spaces.

### 3.5 HIV STATUS

A total of 25% of respondents self-reported as HIV positive, while 3.85% preferred not to disclose their status (Table 7). This level of infection within a small, socially marginalized sample reflects the persistent vulnerability of MSM to HIV transmission in Aizawl city.

Table 6: HIV status of MSM

| HIV Status (n=52%) | % |
|---|---|
| HIV Positive | 25 |
| HIV Negative | 71.15 |
| Did not want to specify | 3.85 |

Source: Primary Survey, 2021

Among those who disclosed their status, unprotected sexual intercourse was identified as the primary mode of transmission (92.31%). Substance use was a major contributing factor, with nearly half (46.16%) reporting intoxication at the time of exposure. A substantial proportion also attributed infection to trust in sexual partners (38.46%), indicating relational vulnerability. Notably, 7.61% reported non-consensual condom removal, underscoring issues of sexual autonomy and coercion. While 7.69% cited syringe sharing, this may be underreported, as MSM who inject drugs are typically excluded from NGO registries.

Table 7: Reported Reason for HIV transmission among HIV-Positive MSM

| Reason for HIV Transmission (n=52%) | Percentage (%) |
|---|---|
| Unprotected sex (total) | 92.31 |
| While intoxicated | 46.16 |
| Trusted the partner | 38.46 |
| Partner removed the condom during intercourse | 7.61 |
| Syringe sharing | 7.69 |
| **Location of Risk Event** | **Percentage (%)** |
| At home | 50.00 |
| At a friend's place | 25.00 |
| Outdoors | 25.00 |

Source: Primary Survey, 2021

Spatially, half of the reported risk events occurred within the respondent's own home, and another 25% took place at a friend's residence. These findings suggest that most high-risk encounters occur in private, familiar spaces rather than public or commercial venues reflecting constrained mobility and limited access to socially safe environments. This spatial confinement mirrors broader patterns of activity space observed in this study, where MSM operate within small, trusted micro-environments shaped by stigma and surveillance. Overall, these findings indicate that HIV transmission among MSM in Aizawl is closely tied to social trust, substance use, and spatial enclosure.

### 3.6 ACTIVITY SPACE MAPPING

For marginalized groups such as MSM, activity space is more than a physical boundary—it embodies patterns of social interaction, access to services, and exposure to risk environments shaped by stigma and exclusion. Figure 2 illustrates the spatial distribution of localities, workplaces, hangout areas, and locations of last sexual encounters reported by MSM respondents in Aizawl City.

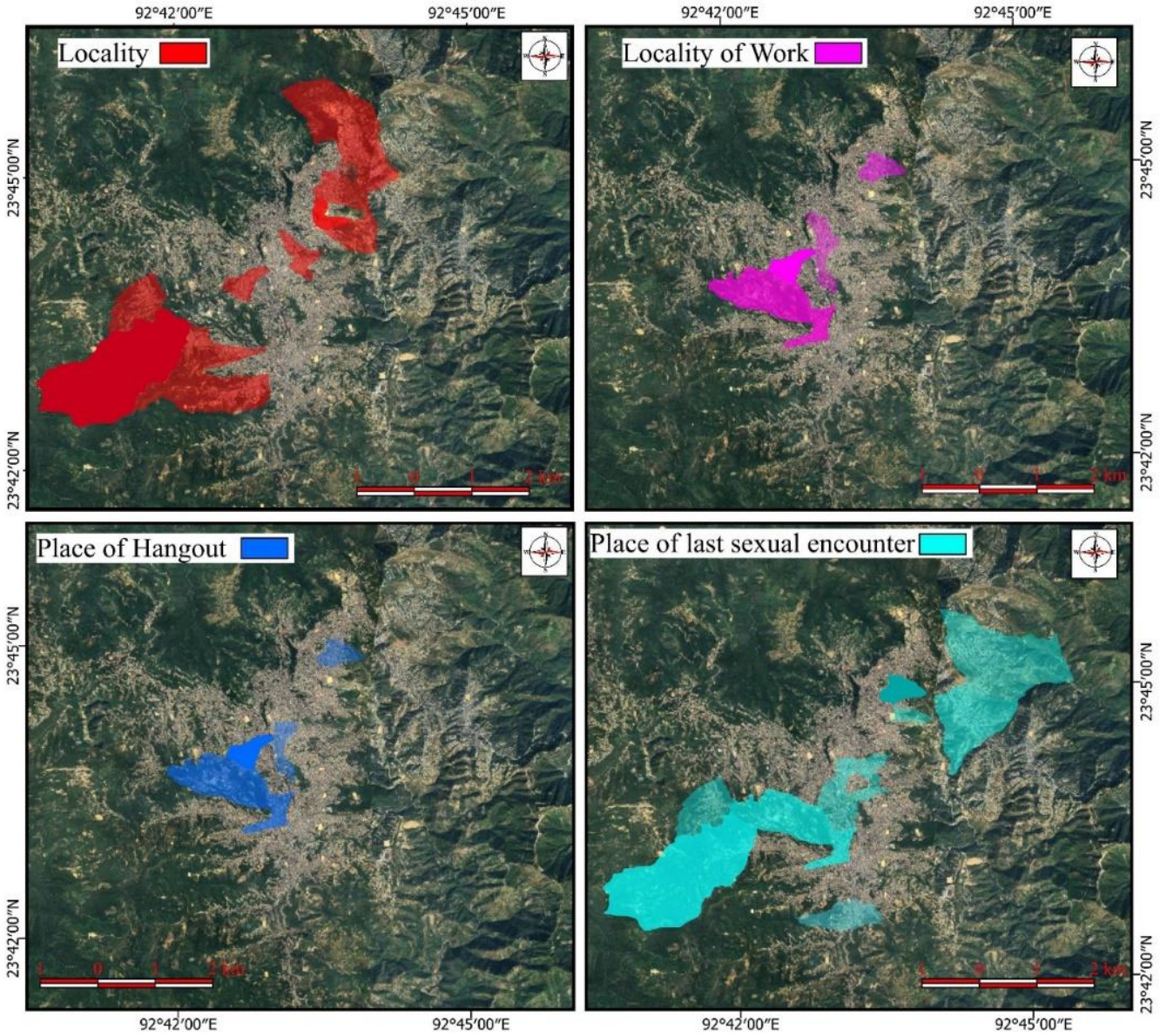


Fig 2: Activity space map of 52 MSM representing the locality (Home), Locality of work, Place of Hangout, and Place of last sexual encounter in Aizawl City using ArcGIS 10.2

Spatial mapping of the 52 respondents revealed that MSM in Aizawl exhibit highly compressed activity spaces, with limited spatial variation between home, workplace, and sites of sexual encounters. The mean core activity space measured 0.4 km², while the mean peripheral area extended to 1.86 km², a fraction of the city's total area (≈130 km²). These compact geographies highlight a restricted range of daily mobility and limited engagement with public urban spaces.

The analysis showed a marked overlap between residential locations and sites of last sexual encounters, suggesting that sexual activity predominantly occurs in familiar, private environments. Central and semi-central localities—such as Dinthar, Dawrpui, Chanmari, Khatla, and Ramhlun—emerged as key nodes of movement and interaction. Dinthar hosted the NGO drop-in center, functioning as both a social hub and a safe meeting space for MSM.

This clustering pattern contrasts with findings from Cassels et al. (2020), who reported greater spatial dispersion of risk environments among MSM in other urban contexts. In Aizawl, the concentration of movement within limited neighborhoods indicates a form of spatial enclosure—a coping strategy adopted to avoid surveillance and discrimination. These lived spaces, shaped by fear of exposure, reflect Lefebvre's notion of lived space, where daily practices negotiate between concealment and belonging.

Qualitative accounts further support this spatial compression. One 25-year-old respondent, a two-wheeler driver residing in Ramthar North, reported that despite his occupational mobility, his social and sexual interactions were confined within a 1 km² area. Encounters were arranged discreetly through mobile apps and usually took place in private homes or secluded public areas. Such restricted movement mirrors the broader spatial realities faced by MSM in Aizawl—where social stigma narrows the geography of safety.

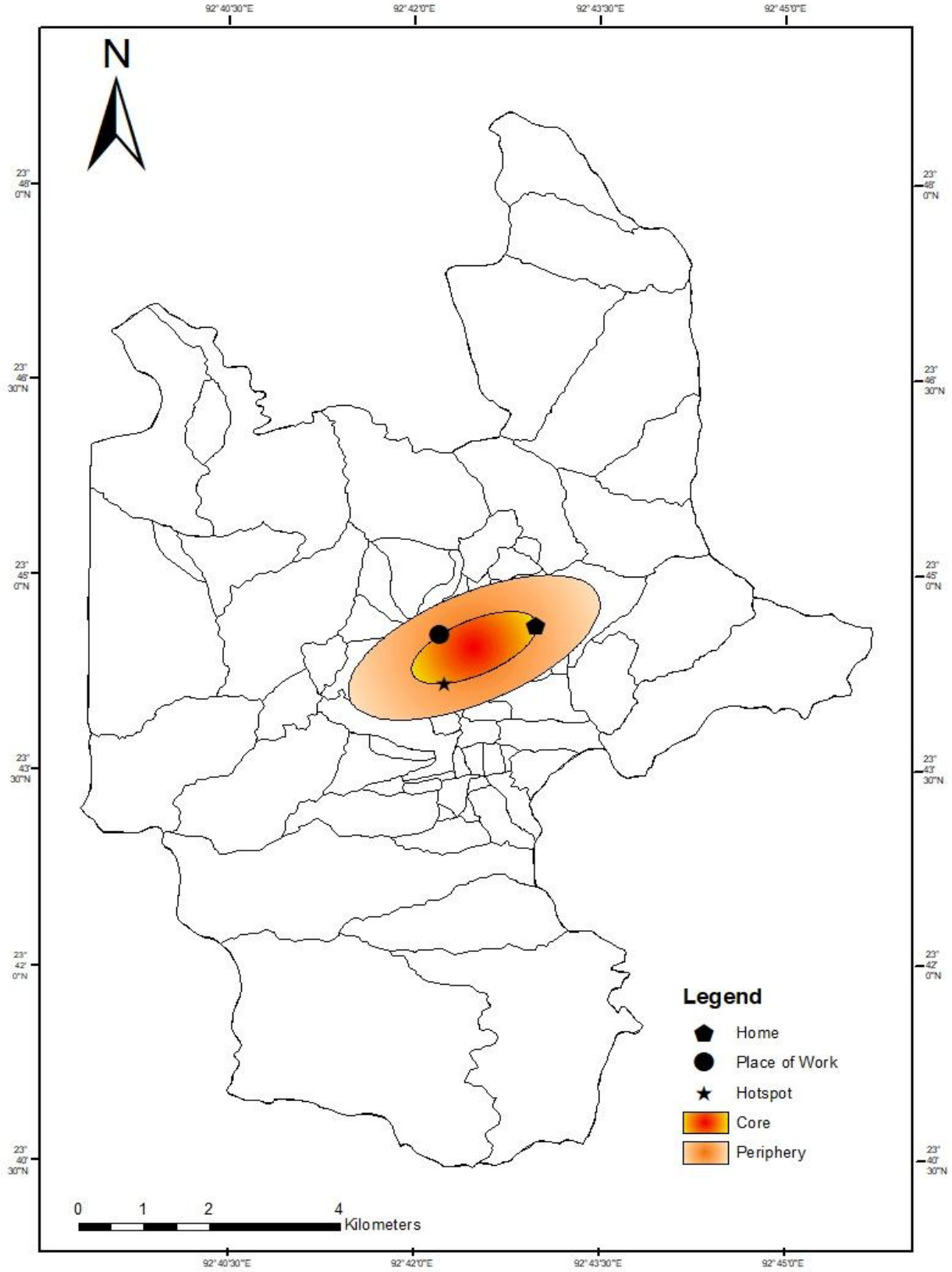


Fig 3: Activity space representation of an MSM individual in Aizawl City

The implications of this limited spatial reach are significant. Restricted movement confines MSM to repetitive and overlapping sexual networks, reducing anonymity and potentially increasing localized HIV transmission risk. Furthermore, avoidance of public or institutional spaces constrains access to HIV prevention, testing, and treatment services. These findings suggest that HIV vulnerability among MSM in Aizawl is not only behavioral but spatially produced, emerging from the interplay between mobility constraints, stigma, and the absence of inclusive public environments.

### 3.7 HIV AND ACTIVITY SPACE LINK

This study also sheds light on the spatial context of HIV transmission among MSM in Aizawl City. From the HIV positive respondents, their place of contracting the virus if known was asked. Figure 4 depicts the link between HIV transmission and mapped activity space.

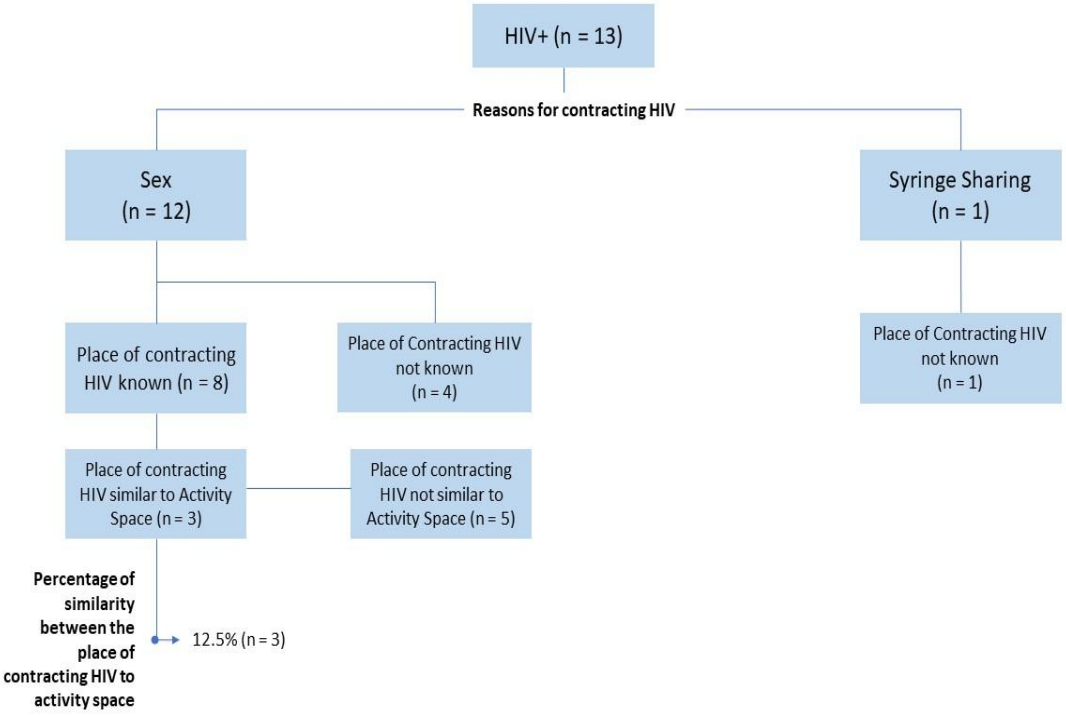


Fig 4: Flow chart showing the link between HIV transmission and Activity space

Figure 4 presents the relationship between HIV transmission and mapped activity spaces. Of the 13 HIV-positive respondents, 12 attributed their infection to sexual contact and one to syringe sharing. Among the eight respondents who could identify the probable location of transmission, only three cases (37.5%) overlapped directly with their recorded activity spaces. The remaining cases occurred beyond their mapped zones.

It is important to note that the activity space mapping captured only routine and regularly visited locations, such as homes, workplaces, and hangouts. Consequently, one-time or spontaneous encounters often facilitated by alcohol use, mobile apps, or social gatherings were not fully represented in the GIS dataset.

This methodological boundary helps explain why certain HIV transmission events occurred beyond the mapped areas. These "off-map" encounters often took place in semi-private or transient settings; such as small gatherings, secluded peripheral zones, or accessible semi-public core areas like those identified in the case study where discretion, anonymity, and opportunity intersected. Such encounters represent episodic extensions of otherwise constrained spatial lives, revealing that even within compressed and familiar environments, MSM occasionally engage in short-range mobility that heightens exposure to risk.

The findings thus suggest a dual spatial dynamic: while most daily interactions are confined to familiar micro-environments, episodic, situational mobility beyond these zones remains a significant vector for HIV exposure. This interplay between spatial constraint and situational mobility illustrates how social stigma not only compresses MSM activity spaces but also drives risk behaviors into unpredictable, hidden settings. Together, these findings illustrate how social stigma, constrained mobility, and hidden geographies interact to produce HIV vulnerability among MSM in Aizawl. The following section discusses these spatial patterns in relation to Lefebvre's theory of the production of space and their implications for targeted HIV interventions.

## 4. DISCUSSION AND CONCLUSION

Men Who Have Sex with Men (MSM) form a socially marginalized minority in Mizoram, where homosexuality is often perceived as a deviation from normative sexuality and subjected to moral scrutiny and pathologization. Such stigma compels concealment and the formation of hidden or "sinful" spaces accessible only to those "in the know" (Halperin, 2003; Brown, 2005). As Sedgwick's (1990) concept of the "closet" suggests, MSM identities are negotiated through secrecy and spatial boundaries. Effective HIV prevention must therefore engage with the sociocultural forces such as homophobia, religious conservatism, and moral stigma that reinforce this concealment (Yadav et al., 2014; Rao et al., 2022).

Within this sociocultural context, the present study reveals that MSM in Aizawl inhabit spatially constrained environments shaped by stigma, surveillance, and the pursuit of privacy. The study reveals that MSM in Aizawl inhabit a spatially constrained world shaped by stigma, surveillance, and the search for privacy. Their activity spaces averaging less than 2 km² are not random but socially produced through daily negotiations with exclusionary structures. The Church, YMA, and other "conceived spaces" of moral authority define norms of masculinity and sexuality that implicitly exclude non-heteronormative identities. Consequently, MSM withdraw into hidden or semi-private "lived spaces," where they can express identity and intimacy away from judgment.

This spatial withdrawal, however, narrows their social visibility and confines them to repetitive, overlapping geographies of risk. Homes, friends' residences, and discreet meeting spots become both refuges and risk zones. The physical compression of activity spaces thus mirrors social marginalization, where social order dictates the boundaries of acceptable behavior.

Substance use emerged as a key mediator between stigma and sexual risk. Alcohol and sedatives were commonly used to manage psychological distress and facilitate social or sexual interaction. These behaviors unfolded primarily within concealed domestic or party settings, transforming private dwellings into social micro-environments that combine relief, intimacy, and risk.

Such practices reveal how emotional vulnerability translates into spatial vulnerability: spaces of coping become spaces of exposure. Substance use also blurs judgment, undermines condom negotiation, and normalizes risky encounters. The high rate of intoxicated sex among HIV-positive respondents (46.16%) exemplifies this behavioral-spatial feedback loop, where stigma drives concealment, concealment drives substance use, and substance use heightens exposure.

While physical movement was spatially limited, digital connectivity expanded MSM interaction into virtual environments. Social media and gay-specific apps constituted crucial extensions of activity space, offering anonymity and connection beyond the immediate community. Yet, this digital migration also facilitated spontaneous, secretive meetings in private physical settings—spaces where condom use was low and alcohol consumption high. Thus, digital platforms do not eliminate spatial risk but reconfigure it linking concealed online identities with hidden physical encounters, thereby multiplying the layers of invisibility.

The study's spatial analysis revealed that most risk behaviors and half of all reported HIV infections occurred within the home. This pattern of "domesticated risk" illustrates how privacy and isolation coexist within confined urban geographies. However, some of the infections occurred during sporadic "off-map" movements brief departures from daily routines to semi-public or peripheral sites. These episodic mobilities, often linked to intoxication or casual digital hookups, represent moments when social and spatial boundaries temporarily dissolve, enabling high-risk exposure.

These dual spatial dynamic compressed daily geographies punctuated by episodic mobility highlights the complexity of risk among MSM. HIV vulnerability arises not from broad urban movement but from fleeting transgressions of constrained spatial lives, a finding consistent with Cassels et al. (2020) but contextually intensified by Aizawl's dense and conservative urban environment.

The findings underscore the need for spatially sensitive and socially inclusive public health strategies. Current interventions often target fixed hotspots or public venues, overlooking the privatized nature of MSM interactions in Mizoram. Since much of the risk occurs within domestic or semi-private contexts, outreach models must move beyond location-based programming to include:

a. Peer-led and virtual outreach: expanding HIV awareness and testing through online platforms and social media.
b. Community-based drop-in centers: safe, inclusive spaces in neutral urban zones that reduce isolation.
c. Mental health and substance use counseling with faih and community engagements.

These interventions must acknowledge that reducing HIV risk among MSM requires transforming not only individual behavior but also the spatial and cultural environments that constrain it.

HIV vulnerability among MSM in Aizawl is both spatially and socially produced. The compression of activity spaces reflects not limited mobility alone but the cumulative effects of stigma, surveillance, and fear. Within these confined environments, substance use and secrecy become strategies of survival that paradoxically heighten risk.

By framing risk through the lens of spatial production, this study highlights the need for public health approaches that engage with space as lived experience redefining safe spaces not only as locations of service delivery but as arenas of social inclusion and dignity.

## 5. LIMITATIONA

The study's exploratory design and small sample (n = 52) limit generalizability. The mapping captured only routine movements, excluding one-time or unreported encounters, and relied on self-reported HIV status. Future research should incorporate longitudinal spatial tracking (e.g., GPS-based methods) and mixed methods to better capture the temporal and emotional dimensions of MSM mobility.

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### Conflict of Interest

The authors declare no conflicts of interest

### Ethics Approval

The survey was conducted with the approval and clearance from the Institutional Ethics Committee, Mizoram State AIDS Control Society (MSACS) under the Government of Mizoram. The Ethics Committee of MSACS cleared the questionnaire and was informed of the survey methodology. Informed consent was taken from all participants. They were made aware of how the data would be used. Personal information, such as name and phone numbers, was not collected to maintain anonymity.

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