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Transmission Dynamics of Mpox in Sierra Leone: Evidence of Symptomatic and Pre-symptomatic Transmission

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ABSTRACT

Background:
Understanding transmission dynamics of mpox in low-resource settings remains limited, particularly in the context of evolving outbreaks in Africa. This study aimed to characterize exposure patterns, transmission pathways, and timing of infection among mpox cases in Sierra Leone.

Methods:
A retrospective, case-ascertained transmission study was conducted among confirmed mpox cases. Data were collected through field investigations and complemented with surveillance data from the District Health Information System (DHIS2). Exposure characteristics, type of interaction, and symptomatic status of the source case at the time of contact were analyzed. Transmission timing was classified as pre-symptomatic, symptomatic, or unknown. Associations between exposure type and transmission timing were assessed using Fisher's exact test.

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Results:
A total of 201 mpox cases were included in the analysis. Among cases with available exposure data, 29% reported contact with a symptomatic individual, while 49% reported no known contact and 21% were unknown. Direct physical non-sexual contact (44%) and sexual contact (32%) were the most common exposure types. Most transmission events occurred during the symptomatic phase (66%), while 17% occurred during the pre-symptomatic phase and 17% were unknown. A statistically significant association was observed between exposure type and transmission timing ($p = 0.010$), indicating that the nature of contact may influence when transmission occurs.

Conclusion:
Mpox transmission in Sierra Leone was primarily driven by close interpersonal contact, with evidence of both symptomatic and pre-symptomatic transmission. These findings highlight the need for strengthened contact tracing and early intervention strategies that extend beyond symptom-based detection.

Keywords: exposure characteristics**,** mpox, Sierra Leone, symptomatic, transmission dynamic,

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INTRODUCTION

Mpox is an emerging zoonotic disease caused by the monkeypox virus (MPXV), defined by fever and rash that can progress to severe disease (M. B. Jalloh et al., 2025; Callaby et al., 2025). While traditionally limited to endemic regions in Central and West Africa, recent outbreaks have revealed a rise in human-to-human transmission, including close physical and sexual contact (Karagoz et al., 2023). Despite increased global interest, there is little evidence on transmission dynamics in low-resource settings, especially in the context of current epidemics in Africa (Furst et al., 2025).

The resurgence of mpox in Sierra Leone in 2025 revealed substantial gaps in our understanding of transmission dynamics, such as the importance of various exposure types and the timing of transmission in relation to symptom onset (Jalloh et al., 2025). Previous research has mostly focused on outbreaks in high-income settings, where transmission is typically focused to specific sexual groups (Rwibasira et al., 2025). However, present studies reveals that transmission in African settings may entail broader pathways, such as transmitting among families and community's level.

Understanding transmission dynamics is a vital component of outbreak management, enabling public health professionals to shift from reactive to proactive, targeted treatments. The route of transmission (droplet vs. aerosol), contact patterns (home vs. community), and timing of infectiousness (pre-symptomatic vs. symptomatic) all have a direct impact on the effectiveness of surveillance, isolation, and contact tracing strategies (Li et al., 2020) .

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The study aimed to characterize transmission dynamics of mpox in Sierra Leone by examining exposure characteristics, transmission pathways, and timing of infectiousness, and by assessing the association between exposure type and transmission timing.

METHODOLOGY

A retrospective, case-based transmission study was carried out to explore the transmission dynamics of mpox among confirmed cases. Simple random sampling was used to recruit study participants from the District Health Information System (DHIS2). Data were gathered during field investigations using the Community Listening App. Data regarding exposure history, nature of interaction with suspected or confirmed cases, and location of exposure was acquired. To increase data accuracy, specific variables were triangulated with data from DHIS 2. This comprehensive approach aimed to provide insights into potential risk factors and help inform targeted public health interventions.

To ensure consistency, data triangulation was carried out by comparing data acquired from field investigators to existing data in the DHIS2. Discrepancies were managed using DHIS2 as a reference. Prior to analysis, data were cleaned to eliminate missing values, inconsistencies, and entry errors. R statistical software was used to analyse the data. Descriptive statistics were employed to summarise exposure and transmission patterns. Transmission timing was classified as pre-symptomatic, symptomatic, or unknown depending on the source case's reported status at the time of contact. Fisher's exact test was used to analyse the

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associations between exposure type and transmission timing. Statistical significance was determined at $p < 0.05$.

RESULTS

Exposure Characteristics of Mpox Cases

Table 1 shows the exposure characteristics of mpox case. It shows that among the 201 confirmed mpox cases, 59/201 individuals (29%) reported having contact with someone presenting similar illness or symptoms or a known probable case, while 99/201 (49%) reported no contact with someone presenting similar illness or symptoms or a known probable case and 43/201 (21%) were classified as unknown. Information on the relationship to the source case was available for only 58 laboratory confirmed cases, with 143 observations missing (approximately 71%). Among the cases with available data, the most reported relationships included friends 12/58 (21%), spouses or partners 12/58 (21%), non-household relatives 11/58 (19%), and other household members 9/58 (16%).

The type of interaction with the case also showed substantial missing data, with 142 observations (approximately 71%) missing. Among those with recorded information, direct physical non-sexual contact was the most common exposure type, accounting for 26/59 (44%) of interactions, followed by sexual contact 19/59 (32%), prolonged close non-contact exposure 8/59 (14%), and contact with contaminated materials (3.4%).

Exposure setting was available 59 study participant. Among these, household exposure accounted for the largest proportion among recorded cases 26/59 (44%), followed by exposure in residences or hotels without household members 7/59 (12%), community

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settings 6/59 (10%), outdoor markets 5/59 (8.5%), workplaces 4/59 (6.8%), and other settings. Healthcare-related exposure was rare.

Travel history data were more complete, with 174/201 cases (87%) reporting no travel outside the region in the preceding 21 days, 24/201 cases (12%) reporting travel, and 3/201 cases (1.5%) classified as unknown, with no missing values. This suggests that most transmission likely occurred locally rather than being driven by importation from other regions.

Transmission Pathway

Table 2 reveals that, of the cases with available data on the source case's symptomatic status at the time of contact, 38/58 (66%) reported exposure to a symptomatic individual, 10/58 (17%) reported exposure when the source case was not symptomatic, and 10/58 (17%) were classified as unknown. However, 143 observations (71%) were missing, leaving only 58 cases with enough data for this investigation. Despite the significant percentage of missing data, the findings indicate that transmission happened more likely after symptom onset, which is consistent with mpox's known infectious periods (Kamadjeu et al., 2026). However, the occurrence of exposures prior to symptom onset suggests the possibility of transmission before clinical recognition.

Transmission Timing

Table 3 shows how the transmission timing analysis identified exposures as pre-symptomatic, symptomatic, or unknown. Of the cases with relevant data, 38/58 (66%) were classified as symptomatic transmission,

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10/58 (17%) as pre-symptomatic transmission, and 10/58 (17%) as unknown. The findings confirm that the bulk of transmission episodes took place during the symptomatic period. However, the discovery of pre-symptomatic transmission in roughly one-sixth of cases implies that transmission may occur prior to symptom onset.

Exposure Type and Transmission Timing

Table 4 shows a statistically significant correlation between exposure type and transmission timing (Fisher's exact test, p = 0.010). Direct physical non-sexual contact was predominantly associated with symptomatic transmission 20/26 (77%), although a smaller proportion occurred during the pre-symptomatic phase 3/26 (12%). Sexual contact showed a similar pattern, with 13/18 (72%) occurring during symptomatic transmission and 4/18 (22%) during pre-symptomatic exposure. Prolonged close non-contact exposure also occurred across both phases. The statistically significant association suggests that the timing of transmission may vary depending on the type of exposure interaction. However, interpretation should consider the small sample size (58 cases with known timing) and the presence of several exposure categories with very few observations.

DISCUSSION

The study provides clarity regarding the transmission dynamics of mpox in Sierra Leone, showing the importance of close interpersonal contact, the preponderance of symptomatic transmission, and the occurrence of presymptomatic transmission. The findings contributed to the limited literature on mpox transmission patterns in low-resource settings and provided context-

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specific information to enhance public health measures. Findings revealed that a significant proportion of cases had no record of prior contact with a symptomatic individual, whereas a significant portion of exposure history remained unknown. The findings revealed that transmission may occur through contacts that are not recognized or not captured during case investigation. This situation may be attributed to limitations in recall, incomplete contact tracing, or the existence of indirect transmission pathways. Additionally, the considerable amount of missing data related to exposure variables further highlights the challenges faced in capturing comprehensive transmission histories during outbreak investigations.

Transmission was directly associated with immediate physical non-sexual contact, followed by sexual contact, in cases where data were available. This pattern suggests that transmission in this context was not limited to sexual networks but also occurred through broader close-contact relationships within households and communities. These findings differ from those observed in several high-income settings during the global outbreak, where transmission was mainly confined to specific sexual groups (Alshamrani et al., 2025; Laurenson-Schafer et al., 2026; Moghib et al., 2025). Instead, the results point to a more varied transmission pattern that includes both sexual and non-sexual exposure pathways. With the available data, it has become evident that household exposure is a critical setting for transmission, highlighting the significance of prolonged close contact in the distribution of infections. The rise in locally sustained cases, coupled with a limited travel history, indicates that the

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outbreak is likely attributed to community-level transmission rather than repeated importation of cases.

The study also found that the majority of transmission episodes happened during the symptomatic phase of disease, which is consistent with previous knowledge of mpox infections (Yuan et al., 2023; Moghadas et al., 2020). However, detecting pre-symptomatic transmission among documented cases underlines a significant barrier for epidemic control. Transmission before symptom onset undermines the effectiveness of interventions based primarily on symptom detection, isolation, and contact tracing (Biggs & Littlejohn, 2023). The result implies that additional techniques, such as early detection of high-risk contacts and increased surveillance, may be necessary to disrupt transmission pathways. The correlation between exposure type and transmission timing suggests that the type of contact can impact transmission timing. Physical and sexual contact have been linked to transmission during both symptomatic and pre-symptomatic stages of the disease. This highlights the need for effective risk communication and prevention measures, as infection can spread before symptoms appear.

CONCLUSION

The study shows that mpox transmission in Sierra Leone was predominantly caused by close interpersonal contact within families and communities, with both sexual and non-sexual exposure pathways contributing to disease spread. While a proportion of transmission was reported during the symptomatic phase, the presence of pre-

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symptomatic transmission indicates an important problem for outbreak containment.

The findings also highlight the need for improved surveillance systems, data completeness, and contact tracing techniques that go beyond symptom-based identification. Early identification and monitoring of contacts, as well as targeted public health initiatives, will be critical for reducing transmission and improving outbreak response in similar settings.

LIMITATIONS

Several limitations should be acknowledged. First, a significant number of exposure-related factors were missing, specifically the type of interaction, exposure setting, and the source case's symptomatic condition at the time of contact. This high amount of missingness impairs the ability to fully characterize the transmission pathways and may introduce bias into the results.

Second, the number of cases with complete information on transmission timing was quite small, possibly reducing statistical power and affecting estimate precision. Finally, as the study was based on observational outbreak data, the findings show associations rather than cause-and-effect relationships and should be interpreted considering limitations in routine surveillance data.

Declaration of Interests

We declare no competing interests

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List of Tables

Table 1: Exposure Characteristics

Exposure Characteristics	N = 201
Patient had contact with anyone presenting similar illness or symptoms or with a known probable	**201**
No	99 (49%)
Unknown	43 (21%)
Yes	59 (29%)
Missing	0
Relationship to the case	**58**
Colleague	2 (3.4%)
Friend	12 (21%)
Healthcare exposure (if yes, please fill out healthcare exposure section below)	2 (3.4%)
Non-household relative	11 (19%)
Another household member	9 (16%)
Sexual partner	4 (6.9%)
Sexual partner other than spouse or main partner	6 (10%)
Spouse/partner	12 (21%)
Missing	143
Type of interaction with the case	**59**
Contact with contaminated materials: contact of the skin or mucous membranes with dislodged lesion material (crusts), through activities such as handling clothing or bedding of a case without personal protective equipment (PPE), or cleaning of contaminated rooms without PPE, including household members who may come in contact with contaminated objects and surfaces in the absence of physical direct contact with the case; injury with needlestick used for case sampling or other	2 (3.4%)

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Exposure Characteristics	N = 201
potentially contaminated needle; contact with a clinical specimen from a suspected or confirmed case during laboratory activities and analysis; and contact with body fluids (e.g., breastmilk, semen) in the absence of direct physical contact.	
Direct physical (non-sexual) contact: skin-to-skin and skin-to-mucosal contact, which includes touching, caressing, hugging, kissing on the skin, holding, carrying, breastfeeding, bathing/wiping, etc. Includes contact with a deceased person skin lesion.	26 (44%)
Other, specify	1 (1.7%)
Prolonged close (non-contact) exposure: This form of transmission can occur when infectious respiratory particles (IRPs) are expelled into the air by the case, then directly deposited on the exposed mucosal surfaces (mouth, nose or eyes) of another person, or when IRPs have travelled either short or long distances from the infectious person and are inhaled by a receiving person. For example, this may include exposure in close proximity to a case; this may include speaking, eating in front of each other, and other close- proximity activities. It may also include aerosol-generating procedures performed on cases in healthcare settings. The distance and time over which this occurs may vary. This is the presumed type of contact when none of the other types have occurred.	8 (14%)
Sexual contact: mucosa-to-mucosa contact, which includes kissing on the mouth, oral (fellatio, cunnilingus and anilingus), vaginal or anal intercourse.	19 (32%)
Unknown	2 (3.4%)
Vertical transmission: transmission from mother to child during pregnancy or to the newborn during birth.	1 (1.7%)
Missing	142
Where did the exposure occur	**59**
At place of residence/hotel (not with household member)	7 (12%)
Community	6 (10%)
Healthcare setting (including laboratory exposure) (if yes, please fill out healthcare exposure section below)	1 (1.7%)
Household (with household member)	26 (44%)
Indoor commercial establishment (store, business, etc.)	1 (1.7%)
Other, specify	4 (6.8%)
Outdoor market	5 (8.5%)

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Exposure Characteristics	N = 201
School/nursery	2 (3.4%)
Unknown	3 (5.1%)
Workplace	4 (6.8%)
Missing	142
Did_the_patient_travel_outside_of_the_region_in_the_past_21_days	**201**
No	174 (87%)
Unknown	3 (1.5%)
Yes	24 (12%)
Missing	0

Table 2: Transmission pathway

Characteristic	N = 201[1]
Was the case symptomatic at the time of contact	**58**
No	10 (17%)
Yes	38 (66%)
Unknown	10 (17%)
Missing	143

[1]n (%)

Table 3: Transmission Timing

Characteristic	N = 201[1]
Transmission timing	**58**
Pre-symptomatic	10 (17%)
Symptomatic	38 (66%)
Unknown	10 (17%)
Missing	143

[1]n (%)

Table 4: Exposure Type by Transmission Timing

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	Transmission timing				
	Pre-symptomatic	Symptomatic	Unknown	Total	p-value[1]
Type of interaction with the case					0.010
Contact with contaminated materials:	0 (0%)	0 (0%)	2 (100%)	2 (100%)	
Direct physical (non-sexual) contact	3 (12%)	20 (77%)	3 (12%)	26 (100%)	
Other, specify	0 (0%)	0 (0%)	1 (100%)	1 (100%)	
Prolonged close (non-contact) exposure:	2 (25%)	5 (63%)	1 (13%)	8 (100%)	
Sexual contact	4 (22%)	13 (72%)	1 (5.6%)	18 (100%)	
Unknown	1 (50%)	0 (0%)	1 (50%)	2 (100%)	
Vertical transmission: transmission from mother to child during pregnancy or to the newborn during birth.	0 (0%)	0 (0%)	1 (100%)	1 (100%)	
Total	10 (17%)	38 (66%)	10 (17%)	58 (100%)	

[1]Fisher's exact test

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