

## Preplanned Studies

## Spatial Analysis of People Living with HIV/AIDS Transmitted Through Commercial Heterosexual Contact or Non-Marital Non-Commercial Heterosexual Contact — China, 2018

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### Summary

#### What is already known about this topic?

Significant changes in human immunodeficiency virus (HIV) transmission modes have occurred in China, and the proportion of heterosexual transmission increased in recent years.

#### What is added by this report?

The proportions of diverse transmission routes and subgroups of heterosexual transmission were analyzed by provincial-level administrative divisions (PLADs), and nationwide spatial clustering of HIV transmission through commercial heterosexual contact (CHC) and non-marital non-commercial heterosexual contact (NMNCHC) was explored.

#### What are the implications for public health practice?

This report provides evidence for geographic clustering of HIV transmission through CHC and NMNCHC in China and identifies priority regions where specified research and targeted HIV prevention and control strategies should be implemented.

Over recent years, significant changes in human immunodeficiency virus (HIV) transmission modes have occurred in China, and the proportion of sexually transmitted infections has increased greatly (1). In addition, both the number of reported cases of people living with HIV/AIDS (PLWHA) and the distribution of diverse HIV transmission routes display regional characteristics (2). However, the nationwide distribution of heterosexual transmission subtypes remains unclear, including commercial heterosexual transmission, non-marital non-commercial heterosexual transmission, and marital heterosexual transmission (3).

Fully understanding the spatial characteristics of heterosexual transmission could establish a basis to formulate targeted regional prevention and control measures. For this purpose, this study used data from

the Chinese HIV/AIDS Comprehensive Response Information Management System (CRIMS) to analyze the spatial distribution characteristics of the two main modes of heterosexual transmission, including transmission through commercial heterosexual contact (CHC) and non-marital non-commercial heterosexual contact (NMNCHC).

Newly identified cases of HIV infection were reported through the web-based CRIMS by individuals from local CDCs and medical institutions (4). Data usage from CRIMS was authorized by the National Center for AIDS/STD Control and Prevention of China CDC. All newly identified PLWHA in 2018 in the CRIMS were included in our study.

The frequency distribution and the constituent ratio of PLWHA infected through various transmission routes and the subgroups of those infected through heterosexual transmission were analyzed in each provincial-level administrative divisions (PLADs). Moreover, Moran's I index was utilized to explore the clustering patterns of PLWHA identified in 2018 in China, with the assumption that cities throughout the country were not significantly different from each other with respect to the spatial distribution of infection. Subsequently, Z-scores with corresponding P-values were presented. Statistically significant Moran's I indexes revealed the presence of overall nationwide clustering. After a national level of clustering was confirmed, local clustering analysis was required to detect specific clustering areas. Hotspot analysis (Getis-Ord  $G_i^*$ ) in ArcGIS (version 13.0, Esri Inc, Redlands, CA, USA) was conducted to determine areas with significantly high clusters and areas with significantly low clusters, using 3 levels of confidence intervals (5).

In this study, PLADs with large numbers of newly identified PLWHA normally have high proportions of heterosexual transmission. In 2018, heterosexual transmission accounted for 71.5% of all transmission. Among the top 10 PLADs with the highest numbers of

reported PLWHA, the proportions of heterosexual transmission were higher than average in 7 PLADs, including Guizhou (92.5%), Guangxi (91.2%), Yunnan (89.8%), Xinjiang (85.6%), Chongqing (83.2%), Sichuan (83.0%), and Hunan (78.6%), while those of Henan (67.3%), Guangdong (62.4%), and Zhejiang (58.9%) were below average. In addition to these top 10 PLADs, the proportions of heterosexual transmission in most other PLADs were below average, except for Xinjiang Production and Construction Corps (XPCC) (87.8%) and Jiangxi (84.4%), where the numbers of cases were relatively smaller than those of other regions (Figure 1A, Figure 1B).

In general, the proportion of newly identified PLWHA transmitted through NMNCHC (49.0%) was higher than through CHC (38.0%) in heterosexual transmission, and the proportion of NMNCHC-related transmission was higher than that of CHC in most PLADs and regions in 2018. Among the top 10 PLADs with the highest number of reported PLWHA, the ratio of NMNCHC to CHC transmission was greater than 1 in 7 PLADs, with Xinjiang having the highest ratio (5.94:1), followed by other PLADs such as Guizhou (2.74:1), Yunnan (2.19:1), Henan (1.27:1), Guangdong (1.18:1), Sichuan (1.05:1), and Hunan (1.03:1). Those with a ratio less than 1 included Zhejiang (0.9:1), Chongqing (0.87:1), and Guangxi (0.56:1) (Figure 1C, Figure 1D).

General spatial autocorrelation was conducted for newly identified PLWHA transmitted through CHC and NMNCHC in China in 2018. Moran's I indexes were greater than 0 and the Z-values were greater than 1.96 for both transmission routes ( $P < 0.0001$ ). These results confirmed the potential existence of nationwide HIV/AIDS epidemic clustering for PLWHA transmitted through CHC and NMNCHC (Table 1).

In 2018, 373 cities reported PLWHA transmitted through heterosexual contact, among which cases transmitted through NMNCHC were reported in 371 cities, while PLWHA transmitted through CHC were reported in 360 cities. Furthermore, 13 cities had identified more than 500 cases of PLWHA reported as transmitted via CHC, located in Chongqing, Sichuan, Guangxi, and Yunnan. In contrast, 20 cities had more than 500 PLWHA reported as being transmitted through NMNCHC, including Chongqing, Sichuan, Yunnan, Xinjiang, Guizhou, Guangdong, and Beijing.

The Getis-Ord  $G_i^*$  statistics revealed that at the 95% confidence level, hotspots of PLWHA infected through CHC were mainly discovered in Sichuan, Chongqing, Guizhou, Guangxi, northeast Yunnan,

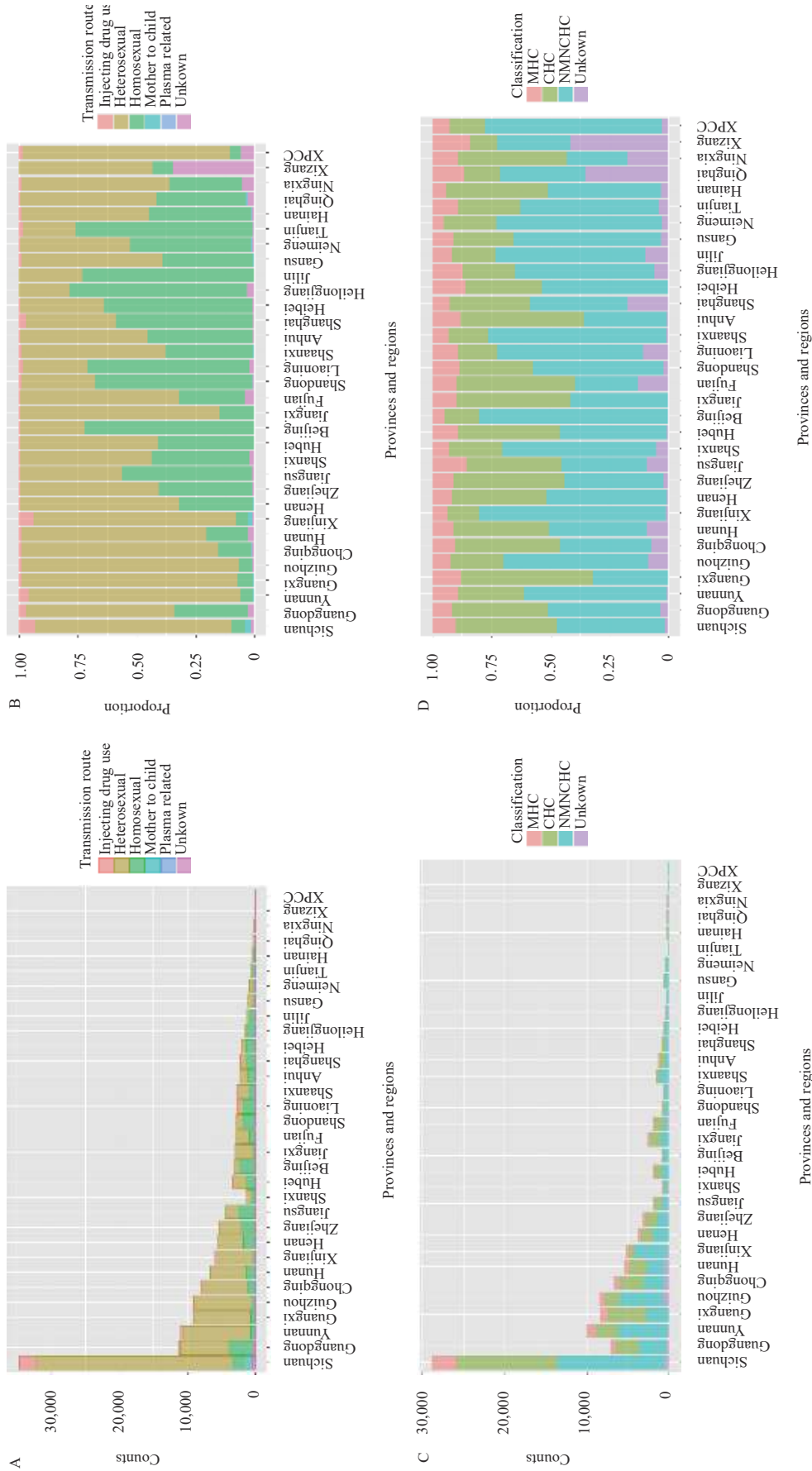
west Guangdong, west Hunan, southwest Hubei, southeast Gansu, and southwest Shaanxi, whereas cold-spots were observed in large areas of northeastern and northern China, comprised of more than 10 PLADs such as Shandong, Hebei, Tianjin, and Beijing. Hotspots for PLWHA infected through NMNCHC were detected mainly in Sichuan, Chongqing, Yunnan, Guizhou, and the western regions of Guangxi, while cold-spots were observed in eastern Hebei, Tianjin, Shandong, Anhui, northern Jiangsu, eastern Henan, and a small part of western Jilin.

## DISCUSSION

This analysis demonstrated that the overall prevalence of HIV in China follows inconsistent distribution patterns across different PLADs. In general, PLADs with higher annual frequencies of newly reported PLWHA have higher proportions of heterosexual transmission. Additionally, the distribution of PLADs and cities is unbalanced in the subclassification of heterosexual transmission. In some regions, transmission via CHC is higher than NMNCHC, while in others, the proportion of transmission through NMNCHC is higher. These findings were consistent with the results of other regional studies (6–7).

There was a certain degree of overlap among cities with higher numbers of reported cases transmitted through CHC and NMNCHC, but CHC and NMNCHC also displayed unique characteristics with respect to the distribution of hotspots. The distribution of NMNCHC was relatively more concentrated, while that of CHC exhibited a wider pattern of distribution. This could be explained by the fact that NMNCHC was more sporadic than CHC and hence more likely to cluster within areas where there was high HIV prevalence. In addition, CHC was more frequent in eastern China, covering some parts of Guangxi and Guangdong, while NMNCHC was more prevalent in western China, mainly concentrated in the southwest. This may indicate that heterosexual commercial services were comparatively more available in some areas of Guangdong or Guangxi. Further research is essential to determine the underlying causes of CHC hotspots in these areas to develop targeted prevention and control strategies.

The hotspots of CHC and NMNCHC also overlapped to a large extent, and approximately 80% of the hotspots of NMNCHC were overlapped with those of CHC. There was likely some interweaving



**FIGURE 1.** Frequency distribution and proportion of newly identified PLWHA transmitted through different transmission routes and through different types of heterosexual transmission by PLADs. (A) Frequency distribution of newly-identified PLWHA transmitted through different transmission routes by PLADs; (B) Proportion of newly-identified PLWHA transmitted through different transmission routes by PLADs; (C) Frequency distribution of newly-identified PLWHA transmitted through different types of heterosexual transmission by PLADs; (D) Proportion of newly-identified PLWHA transmitted through different types of heterosexual transmission by PLADs.  
 Abbreviations: PLADs=provential-level administrative divisions; MHC=marital heterosexual contact; CHC=commercial heterosexual contact; NMNCHC=non-marital non-commercial heterosexual contact; PLWHA=people living with HIV/AIDS; XPCC=Xinjiang Production and Construction Corps.

TABLE 1. Results of general spatial autocorrelation for the newly identified PLWHA reported as transmitted through CHC and NMNCHC in 2018 in China.

Transmission routes	Moran's I	Z-value	P-value
CHC	0.2916	22.33	<0.0001
NMNCHC	0.1847	15.32	<0.0001

Abbreviations: CHC=commercial heterosexual contact; NMNCHC=non-marital non-commercial heterosexual contact; PLWHA=people living with HIV/AIDS.

between these two populations. For example, some men might be engaged in both commercial and non-marital non-commercial heterosexual behaviors, which may transmit HIV from infected female sex workers (FSWs) to uninfected women in the general population, thereby spreading HIV from high-risk groups to the general population through heterosexual transmission (8).

However, in the coastal areas of China, no hotspot for CHC or NMNCHC was identified. This may be because the frequency of HIV transmission in coastal areas was relatively low, and the distribution density of the HIV epidemic was relatively small. Consequently, there were fewer sexually transmitted diseases. Nonetheless, this could also be because some large cities in areas such as Beijing or Tianjin have a high prevalence of men who have sex with men (MSM) transmission, accounting for the majority of newly identified PLWHA (9–10). Furthermore, this study discovered that although the overall proportion of heterosexual transmission in Beijing or Tianjin was comparatively small, NMNCHC remained the principal mode of transmission via heterosexual contact in these areas. Further research is necessary to evaluate the relationship between MSM groups and those cases reported as infected through CHC or NMNCHC.

This study was subject to some limitations. First, the history of sexual contact in the CRIMS is self-reported, which could lead to inaccurate reports due to social desirability, stigmatization, or recall bias. Second, different regions have inconsistent rates of identified cases, which may influence conclusions. However, a large sample size and nationwide coverage could compensate for these deficiencies to some extent.

In summary, this study provided evidence for the geographic clustering of HIV transmission through CHC and NMNCHC in China and identifies priority regions where specified research and targeted HIV prevention and control measures should be implemented.

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