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**Epidemiological analyses of regional and age differences of HIV/AIDS
prevalence in China, 2004-2016**

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Abstract

Objectives: To describe the prevalence of HIV/AIDS in China from 2004 to 2016 and to assess whether regional and age differences exist with HIV/AIDS infection.

Methods: We searched the Chinese Public Health Science Data Center by the keywords of “HIV” or “AIDS”, and collected the data referred to HIV/AIDS morbidity, mortality, and new HIV infection rate, 2004 to 2016.

Results: The HIV/AIDS morbidity, mortality, and new HIV infection rate continually increased per year in China from 2004 to 2016 (0.235, 0.057 and 1.020 in 2004; 3.990, 1.034 and 6.442 in 2016 respectively) (all $p < 0.001$). The middle-aged HIV/AIDS populations showed the highest infection and regional difference significantly existed in the geographical distribution of HIV/AIDS prevalence.

Conclusions: Our analyses of HIV/AIDS prevalence during more than a decade indicate that HIV/AIDS prevalence is getting more and more serious and the rapid spread of HIV exists with the characteristics of regional and age differences.

Keywords: AIDS; HIV infection; epidemiology

Introduction

The prevalence of Human immunodeficiency virus/Acquired Immune Deficiency Syndrome (HIV/AIDS), especially in developing countries, still was a tremendous challenge to public health authorities (Campbell, et al. 2017, Paraskevis, et al. 2011, Bonovas and Nikolopoulos 2012). According to the report of the Joint United Nations Programme on AIDS (UNAIDS), there were nearly about 36,900,000 people living with HIV, 940,000 AIDS-related deaths and 1,800,000 new HIV infections worldwide in 2017 (UNAIDS, 2018). As one of the chronic diseases, AIDS seriously affects the public health around the world. And the mortality caused by AIDS is significantly higher than other sexually transmitted disease (STD) (Li, et al. 2014).

China faces more challenges in reducing the incidence of new HIV infection and the cases of HIV infection are increasing around the country. The rapid economic growth, large and ethnic diversity, geographic expanse and the institutional transition have all shaped the epidemiological characteristics of HIV/AIDS in China (Sheng and Cao 2008). Moreover, sexual behaviors, condom use, male circumcision, antiretroviral therapy and sharing syringes among drug users all have different impacts on the HIV/AIDS prevalence (Zhang, et al. 2008, Nikolopoulos and Bonovas 2017, Kelly, et al. 2017). A series of studies on HIV/AIDS prevalence in United States (Rios-Gonzalez and Flores-Enriquez 2018), China (Yuan, et al. 2018, Yang, et al. 2017, Lu, et al. 2017, Tang, et al. 2016, Pan, et al. 2016), Africa (Scriven, et al. 2016), German (Stecher, et al. 2018) and Ukraine (Vasylyeva, et al. 2018) have been

published, but rare national studies were reported about the impacts of the regional and age differences on clinical epidemiology of HIV/AIDS. Considerable changes of related policies have been provided including the implementation of innovative strategies and a comprehensive anti-HIV program over the last 20 years in China. However, due to the lack of data about the epidemiology of HIV/AIDS, more efficient HIV/AIDS prevention and control are still big challenges.

The aims of this study are to explore the HIV/AIDS morbidity, mortality and new infection rates in China from 2004 to 2016, and to analyze the characteristics of regional and age differences of HIV/AIDS patients for providing additional guidance for the government to raise the awareness about HIV/AIDS prevention and control in China.

Methods

AIDS represents Acquired Immune Deficiency (AID)-induced clinical Syndrome (AIDS) characterized by Kaposi's sarcoma (KS) and Pneumocystis carinii pneumonia (PCP) associated with compromised innate immunity and decreased CD4 T lymphocyte count, and progressive failure of the immune system in AIDS patients allows life-threatening opportunistic infections and kinds of disease to thrive. New HIV infections are defined as newly acquired blood HIV antibody displayed positive by ELISA and Western blot, and were detected with large number of viral load by PCR. AIDS-related deaths are defined as all deaths from AID-induced clinical diseases such as KS, PCP, and other optimistic infections. The data referred to

HIV/AIDS morbidity, mortality and new HIV infection rate in this study was searched from the Chinese Public Health Science Data Center (CPHSD) by the keywords of “HIV” or “AIDS”, 2004 to 2016. And the data of new HIV infections, AIDS cases and AIDS-related death number was retrieved from 31 regions in China, except Taiwan, Hong Kong and Macao. Morbidity, mortality and new HIV infection rate of HIV/AIDS reported by CPHSD were equal to the number of cases of infectious diseases/population \times 100,000, the number of deaths/population \times 100,000, and the number of deaths/number of cases \times 100%, respectively.(Li, et al. 2014) According to the stratified age and region, subgroup analysis was to explore the difference of HIV/AIDS prevalence. This study was approved by the ethics committee of Guilin Medical University Affiliated Hospital (GLMC191211HL).

The corresponding data was expressed as mean \pm standard deviation (SD), mean \pm standard error (SE) or percentages in this study as appropriate. For continuous variables in normal distribution, student's *t*-test and one-way ANCOVA were performed to analyze the differences. The *p* value $<$ 0.05 was considered as statistically significant difference. The GraphPad Prism 5 and the SPSS program (SPSS version 15, SPSS Inc., Chicago, IL) were used to for statistical analyses, and Microsoft PowerPoint 2007 and Adobe Illustrator CS5 were used to draw the geographical distribution map of China.

Results

HIV/AIDS in China

This study retrospectively analyzed the data about HIV/AIDS reported publicly by Chinese government, and found the AIDS morbidity (1/100,000), AIDS mortality (1/100) and new HIV infection rate (1/100,000) continually increased per year: 0.235, 0.057 and 1.020 in 2004; 0.761, 0.408 and 3.138 in 2008; 3.112, 0.859 and 4.334 in 2012; and 3.990, 1.034 and 6.442 in 2016 respectively (Figure 1) (Table 1). The results of linear regression analysis indicated good concordances (all $r^2 > 0.850$, all $P < 0.001$). In addition, it's shown that about 318,895 AIDS cases (Mean \pm SD: 24,530 \pm 19,107), 98,132 AIDS-related deaths (7,549 \pm 4,716) and 652,470 new HIV infections (50,190 \pm 22,337) happened in 2004 to 2016.

Regional difference of HIV/AIDS prevalence

A total of 31 regions were included in this study. The number of AIDS cases, AIDS-related death and new HIV infection continually increased per year in China from 2004 to 2016 (all $P < 0.001$). The geographical distribution map of China was drawn to show the regional difference of HIV/AIDS prevalence. According the data of the number of AIDS cases, AIDS-related deaths and new HIV infections, Henan, Yunnan, Guangxi and Xinjiang provinces are among the high risk regions (Figure 2A-C).

In the capital, Beijing, the AIDS morbidity (1/100,000), AIDS mortality (1/100) and new HIV infection rate (1/100,000) have increased from 0.479, 0.014 and 1.384 in 2004 to 3.651, 0.149 and 11.39 in 2016, respectively (all $P < 0.001$). And growing rates also existed in the regions with the highest HIV/AIDS morbidity rates such as Henan Province, Guangxi Province and Yunnan Province (all $P < 0.001$).

Age differences of HIV/AIDS prevalence

To explore the age differences of HIV/AIDS prevalence, we divided the cases into three groups: 0-20 years old, 20-50 years old and >50 years old. And it showed the number of AIDS cases, AIDS-related deaths and new HIV infections in 20-50 years old group were significant higher than other groups (all $P < 0.05$) (Figure 3). Moreover, the cases in 20-50 years old group were sectionalized by every 10 years. And the results indicated that the cases in the 20-30 years old showed the highest incidence (Figure 4).

Discussion

Our analyses of more than a decade of data indicated that HIV/AIDS morbidity, mortality, and new HIV infection rate continually increased per year in China, and regional and age differences of HIV/AIDS prevalence significantly exist, which implied the challenge of controlling the rapid spread of HIV/AIDS was tremendous and more effective prevention strategies should be implemented to reduce the incidence.

The prevalence of HIV/AIDS, especially in developing countries, is still a tremendous challenge to public health authorities in the world (Campbell, et al. 2017, Paraskevis, et al. 2011, Bonovas and Nikolopoulos 2012, Rubinstein, et al. 2014, Maartens, et al. 2014, Oster, et al. 2018). In this study, the results showed that the age and regional differences of HIV/AIDS patients may provide more credible evidence for the Chinese government to make considerable changes of policies for controlling

the spread of HIV. Though the goal of UNAIDS to end to the HIV epidemic by 2030 seems to be very ambitious, it is really attainable (Nikolopoulos and Bonovas 2017). Up to now, there are neither thorough cure of HIV/AIDS nor effective and safe vaccine (Alchin 2014), and even some adverse effects exist in antiretroviral treatments, but a great progress has been made in prevention and cure of HIV/AIDS and the morbidity, mortality, and new HIV infection rate continually decreased per year all over the world.

As the biggest developing country with 1.4 billion people, China faces an enormous challenge in combating the prevalence of HIV/AIDS (Sheng and Cao 2008). In our study, the fact that the morbidity, mortality, and new HIV infection rate continually increased per year in China aggravates the challenge for prevention and treatment. And the number of new HIV infections in each of several provinces had exceeded 30,000, such as Yunnan, Guangxi, Sichuan, Guangdong and Xinjiang Province. The highest three regions of AIDS-related death in the past 12 years contain Yunnan, Guangxi and Sichuan Province. And the number of AIDS-related death was highest mainly in Yunnan and Guangxi Province. One most possible reason is that in these undeveloped provinces, the financial and economy level of development all lags behind the national level. Populations with lower educational level and cognitive ability always show higher risk behaviors and lower health outcomes. The lack of comprehensive knowledge and good sexual health of HIV/AIDS might have exacerbated the prevalence. The injecting drug users, homosexual, sex workers, and the blood donors with HIV virus in rural China during the mid-1990s all accelerated

the prevalence of HIV/AIDS (Sheng and Cao 2008, Zhang, et al. 2008). Ethnic affiliation may be a powerful influence for the prevalence of HIV infection in China which is a multinational country and own 56 ethnic (Marti-Pastor, et al. 2015).

Additionally, our result showed that higher risk existed in the young and middle-aged populations, especially in 30-40 years old people. Likewise, the previous study indicated that in the population aged 20 to 29, the rate of HIV incidence was significant higher than others in the USA (Warner, et al. 1993), and another research showed that men aged 21 to 29 had the highest incidence which displayed a similar trend (Hakre, et al. 2015). Johnson, A.S. et al. also reported that in the USA, the incidence rate of HIV (1/100,000) among males aged 13 to 24 increased from 12.5 in 2002 to 17.3 in 2011, and among men the number of new HIV infections also increased, especially those who have sex with men (MSM) transmission category (Johnson, et al. 2014). Marti-Pastor, M., et al. also found that in the groups aged 25-34 years the populations with HIV were significant higher than others (Marti-Pastor, et al. 2015). The young and middle-age population was located in active sexual life and high risky behaviors were the reasons of increasing the incidence rate of HIV. Surveillance systems, evaluation systems, policies and laws should be implemented to control this STD.

The Chinese government had taken more strategies to prevent and cure HIV/AIDS cases. In the early cases of HIV/AIDS patients appeared in China, the response of government was to stop and prevent HIV crossing the border, but it is not effective. Along with the spread of HIV throughout China, more active strategies of

prevention have been implemented such as caring of the HIV carriers, forbidding blood donation of unsafe blood, health education, increasing knowledge of prevention and widespread testing, and funding the programs of HIV/AIDS research. Since early 21 century, a new policy of HIV/AIDS prevention called “Four Frees and One Care” has been carried out which effectively delayed the spread of HIV (Mkangara, et al. 2008). In general, a great progress to prevent the epidemic of HIV has been made as a result of a series of programs such as expanding surveillance system, wide spread testing of HIV/AIDS, enhancing education, shutdown entertainment sites with sexual service, supporting for MSM with appropriate advice of sex practices, extending condom use, antiviral therapy of HIV carriers and banning illegal blood collecting centers (Sheng and Cao 2008). And due to the widely used antiretroviral therapy, people living with HIV now could have good immunological responses which improve the life expectancy (Sabin and Reiss 2017).

Some limitations exist in present study that the collected data don't cover the whole HIV/AIDS population in China, because the low rate of HIV test exists in developing areas or rural villages and the HIV carriers are not exposed. Otherwise the deficiency of authority of accessing to the epidemiological data of HIV/AIDS in Taiwan, Hong Kong and Macao may result in bias in this study. Furthermore, the public data in this study are incomplete which prevents us from analyzing other risk factors such as ethnicity, occupation, living environment, taking drugs, blood donation and prostitution. However, this large sample of HIV/AIDS data as one of the few studies on this topic covers most regions in China and focuses on regional and age

differences of HIV/AIDS prevalence in the past twelve years, and concludes that the rapid spread of HIV prevalence with the characteristics of regional and age differences is horrendous. Public attention should be aroused and more effective prevention strategies should be implemented to reduce the incidence in controlling and preventing contagious HIV/AIDS spread.

Conclusions

This study analyzed the epidemiologic characteristics and concludes that the regional and age differences of HIV/AIDS prevalence significantly existed; and this result may provide the basic data for prevention and control of sexually transmitted disease. More effective and efficient control programs with expanded geographical and aged population coverage are needed to be implemented.

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Conflict of interest statement

None

Contributions

Yong-chao Qiao designed the study, implemented the study protocol, collected and

analyzed data and wrote the first manuscript. Yan Xu directed statistical analyses of the data and designed the study. Dong-xiang Jiang, Xiao Wang and Feng Wang analyzed and interpreted the data. Jun Yang and Ye-sheng Wei also designed the study and revised the manuscript. All authors contributed to the discussion, reviewed and edited the manuscript, and approved the final manuscript.

Figure Legends

Figure 1 The incidence of AIDS cases (1/100,000), AIDS-related death (1/100) and new HIV infection (1/100,000) in Chinese populations, 2004-2016

Figure 2 The averaged number (year) about regional distribution of AIDS cases (A), AIDS-related death (B) and new HIV infection (C) in Chinese populations, 2004-2016

Figure 3 The averaged number (year) about age difference of AIDS cases (A), AIDS-related death (B), new HIV infection (C) and percent distribution (D) in Chinese populations, 2004-2016

Figure 4 The averaged number (year) about age difference of AIDS cases (A), AIDS-related death (B) and new HIV infection (C) in Chinese populations, 2004-2016

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