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A Strong Correlation between the Annual Incidence of Amebiasis and Homosexual Human Immunodeficiency Virus Type Infection in Men

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This study investigated the relation between the incidence of human immunodeficiency virus (HIV) infection/AIDS and other sexually transmitted diseases (STD). The study revealed a linear relationship between HIV infections (denoted as “HIV” in patients diagnosed before the development of AIDS symptoms) among homosexual individuals (called “homosexual HIV” hereafter) and amebiasis among men (called “male amebiasis” hereafter).

The data used for the present analysis were derived from the database of the National Epidemiological Surveillance of Infectious Disease (NESID) (1) and from the AIDS Surveillance Committee, Ministry of Health, Labour and Welfare: Annual report of HIV/AIDS trends (2). HIV/AIDS, amebiasis, giardiasis, and syphilis are notifiable STDs for all the cases, which appear in Table 1-1 (Notifiable diseases), and gonorrhea is a regularly reported disease from the sentinel clinics, which appears in Table 9-2 (Sentinel-reporting diseases [monthly]) in the NESID (1). For amebiasis and giardiasis, only symptomatic cases are notifiable (3). The present analysis was conducted by using Microsoft Excel 2010.

Fig. 1A shows the total number of annual cases of HIV/AIDS, amebiasis, giardiasis, and syphilis reported in each year from 1999 to 2013 in Japan. All these infections were predominant in men, i.e., 90.2% and 96.0% for HIV/AIDS; 84.8% and 87.6%, amebiasis; 74.5% and 85.4%, giardiasis; 67.5% and 80.0%, syphilis; in 2000/2013.

Fig. 1B shows the plot of the total number of annual cases of amebiasis, syphilis, and giardiasis, and the annual sentinel-reported number of gonorrhea cases (y-axis) versus the total number of annual HIV/AIDS cases (x-axis); the plots represent the data from 1999 to 2013. The plot of amebiasis (●) against HIV/AIDS showed a straight line indicating that the ratio of the 2 diseases remained relatively constant over time despite of the fluctuations in their annual incidences (Fig. 1A). Plot patterns of syphilis (△), giardiasis (◇), and gonorrhea (□) against HIV/AIDS were aberrant. Thus, the further study was focused on investigating the relation

between male HIV/AIDS (comprising 90–95% of the total HIV/AIDS cases) and male amebiasis.

Fig. 1C shows the plot of the annual number of homosexual HIV (Fig. 1-C1), homosexual AIDS (Fig. 1-C2), heterosexual HIV (Fig. 1-C3), and heterosexual AIDS (Fig. 1-C4) cases against the annual number of male amebiasis cases. A linear relationship was observed between homosexual HIV and male amebiasis cases with slopes of 1.79 in Tokyo and 0.54 in the Kanto-Koshinetsu area (Fig. 1-C1). The slope of the plot of homosexual AIDS against male amebiasis cases was 0.23 and 0.17 in Tokyo and Kanto-Koshinetsu, respectively (Fig. 1-C2), and their correlation was lower (correlation coefficient [CC]: 0.776–0.799) than of the homosexual HIV against male amebiasis cases (CC: 0.902–0.929) (Fig. 1-C1). No positive correlation was observed between heterosexual HIV or AIDS and male amebiasis cases (Fig. 1-C3 and Fig. 1-C4, respectively).

It is important to note here that amebiasis is an acute infection with an incubation period ranging from a few days to 2–4 weeks (4), whereas “HIV” may be detected any time between the infection and the development of AIDS. The strong correlation between the annual incidence of the male amebiasis and male homosexual “HIV” infection, in spite of the fluctuations in the annual incidence, may suggest that most male homosexual “HIV” cases may represent HIV infections shortly after the infection.

Fig. 2A shows the plots of homosexual or heterosexual HIV (y-axis) versus male amebiasis (x-axis) in Tokyo and in 7 areas (excluding the part of Tokyo in the Kanto-Koshinetsu area). A positive correlation, indicated by the rightward ascending plots and the significant level of the CC, was observed between homosexual HIV and amebiasis, but not between heterosexual HIV and amebiasis cases. As the slope of homosexual HIV cases appeared steeper in the regions with a higher incidence of homosexual HIV infection, the slope value was plotted against the normalized incidence of HIV infection in homosexual individuals (total number of homosexual HIV per region divided by the total population of the region in millions) for Tokyo and the 7 regions (Fig. 2B). The plots showed a straight line; $y = 0.572 \ln(x) - 1.260$, where y is the slope and x is the normalized incidence of HIV homosexual cases. As the slope indicated the ratio of the number of homosexual HIV cases to that of male amebiasis, it suggested that the ratio of male homosexual HIV cases to that of male amebiasis increased in proportion to the logarithm of the adjusted number of homosexual HIV cases.

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Fig. 1. Trends of HIV/AIDS and other sexually transmitted diseases reported in Japan from 1999 to 2013. (A) Annual number of HIV/AIDS, amebiasis, giardiasis, and syphilis from 1999 to 2013. The data were derived from Table 1-1, Notifiable diseases, of National Epidemiological Surveillance of Infectious Disease (NESID) of Japan. (B) Relation between annual number of Japanese HIV/AIDS and annual number of amebiasis (●), giardiasis (◇), syphilis (△), or gonorrhea (□). HIV data were derived from Table 10-1 and 10-4 of Annual report of HIV/AIDS. The data of amebiasis, giardiasis, and syphilis were derived from Table 1-1 of NESID and that of gonorrhea, a sentinel surveillance notifiable disease, from Table 9-1 (Sentinel-reporting diseases [monthly]) of NESID. A linear approximation line is shown for relation between HIV/AIDS and amebiasis (85% are men). (C) Relation between annual number of homosexual or heterosexual HIV or AIDS and annual number of male amebiasis cases in Tokyo (closed symbols) and in the Kanto-Koshinetsu (open symbols). The x-axis indicates the number of male amebiasis patients in each area/year and the y-axis indicate the number of HIV or AIDS in each area/year. C1, homosexual HIV vs. male amebiasis; C2, homosexual AIDS vs. male amebiasis; C3, heterosexual HIV vs. male amebiasis; C4, heterosexual AIDS vs. male amebiasis. Correlation coefficients (CC) between male amebiasis and HIV or AIDS are shown after explanation of symbols in parentheses.

The trends of homosexual HIV, heterosexual HIV, and male amebiasis infections from 1999 to 2013 are shown in Fig. 3. The number of homosexual HIV (○) cases has been decreasing or stabilized in Tokyo and Kinki area since 2008, whereas it has been increasing in the Kanto-Koshinetsu and Kyushu areas. Amebiasis followed a similar trend to that of homosexual HIV infection even in the regional level; amebiasis incidence has been decreasing or was stabilized since 2008 in Tokyo and Kinki area, whereas it has continued to increase in the Kanto-Koshinetsu and Kyushu areas.

The present analysis revealed a positive correlation between the incidence of homosexual HIV infection and that of male amebiasis. Such a situation suggests a co-infection of HIV and ameba or a shared community for the transmission of the 2 pathogens. In the latter case, as the incidence of HIV infection and that of amebiasis

increases, the probability of co-infection (C) will increase by a multiple of the incidence of HIV (H) and amebiasis (A), i.e., $C \propto H \times A$. The patients with co-infection will visit clinics for symptoms of acute amebiasis. This situation might explain the higher detection rate of HIV infection as “HIV” among homosexual individuals than among heterosexual individuals (5,6).

The data presented in this communication is entirely compatible with the past data regarding HIV/AIDS and amebiasis, such as a high incidence of amebiasis among homosexual individuals (7–9) and presence of co-infection with ameba among HIV/AIDS patients (10). The present data suggests the importance of cross checking of amebiasis versus HIV in clinical settings. Complexities of human-pathogen, human-human, pathogen-pathogen and human-society interactions being taken into account, it was surprising that the relation between

Fig. 2. (A) Relation between annual number of male amebiasis cases and annual number of HIV acquired through homosexual or heterosexual routes (homosexual or heterosexual HIV, respectively). The x-axis indicates annual number of amebiasis in each area/year and the y-axis indicates the number of homosexual (○) or male heterosexual (●) HIV. A1: Tokyo (CC: 0.902 for homosexuals and -0.225 for heterosexuals); A2: Kanto-Koshinetsu (Ibaraki, Tochigi, Gunma, Saitama, Chiba, Kanagawa, Niigata, Yamanashi, and Nagano; CC: 0.544 for homosexuals and -0.403 for heterosexuals); A3: Kinki (Shiga, Kyoto, Osaka, Hyogo, Nara, and Wakayama; CC: 0.874 for homosexuals and 0.586 for heterosexuals); A4: Tokai (Gifu, Shizuoka, Mie, and Aichi; CC: 0.853 for homosexuals and 0.566 for heterosexuals); A5: Kyushu (Fukuoka, Saga, Nagasaki, Kumamoto, Oita, Miyazaki, Kagoshima, and Okinawa; CC: 0.840 for homosexuals and 0.747 for heterosexuals); A6: Hokkaido-Tohoku (Hokkaido, Aomori, Iwate, Miyagi, Akita, Yamagata, and Fukushima; CC: 0.874 for homosexuals and -0.068 for heterosexuals); A7: Chugoku-Shikoku (Tottori, Shimane, Okayama, Hiroshima, Yamaguchi, Tokushima, Kagawa, Ehime, and Kochi; CC: 0.811 for homosexuals and 0.739 for heterosexuals); and A8: Hokuriku (Toyama, Fukui, and Ishikawa; CC: 0.678 for homosexuals and -0.005 for heterosexuals). (B) Relation between the slopes of homosexuals in panels A1–A8 and the incidence of HIV acquired through homosexual route. The slopes of the data for homosexual HIV in A1–A8 are plotted in the y-axis and the normalized total numbers of homosexual HIV in the x-axis, which was obtained by dividing the total number of homosexual HIV in 1999–2013 with total population ($\times 1,000,000$) in 2010 for each area.

the incidence of homosexual HIV infection and that of male amebiasis could be expressed as simple mathematical equations.

Conflict of interest None to declare.

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Fig. 3. Annual number of male amebiasis (□), homosexual HIV (○), and heterosexual HIV (●) from 1999 to 2013 in various areas in Japan.