Prevalence and the associated factors of hepatitis B and hepatitis C viral infections among HIV-positive individuals in same-day antiretroviral therapy initiation program in Bangkok, Thailand

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Abstract

Background: Viral hepatitis is highly prevalent among people with HIV (PWH) and can lead to chronic liver complications. Thailand started universal hepatitis B vaccination at birth in 1992 and achieved over 95% coverage in 1999. We explored the prevalence of hepatitis B and C viral infections and the associated factors among PWH from same-day antiretroviral therapy (SDART) service at the Thai Red Cross Anonymous Clinic, Bangkok, Thailand.

Methods: We collected baseline characteristics from PWH enrolled in the SDART service between July 2017 and November 2019. Multivariable logistic regression was performed to determine factors associated with positive hepatitis B surface antigen (HBsAg) and hepatitis C antibody (anti-HCV).

Results: A total of 4011 newly diagnosed PWH who had HBsAg or anti-HCV results at baseline: 2941 men who have sex with men (MSM; 73.3%), 851 heterosexuals (21.2%), 215 transgender women (TGW; 5.4%), and 4 transgender men (0.1%). Median age was 27 years. Overall seroprevalence of HBsAg and anti-HCV were 6.0 and 4.1%, respectively. Subgroup prevalence were 6.2 and 4.7% among MSM, 4.6 and 2.4% among heterosexuals, and 9.3 and 3.7% among TGW, respectively. Factors associated with HBsAg positivity were being MSM, TGW, born before 1992, CD4 count < 200 cells/mm³, and alanine aminotransferase ≥ 62.5 U/L. Factors associated with anti-HCV positivity were being MSM, age > 30 years, alanine aminotransferase ≥ 62.5 U/L, creatinine clearance < 60 ml/min, and syphilis infection.

Conclusions: Around 5–10% of newly diagnosed PWH in Bangkok had hepatitis B viral infection after 25 years of universal vaccination. Anti-HCV positivity was found in 4–5% of PWH who were MSM and TGW. As World Health Organization and Thailand national guidelines already support routine screening of hepatitis B and C viral infections in PWH and populations at increased risk of HIV including MSM and TGW, healthcare providers should reinforce this strategy.
Background
Hepatitis B virus (HBV) and hepatitis C virus (HCV) infections are prevalent globally. In 2015, chronic HBV infection was estimated to be in 3.5% of the world population [1]. People with HIV (PWH) had a higher estimated prevalence rate of 7.4% [1]. In Thailand, a study estimated that 5.1% of the general population was infected with HBV in 2015 [2]. The proportion of infection was higher at 8.1% among men who have sex with men (MSM) and 8.1% among PWH [2]. A study conducted from 2006 to 2008 reported that 13.8% among MSM living with HIV were coinfected with HBV in Bangkok, Thailand [3]. Similarly, the global hepatitis C prevalence in 2015 was 1.0%, while 6.2% was the reported HCV prevalence among PWH. However, there is a heterogeneity of risk HCV infection among PWH populations: 82.4% in PWH who inject drugs, 6.4% in MSM living with HIV, and only 2.4% in PWH from the general population [1]. A national survey of the Thai general population in 2014 showed that hepatitis C antibody (anti-HCV) seroprevalence was 0.9% [4]. In contrast, a study focused on PWH found that anti-HCV seroprevalence was 7.7% [5], demonstrating that PWH shoulders a disproportionate burden of HCV infection when compared to the general population.

Furthermore, more than 70% of people infected with HCV and less than 6% of people who acquired HBV as an adult could turn into chronic carriers [1, 6]. Twenty per cent of chronic carriers could develop cirrhosis and hepatocellular carcinoma which are life threatening [1]. Having cofactors such as HIV infection and alcohol consumption can also accelerate the development of end-stage liver diseases [1, 6]. HBV and HCV are not only transmitted from mother to child but also sexually transmitted and share routes of transmission, including percutaneous and mucosal exposures [6, 7]. Having unprotected sex, multiple sexual partners, injection drug use, and a history of other sexually transmitted infections are important factors associated with HBV acquisition [6]. HCV is transmitted mainly through unsafe healthcare settings and injection drug use [1]. However, sexual transmission of HCV among PWH and MSM has been observed [6, 8–12]. MSM and transgender women (TGW) are prone to HCV infection due to the high prevalence of needle sharing, either for illicit drugs or cosmetic injections, and mucosal trauma associated with anal intercourse [9, 13–16].

Unlike HCV infection, HBV infection is a vaccine-preventable disease. Universal hepatitis B vaccination at birth was integrated into Thailand’s Expanded Program on Immunization (EPI) in 1992 and reached over 95% coverage in 1999 [17]. In 2014, a different proportion in HBV infection was seen among persons born before 1992 (4.5%) and persons born after 1992 (0.6%) [17]. Thailand national HIV treatment guidelines recommended baseline screening of newly diagnosed PWH with hepatitis B surface antigen (HBsAg) and anti-HCV, as HBV and HCV coinfections are commonly found and play a critical role in selecting antiretroviral therapy regimens [18].

The Thai Red Cross Anonymous Clinic (TRCAC) is the largest testing center for HIV and sexually transmitted infections in Bangkok, Thailand. Eligible clients who test positive for HIV are included in the same-day antiretroviral therapy (SDART) service [19]. Because this service includes clients of varied populations, namely heterosexuals, MSM, TGW, and transgender men (TGM), this study aims to explore prevalence and the associated risk factors of HBV and HCV seropositivity among PWH in the SDART service.

Methods
This is a cross-sectional descriptive study collecting demographic and laboratory data of clients in the SDART service from 13 July 2017 to 30 November 2019. Included in this study were newly diagnosed PWH at TRCAC who tested for either HBsAg or anti-HCV at baseline. Demographic data included population category, age, birth year, educational level, residential location, and level of income. Persons born in or after 1992 were classified as “born after EPI,” and persons born before 1992 were “born before EPI.” This translates to the age of 25 years for individuals who tested in 2017, 26 in 2018, and 27 in 2019. Baseline laboratory tests included HBsAg, anti-HCV, CD4 count, alanine aminotransferase (ALT), creatinine clearance (CrCl), treponemal test, and nontreponemal test. A severe decrease in CD4 count was defined as a CD4 count of less than 200 cells/mm³ [20]. Regarding ALT, a cutoff of 62.5 U/L calculated from 1.25 times the upper normal limit of the local laboratory was used to indicate a mild increase [20]. Creatinine clearance was calculated with the Cockcroft-Gault equation and categorized as severely decreased if less than 60 ml/min [20]. Syphilis was diagnosed when the treponemal test (enzyme immunoassay, chemiluminescent microparticle
Table 1  Distribution of HIV-Positive Individuals by Sociodemographic and Laboratory Characteristics

| Characteristic                        | Total n (%) or value | HBsAg Positive n (%) or value | Anti-HCV Positive n (%) or value |
|---------------------------------------|----------------------|-------------------------------|---------------------------------|
| **Sociodemographic data**             |                      |                               |                                 |
| Population                            | 4011                 | 242                           | 164                             |
| MSM                                   | 2941 (73.3)          | 182 (75.2)                    | 136 (82.9)                      |
| Heterosexual                          | 851 (21.2)           | 39 (16.1)                     | 20 (12.2)                       |
| TGW                                   | 215 (5.4)            | 20 (8.3)                      | 8 (4.9)                         |
| TGM                                   | 4 (0.1)              | 1 (0.4)                       | 0 (0.0)                         |
| Age (years), median (IQR)             | 27 (23–34)           | 31 (26–37)                    | 29 (24–37)                      |
| Age (years)                           | 4011                 | 242                           | 164                             |
| ≤ 20                                  | 438 (10.9)           | 13 (5.4)                      | 8 (4.9)                         |
| 21–30                                 | 2112 (52.7)          | 107 (44.2)                    | 81 (49.4)                       |
| 31–40                                 | 1016 (25.3)          | 89 (36.8)                     | 51 (31.1)                       |
| 41–50                                 | 349 (8.7)            | 27 (11.2)                     | 19 (11.6)                       |
| > 50                                  | 96 (2.4)             | 6 (2.5)                       | 5 (3.0)                         |
| Birth year                            | 4011                 | 242                           | 164                             |
| ≤ 1992                                | 2167 (54.0)          | 176 (72.7)                    | 105 (64.0)                      |
| ≥ 1992                                | 1844 (46.0)          | 66 (27.3)                     | 59 (36.0)                       |
| Birth year                            | 4011                 | 242                           | 164                             |
| < 1999                                | 3700 (92.2)          | 233 (96.3)                    | 158 (96.3)                      |
| ≥ 1999                                | 311 (7.8)            | 9 (3.7)                       | 6 (3.7)                         |
| Educational level                     | 2320                 |                               |                                 |
| High school or below                  | 794 (34.2)           | 49 (35.5)                     | 27 (24.1)                       |
| College or above                      | 1526 (65.8)          | 89 (64.5)                     | 85 (75.9)                       |
| Residential location                  | 2019                 | 116                           | 99                              |
| Bangkok                               | 1381 (68.4)          | 75 (64.7)                     | 66 (66.7)                       |
| Outside Bangkok                       | 638 (31.6)           | 41 (35.3)                     | 22 (33.3)                       |
| Monthly income (baht)                 | 1337                 | 78                            | 62                              |
| ≤ 10,000                              | 256 (19.1)           | 7 (9.0)                       | 8 (12.9)                        |
| > 10,000                              | 1081 (80.9)          | 71 (91.0)                     | 54 (87.1)                       |
| **Laboratory data**                   |                      |                               |                                 |
| HBsAg                                 | 4011                 |                               | 164                             |
| Positive                              | 242 (6.0)            |                               | 12 (7.3)                        |
| Negative                              | 3769 (94.0)          |                               | 152 (92.7)                      |
| Anti-HCV                              | 3990                 | 221                           |                                 |
| Positive                              | 164 (4.1)            | 12 (5.4)                      |                                 |
| Negative                              | 3826 (95.9)          | 209 (94.6)                    |                                 |
| CD4 count (cells/mm³)                 | 4004                 | 240                           | 163                             |
| < 200                                 | 1038 (25.9)          | 86 (35.8)                     | 37 (22.7)                       |
| ≥ 200                                 | 2966 (74.1)          | 154 (64.2)                    | 126 (77.3)                      |
| ALT (U/L)                             | 3976                 | 219                           | 162                             |
| < 62.5                                | 3623 (91.1)          | 177 (80.8)                    | 98 (60.5)                       |
| ≥ 62.5                                | 353 (8.9)            | 42 (19.2)                     | 64 (39.5)                       |
| CrCl (ml/min)                         | 3923                 | 213                           | 160                             |
| < 60                                  | 29 (0.7)             | 0 (0.0)                       | 5 (3.1)                         |
| ≥ 60                                  | 3894 (99.3)          | 213 (100.0)                   | 155 (96.9)                      |
| Syphilis                              | 3972                 | 225                           | 163                             |
| Positive                              | 767 (19.3)           | 54 (24.0)                     | 54 (33.1)                       |
| Negative                              | 3205 (80.7)          | 171 (76.0)                    | 109 (66.9)                      |

HBsAg hepatitis B surface antigen, anti-HCV hepatitis C antibody, MSM men who have sex with men, TGW transgender women, TGM transgender men, ALT aspartate aminotransferase, CrCl creatinine clearance
immunoassay, rapid immunochromatographic assay, or
Treponema pallidum hemagglutination assay) and non-
treponemal test (either rapid plasma reagin or venereal
disease research laboratory) were both positive. Clients
who did not initiate antiretroviral therapy at TRCAC
might not have all baseline laboratory test results.

Data analysis
Data were analyzed using Stata Version 15.0. Continuous
parameters were presented as median with interquar-
tile range (IQR). Categorical parameters were expressed
in frequency and percentages. The prevalence of posi-
tive HBsAg and anti-HCV were calculated. Univariate
and multivariable analyses were performed to determine
factors associated with positive HBsAg and anti-HCV.
Univariate analysis comparing HBsAg-positive PWH
with HBsAg-negative using simple logistic regression
model was tested. Factors with $p$-value less than 0.2
were selected into multivariable analysis. Multivariable anal-
ysis with a stepwise multiple logistic regression model
including associated factors related to positive HBsAg or
anti-HCV was conducted and reported with an adjusted
odds ratio (aOR) and a 95% confidence interval (CI). A
$p$-value of less than 0.05 was considered statistically
significant.

Results
The total number of PWH who had HBsAg or anti-HCV
results at baseline was 4011 out of 6037: 4011 had HBsAg
results available, while 3990 had anti-HCV results avail-
able. Most of them were MSM (73.3%), followed by het-
erosexuals (21.2%), TGW (5.4%), TGM (0.1%). Median
age was 27 years (IQR 23–34). Sociodemographic and
sexual characteristics are shown in Table 1. Of the
included clients, 46.0% were born after EPI, 25.9% had
a CD4 count of less than 200 cells/mm$^3$, and 19.3% had
syphilis diagnosed at baseline.

The overall prevalence of positive HBsAg was 6.0%.
TGW had a prevalence of 9.3%, followed by MSM, 6.2%.
People born after the EPI (1992 or later) had a prevale-
ce of 3.6% as compared to 8.1% in people born before the
EPI. Individuals born after the EPI reached more than
95% coverage (1999 or later) had a prevalence of 2.9%
as compared to 6.3% in those born before 95% coverage.
All nine clients who were born in 1999 or later and had a
positive HBsAg were MSM.

The overall anti-HCV seroprevalence was 4.1%. MSM
had the highest prevalence among all study population
(4.7%). PWH aged over 30 years had a prevalence of 5.2%,
while it was 3.5% among those younger than 30 years. Of
3990 who tested for both HBsAg and anti-HCV, 12 (0.3%)
were positive for both. Overall and age-stratified preva-
ience of HBsAg and anti-HCV are shown in Table 2.

Factors found significant at the 95% confidence level
from the univariate analysis were carried over to the mul-
tivariable analysis as presented in Tables 3 and 4. Fac-
tors associated with positive HBsAg were being MSM
(adjusted odds ratio [aOR] 1.64, 95% CI 1.13 to 2.40,
$p=0.010$), being TGW (aOR 2.87, 95% CI 1.60 to 5.17,
$p<0.001$), being born before 1992 (aOR 2.32, 95% CI
1.69 to 3.16, $p<0.001$), CD4 count < 200 cells/mm$^3$(aOR
1.38, 95% CI 1.03 to 1.86, $p=0.031$), and ALT $\geq 62.5$ U/L
(aOR 2.39, 95% CI 1.66 to 3.43, $p<0.001$). Factors associ-
ated with positive anti-HCV were being MSM (aOR 2.11,
95% CI 1.26 to 3.55, $p=0.005$), age > 30 years (aOR 1.54,
95% CI 1.10 to 2.17, $p=0.012$), ALT $\geq 62.5$ U/L (aOR
7.74, 95% CI 5.48 to 10.9, $p<0.001$), CrCl < 60 ml/min
(aOR 5.58, 95% CI 1.95 to 16.0, $p=0.001$), and syphilis
positive (aOR 1.95, 95% CI 1.36 to 2.78, $p<0.001$).

Discussion
Among PWH who were newly diagnosed at the Thai
Red Cross Anonymous Clinic, we found 6% prevalence
of HBV and 4% prevalence of anti-HCV positivity. Being
MSM, TGW, and born before the inclusion of universal
hepatitis B vaccination in Thailand’s EPI were statistically
associated with HBV infection. Moreover, being MSM
and having syphilis increased the chance of being anti-
HCV positive.

More than 70% of our clients were MSM, and 5% were
TGW. These findings are consistent with the proportions
of new HIV infections in Thailand as projected by the
AIDS Epidemic Model [21]. We found the HBV preva-
ience to be highest among TGW (9%), followed by MSM
(6%). The anti-HCV seroprevalence was highest among
MSM (5%), followed by TGW (4%). These data support
the findings from previous studies which demonstrated
higher prevalence rates of HBV and HCV among PWH
who were MSM and TGW than those who were of heter-
osexual populations [1, 3, 15, 22–24]. The HBV preva-
ience shown in our clients is quite concerning, as 27% of

| Age (Years)  | HBsAg       | Anti-HCV   |
|-------------|-------------|------------|
|             | No. of HBsAg+ / No. of Tested | % | No. of Anti-HCV+ / No. of Tested | % |
| Overall     | 242/4011    | 6.0 | 164/3990 | 4.1 |
| ≤ 20        | 13/438      | 3.0 | 8/435   | 1.8 |
| 21–30       | 107/2112    | 5.1 | 81/2106 | 3.8 |
| 31–40       | 89/1016     | 8.8 | 51/1007 | 5.1 |
| 41–50       | 27/349      | 7.7 | 19/346  | 5.5 |
| > 50        | 6/96        | 6.3 | 5/96    | 5.2 |

|             |
|-------------|-------------|------------|

HBsAg hepatitis B surface antigen, anti-HCV hepatitis C antibody
HBV-infected individuals were born after EPI, indicating that the HBV epidemic is still ongoing. However, among clients infected with HBV, only 4% were born in 1999 or later, which was the year that EPI reached more than 95% coverage. Lower prevalence of HBV in younger generations could be due to both the success of EPI and shorter duration at risk. The overall prevalence of HBV and HCV found in our study were slightly lower than that of the global and Thai reports among PWH [1, 2, 5], possibly because our clients were relatively young with over 60% aged 30 years or less. Apart from viral hepatitis, almost 20% of our clients had syphilis at baseline, illustrating higher burden than what was previously reported in general MSM population by World Health Organization (WHO; 6%) in 2018 [25].

MSM and TGW had 1.6 and 2.9 times the odds of HBV infection compared with heterosexual populations, respectively, which could be explained by sexual practices and routes which are more vulnerable to mechanical trauma [26]. Consistent with the national survey [17], we saw a contrast of HBV prevalence between people who were born before and after EPI (8% vs. 4%). PWH who were born before EPI had 2.3 times higher odds of having HBV infection. Another possible explanation of

| Factor                        | No. of HBsAg+ / No. of Tested | %       | Univariate Crude OR (95% CI) | p     | Multivariable† Adjusted OR (95% CI) | p     |
|-------------------------------|--------------------------------|---------|-----------------------------|-------|-------------------------------------|-------|
| Population                    | 4011                           |         |                             |       |                                     |       |
| Heterosexual                  | 39/851                         | 4.6     | Reference                   |       | Reference                           |       |
| MSM                           | 182/2941                       | 6.2     | 1.37 (0.96 to 1.96)         | 0.079 | 1.64 (1.13 to 2.40)                | 0.010 |
| TGW                           | 20/215                         | 9.3     | 2.14 (1.22 to 3.74)         | 0.008 | 2.87 (1.60 to 5.17)                | < 0.001 |
| TGM                           | 1/4                            | 25.0    | 6.94 (0.71 to 68.3)         | 0.097 | 5.77 (0.57 to 58.7)                | 0.138 |
| Birth year                    | 4011                           |         |                             |       |                                     |       |
| < 1992                        | 176/2167                       | 8.1     | 2.38 (1.78 to 3.18)         | < 0.001 | 2.32 (1.69 to 3.16)            | < 0.001 |
| ≥ 1992                        | 66/1844                        | 3.6     | Reference                   |       | Reference                           |       |
| Monthly income (baht)         | 1337                           |         |                             |       |                                     |       |
| ≤ 10,000                      | 7/256                          | 2.7     | Reference                   |       |                                     |       |
| > 10,000                      | 71/1081                        | 6.6     | 2.50 (1.14 to 5.50)         | 0.023 |                                     |       |
| Residential location          | 2019                           |         |                             |       |                                     |       |
| Bangkok                       | 75/1381                        | 5.4     | Reference                   |       |                                     |       |
| Outside Bangkok               | 41/638                         | 6.4     | 1.20 (0.81 to 1.77)         | 0.372 |                                     |       |
| Educational level             | 2320                           |         |                             |       |                                     |       |
| College or above              | 89/1526                        | 5.8     | Reference                   |       |                                     |       |
| High school or below          | 49/794                         | 6.2     | 1.06 (0.74 to 1.52)         | 0.743 |                                     |       |
| Anti-HCV                      | 3990                           |         |                             |       |                                     |       |
| Negative                      | 209/3826                       | 5.5     | Reference                   |       |                                     |       |
| Positive                      | 12/164                         | 7.3     | 1.37 (0.75 to 2.50)         | 0.311 |                                     |       |
| CD4 count (cells/mm³)         | 4004                           |         |                             |       |                                     |       |
| < 200                         | 86/1038                        | 8.3     | 1.65 (1.25 to 2.17)         | < 0.001 | 1.38 (1.03 to 1.86)                | 0.031 |
| ≥ 200                         | 154/2966                       | 5.2     | Reference                   |       | Reference                           |       |
| ALT (U/L)                     | 3976                           |         |                             |       |                                     |       |
| < 62.5                        | 177/3623                       | 4.9     | Reference                   |       | Reference                           |       |
| ≥ 62.5                        | 42/353                         | 11.9    | 2.63 (1.84 to 3.75)         | < 0.001 | 2.39 (1.66 to 3.43)                | < 0.001 |
| CrCl (ml/min)                 | 3923                           |         |                             |       |                                     |       |
| < 60                          | 0/29                           | 0.0     | –                           |       | –                                   |       |
| ≥ 60                          | 213/3894                       | 5.5     | –                           |       | –                                   |       |
| Syphilis                      | 3972                           |         |                             |       |                                     |       |
| Negative                      | 171/3205                       | 5.3     | Reference                   |       |                                     |       |
| Positive                      | 54/767                         | 7.0     | 1.34 (0.98 to 1.84)         | 0.067 |                                     |       |

HBsAg: hepatitis B surface antigen, CI: confidence interval, anti-HCV: hepatitis C antibody, ALT: alanine aminotransferase, CrCl: creatinine clearance
† n = 3974
the association to birth year could be that younger people had less time for exposure to the infection than older people. Nonetheless, the findings from this study shows that HBV infection was not completely eliminated by the EPI. Some newborns might be born to an HBV-infected mother, not complete the full course of the immunization, not respond to HBV vaccination, or be unvaccinated. Regarding PWH who do not have immunity to HBV, it is advised to immunize all PWH regardless of CD4 level [18], even though lower CD4 count is one of the factors affecting the effectiveness of the HBV immunization [27–29].

There are many reports of the HCV epidemic among MSM living with HIV in major cities of the world in Europe, Asia-Pacific, and Thailand [8–10, 30–36], and many findings demonstrated an upward trend of HCV infection [9, 30–36]. For example, a study in Thailand found that HCV incidence increased from 0.7–1.1 per 100 person-years in 2014–2016 to 4.5 per 100 person-years in 2018 [30]. Our findings also indicated similar discovery, as we found that being MSM and having syphilis doubled the risk of having positive anti-HCV in our study. HCV infection is widely known to be associated with recreational drug use [9, 10, 30, 31, 35, 37–40], as some MSM utilize recreational drugs to enhance their sexual pleasure, the phenomenon known as chem-sex [41, 42]. Studies on people who did not use injection drugs found that HCV infection was still associated with recreational drug use and syphilis [33, 35, 43], suggesting that transmission of HCV is associated with sexual

### Table 4

#### Hepatitis C Antibody Prevalence in HIV-Positive Individuals and the Associated Factors Assessed by Univariate and Multivariable Analyses

| Factor                     | No. of Anti-HCV+ / No. of Tested | % | Univariate |                  |                  | Multivariable† |
|----------------------------|----------------------------------|---|------------|-----------------|-----------------|----------------|
|                            |                                  |   |            | Crude OR (95% CI) | p               | Adjusted OR (95% CI) | p               |
| Population                 |                                  |   |            |                  |                 |                |
| Heterosexual               | 20/849                           | 2.4 | Reference  |                  | Reference       |
| MSM                        | 136/2923                         | 4.7 | 2.02 (1.26 to 3.25) | 0.004 | 2.11 (1.26 to 3.55) | 0.005 |
| TGW                        | 8/214                            | 3.7 | 1.61 (0.70 to 3.71) | 0.263 | 1.78 (0.74 to 4.30) | 0.199 |
| TGM                        | 0/4                              | 0.0 | –          | –               | –               |                |
| Age                        |                                  |   |            |                  |                 |                |
| ≥ 30                       | 89/2541                          | 3.5 | Reference  |                  | Reference       |
| > 30                       | 75/1449                          | 5.2 | 1.51 (1.10 to 2.06) | 0.011 | 1.54 (1.10 to 2.17) | 0.012 |
| Monthly income (baht)      |                                  |   |            |                  |                 |                |
| ≤ 10,000                   | 8/256                            | 3.1 | Reference  |                  | Reference       |
| > 10,000                   | 54/1074                          | 5.0 | 1.64 (0.77 to 3.49) | 0.199 |                |                |
| Residential location       |                                  |   |            |                  |                 |                |
| Bangkok                    | 66/1367                          | 4.8 | Reference  |                  | Reference       |
| Outside Bangkok            | 33/632                           | 5.2 | 1.09 (0.71 to 1.67) | 0.706 |                |                |
| Educational level          |                                  |   |            |                  |                 |                |
| College or above           | 85/1514                          | 5.6 | Reference  |                  | Reference       |
| High school or below       | 27/787                           | 3.4 | 0.60 (0.38 to 0.93) | 0.022 |                |                |
| CD4 count (cells/mm³)      |                                  |   |            |                  |                 |                |
| < 200                      | 37/1027                          | 3.6 | Reference  |                  | Reference       |
| ≥ 200                      | 126/2958                         | 4.3 | 1.19 (0.82 to 1.73) | 0.360 |                |                |
| ALT (IU/L)                 |                                  |   |            |                  |                 |                |
| < 62.5                     | 98/3623                          | 2.7 | Reference  |                  | Reference       |
| ≥ 62.5                     | 64/352                           | 18.2 | 7.99 (5.71 to 11.2) | < 0.001 | 7.74 (5.48 to 10.9) | < 0.001 |
| CrCl (ml/min)              |                                  |   |            |                  |                 |                |
| < 60                       | 5/29                             | 17.2 | 5.03 (1.89 to 13.3) | 0.001 | 5.58 (1.95 to 16.0) | 0.001 |
| ≥ 60                       | 155/3894                         | 4.0 | Reference  |                  | Reference       |
| Syphilis                   |                                  |   |            |                  |                 |                |
| Negative                   | 109/3203                         | 3.4 | Reference  |                  | Reference       |
| Positive                   | 54/762                           | 7.1 | 2.16 (1.55 to 3.03) | < 0.001 | 1.95 (1.36 to 2.78) | < 0.001 |

*Anti-HCV hepatitis C antibody, CI confidence interval, ALT alanine aminotransferase, CrCl creatinine clearance
† n = 3901
intercourse. It has been estimated that the prevalence of drug injection among newly diagnosed Thai PWH in 2020 is 12% [44]. Unfortunately, we did not collect data on substance use and chemsex in our study and could not assess these potential associations. However, as MSM and syphilis were key factors associated with HCV infection among our clients, we hypothesized that HCV acquisition in our HIV-positive MSM clients was likely linked to sexual transmission and possibly in the chemsex context.

There were a few limitations in our study. This study was conducted at one site and two-thirds of our PWH clients lived in Bangkok, suggesting that they may be more educated and had higher income when compared to PWH from other regions in Thailand. Thus, our study sample might not represent the overall population of PWH in Thailand. Additionally, we could not retrieve hepatitis B vaccination history from original medical records, and therefore needed to use PWH clients’ birth year as a surrogate. As previously mentioned, we did not record substance use and chemsex data and thus could not explore their possible associations with HBV and HCV infections in our study. Lastly, we did not perform HCV RNA in anti-HCV-positive clients; therefore, the observed anti-HCV seroprevalence may be higher than the actual infection rate.

WHO aimed to eliminate hepatitis B and C infections by 2030 [45]. To achieve this, a country must target the areas determined to have beneficial impacts as described in Table 5 [45, 46]. In Thailand, HBV vaccination has reached 95% coverage since 1999 [17]. However, Thailand’s diagnosis and treatment coverage of HBV and HCV are far from the target [46]. WHO and Thailand already recommend HBV and HCV infection screening in PWH and those who are at risk of HIV including MSM and transgender people [18, 47, 48]. From the results of this study, continuation of HBV and HCV screening for everyone living with HIV regardless of age would uncover a high proportion of undiagnosed infections and be a chance to bring them to treatment. Providing HIV preexposure prophylaxis to HIV-negative persons at risk of HIV acquisition and following the current WHO and Thailand guidance to test for HIV, HBV, and HCV infections at commencement of the services can be an opportunity to screen, vaccinate (HBV), and if needed, treat these infections to prevent further transmission [49, 50]. In spite of that, catch-up hepatitis B immunization needs to be paid out of pocket for in Thailand. Regarding HCV, some global HCV elimination efforts have now included pangenotypic direct-acting antiretroviral (DAA) therapy for most HCV-infected individuals [51, 52]. In Thailand, costs of HCV genotyping and treatment have been high, but the voluntary licensing of DAA medications is becoming implemented in Thailand [53]. However, the current restriction to only start DAA in individuals with fibrosis METAVIR Stage F2 means that individuals with HCV can continue to transmit the virus to others. Future studies will need to explore strategies to timely and efficiently test and treat HCV, especially among PWH, to contribute to the elimination of HCV.

Conclusions

Thailand’s EPI has successfully reduced HBV infection. However, the infection rate among newly diagnosed PWH remained at around 5–10%. Hepatitis C infection was found in 4–5% of PWH who were MSM and TGW. Healthcare providers should reinforce HBV and HCV screening in PWH, MSM, and TGW and provide linkage to appropriate prevention and treatment interventions. Catch-up hepatitis B vaccination should be made available under national health coverage.

### Table 5 Global Baseline and Thailand’s Progress Toward the Elimination of Hepatitis B and C by 2030

| Target Area     | Global Baseline 2015 | Thailand Estimates 2019 | WHO Target 2030 |
|-----------------|----------------------|-------------------------|-----------------|
| HBV birth dose  | 38%                  | 99%                     | 90%             |
| HBV 3+ doses    | 82%                  | 97%                     | 90%             |
| Blood safety    | 89%                  | 100%                    | 100%            |
| Injection safety| 5%                   | 100%                    | 90%             |
| Syringes per PWID | 20                  | 24                     | 300             |
| HBV diagnosed   | < 5%                 | 7%                      | 90%             |
| HBV treated     | < 1%                 | 1%                      | 80%             |
| HCV diagnosed   | < 5%                 | 36%                     | 90%             |
| HCV treated     | < 1%                 | 11%                     | 80%             |

*WHO: World Health Organization, HBV: hepatitis B virus, PWID: person who injects drugs, HCV: hepatitis C virus
† Number of sterile needles and syringes provided per person who injects drugs per year

### Abbreviations

- aOR: Adjusted odds ratio
- CI: Confidence interval
- CrCl: Creatinine clearance
- ALT: Alanine aminotransferase
- Anti-HCV: Hepatitis C antibody
- DAA: Direct-acting antiretroviral
- EPI: Expanded Program on Immunization
- HBsAg: Hepatitis B antigen
- HIV: Hepatitis B virus
- HCV: Hepatitis C virus
- IQR: Interquartile range
- MSM: Men who have sex with men
- PWID: Person who injects drug
- PWH: People with HIV
- SDART: Same-day antiretroviral therapy
- TGW: Transgender women
- TRCAC: Thai Red Cross Anonymous Clinic
- WHO: World Health Organization

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Authors' contributions
ST, TC, SA, TP, AA, PP, RR, and NP contributed to the design and concept of the study. ST, TC, SA, and MS contributed the data. JP and SA extracted and prepared the data. ST and JP analyzed the data. ST wrote the manuscript. TC, PS, AA, MA, and NP assisted in interpretation of the data, provided intellectual input, and provided edits. All authors have reviewed and approved the final version.

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Availability of data and materials
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The One-Day Antiretroviral Therapy Initiation protocol (NCT04032028) was approved by the Institutional Review Board of the Faculty of Medicine, Chulalongkorn University with Approval Number 158/56. Institutional Review Board of the Faculty of Medicine, Chulalongkorn University has waived the informed consent for the study. All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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