Prevalence of blood-borne virus infections and uptake of hepatitis C testing and treatment in Australian prisons: the AusHep study

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Summary

Background Incarcerated people are at high risk of blood-borne virus infections, particularly HCV, and a priority population for elimination efforts. This national bio-behavioural survey evaluated blood-borne virus prevalence and HCV testing-and-treatment uptake amongst people in Australian prisons.

Methods Randomly-selected participants from 23 representative prisons nationally were offered point-of-care testing for HIV and HCV (anti-HCV) antibodies, hepatitis B surface antigen (HBsAg), and HCV RNA (if anti-HCV positive). Demographic data and previous HCV testing and treatment were collected by structured interview.

Findings 1599 individuals participated (98% participation; 89%male; median age 35 years; 49% ever injected drugs). Prevalence estimates were: 31.7% (95% CI:28.8–34.8) for anti-HCV; 8.0%for HCV RNA (95% CI:6.4–9.9); 0.5% (95% CI:0.2–1.1) for HBsAg, and 0.8% (95% CI: 0.4–1.7) for HIV antibody. Among participants who had ever injected drugs (n = 787), HCV RNA prevalence was highest among those injecting and sharing needles/syringes within the past month [27.9%; adjusted odds ratio (aOR):4.54 (95% CI:2.65–7.77). Among participants (n = 1599), 70.4% (95% CI: 67.4–73.2) had ever been tested for HCV (62.6% in prison). The highest likelihood of having had HCV testing was observed among participants who injected drugs in the past month (aOR = 10.37, 95% CI:5.72–0.18.78). Among those eligible (n = 318), 84.6% (95% CI:79.2–88.7) had ever received HCV treatment (75.0% in prison), and 67.8% (95% CI:61.7–73.4) were cured. The likelihood of HCV treatment was higher among those previously imprisoned, (aOR = 2.67, 95% CI:1.20–5.93).

Interpretation Despite high overall HCV testing and treatment uptake, the lower uptake and substantial ongoing HCV disease burden in some sub-populations highlights the need for continued prison-based elimination efforts with population-specific interventions.

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Keywords: HCV; HBV; HIV; Jail; Prison; Epidemiology

Introduction

People who inject drugs are over-represented in custodial centres in most countries, including in Australia, primarily as a result of incarceration for offences related to injecting drug use.[1] Globally, an estimated 58% of people who inject drugs have a history of incarceration.[2] As a consequence, people in prison are at greater risk of blood-borne virus infections (BBVs) compared to the general community. Amongst all the BBVs, HCV has the greatest disease burden, with an estimated 15–18% of people in prison worldwide estimated living with HCV infection.[3] In Australia, the terms 'jails' and 'prisons' are used to

Abbreviations: Ab, antibody; aOR, adjusted odds ratio; AusHep, Australian Hepatitis and Risk Survey in Prisons; BBV, blood-borne virus; CI, confidence interval; DAA, direct acting antivirals; IRB, Institutional review board; OAT, opioid agonist treatment; HBsAg, hepatitis B virus surface antigen; HBV, hepatitis B virus; HCV, hepatitis C virus; RNA, ribonucleic acid; STROBE, Strengthening the Reporting of Observational Studies in Epidemiology; WHO, World Health Organization

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Research in context

Evidence before this study

Peer-reviewed databases (MEDLINE and Scopus) and grey literature were searched for studies evaluating epidemiology of blood-borne virus infections in Australian prisons at the national level. The search terms included: "blood-borne virus", "hepatitis C", "HCV", "hepatitis B", "HBV", "HIV", "prison", "Australia". The only study identified was the National Prison Entrants' Blood Borne Virus Survey, a triennial bio-behavioural survey last conducted in 2016. While this study provided historical data and served as a reference to evaluate changes in the blood-borne virus infection epidemics, updated data are required to assess the current situation. Moreover, the previous study: included prison entrants only and not people already imprisoned; had limited participation (50%); and had an insufficient sample size to provide reliable jurisdiction-level data.

Added value of this study

In the Australian Hepatitis and Risk Survey in Prisons (AusHep study), we overcame the methodological limitations of the National Prison Entrants' Blood Borne Virus Survey, and generated updated data regarding the prevalence of hepatitis C virus (HCV), hepatitis B virus (HBV) and HIV infections among people in Australian prisons and their engagement in the HCV clinical care pathway. The estimated prevalence rates for HCV, HBV, and HIV were 8.0%, 0.5%, and 0.8%, respectively. HCV prevalence varied widely across jurisdictions (range: 0–15%). Among all participants, 70% had been tested for HCV (63% in prison). Among participants eligible for HCV treatment, 85% had received treatment (75% in prison), and 68% were cured. This study has identified a significantly lower prevalence of HCV infection than previously reported, reflecting both community and prison-based scale up of testing and treatment, but a substantial residual prevalence of chronic HCV infection remains. The highest HCV prevalence was observed among those who recently injected drugs and shared needle or syringe.

Implications of all the available evidence

In Australia, these data inform the strategies for elimination of blood-borne virus infections at both the national and jurisdictional levels. This study also identified sub-populations with higher prevalence of HCV and/or lower uptake of testing and treatment for whom targeted interventions are required. At the international level, this study may serve as a model for national prison-based surveillance of blood-borne virus infections as a key component of elimination strategies.

describe locations where an individual is housed whilst waiting trial or serving sentencing. The terms are mostly used interchangeably, depending on the legal system and local policies of corrections in each state and territory. Prisons, encompassing both 'jails' and 'prisons' in this context, are primarily short stay and highly transient settings with frequent movement of individuals both within the prison system and between prison and the community. When in the community, people in prisons encounter several social and economic cchallenges, such as financial instability, mental health issues, and drug use, which often lead to the deprioritisation of BBV testing and treatment.[4] Despite many challenges associated with imprisonment, it often provides an opportunity for a largely marginalized population that may not engage with health services in the community, to address their health needs. Further, it is likely that without efforts to scale-up prison-based testing and treatment services, efforts to achieve World Health Organization (WHO) targets for BBV elimination by 2030, will be undermined.[5,6]

In 2022 the Australian prison system housed an estimated 40,600 individuals in over 110 individual centres at any given time.[7] People in prisons included 93% males, 32% First Nations people, with 14% incarcerated for a drug-related principal offence, and 37% on 'remand' (i.e., individuals who have been charged with a crime but not yet convicted, hence awaiting trial but who are held in the same prison centres).[7] The jurisdictions vary in BBV testing policies from universal opt-out testing offered at reception (i.e., on entry) to risk factor-based testing. Since 2016, when government-subsidised HCV direct-acting antiviral (DAA) therapies became available in Australia, including for those incarcerated,[8] prison-based HCV treatment has made a major contribution to the national HCV treatment uptake. The proportion of all individuals initiating DAA treatment in Australia who did so whilst in prison has increased steadily from 6% of the national total in 2016 to 35% in 2022, thereby underpinning national elimination efforts.[9] All jurisdictions offer opioid agonist treatment (OAT) although policies for selecting eligible people are different across jurisdictions. There are no prison-based needle-syringe programs.

Given the high burden of BBVs in the prison setting, prison-based surveillance systems are recommended for monitoring prevalence, as well as testing and treatment uptake, to inform development and evaluation of BBV management programs.[10] Some countries have such systems in place at a sub-national level (e.g., state or province),[11–13] however, very few countries gather nationally representative data. National prison-based BBV surveillance systems in countries that do report data are based on data extractions from medical or administrative records and registry-based data,[14,15] or are focused solely on HIV.[16,17]

In Australia, national BBV surveillance data in the prison sector was previously provided by the National Prison Entrants' Blood Borne Virus Survey, a triennial

bio-behavioural survey among prison entrants.[18] This survey collected data only upon entry into prisons, and therefore did not capture in-prison testing or treatment; had limited participation (50%); and had insufficient sample size to provide reliable jurisdiction-level data. Other existing national surveillance mechanisms based on laboratory notifications of the BBVs, or dispensing of antiviral treatment prescriptions[19,20] do not reliably identify prison-based testing and treatment, thus are not able to reliably provide data on prison-based testing and treatment uptake. The Australian Hepatitis and Risk Survey in Prisons (AusHep study), therefore aimed to estimate the prevalence of HCV, hepatitis B virus (HBV) and HIV infections and to evaluate engagement in the stages of the HCV clinical care pathway amongst people in Australian prisons.

Methods

An overview of the methodology, as well as the challenges and facilitators in conducting the AusHep study has been previously described,[21] but the methods are outlined below. The manuscript has been reported in line with the STROBE criteria for cross-sectional studies.[22]

Study design and setting

The AusHep study is an annual cross-sectional bio-behavioural survey of representative populations of people in prison in each jurisdiction (i.e., state or territory) in Australia, which is planned to be repeated at least biennially. The first round of the study was conducted during April 2022 to June 2023. Twenty-three representative state-run prison centres from six of eight jurisdictions (New South Wales, Northern Territory, Queensland, South Australia, Tasmania, and Western Australia) were selected as study sites. These jurisdictions collectively housed 83% of people in prison in Australia in 2022.[7] In most jurisdictions, a minimum of one-quarter of the prisons were selected using a strategy that considered the available infrastructure in each prison for feasibility, while ensuring representation of all prison security classes (minimum, medium, maximum), remoteness of prison location, female prisons, and prisons with a predominant population of First Nations people (Supplementary Table S1).

Participants and study size

All people in prison, including those on remand and those sentenced, who provided informed consent were eligible to participate in the study. Individuals who were unable to speak English and comprehend the survey were excluded. Using the principles of two-stage cluster sampling, first, the study prisons were selected as clusters (as described above). Then at each prison (cluster), the study population was selected randomly using computer-generated random numbers from the list of all people present in the prison. People who were not willing to participate were replaced by other randomly selected individuals. Given the high burden of HCV compared to other BBVs in Australian prisons,[23] the sample size was calculated with the primary aim of estimating HCV prevalence at the jurisdiction-level with 5% margin of error and 95% confidence, using the principles of simple random sampling (total required n = 1592). The sample size was calculated for each jurisdiction separately. For each jurisdiction, the most representative and recent HCV prevalence estimate in the prison available in the peer-reviewed or grey literature were used for sample size calculation. For jurisdictions with more than one study prison site, the sample size in each prison was calculated proportional to the prisoner population of that prison.

Study procedures, and measurements

All participants provided informed written consent. For each participant, an interviewer-administered survey was conducted by trained study nurses to address the prevalent low literacy, and included questions about: demographics; BBV risk behaviours (e.g., injecting drug use, stabbing, fighting, unsafe sexual activity, and body piercing/tattooing), and injecting risk behaviours; access to OAT; previous HIV, HBV, and HCV testing and treatment; and HBV vaccination.

Participants provided saliva and fingerstick whole blood samples for point-of-care testing for HIV antibody (HIV Ab), HBsAg, HCV Ab and HCV RNA, all in the same session. HCV Ab testing was performed using OraQuick® HCV Rapid Antibody Test (OraSure Technologies, USA) with saliva samples. Participants with a positive HCV Ab test were offered point-of-care HCV RNA testing with a fingerstick whole blood sample, using the Xpert® HCV Viral Load Fingerstick test (Cepheid, USA; lower limit of quantification of 100 IU/mL). HBsAg testing was performed using Alere Determine™ II HBsAg test (Alere International, Ireland) with fingerstick whole blood samples. HIV Ab testing was performed using the OraQuick Advance® Rapid HIV-1/2 Antibody Test (Orasure Technologies, USA) with saliva samples.

Variables and analysis outcomes

HCV, HIV and HBV status were identified based on the study-conducted blood or saliva test results and used to estimate prevalence. This means all data on participants' test results (i.e., HCV Ab, HCV RNA, HIV Ab, and HBsAg status) were based on the study-conducted tests. The history of HCV testing, diagnosis and treatment were based on self-reported data collected during the interviews.

For evaluation of the engagement of people in Australian prisons in various stages of the HCV clinical care pathway (i.e. the HCV care cascade), the analysis outcomes included: proportion of participants who self-

reported prior HCV Ab testing (among total participants); proportion of participants who self-reported prior HCV RNA testing (among those who were HCV Ab positive based on study-conducted testing); proportion of participants ever diagnosed for chronic HCV infection (among those who were HCV Ab positive based on study-conducted testing); proportion of participants who self-reported receiving HCV treatment (among those eligible for treatment); and proportion of participants cured of HCV (among those eligible for treatment). Participants diagnosed for chronic HCV were defined as those who had ever been told by a health professional that they had chronic HCV. People eligible for treatment were defined as those with detectable HCV RNA (study-conducted test), regardless of the history of treatment or those HCV Ab positive (study-conducted test) who had a self-reported history of HCV treatment. HCV cure was defined by a positive HCV Ab and undetected HCV RNA among those who had received treatment (study-conducted test).

Statistical analysis

The prevalence of HCV Ab, HCV RNA, HBsAg, and HIV Ab and the corresponding 95% confidence intervals (95% CI) were calculated nationally, in each jurisdiction, and by characteristics of participants, including sex, age groups, education, country of birth, First Nations identity, security classification, duration of incarceration, history of previous imprisonment, sexual identity, injecting drug use history, and history of other BBV risk factors (i.e., tattooing, piercing, stabbing, or fighting in prison). Logit-transformed 95% CIs were calculated for most prevalence estimates. In cases where the number of events was zero, we applied the exact (Clopper-Pearson) 95% CI.

The proportion of participants engaged in HCV clinical care and the corresponding 95% CI were calculated for each stage of HCV care cascade. For estimation of the national BBV prevalence and proportion of participants engaged in HCV clinical care, the sample size in each jurisdiction was weighted by the prisoner population of that jurisdiction and the distribution of gender, and First Nations identity among people in prison, based on data from the Australian Bureau of Statistics in 2022.[7]

Logistic regression analyses were used to evaluate: factors associated with any HCV testing among total participants; factors associated with HCV treatment among those eligible; and factors associated with HCV infection (HCV RNA positive) among those with a history of injecting drugs. Hypothesized study variables for inclusion in the regression models were selected *a priori*, and included age, sex, education, country of birth, First Nations identity, security classification, duration of incarceration, history of previous imprisonment, sexual identity, injecting drug use history, other HCV risk factors. For models among people who inject drugs, additional variables were included such as recent injecting and sharing needle or syringe (past month), and OAT. In each model, the linearity assumption was assessed by examining the linear relationship between the study variables and the logit of the outcome variable. In some models, age did not meet the linearity assumption and hence it was included in the models as a categorical variable (i.e., age groups). In each unadjusted model, the covariates with a p value < 0.20 were included in the adjusted analysis. In all models, robust variance estimates were used with prison sites specified as the clusters to adjust for possible correlation of participants within each prison. Statistical significance was assessed at $p < 0.05$ (two-sided p values). Data analysis was performed using Stata 17.0 (StataCorp, College Station, TX, USA).

Institutional review board approvals

Human research ethics or Institutional review board (IRB) approval was initially obtained from the University of New South Wales (UNSW) Human Research Ethics Committees (HREC; HC190778). In New South Wales, approvals were then obtained from Justice Health and Forensic Mental Health Network (2019/ETH13823); Aboriginal Health and Medical Research Council (1643/20); and Corrective Services New South Wales (D21/0583450). In Tasmania, the University of Tasmania (23824) provided HREC approval. In Queensland, the ACT HREC approval (2020/ETH00024) was used under the National Mutual Acceptance scheme which covers research studies conducted in all Queensland Offender services, in addition to approval from Queensland Corrective Services (QCS/02797–2021). In South Australia, Central Adelaide Local Health Network (21SAPHS0341) ratified ACT Health HREC, and approvals were also obtained from the Aboriginal Health Research Ethics Committee (04-21-923); and South Australia Department of Corrective Services (CEN/20/1538). In the Northern Territory, approvals were obtained from Central Australia HREC (CA-20-3866); Menzies School of Health Research (2020–3655); and Northern Territory Corrective Services (HC190778). In Western Australia, approvals were obtained from Western Australian Aboriginal Health Ethics Committee (991); and Western Australia Research Applications and Advisory Committee - Department of Justice (468).

Role of the funding source

This study was funded by the Australian Department of Health and Aged Care. The funders had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The sponsor (The Kirby Institute, UNSW Sydney, Sydney, NSW, Australia) collected the data, managed study samples, and monitored study conduct.

Results

Description of participants

A total of 1599 individual people in prison were enrolled, with 98% of those invited agreeing to participate. In five participants (0.3%), the results of the study-conducted HCV RNA tests were invalid (even in repeated tests), for whom standard of care HCV RNA results (conducted by prison health services) were recorded. A valid result was obtained for all HCV Ab, HIV Ab and HBsAg study-conducted tests.

Participants were 88.7% male (n = 1418), had a median age of 35 years (IQR p25–75: 28–44), 48.5% (n = 776) identified as First Nations, 49.2% (n = 787) had a history of injecting drug use, and 18.7% (n = 299) injected in the past month (Table 1). The median incarceration duration was eight months and 22.1% (n = 354) were on remand (awaiting sentencing). The age and sex distribution among study participants were comparable to the population in prison in each jurisdiction in 2022 (Supplementary Table S2).

Prevalence of blood-borne virus infections

The national prevalence estimate for people in prison for HCV Ab was 31.7% (95% CI: 28.8–34.8) and for HCV RNA was 8.0% (95% CI: 6.4–9.9). There were wide variations in HCV prevalence across jurisdictions (HCV Ab: 1.6%–44.2%; HCV RNA: 0.0%–15.1%, Fig. 1A and B). HCV RNA prevalence was highest (23.8%, 95% CI: 18.5–30.0) among those reporting injecting drug use in the past month (Table 1).

The national HBsAg prevalence estimate was 0.5% (95% CI: 0.3–1.1), with the highest jurisdictional prevalence in Northern Territory (3.3%, 95% CI: 1.7–6.3; Fig. 1C). The highest HBsAg prevalence was identified among those born outside Australia (1.4%, 95% CI: 0.3–6.5) and First Nations people (1.0%, 95% CI:0.5–2.0; Table 1).

The national HIV Ab prevalence estimate was 0.8% (95% CI: 0.4–1.7), ranging from 0.0% to 1.3% across jurisdictions (Fig. 1D). Participants identifying as homosexual/bisexual had the highest HIV prevalence (8.0%, 95% CI: 2.9–20.5; Table 1).

Factors associated with hepatitis C among people with a history of injecting drug use

Among participants who reported past or current injecting drug use (n = 787), the prevalence of HCV infection (HCV RNA positive) was 12.7% (n = 100). Those who reported injecting drug use and sharing needle or syringe within the past month (n = 226) had the highest HCV prevalence of 27.9% (n = 63, Table 2). The likelihood of HCV infection in this group was more than four times higher than those that reported a history of injecting, but not in the past month [adjusted odds ratio (aOR): 4.54 (95% CI: 2.65–7.77). Likelihood of HCV was also significantly higher among participants with a past history of OAT who were not currently receiving therapy (vs. current OAT, aOR: 2.27, 95% CI: 1.46–3.55) and those reporting other HCV risk factors (aOR: 2.00, 95% CI: 1.12–3.58; Table 2).

Hepatitis C cascade of care

Overall, 70.4% (95% CI: 67.4–73.2) of participants had ever been tested for HCV (any test), including 62.6% (95% CI: 59.5–65.7) who had ever been tested in prison, and 36% (95% CI: 33.4–39.5) who were tested in prison in the past year amongst all participants (Fig. 2A). Among participants who were HCV Ab positive, 89.8% (95% CI: 85.9–92.7) had ever been tested for HCV RNA. Among those eligible for HCV treatment (n = 318), an estimated 84.6% (95% CI: 79.2–88.7) had ever received HCV treatment (75.0%, n = 239 received treatment in prison), and 67.8% (95% CI: 61.7–73.4) were cured (Fig. 2B). Among people who had received HCV treatment (n = 270), 24.8% (n = 76) received treatment in the last year, and 27.4% (n = 74) had been treated more than once.

Among all participants with a positive HCV Ab test result (n = 444), 23.0% (n = 102) had detectable HCV RNA indicating current infection, 28.4% (n = 126) had undetectable HCV RNA with no reported history of HCV treatment indicating likely spontaneous clearance, and 48.6% (n = 216) had undetectable HCV RNA with a history of HCV treatment indicating likely treatment-induced clearance. Among 102 people with a positive HCV RNA test, 34.3% (n = 35) were unaware of their HCV status.

Among participants with a positive HCV Ab test who reported receiving HCV treatment (n = 270), 20% (n = 54) had detectable HCV RNA indicating treatment failure or post-treatment re-infection.

Factors associated with hepatitis C testing

Among all participants (n = 1599), the likelihood of ever being tested for HCV was significantly higher in older participants, those with greater than two months duration of incarceration, those that identified as homosexual/bisexual, those with a history of past or recent injecting drugs, and those with a history of other potential HCV risk factors (Table 3). A higher proportion of people with a history of injecting drug use had received testing (88% (n = 695) vs. 45% (n = 365)). Compared to participants who never injected drugs, the likelihood of having had HCV testing was six times higher in those with a history of injecting more than a month ago (aOR = 6.18, 95% CI: 3.88–8.87) and ten times higher among those injecting in the past month (aOR = 10.37, 95% CI: 5.72–18.78; Table 3).

Among participants with a history of injecting drug use (n = 787), the likelihood of ever being tested for HCV was lower in First Nations people and those born overseas, while it was higher in older participants, those with a history of past or current OAT, and those with a history of other potential HCV risk factors (Supplementary Table S3).

	Participant n (%) n = 1599	Prevalence (95% CI)			
		HCV Ab n = 444 HCV Ab+	HCV RNA n = 102 HCV RNA+	HBsAg n = 15 HBsAg+	HIV Ab n = 12 HIV Ab+
Age	Median: 35.1 (IQR: 28.3–43.6)				
18–24 years	171 (10.7)	22.4 (14.9–32.2)	7.9 (4.1–14.8)	0.0 (0.0–2.1)	0.0 (0.0–0.21)
25–34 years	572 (35.8)	38.1 (33.1–43.4)	9.7 (6.9–13.4)	0.9 (0.3–2.6)	0.6 (0.1–2.8)
35–44 years	467 (29.2)	33.1 (27.7–39.0)	8.2 (5.4–12.3)	0.6 (0.2–1.7)	0.6 (0.2–1.5)
45 years and older	389 (24.3)	25.1 (20.1–30.8)	5.5 (3.3–9.1)	0.2 (0.1–0.5)	1.6 (0.6–4.5)
Sex					
Male	1418 (88.7)	32.3 (29.3–35.5)	8.2 (6.6–10.2)	0.5 (0.2–1.1)	0.8 (0.4–1.7)
Female	181 (11.3)	17.0 (11.6–24.3)	2.5 (0.9–6.6)	0.4 (0–2.5)	0.7 (0.1–4.5)
Education					
Below tertiary	1326 (82.9)	34.9 (31.6–38.4)	9.5 (7.6–11.9)	0.4 (0.2–0.9)	0.8 (0.3–1.8)
Tertiary	273 (17.1)	20.9 (15.6–27.4)	2.8 (1.3–5.8)	0.8 (0.2–4.2)	0.9 (0.2–4.1)
Country of birth					
Australia	1450 (90.7)	35.8 (32.5–39.1)	9.1 (7.3–11.3)	0.4 (0.2–0.7)	0.9 (0.4–1.9)
Other countries	149 (9.3)	8.2 (4.3–15.2)	1.2 (0.3–4.7)	1.4 (0.3–6.5)	0.3 (0–2.0)
First nations identity					
Yes	776 (48.5)	43.7 (39.5–48.1)	11.2 (8.6–14.3)	1.0 (0.5–2.0)	0.6 (0.2–1.7)
No	823 (51.5)	26.6 (23.0–30.5)	6.6 (4.7–9.1)	0.3 (0–1.4)	0.9 (0.4–2.2)
Security classification					
Sentenced	1245 (77.9)	31.0 (27.8–34.5)	7.7 (6.0–9.9)	0.5 (0.2–1.2)	0.9 (0.4–2.0)
Remand	354 (22.1)	34.5 (28.4–41.0)	9.0 (6.0–13.5)	0.6 (0.2–1.8)	0.4 (0–1.5)
Duration of current incarceration	Median: 22.1 (IQR: 2.9–23.7)				
≤2 months	266 (16.6)	30.4 (23.3–38.5)	8.2 (4.8–13.6)	0.4 (0.1–2.0)	1.2 (0.2–7.9)
>2 months	1333 (83.4)	31.9 (28.8–35.2)	7.9 (6.2–10.2)	0.5 (0.2–1.2)	0.8 (0.4–1.6)
Previously imprisoned					
Yes	1215 (76.0)	40.1 (36.6–43.8)	9.7 (7.7–12.1)	0.4 (0.2–0.9)	1.1 (0.5–2.2)
No	384 (24.0)	8.4 (5.5–12.6)	3.1 (1.5–6.3)	0.8 (0.2–3.5)	0.1 (0–0.8)
Sexual identity					
Heterosexual	1510 (94.4)	31.7 (28.7–34.8)	7.8 (6.2–9.7)	0.5 (0.3–1.2)	0.4 (0.1–1.0)
Homo/Bisexual	89 (5.6)	32.4 (20.8–46.6)	11.0 (4.5–24.3)	0.2 (0–1.7)	8.0 (2.9–20.5)
IDU status					
Never IDU	812 (50.8)	1.4 (0.7–3.0)	0.5 (0.1–2.1)	0.8 (0.3–1.9)	0.7 (0.3–2.0)
History of IDU, not past month	488 (30.5)	51.1 (45.4–56.9)	9.1 (6.2–13.2)	0.1 (0–1.0)	0.9 (0.3–3.1)
IDU past month	299 (18.7)	74.5 (68.3–79.8)	23.8 (18.5–30.0)	0.4 (0.1–2.6)	0.9 (0.2–4.7)
History of other HCV risk factors[a]					
Yes	776 (48.5)	48.8 (44.4–53.2)	13.0 (10.3–16.3)	0.10 (0.0–0.2)	0.4 (0.1–1.0)
No	823 (51.5)	12.3 (9.6–15.6)	2.2 (1.3–3.8)	1.1 (0.5–2.3)	1.3 (0.6–3.2)

CI, confidence interval; IDU, injecting drug use. [a]Other potential HCV risk factors included any history of stabbing, fighting, tattooing or piercing (in prison).

Table 1: **Baseline characteristics of participants, and prevalence of HCV, HBV and HIV among participants, by baseline characteristics.**

Factors associated with hepatitis C treatment

Among participants eligible for HCV treatment (n = 318), the proportion who reported having ever received treatment was over 80% in the large majority of sub-groups (Table 4). The likelihood of treatment was higher among the 25–34 years age group (vs. 18–24 years aOR = 2.81, 95% CI: 1.48–5.33), 34–44 years age group (vs. 18–24 years aOR = 3.25, 95% CI: 1.31–8.13), and those previously imprisoned (aOR = 2.67, 95% CI: 1.20–5.93). First Nations status, country of birth and injecting drug use status were not associated with HCV treatment uptake (Table 4).

Among participants eligible for HCV treatment who had a history of injecting drug use (n = 310), treatment uptake showed no significant association with tested variables (Supplementary Table S4).

Discussion

The initial AusHep survey has provided representative estimates of BBV prevalence and engagement with HCV care amongst people in Australian prisons. Although all lower than previous surveillance estimates, the prevalence of chronic HCV was substantially higher than that of HBV and HIV, arguing for continued focus on prison-based scale up of testing and treatment for HCV. The effort to date in supporting prison-based HCV testing and treatment uptake were reflected in the

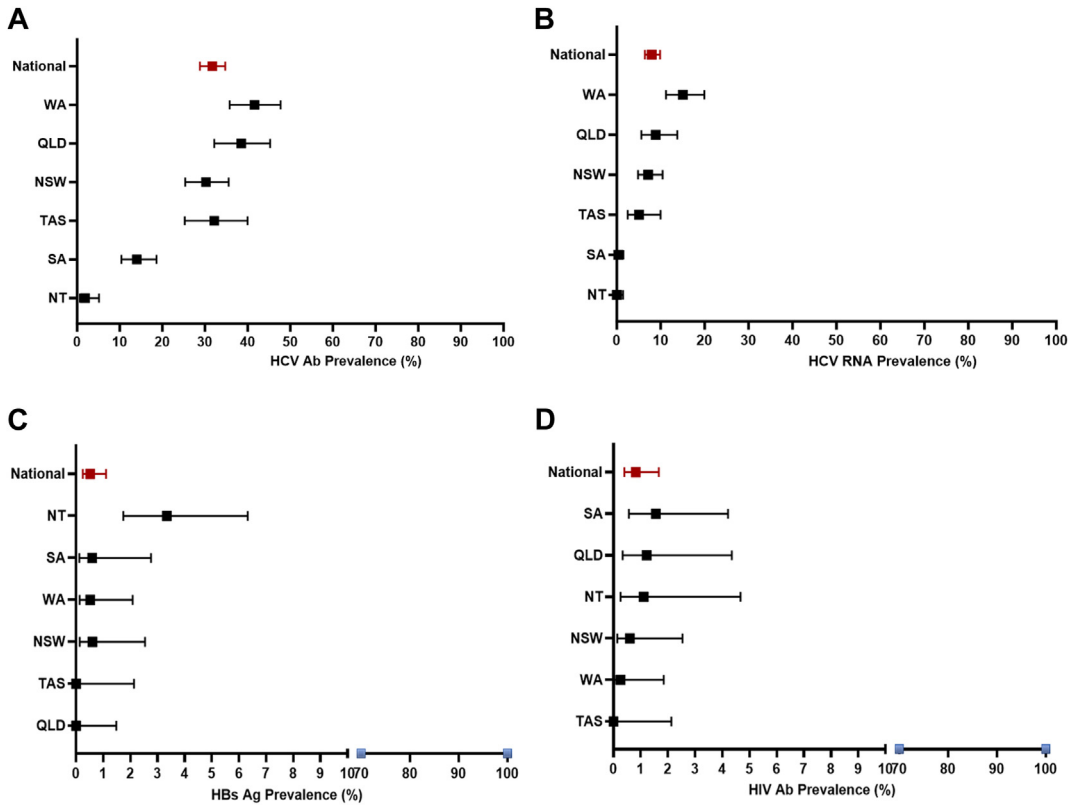

Fig. 1: Prevalence of HCV Ab (A), HCV RNA (B), HBsAg (C), and HIV Ab (D), nationally and by jurisdiction.

findings, although some sub-populations with a substantial HCV burden and lower uptake of testing and treatment were identified. This planned repeated national biobehavioural BBV surveillance in the prison sector is unique internationally, with findings which directly inform national elimination efforts.

The HCV RNA prevalence was 8% overall, but it was markedly higher among those reporting injecting drugs. HCV RNA prevalence was 13% among those with a history of injecting drug use, 17% among those reporting recent injecting, and 28% among those reporting sharing injecting equipment. This is the first national estimate of HCV RNA prevalence indicative of infection among people in prison in Australia, given that the HCV RNA testing was not conducted in the preceding surveillance program (National Prison Entrants Blood Borne Virus survey).[23] Internationally, very few studies provide nationally-representative estimates of HCV prevalence in prisons.[14,24–26] In a recent study from the United States based on an administrative survey of the individual state prison systems, an estimated 8.7% of those in prison, representing over 91,000 incarcerated people, were living with chronic HCV.[14] Unfortunately, the data varied in representativeness in individual states, and no information regarding risk behaviour or treatment uptake rates were available.

In Australia, other jurisdictional prison-based studies, conducted before, or at the beginning of the DAA era, reported an HCV RNA prevalence of 20% among all people in prison,[27,28] and 41% among those with a history of injecting drugs.[27,29] The lower HCV RNA prevalence observed in the current study likely reflects high DAA treatment uptake in Australia - both in the prisons and the community. By the end of 2022, 105,024 individuals had initiated DAA treatment in Australia,[19] of whom 35% initiated treatment in prison in 2022, an increase from 6% in 2016.[9] HCV RNA prevalence also varied across jurisdictions from less than 1%–15%. These findings suggest that tailored strategies are needed for the HCV epidemic in individual jurisdictions and for different at-risk populations to achieve HCV elimination.

The HBV prevalence was 0.5% nationally, with the highest prevalence identified in the Northern Territory (3.3%). Higher HBV prevalence in this jurisdiction is explained by the higher proportion of First Nations people in the prisoner population (87% in 2022) in whom chronic HBV infection remains significantly higher than in the general population.[7] The national prisons HBV prevalence identified in this study was lower than that in 2016 from the National Prison Entrants' Blood Borne Virus Survey of 3%.[23] In the

	HCV RNA positive n/Total n (%)	Unadjusted		Adjusted[b]	
		OR (95% CI)	p	OR (95% CI)	p
Age			0.2854		
18–24 years	11/69 (15.9)	1.00			
25–34 years	43/285 (15.1)	0.94 (0.42–2.11)	0.8748		
35–44 years	27/251 (10.8)	0.64 (0.24–1.70)	0.3677		
45 years and older	19/182 (10.4)	0.61 (0.17–2.17)	0.4496		
Sex					
Male	96/690 (13.9)	1.00		1.00	
Female	4/97 (4.1)	0.27 (0.10–0.69)	0.0065	0.47 (0.19–1.18)	0.1066
Education					
Less than tertiary	91/675 (13.5)	1.00		1.00	
Tertiary	9/112 (8.0)	0.56 (0.26–1.19)	0.1322	0.69 (0.24–1.98)	0.4896
Country of birth					
Australia	99/758 (13.1)	1.00		1.00	
Other countries	1/29 (3.5)	0.24 (0.06–0.89)	0.0324	0.26 (0.04–1.54)	0.1379
First nations identity					
No	41/384 (10.7)	1.00		1.00	
Yes	59/403 (14.6)	1.43 (0.90–2.28)	0.1258	0.90 (0.51–1.60)	0.7296
Previously imprisoned					
No	10/95 (10.5)	1.00			
Yes	90/692 (13.0)	1.27 (0.71–2.27)	0.4176		
Sexual identity					
Heterosexual	93/738 (12.6)	1.00			
Homo/Bisexual	7/49 (14.3)	1.16 (0.37–3.57)	0.8010		
OAT			0.0220		
Current OAT	14/141 (9.9)	1.00		1.00	
Never OAT	58/506 (1.5)	1.17 (0.57–2.44)	0.6660	1.17 (0.57–2.43)	0.5658
Past history of OAT, not current	28/140 (20.0)	2.27 (1.46–3.52)	0.0003	2.27 (1.46–3.52)	0.0003
IDU and sharing needle/syringe			<0.0001		
History of IDU, but not past month	31/488 (6.4)	1.00		1.00	
IDU past month, did not share needle/syringe	6/73 (8.2)	1.32 (0.50–3.48)	0.5749	1.42 (0.49–4.11)	0.5141
IDU past month, shared needle/syringe	63/226 (27.9)	5.70 (3.56–9.11)	<0.0001	4.54 (2.65–7.77)	<0.0001
History of other HCV risk factors[a]					
No	16/270 (5.9)	1.00		1.00	
Yes	84/517 (16.3)	3.08 (1.84–5.14)	0.0001	2.00 (1.12–3.58)	0.0198

OR, odds ratio; CI, confidence interval; IDU, injecting drug use; OAT, opioid antagonist therapy. [a]Other potential HCV risk factors included any history of stabbing, fighting, tattooing or piercing (in prison). [b]Number of participants included in the adjusted model = 787.

Table 2: **Factors associated with HCV infection among participants with a history of injecting drugs.**

National Prison Entrants' Blood Borne Virus Survey, 20% of the total participants who were tested for HBsAg (n = 52/260) were from the Northern Territory prisons, a significantly higher proportion than the 5% in the national prisoner population.[23] Since this study did not weight their HBV prevalence estimate to address prisoner population size in each jurisdiction, their national estimate may have been skewed towards the higher prevalence found in the Northern Territory prisons. To ensure the accuracy of our national estimates, we used weighted estimates that account for both jurisdictional prisoner populations and the distribution of First Nations people among those in prison. This approach provides a more representative national estimate and likely explains the lower HBV prevalence observed in our study compared to the National Prison Entrants' Blood Borne Virus Survey.

The HIV Ab prevalence was estimated at 0.8%. This low prevalence, consistent with other studies,[23,27] is in contrast with relatively high HIV prevalence among people in prison in many other countries.[30] This finding is likely explained by the fact that the HIV epidemic in Australia has been concentrated among men who have sex with men, rather than in people who inject drugs[31] whereas in other countries, injecting drug use is recognised as the primary mode for HIV transmission.[11,32] In this study, the highest HIV prevalence (8.0%) was found amongst participants identifying as homosexual or bisexual.

A high proportion of people who reported ever receiving HCV testing (70%) was observed. Prison-

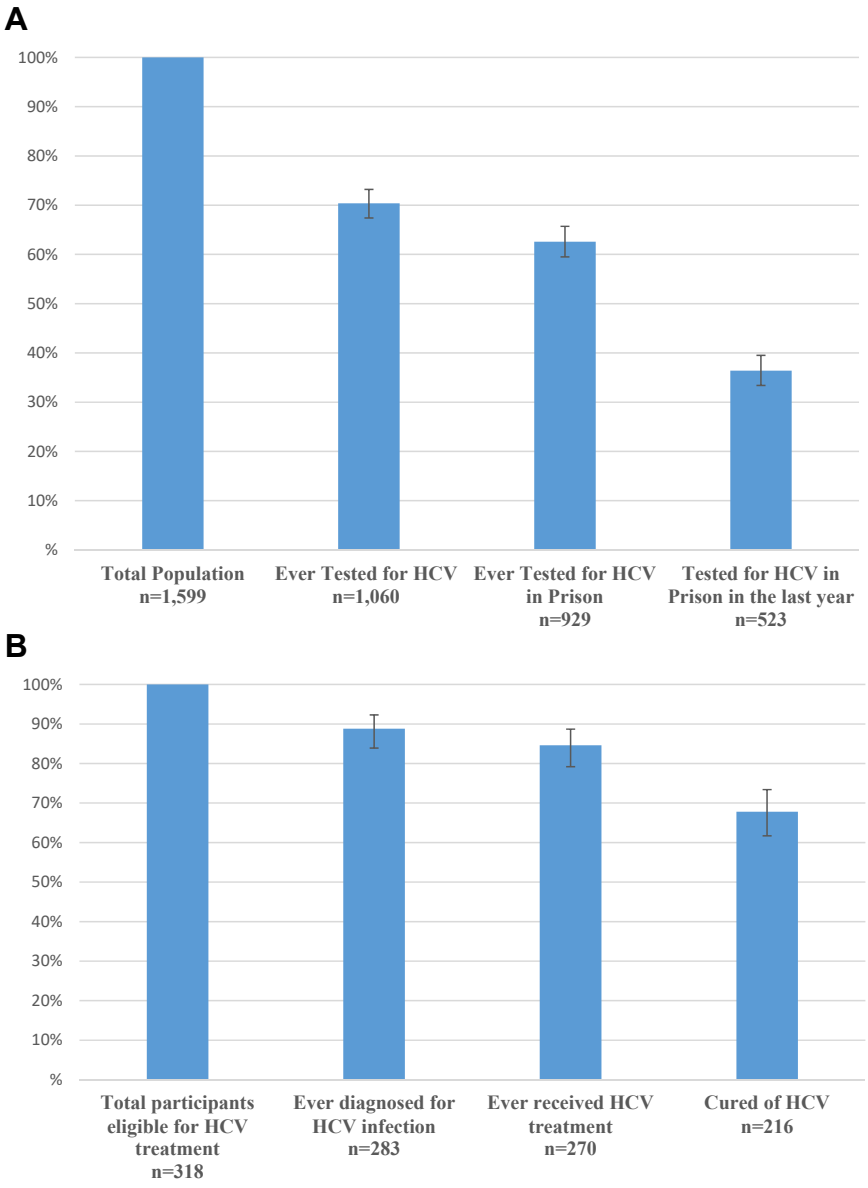

Fig. 2: HCV care cascade among all participants (A) and among those eligible for treatment (B). In Fig. 2A, the denominator for all the columns is the total population; in Fig. 2B, the denominator for all columns are participants eligible for HCV treatment. Error bars represent 95% confidence interval around the estimates. Estimated proportions were weighted by distribution of gender, First nation's identity and jurisdictional prisoner populations, therefore does not necessarily correspond to the numbers reported underneath each column.

based HCV testing uptake was also relatively high, with 63% of participants reporting testing in prison. Despite recommendations from WHO for HCV screening for all prisoners,[6] the uptake of prison-based HCV testing remains suboptimal in most countries. For example, estimates of the proportion of people in prison tested for HCV during imprisonment include those from regional prisons such as 33% in New York city jails,[12] to national estimates of 28% in Hungary,[33] 45% in Georgia,[25] and 47% in England.[34] This suboptimal testing coverage is partly due to lack of prison-specific strategies in many countries. In 2019, only 35% of the countries worldwide who had developed a national hepatitis plan, referenced HCV testing and treatment for people in prison in their national policy documents.[35] In Australia, prison-based HCV screening strategies vary between and within jurisdictions, including three of the six jurisdictions surveyed here, but there is a recent national recommendation to implement universal opt-out HCV screening (i.e., testing offered to all people with the

	Tested for HCV n/Total n (%)	Unadjusted		Adjusted[b]	
		OR (95% CI)	p	OR (95% CI)	p
Age			<0.0001		
18–24 years	76/171 (44.4)	1.00		1.00	
25–34 years	392/572 (68.5)	2.72 (1.85–4.00)	<0.0001	2.98 (1.81–4.92)	<0.0001
35–44 years	338/467 (72.4)	3.28 (2.2–4.79)	<0.0001	3.79 (2.43–5.89)	<0.0001
45 years and older	254/389 (65.3)	2.35 (1.76–3.14)	<0.0001	3.07 (2.06–4.57)	<0.0001
Sex					
Male	930/1418 (65.6)	1.00			
Female	130/181 (71.8)	1.34 (0.81–2.20)	0.2522		
Education					
Less than tertiary	865/1326 (65.2)	1.00			
Tertiary	195/273 (71.4)	1.33 (0.74–2.39)	0.3343		
Country of birth					
Australia	989/1450 (68.2)	1.00		1.00	
Other countries	71/149 (47.7)	0.42 (0.24–0.75)	0.0030	0.82 (0.53–1.27)	0.3793
First Nations Identity					
No	585/823 (71.0)	1.00			
Yes	475/776 (61.2)	0.64 (0.30–1.36)	0.2457		
Security classification					
Sentenced	846/1245 (70.0)	1.00		1.00	
Remand	214/354 (60.5)	0.72 (0.51–1.01)	0.0594	0.81 (0.59–1.11)	0.1905
Duration of current incarceration					
≤ 2 months	148/266 (55.6)	1.00	0.0001	1.00	
> 2 months	912/1333 (68.4)	1.73 (1.32–2.26)		2.05 (1.29–3.26)	0.0022
Previously imprisoned					
No	192/384 (50.0)	1.00		1.00	
Yes	868/1215 (71.4)	2.5 (1.61–3.90)	0.0001	1.32 (0.88–1.98)	0.1760
Sexual identity					
Heterosexual	990/1510 (65.6)	1.00		1.00	
Homosexual/Bisexual	70/89 (78.7)	1.94 (0.98–3.83)	0.0580	1.88 (1.02–3.46)	0.0420
IDU status:			<0.0001		
Never IDU	365/812 (45.0)	1.00		1.00	
History of IDU, not past month	426/488 (87.3)	8.41 (5.56–12.72)	<0.0001	6.18 (3.88–8.87)	<0.0001
IDU past month	269/299 (90.0)	11.00 (6.28–19.19)	<0.0001	10.37 (5.72–18.78)	<0.0001
History of other HCV risk factors[a]					
No	441/832 (53.6)	1.00		1.00	
Yes	619/776 (79.8)	3.42 (2.70–4.31)	<0.0001	2.01 (1.56–2.57)	<0.0001

OR, odds ratio; CI, confidence interval; IDU, injecting drug use. [a]Other HCV risk factors included any history of stabbing, fighting, tattooing or piercing (in prison). [b]Number of participants included in the adjusted model = 1598.

Table 3: **Factors associated with HCV testing among all participants.**

opportunity to decline) for all new prison entrants.[36] This strategy is supported by robust evidence demonstrating that BBV testing uptake will increase significantly if universal opt-out programs are implemented.[37–39] Despite this evidence, risk-based screening, wherein individuals are offered screening based on their higher risk for acquiring an HCV, has been most cost-effective in settings where HCV prevalence is low.[40] Therefore, the testing strategy should be balanced on the overall coverage of testing, and how cost effective it likely will be. Our study also showed that people with a longer duration of incarceration and those with previous imprisonment were more likely to receive HCV testing. Universal HCV screening for all new prison entrants will also provide testing opportunities for those with short stays in prison. Another strategy demonstrated to increase HCV testing uptake is prison-based HCV awareness and screening campaigns through focused and concerted efforts to increase HCV testing and treatment uptake in a short timeframe.[41,42] Simplified testing strategies using finger-stick whole blood samples, such as dried blood spot testing[43–45] and point-of-care testing[46,47] have also been shown to increase uptake of HCV treatment in prisons. In Australia,

	Received HCV treatment Total n (%)	Unadjusted		Adjusted[b]	
		OR (95% CI)	p	OR (95% CI)	p
Age			0.1362		
18–24 years	12/19 (63.2)	1.00		1.00	
25–34 years	103/123 (83.7)	3.00 (1.18–7.64)	0.0210	2.81 (1.48–5.33)	0.0016
35–44 years	80/94 (85.1)	3.33 (1.818–9.39)	0.0227	3.25 (1.31–8.13)	0.0114
45 years and older	75/82 (91.5)	6.25 (0.91–42.96)	0.0624	5.34 (0.95–29.95)	0.0592
Sex					
Male	254/298 (85.2)	1.00			
Female	16/20 (80.0)	0.69 (0.26–1.87)	0.5287		
Education					
Less than tertiary	229/272 (84.2)	1.00			
Tertiary	41/46 (89.1)	1.54 (0.54–4.37)	0.3899		
Country of birth					
Australia	265/311 (85.2)	1.00			
Other countries	5/7 (71.4)	0.43 (0.06–3.33)	0.4217		
First Nations Identity					
No	141/160 (88.1)	1.00		1.00	
Yes	129/158 (81.7)	0.60 (0.28–1.29)	0.1893	0.73 (0.34–1.59)	0.4325
Security classification					
Sentenced	223/253 (88.1)	1.00		1.00	
Remand	47/65 (72.3)	0.35 (0.14–0.87)	0.0241	0.42 (0.15–1.17)	0.0966
Duration of current incarceration (IQR p25, 75: 2.9–23.7)					
≤2 months	33/43 (76.4)	1.00		1.00	
>2 months	237/275 (86.2)	1.89 (0.95–3.76)	0.0695	1.97 (0.96–4.05)	0.0665
Previously imprisoned					
No	21/29 (72.4)	1.00		1.00	
Yes	249/289 (86.2)	2.37 (0.82–6.90)	0.01129	2.67 (1.20–5.93)	0.0158
Sexual identity					
Heterosexual	254/298 (85.2)	1.00			
Homosexual/Bisexual	16/20 (80.0)	0.69 (0.25–1.93)	0.5287		
IDU status			0.1142		
Never IDU	6/8 (75.0)	1.00			
History of IDU, not past month	147/167 (84.0)	2.45 (0.81–7.38)	0.1113	1.97 (0.70–5.56)	0.1986
IDU past month	117/143 (85.3)	1.50 (0.38–5.92)	0.5626	1.83 (0.47–7.13)	0.3865
History of other HCV risk factors[a]					
No	55/67 (82.0)	1.00			
Yes	215/251 (85.7)	1.30 (0.67–2.52)	0.4695		

OR, odds ratio; CI, confidence interval; IDU, injecting drug use. [a]Other HCV risk factors included any history of stabbing, fighting, tattooing or piercing (in prison). [b]Number of participants included in the adjusted model = 318.

Table 4: **Factors associated with a history of HCV treatment amongst those eligible for treatment.**

HCV testing scale-up through a national HCV point-of-care testing program (including through high-intensity testing campaigns) has led to high prison-based HCV treatment uptake of those tested (86%). Despite the high overall uptake of HCV testing in the current study among participants with a history of injecting drug use, sub-populations with a lower likelihood of testing, such as First Nations people and those born oversees were identified. Targeted interventions, such as culturally adapted education and awareness programs, peer programs[44] are likely to be required to consistently increase testing uptake across all sub-populations.

Among people eligible for HCV treatment, 85% had ever received treatment, while 75% received treatment while they were in prison. Although the WHO recommends treating all individuals with chronic HCV, there is no target for the prison sector,[48] or an available global estimate of HCV treatment uptake among people in prison, it was estimated that across countries between 2% and 89% of people who inject drugs with HCV had ever received treatment, with treatment uptake being less than 25% in most countries.[49] HCV treatment uptake among people in prison is expected to be low in many countries, particularly in countries with no or

limited access to prison-based treatment services.[35] Another barrier to treatment uptake in many prison settings includes complex care pathways from HCV testing to initiating treatment which require several pre-treatment blood tests and clinical assessments. Due to this lengthy process, several people may miss out on treatment opportunity given the typical short-stay in prison.[12,50] There are also policies in some settings which restrict access to treatment, by limiting treatment eligibility to those with long sentences.[25] Point-of-care HCV testing followed by fast-tracked treatment initiation, has been demonstrated as an effective approach to increase treatment uptake.[38,46]

Among those who reported receiving HCV treatment, 20% still had detectable HCV RNA (due to treatment failure or post-treatment reinfection) and required re-treatment. Studies from Australia and other countries with suboptimal harm reduction coverage in prisons have identified high rates of HCV reinfection among people in prison.[51–54] Although treatment scale-up in the prison will decrease HCV transmissions, including the reinfection rate,[27] regular post-treatment surveillance is recommended in the prison setting, for early detection and re-treatment of HCV reinfection cases. Further, high coverage OAT and needle and syringe programs are key interventions shown to prevent HCV transmissions in the community and should be similarly deployed in the prisons.[55,56]

This study had several limitations. The HCV care cascade estimates were based on self-reported data on HCV testing and treatment. Recall bias and limited health literacy of some participants may impact the accuracy of this self-reported data. To minimise this bias, questionnaires were completed through interviews with trained nurses as opposed to being self-administered, enabling study nurses to clarify questions for participants with low heath literacy. Self-reported data was also verified by data from health records in 11 prisons, with good consistency observed. Social desirability bias may have also impacted on the accuracy of self-reported data collected from participants, as the research nurses conducted face-to-face interviews with participants. To minimise this bias, the study team ensured privacy and confidentiality of all participants, and were diligent to ensure that data collection was done without other correctional staff or other inmates listening. Given the cross-sectional study design, this study may have also been subject to incidence-prevalence bias and unmeasured confounding. Limited data are available on sensitivity of point-of-care HCV Ab tests in the DAA era when HCV RNA prevalence is low. Lower sensitivity of point-of-care HCV Ab tests in people with negative HCV RNA could result in underestimation of HCV Ab prevalence. HCV RNA was only measured in participants who had a HCV positive Ab test result. As such, some individuals at the very early stages of acute HCV primary infection (before development of detectable HCV Ab in serum) might have been missed in this study. To address this limitation in the next rounds of the study, the methodology can be revised to perform HCV RNA on all those who report recent risk factors to acquiring HCV (e.g., those reporting sharing injecting equipment). Two of eight Australian jurisdictions (housing 17% of the Australian prisoner population) did not participate in this round of AusHep due to logistical or governance issues. Although this may have impacted the representativeness of the findings, it is reasonable to assume minimal impact from these missing jurisdictions given comparable age and gender distribution of the AusHep study population with the Australian prisoner population in 2022.[7] Lastly, given the cross-sectional study design, the models were not able to evaluate causation or risk prediction. Each model output should be interpreted as a measure of "association" between the outcome and study variables.

The AusHep study has identified lower BBV prevalence rates than those previously reported, but a substantial residual prevalence of chronic HCV remains. The study has also revealed remarkably high levels of engagement in the HCV care cascade, much of which is occurring in the prisons. Further efforts are needed to reduce the burden of HCV disease by enhancing testing and treatment uptake particularly amongst sub-populations including First Nations people, those born oversees, and those on remand. These findings should guide prison-based BBV prevention and treatment programs in Australia to underpin national elimination efforts, and also potentially serve as a model for prison-based BBV surveillance worldwide.

Contributors

RB, BH, ARL and YS conceived and designed the study, with inputs from GJD and JG. RB, BH, ARL, YS, and XL contributed to study implementation, with RB conducting participant enrolment, blood tests, and data collection. RB analysed the data under supervision of BH. RB, BH, YS, GJD and ARL interpreted the findings. RB drafted the initial version of the manuscript, with substantial contribution from BH and ARL. All other authors critically assessed the manuscript and contributed to revisions.

Data sharing statement

Individual participant data that underlie the results reported in this Article, and a data dictionary, will be available, after de-identification (text, tables, figures, and appendices), beginning 9 months and ending 36 months following publication of the Article. Data requests, including a methodologically sound proposal, may be submitted to the Kirby Institute. The study group will review data request applications. Following approval, data will be shared to achieve the aims in the approved proposal. Data requesters will need to sign a data access agreement before having access to the data.

For data requests, please contact recpt@kirby.unsw.edu.au.

Declaration of interests

ARL is a consultant/adviser and has received investigator-initiated research grants from Gilead, AbbVie, Bristol-Myers Squibb, and Sequiris. GJD is a consultant or adviser for, and has received research grants from, AbbVie, Abbot Diagnostics, Gilead Sciences, Bristol Myers Squibb, Cepheid, GlaxoSmithKline, Merck, Janssen, and Roche. JG is a consultant or adviser for, and has received research grants from AbbVie,

bioLytical, Camurus, Cepheid, Gilead Sciences, Hologic, and Indivor, and has received honoraria from AbbVie, Abbott, Cepheid, Gilead, and Roche. Other co-authors had none to declare. BH, GJD and JG are supported by NHMRC Investigator Grants. ARL is supported by an NHMRC Practitioner Fellowship. RB is supported by the Australian Government Research Training Program.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.lanwpc.2024.101240.

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