WHO Collaborating Centre for Viral Hepatitis
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Doherty Institute

SURVEILLANCE FOR HEPATITIS B INDICATORS
NATIONAL REPORT 2022

Tracking Australia's progress towards hepatitis B elimination

WHO Collaborating Centre for Viral Hepatitis
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ABBREVIATIONS

ABS	Australian Bureau of Statistics
ACT	Australian Capital Territory
CHB	Chronic hepatitis B
COVID-19	Coronavirus disease 2019
DC	Decompensated cirrhosis
DSS	Department of Social Services
FoI	Force of infection
GHSS	Global Health Sector Strategy
HCC	Hepatocellular carcinoma
National Strategy	Australia's 3rd National Hepatitis B Strategy 2018 - 2022
NNDSS	National Notifiable Diseases Surveillance
NOM	Net overseas migration
NSW	New South Wales
NT	Northern Territory
PBS	Pharmaceutical Benefits Scheme
PR	Plausible range
QLD	Queensland
SA	South Australia
TAS	Tasmania
VIC	Victoria
WA	Western Australia
WHO	World Health Organization

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EXECUTIVE SUMMARY

CHRONIC HEPATITIS B PREVALENCE

- In 2022, an estimated 205,549 people were living with chronic hepatitis B (CHB) in Australia, representing 0.78% of the population.
- Substantial changes to the number of people migrating into and out of Australia will have an impact on the future number of people living with CHB. Due to the unpredictability of migration patterns, modelled projection estimates will be updated as new information becomes available.

CHRONIC HEPATITIS B DIAGNOSIS

- An estimated 148,159 (72.1%) people living with CHB in 2022 had ever been diagnosed.
- Australia did not reach the National Strategy 2022 diagnosis target of 80%, with 16,280 more people living with CHB who required diagnosis to reach this target.
- At the current rate of progress, Australia will not reach the 2022 diagnosis target until 2037.
- It is estimated than in Australia the WHO 2025 target of diagnosing 60% of people living with CHB was already met prior to 2000, however at the current rate of progress the WHO 2030 target of 90% will not be met until after 2050.

CHRONIC HEPATITIS B ENGAGEMENT IN CARE

- During 2022, 52,515 (25.5%) people were engaged in care for their CHB, receiving either antiviral treatment or the recommended annual viral load test.
- Australia did not reach the 2022 National Strategy target of 50% in care, with 50,260 more people required to be in care to reach this target.
- At the current rate of progress, Australia will not reach the 2022 National Strategy target of 50% in care until 2047.

CHRONIC HEPATITIS B TREATMENT

- In 2022, 26,504 (12.9%) people were dispensed drugs for the treatment of hepatitis B through the Pharmaceutical Benefits Scheme.
- In 2022, 29.4% of people living with CHB in Australia were estimated to be eligible for treatment.
- Australia did not reach the 2022 National Strategy target of 20% of all people living with CHB receiving treatment, with 14,606 more people requiring treatment to reach this target.
- At the current rate of progress, Australia will not reach the 2022 National Strategy treatment target of 20% until 2036.
- It is estimated that in Australia the WHO 2025 target of treating 50% of eligible people who have been diagnosed with CHB was already met in 2018, however will not reach the WHO 2030 treatment target of 80% until 2034.

DEATHS ATTRIBUABLE TO CHRONIC HEPATITIS B

- The modelled number of deaths attributable to CHB in 2022 was 466, which equates to a mortality rate of 1.77 deaths per 100,000 total population. Of these deaths 391 were attributable to hepatocellular carcinoma (HCC) while 75 were due to decompensated cirrhosis (DC).

- Between 2017 and 2022, there has been a 6.9% increase in deaths attributable to CHB nationally.
- The National Strategy target of a 30% reduction in attributable deaths by 2022 (when compared to the end of 2017) was not reached. Given an ageing population, substantial increases in future treatment uptake are needed to further reduce mortality.
- To reach this target, the total number of CHB attributable deaths would have needed to fall to 306 deaths in 2022.
- As a low prevalence country, Australia's current CHB attributable mortality is already well below the WHO GHSS target rates of 7 per 100,000 by 2025 and 4 per 100,000 by 2030.

JURISDICTIONAL DISPARITIES

- Substantial differences in estimated prevalence, access to care and burden of disease were noted between states and territories in 2026:
    - Prevalence of CHB ranged from 0.28% (TAS) to 1.72% (NT).
    - The proportion diagnosed ranged from 56.4% (WA) to 83.9% (NSW).
    - The proportion in care ranged from 12.8% (WA) to 30.7% (ACT)
    - The proportion of all those living with CHB receiving antiviral treatment ranged from 8.7% (WA) to 15.8% (ACT).

INTRODUCTION

In Australia approximately 0.8% of the population is living with chronic hepatitis B (CHB) [1-3], with people born overseas and Aboriginal and Torres Strait Islander peoples representing three quarters of those affected[4]. CHB is a significant public health problem and is now the most prevalent blood-borne viral infection in Australia[4,5]. CHB is a leading cause of liver cancer, the 6th most common cause of cancer mortality in Australia[6]. Substantial improvements in access to appropriate care, monitoring and treatment are required to address hepatitis B-related mortality nationally.

Australia's National Hepatitis B Strategies have been fundamental in guiding the response to hepatitis B since 2010, with modest progress occurring over this period. The 3rd National Hepatitis B Strategy 2018 - 2022[7] (National Strategy), released in 2018, set goals to make significant progress towards eliminating hepatitis B as a public health threat, including reducing the burden of disease and eliminating the negative impact of stigma, discrimination, and legal and human rights issues on people's health. The National Strategy highlights priority areas and populations, and outlines targets to measure progress throughout the span of the strategy. A new strategy for the period 2023-2030 is in the process of being finalised.

The targets under the current National Strategy reported in this analysis are listed in Table 1 below, which includes cascade of care indicators.

Table 1. Australia's National Hepatitis B Strategy 2022 targets.

Targets addressed in this report	2022 targets
People living with chronic hepatitis B who are diagnosed	80%
People living with chronic hepatitis B receiving care	50%
People living with chronic hepatitis B receiving antiviral treatment	20%
Hepatitis B attributable mortality	30% reduction*
Targets not addressed in this report	
Hepatitis B childhood vaccination coverage	95%
Newly acquired hepatitis B infections across all age groups	50% reduction*
Experience of stigma among people living with hepatitis B	Reduce

**From 2017*

Measuring the progress towards the targets of the National Strategy will allow current gaps to be identified, and priority areas to be highlighted to help shape the public health and policy response to hepatitis B in Australia.

Australia has also endorsed the World Health Organization (WHO) Global Health Sector Strategy (GHSS) on Viral Hepatitis for the period 2022 – 2030[8], which calls for the elimination of hepatitis B as a public health threat by 2030. The indicators and targets included in this strategy span impact, programmatic coverage, and policy milestones. This report will only cover a select number of indicators that are generated through our model. The WHO GHSS includes 2025 targets as a roadmap to achieving the 2030 targets, and updated treatment and mortality targets for 2030, compared to the previous 2016 – 2021 Strategy[9]. The updated treatment target has changed to require reporting of treatment uptake as the proportion of people living with CHB on treatment who are eligible *and* diagnosed; this is compared to the previous target which referred only to eligibility status, not diagnosis. Due to uncertainties in the proportion diagnosed, proportion eligible

for treatment and unknown differences between populations that have and have not been diagnosed, estimates for this target may not be reliable. The targets included in this report are listed in Table 2 below.

Table 2. **The WHO Global Health Sector Strategy on Viral Hepatitis B targets (2022-2030)**

Targets addressed in this report	2025 target	2030 targets
Hepatitis B prevalence amongst children 0-4 years old	0.5%	0.1%
People living with chronic hepatitis B who are diagnosed	60%	90%
People living with chronic hepatitis B diagnosed and eligible for antiviral treatment who are receiving treatment	50%	80%
Hepatitis B attributable mortality	7 deaths per 100 000	4 deaths per 100 000

REPORT BACKGROUND AND UPDATES

This report summarises work undertaken by the WHO Collaborating Centre for Viral Hepatitis at the Doherty Institute on the Surveillance for Hepatitis B Indicators Project funded by the Australian Government Department of Health and Aged Care. The objective of this project is to develop disease burden estimation and mathematical modelling approaches to inform the surveillance, monitoring, and evaluation of progress towards achieving the objectives of the 3rd National Hepatitis B Strategy 2018 - 2022 and reporting against Hepatitis B Indicators in the National Blood-Borne Viruses and Sexually Transmissible Infections Surveillance and Monitoring Plan 2018 - 2022. This report will not assess vaccination, reduction in local transmission or stigma targets specifically. Further reporting against these indicators can be found in the National Viral Hepatitis Mapping Reports[4], the Kirby Institute's Annual Surveillance Reports[10], and the Centre for Social Research in Health Stigma Indicators Monitoring Project Reports[11].

This report for the year 2022 is the sixth publicly available National Surveillance for Hepatitis B Indicators Annual Report. All reports can be accessed here. An online portal is now available to further explore data and provides interactive visualisations of hepatitis B modelled phase distribution, cascade of care uptake and burden of disease estimation across Australia and jurisdictions. The online portal can be accessed at:
https://www.doherty.edu.au/viralhepatitis/centre-activities/powerbi-whoccvh

Estimates included in this report are derived using a mathematical model for the natural history of hepatitis B in Australia, which extends on previous work[2,3,12,13]. The model accounts for diversity in prevalence and impact of overseas migration, incorporating detailed disease phase dynamics, and examining the impact of domestic and overseas vaccination programs, together with the impact of antiviral treatment on mortality attributable to CHB at a population level. Further information regarding the model can be found in the associated peer-reviewed publication[2].

To ensure estimates most accurately reflect the current epidemiology and clinical pattern of CHB in Australia, data inputs and assumptions are updated annually to incorporate new information. For this reason, historical indicator estimates provided in this report will differ from previous outputs reported in the Kirby Institute's Annual Surveillance Reports,[10] the Doherty Institute's National Viral Hepatitis Mapping Project Reports[4,5,14], and the National Surveillance for Hepatitis B Indicators: Annual Report[15-18].

Improvements have been made to the model since 2021 estimates were reported. These include:

- Methodological updates have been implemented in the model, incorporating diagnosis through the addition of nine new health states (Please refer to Figure A2 for a schematic diagram of the mathematical model). Calibration was performed to align the model and the newly implemented health states with hepatitis B notifications from the National Notifiable Diseases Surveillance System. Subsequently, the model directly estimates the annual number of diagnosed individuals living with CHB. The calculation for the proportion of people living with CHB who have been diagnosed is now calculated differently, using the yearly number of diagnosed individuals with CHB as the numerator and the total yearly number of people living with CHB as the denominator.

- The model's projected estimates for future Net Overseas Migration have been revised using the most recent population projections from the ABS[19], which more accurately reflect

recent trends. In previous reports, projections from Wilson et al[20] were used, which underestimated the record high Net Overseas Migration that was experienced in 2022. This means the estimated future number of people living with CHB has increased in the current report, which has a flow on effect when projecting against future targets.

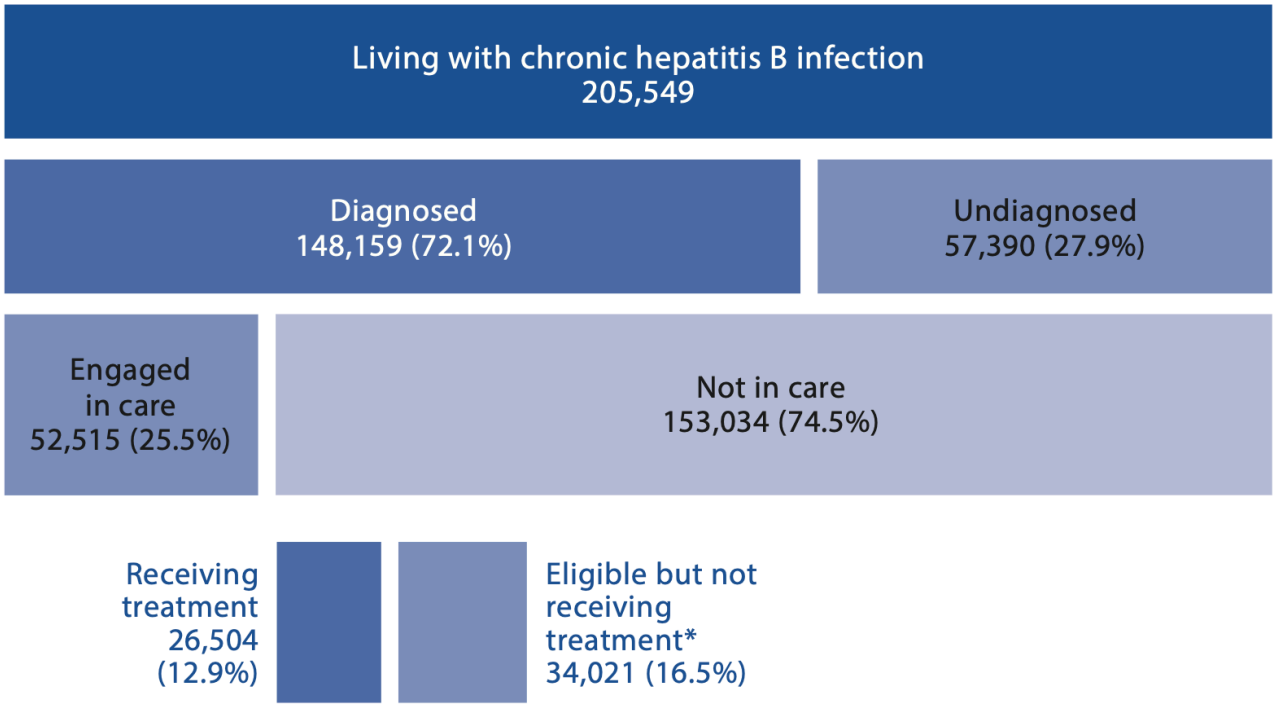
SUMMARY OF ESTIMATES

Table 3. Summary of hepatitis B indicator estimates, 2022.

State/ Territory	People living with CHB	Diagnosed (%)	In care* (%)	Treatment uptake (%)	Total deaths attributable to CHB	HCC deaths attributable to CHB	DC deaths attributable to CHB
ACT	2,927	69.6%	30.7%	15.8%	<10	<10	<10
NSW	73,671	83.9%	30.6%	15.4%	163	141	21
NT	4,360	71.9%	23.1%	11.2%	11	<10	<10
QLD	32,744	68.0%	20.1%	9.8%	71	59	12
SA	10,513	69.2%	17.0%	11.1%	22	18	<10
TAS	1,621	63.6%	17.0%	9.4%	<10	<10	<10
VIC	58,268	66.1%	28.6%	13.5%	138	115	23
WA	21,445	56.4%	12.8%	8.7%	51	41	10
Australia	205,549	72.1%	25.5%	12.9%	466	391	75

Note: Jurisdictional estimates were standardised to ensure the sum of jurisdictional data aligns with the modelled national estimate. Estimates less than 10 have been suppressed due to difficulties in ensuring accuracy in small numbers.
HCC: Hepatocellular carcinoma, DC: Decompensated cirrhosis
** In care represents those on treatment or monitoring (viral load while not receiving treatment)*

Figure 1. Chronic hepatitis B cascade of care, Australia, 2022.



Data source: CHB prevalence estimates based on mathematical modelling incorporating population-specific prevalence and ABS population data. Proportion diagnosed estimated using modelling combined with notifications data. Treatment and monitoring (viral load test while not receiving treatment) data sourced from Medicare statistics.

To explore data further, visit the online portal, which provides interactive visualisations of these outputs.

SUMMARY PROGRESS TOWARDS NATIONAL CASCADE OF CARE TARGETS

Despite the continued increases in the number of people diagnosed with chronic hepatitis B and receiving antiviral treatment, Australia has not reached the 2022 targets contained in the current National Strategy, as shown in Table 4 below.

Table 4. Heat map of progress towards National Hepatitis B Strategy 2018 – 2022 targets

Progress towards National Hepatitis B Strategy 2018 - 2022 targets				
Year	**Diagnosis**	**Care**	**Treatment**	**Mortality**
	Proportion of people with CHB diagnosed	**Proportion of people with CHB who received treatment or monitoring**	**Proportion of people with CHB who received treatment**	**Percentage change of CHB attributable mortality from 2017**
	2022 Target - 80%	2022 Target - 50%	2022 Target - 20%	2022 Target - 30% reduction
2017	67.8%	24.2%	9.9%	-
2018	68.0%	25.0%	10.6%	0.9%
2019	68.1%	25.3%	11.1%	2.3%
2020	70.2%	24.9%	11.8%	4.1%
2021	72.7%	26.0%	12.7%	6.2%
2022	**72.1%**	**25.5%**	**12.9%**	**6.9%**
2023	70.2%	25.7%	13.6%	7.6%
2024	69.1%	26.2%	14.0%	8.7%
2025	68.7%	26.7%	14.5%	10.3%
2026	68.8%	27.4%	15.1%	12.2%
2027	69.1%	28.0%	15.6%	14.0%
2028	69.8%	28.7%	16.2%	16.1%
2029	70.6%	29.5%	16.8%	18.1%
2030	71.7%	30.4%	17.3%	20.2%
2031	72.9%	31.2%	17.9%	22.0%
2032	74.2%	32.2%	18.4%	24.1%
2033	75.5%	33.2%	18.9%	25.7%
2034	76.8%	34.2%	19.4%	27.5%
2035	78.1%	35.2%	19.8%	29.1%
Projected year to reach 2022 target	2037	2047	2036	>2050

Key: Colour gradient represents progress towards reaching the target. Green = target achieved, Red = substantial progress still required to meet target.

SUMMARY PROGRESS TOWARDS GLOBAL HEALTH SECTOR STRATEGY TARGETS

Australia has already met or is on track to meet the WHO GHSS 2025 targets. Australia already met the 2025 target of diagnosing 60% of people living with CHB prior to 2000 and the target of treating 50% of eligible people diagnosed with CHB in 2018, noting there are many uncertainties in the estimation of this latter indicator. Additionally, the current CHB attributable mortality is already well below the target rates of 7 per 100,000 by 2025 and 4 per 100,000 by 2030. However, Australia is not currently on track to reach the WHO GHSS 2030 diagnosis and treatment targets, as shown in Table 5 below.

Table 5. Heat map of progress towards WHO GHSS on Viral Hepatitis 2030 targets

Year	Prevalence	Diagnosis	Treatment	Mortality
	CHB prevalance among children 0-4 years old	Proportion of people with CHB diagnosed	Proportion of people diagnosed and eligible for CHB treatment who are receiving treatment	CHB attributable mortality rate (deaths per 100,000)[2]
	2030 target - 0.1%	2030 target - 90%	2030 target - 80%	2030 target - 4 per 100,000
2017	0.06%	67.8%	47.4%	1.76
2018	0.06%	68.0%	50.3%	1.75
2019	0.06%	68.1%	52.8%	1.75
2020	0.05%	70.2%	53.9%	1.77
2021	0.08%	72.7%	55.7%	1.80
2022	0.09%	72.1%	56.8%	1.77
2023	0.10%	70.2%	60.9%	1.76
2024	0.10%	69.1%	63.3%	1.75
2025	0.10%	68.7%	65.7%	1.75
2026	0.10%	68.8%	68.1%	1.76
2027	0.10%	69.1%	70.2%	1.76
2028	0.10%	69.8%	72.2%	1.77
2029	0.10%	70.6%	74.0%	1.78
2030	0.09%	**71.7%**	**75.6%**	**1.78**
2031	0.09%	72.9%	77.1%	1.79
2032	0.09%	74.2%	78.3%	1.79
2033	0.09%	75.5%	79.4%	1.79
2034	0.08%	76.8%	80.3%	1.79
2035	0.08%	78.1%	81.1%	1.79
Projected year to reach 2030 target	Achieved	>2050	2034	Achieved

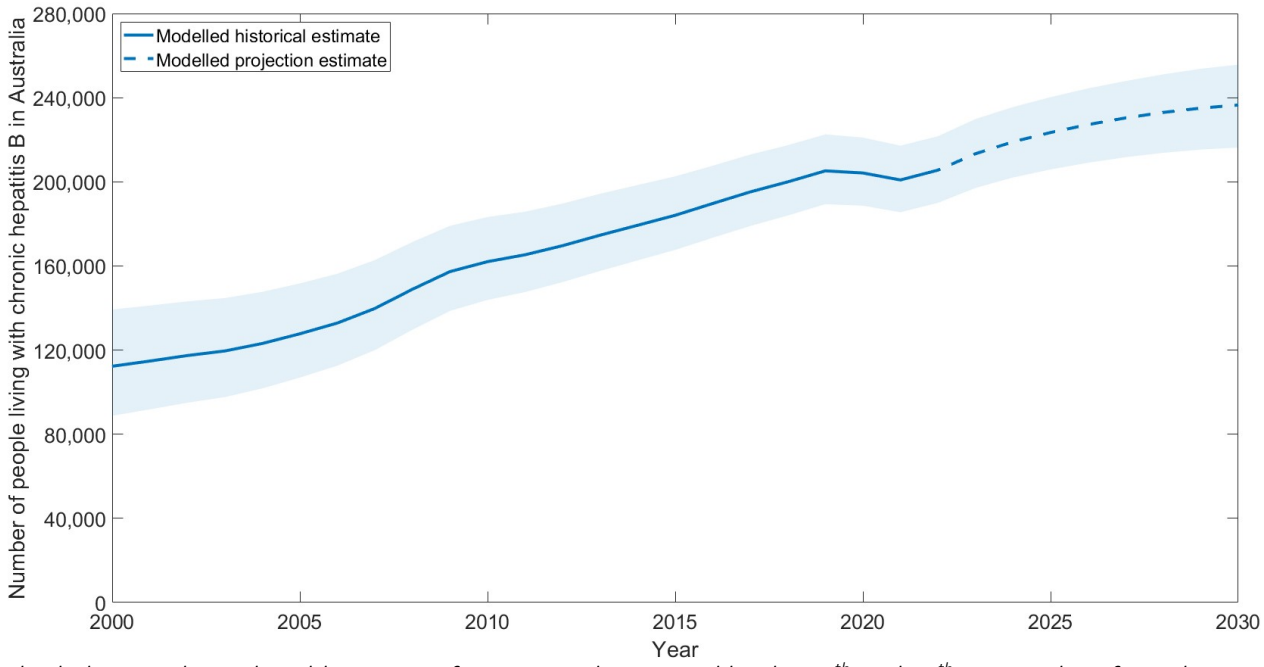
Key: Colour gradient represents progress towards reaching the target. Green = target achieved, Red = substantial progress still re quired to meet target.

CHRONIC HEPATITIS B PREVALENCE

NATIONAL ESTIMATES

During 2022, an estimated 205,549 (plausible range (PR) 189,997 to 221,653, see Methodological Notes) people were living with CHB in Australia, representing 0.78% of the population. Modelled estimates show that the number of people living with CHB has increased over time in Australia, with an additional 93,238 people living with CHB in 2022 when compared to 2000 (Figure 2, Appendix Table A1). Due to the impacts of COVID-19 on migration, in 2020 and 2021 the estimated number of people living with CHB decreased for the first time since 1994. In 2022, there were record high migrant arrivals with an increase in Net Overseas Migration of 5,400% compared to 2021 (386,600 in 2022 vs 7,000 in 2021). This resulted in increases in the estimated number of people living with CHB in 2022.

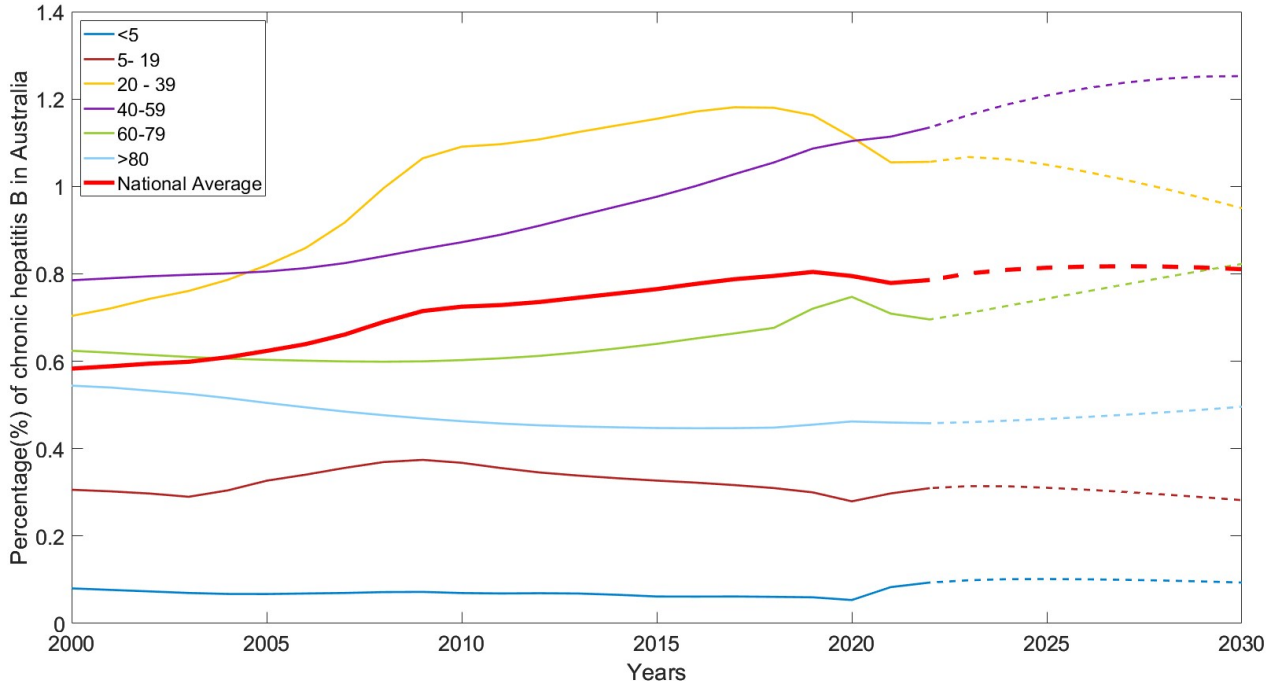
Figure 2. Estimated number of people living with chronic hepatitis B in Australia, 2000 – 2030.



Shaded areas show plausible ranges of estimates determined by the 10th and 90th percentiles of simulations. Refer to Appendix Table A1

The estimated prevalence of CHB has increased substantially over time, from 0.60% in 1970 to 0.78% in 2022, and this trend varies according to age group (Figure 3). Most people living with CHB in Australia were born overseas and acquired hepatitis B in childhood prior to migration, and therefore changes in total numbers, countries of origin, and age distributions of Australia's migrant population (such as occurred during the COVID-19 pandemic) will affect the estimates of hepatitis B in Australia. The decreasing trends observed from 1991 in the under 5-year age group, and from 2009 in the 5 – 19 years age group, highlight the impact of childhood hepatitis B vaccination programs both domestically and internationally. Minor increases in prevalence amongst these younger age groups can be seen in 2021 and 2022, due to increases in migration of those aged 0-4 years. Australia has already achieved the WHO GHSS target of <0.1% chronic hepatitis B prevalence in children aged under 5 years by 2030, with a current prevalence of 0.09%. Detailed information on the epidemiology of CHB in Australia according to priority groups can be found in the Viral Hepatitis Mapping Project: Hepatitis B National Report 2022[4,5,21].

Figure 3. Estimated prevalence of chronic hepatitis B in Australia by age group, 2000 – 2030.



Dotted lines represent modelled projection estimates.

During 2022, the distribution of people living with CHB (without cirrhosis) in each phase of chronic infection was estimated to be:

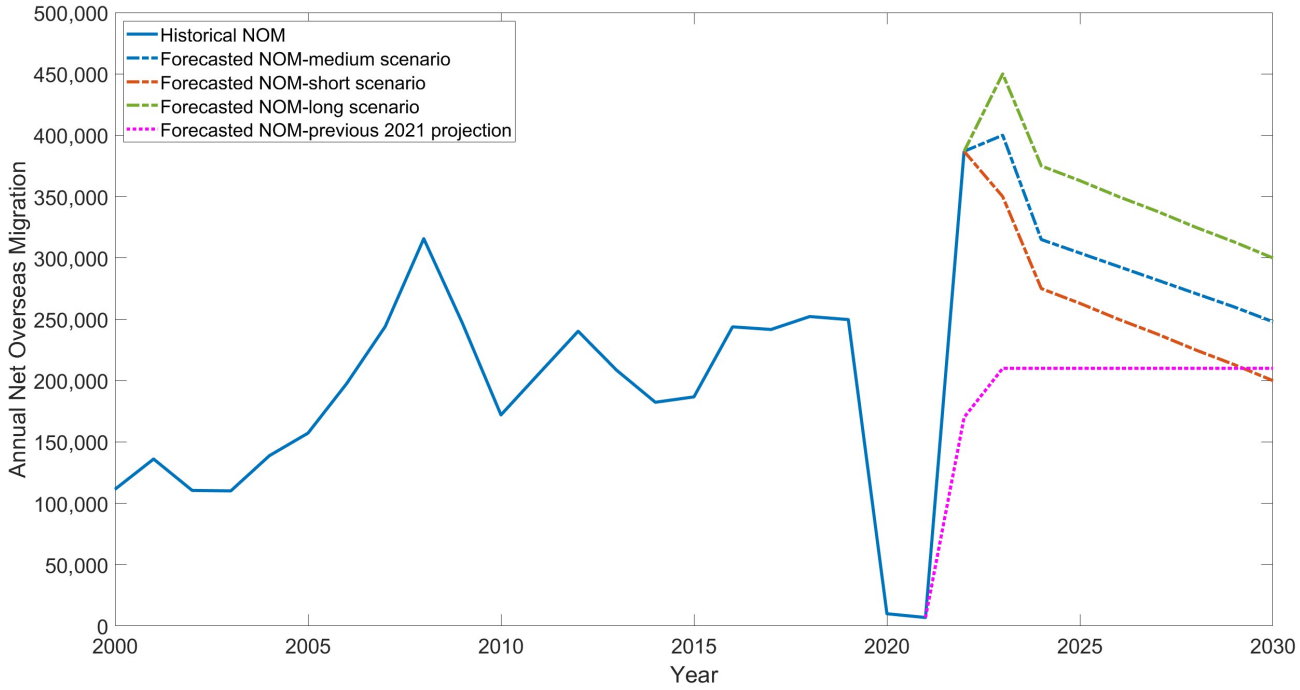
- 24.5% in immune tolerance (HBeAg-positive chronic hepatitis B infection)
- 5.7% in immune clearance (HBeAg-positive chronic hepatitis)
- 46.1% in immune control (HBeAg-negative chronic hepatitis B infection), and
- 17.5% in immune escape phase (HBeAg-negative chronic hepatitis).

In addition, an estimated 5.2% of people living with CHB had cirrhosis and 1.0% had advanced liver disease (HCC and DC). The proportion of people living with CHB in each phase varies by age group (Appendix Figure A1) and has remained stable for several years. These estimates have implications for public health messaging and policy around CHB management and treatment eligibility to prevent liver disease and the importance of engaging priority populations, allowing prioritisation of those at greatest risk of disease progression and less likely to be engaged with the health sector.

Uncertainty in estimated future number of people living with CHB in Australia due to impacts of migration

Changing patterns of migration to Australia, and the impact of infant hepatitis B vaccination programs in countries with high prevalence of CHB, have a significant impact on projections of the number of people living with CHB in Australia. These future migration patterns are dependent on various factors including local and international economic conditions, government policy, and other emerging factors. In our 2020 and 2021 reports we explored the effect of changes in migration numbers due to COVID-19 on the future projected number of people living with CHB by investigating different possible scenarios of future net overseas migration[20]. In 2022, migration numbers exceeded previous estimates made, affecting future estimates of the number of people living with CHB compared to previous reporting. Future projections have been updated and are based on the latest release of ABS net overseas migration projections, moderate scenario[19].

Figure 4. Historical and projected national net overseas migration (NOM) numbers 2000 – 2030

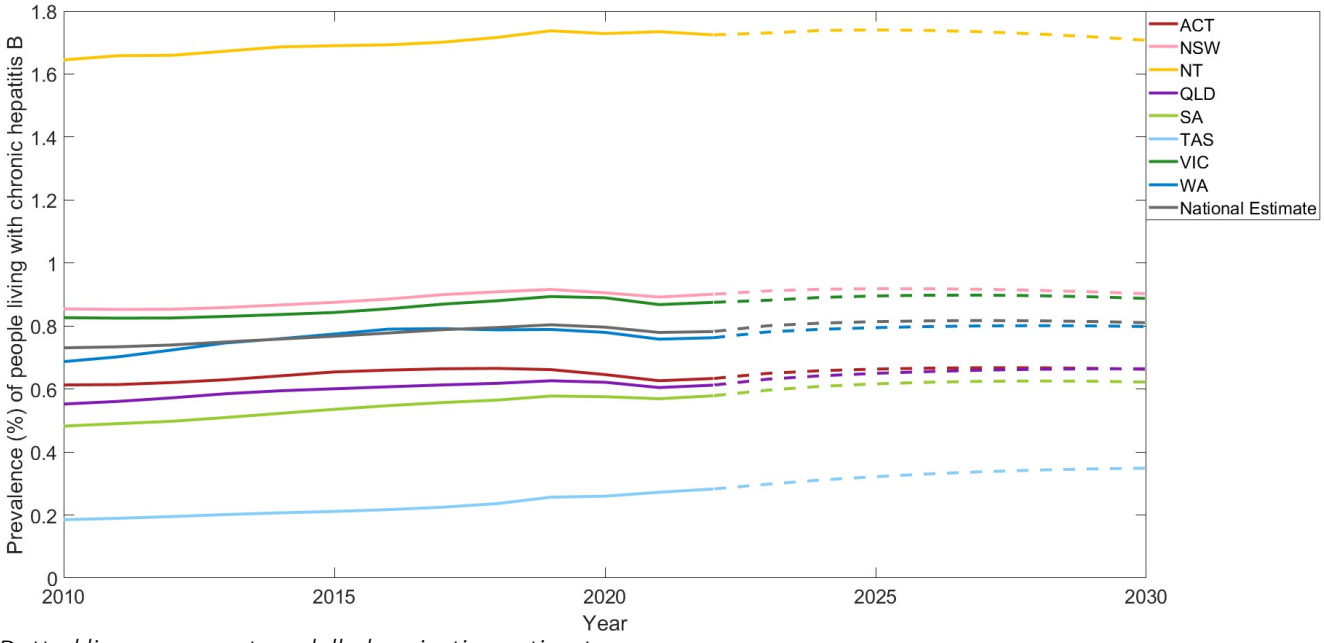


STATE AND TERRITORY ESTIMATES

Modelled estimates show that the number of people living with CHB has generally increased over time in all jurisdictions. Due to the impact of COVID-19 on migration, the number of people living with CHB slightly declined from 2020 in ACT, NSW and VIC and from 2021 in QLD, SA and WA (Appendix Table A1). However, the number of people living with CHB increased again across all jurisdictions in 2022.

CHB prevalence varies across state and territories due to differing population demographics, with the highest jurisdictional prevalence in 2022 estimated in NT (1.72%), and the lowest in TAS (0.28%). Among other jurisdictions, prevalence estimates for NSW (0.90%) and VIC (0.88%) were above the national average (0.78%), and WA (0.76%), ACT (0.63%), QLD (0.61%) and SA (0.58%) were below (Table 6, Figure 5). Future projections show varying trends in CHB prevalence across jurisdictions. It is estimated that by 2030 the largest increases will be seen in TAS (23.41% increase), QLD (8.5% increase) and SA (7.53% increase). Moderate increases will be seen in WA (4.67% increase) and ACT (4.62% increase), smaller increases in VIC (1.41% increase) and NSW (0.19% increase), with a decrease seen in only NT (0.99% decrease). This may be partly attributable to epidemiological differences (including the relative proportion of Aboriginal or Torres Strait Islander people living with CHB) and the differences in historic and projected migration patterns over time.

Figure 5. Prevalence of chronic hepatitis B by jurisdiction, 2010 – 2030



Dotted lines represent modelled projection estimates.

Table 6. Estimated number of people living with chronic hepatitis B and prevalence by jurisdiction, 2022.

State/Territory	People living with CHB	Plausible range		Prevalence (%)
		Minimum	Maximum	
ACT	2,927	2,715	3,192	0.63%
NSW	73,671	68,264	79,380	0.90%
NT	4,360	4,223	4,441	1.72%
QLD	32,744	30,572	33,979	0.61%
SA	10,513	9,710	11,395	0.58%
TAS	1,621	1,474	1,774	0.28%
VIC	58,268	53,275	64,242	0.88%
WA	21,445	19,764	23,250	0.76%
Australia	205,549	189,997	221,653	0.78%

Note: Jurisdictional estimates were standardized to ensure the sum of indicator variables across the jurisdictions aligns with the modelled national estimate.

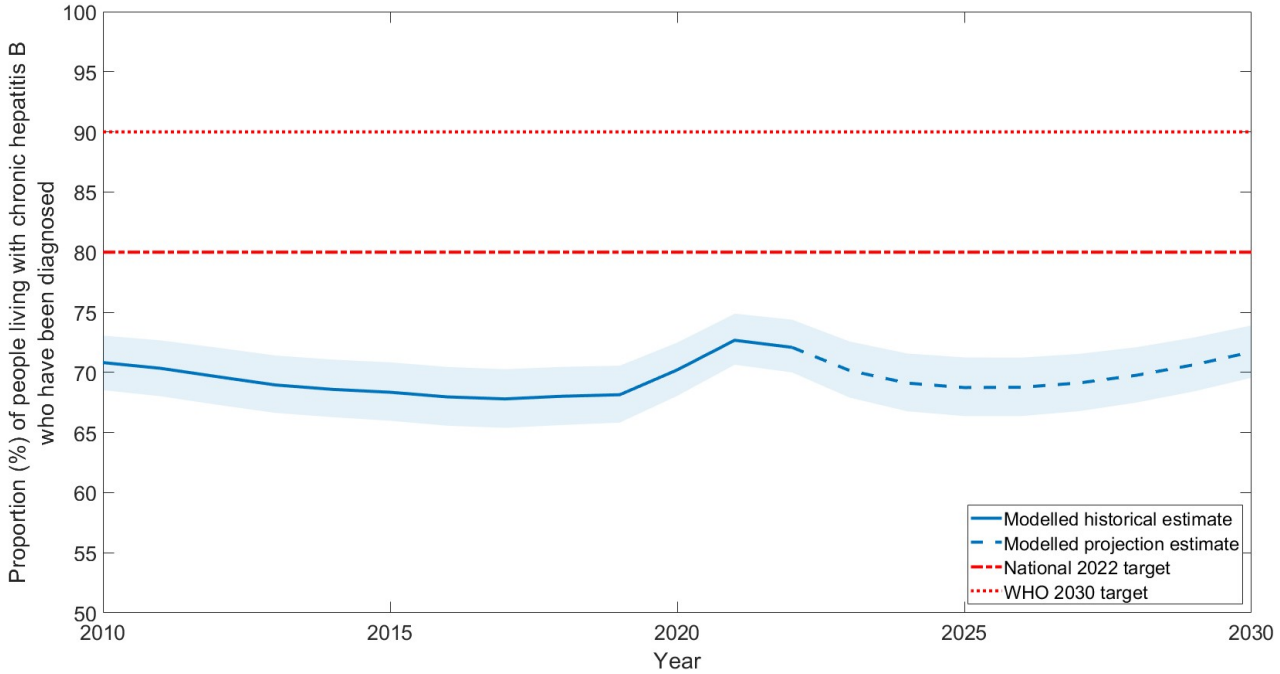
CHRONIC HEPATITIS B DIAGNOSIS

NATIONAL ESTIMATES

In 2022, an estimated 148,159 people living with CHB in Australia had ever been diagnosed, representing 72.1% (PR 70.0% to 74.38%) of all Australians living with CHB. Historical trends show variations in this proportion with modest improvements since 2018 (Figure 6, Appendix Table A2). In 2022, although the number of people living with CHB who had been diagnosed increased from 2021, the proportion decreased. Although thousands of individuals are diagnosed with CHB in Australia each year, the population living with CHB has also increased, therefore the rate of diagnosis must increase substantially to have an impact on the total proportion diagnosed.

The number of people living with CHB who have been diagnosed is calculated using hepatitis B unspecified notifications, sourced from the National Notifiable Diseases Surveillance System (NNDSS) [22]. However, NNDSS data contains duplicates when individuals have been diagnosed in multiple jurisdictions, inflating the number of people diagnosed and making the true proportion diagnosed less than previously estimated. Data linkage projects in NSW and VIC estimated that approximately 8% of notifications were internal duplicates, occurring repeatedly within the same jurisdiction. Given this finding, the reported proportion diagnosed assumes 8% of national notifications are duplicates, which is most likely a conservative estimate. A national data linkage project is currently underway which aims to generate robust estimates of national duplicate notifications, and these will be incorporated into future reporting when available.

Figure 6. Estimated proportion of people living with chronic hepatitis B in Australia who have been diagnosed, 2010 – 2030.



Refer to Appendix Table A2. Shaded areas show plausible ranges of estimates determined by the 10th and 90th percentiles of simulations. Estimates assume 8% of hepatitis B notifications are duplicates.
Future projections follow trends from 2016-2019 and are subject to significant uncertainty.
Numerator source: National Notifiable Diseases Surveillance System (NNDSS), due to the dynamic nature of the NNDSS, data are subject to retrospective revision and may vary from data reported in published NNDSS reports and reports of notification data by states and territories.

Australia did not achieve the 2022 National Strategy target of 80%, 16,280 more people living with CHB required diagnosis to reach this target. Since 2010 the annual number of national notifications has fluctuated, but followed a decreasing trend[22]. This also reflects continued declines in the number of serology tests performed since the onset of the COVID-19 pandemic, with 14% fewer serology tests performed during 2020 and 2021 compared to 2019 and an overall 18% reduction in 2022 compared to 2019[23,24]. This is likely due to the health system impacts of the pandemic and the interruption to usual care observed for many aspects of health care. This trend does appear to be abating in 2023, with data indicating the number of serology tests conducted in 2023 was only 8% lower than 2019. Further information on 2023 serology data can be found in the Viral Hepatitis Mapping Project: Hepatitis B National Report 2022.

Combining future population estimates (including the underlying assumptions about migration numbers and demographics) with the assumption that notifications will continue to follow the 2016 - 2019 trend through 2030, the proportion diagnosed is projected to decline until 2027 (68.15%) before rebounding and increasing thereafter. With the current projection, it is estimated that Australia will not achieve the 2022 National Strategy target for proportion diagnosed of 80% until 2037. This projection incorporates assumptions regarding trends in the number of diagnoses, future increases in migration numbers and changes in the demographics, including age and country of birth of future Australians. Changes in factors such as testing patterns will influence these estimates.

Australia has already achieved the WHO GHSS target of diagnosing 60% of people living with CHB by 2025. However, Australia is not on track to reach the 2030 90% diagnosis target, and it is estimated this will not be achieved until after 2050.

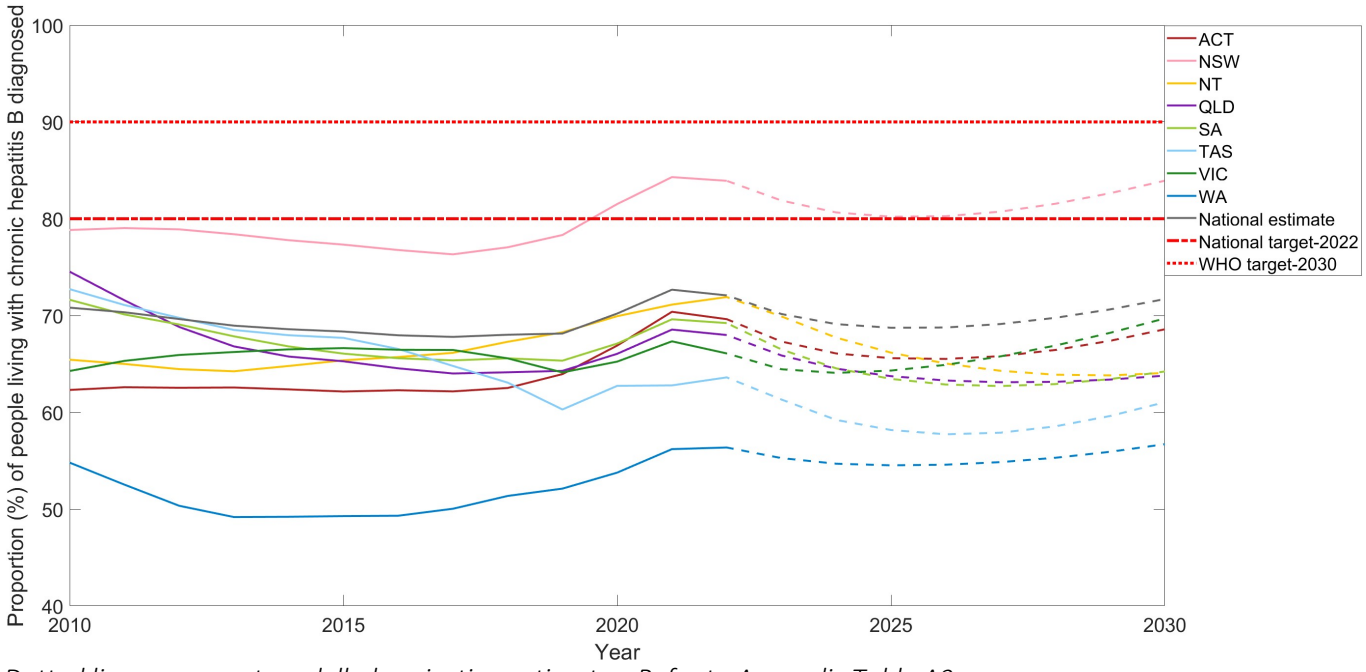
STATE AND TERRITORY ESTIMATES

Since 2010 the estimated proportion of people living with CHB who have ever been diagnosed has been variable nationwide and across jurisdictions (Figure 7, Appendix Table A2). NSW (83.9%) had the highest proportion diagnosed in 2022 (Table 7); estimates for all other states and territories were below the national average of 72.1%, with NT (71.9%), ACT (69.6%), SA (69.2%), QLD (68.0%), VIC (66.1%), WA (56.4%) and TAS (63.6%). As the proportion diagnosed is dependent on routinely collected surveillance data, disparities between states and territories will be influenced by variations in screening practices, underlying population differences in each jurisdiction and duplicate notifications. These estimates assume all jurisdictions have the same level of duplicate notifications of 8%, however this will be updated accordingly when jurisdiction-specific estimates of duplicate notifications are derived using the data linkage work described above.

NSW (83.9%) was the only jurisdiction to achieve the 2022 National Strategy target of 80% of people living with CHB being diagnosed (Figure 7). The maximum plausible range indicates that for ACT, SA and VIC the diagnosis target could have also already been reached with 83.5%, 82.3% and 80.7% respectively. However, this is unlikely as the target was not achieved in the majority of model simulations. Focusing on the point estimate, and most likely outcomes, VIC and ACT are projected to reach the national 2022 target in 2037 and 2038, respectively, with other jurisdictions expected to achieve this target after 2040. A significantly increased rate of diagnosis is required in all jurisdictions to reach the WHO GHSS 90% diagnosis target by 2030. This, however, is dependent on the true number of duplicates present in notification data. As the number of people living with CHB is estimated to increase substantially in the future, coupled with declining annual changes in

notifications, a decline in the proportion diagnosed is anticipated in all jurisdictions in the coming years, followed by further increases as the number of people living with CHB starts to decline due to the influences of vaccination.

Figure 7. Estimated proportion of people living with chronic hepatitis B who have been diagnosed by jurisdiction, 2010 – 2030.



Dotted lines represent modelled projection estimates. Refer to Appendix Table A2
Future projections follow trends from 2016-2019. Future projections are subject to significant uncertainty.
Numerator source: National Notifiable Diseases Surveillance System (NNDSS). Due to the dynamic nature of the NNDSS, data are subject to retrospective revision and may vary from data reported in published NNDSS reports and reports of notification data by states and territories.

Table 7. Estimated proportion of people living with chronic hepatitis B who have been diagnosed by jurisdiction, 2022.

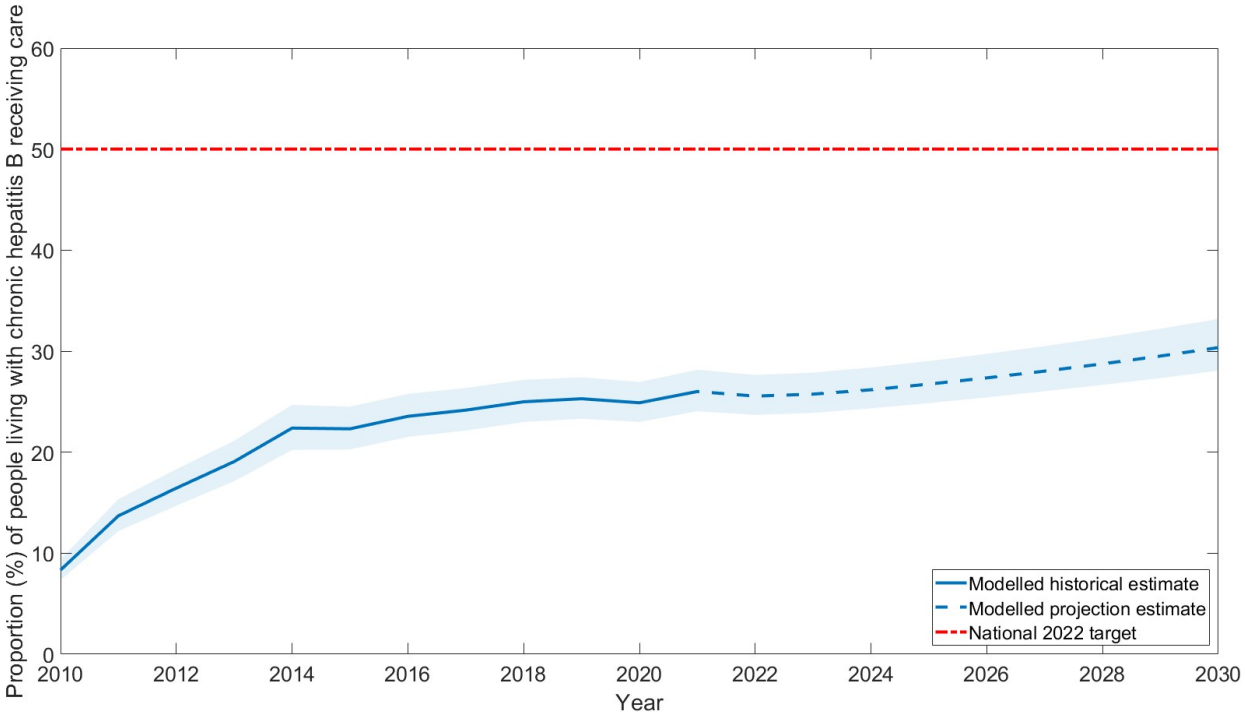
State/Territory	Proportion diagnosed	Plausible range	
		Minimum	Maximum
ACT	69.6%	58.1%	83.5%
NSW	83.9%	71.7%	99.0%
NT	71.9%	68.3%	76.6%
QLD	68.0%	61.7%	76.7%
SA	69.2%	58.7%	82.3%
TAS	63.6%	54.1%	77.1%
VIC	66.1%	54.3%	80.7%
WA	56.4%	47.7%	67.6%
Australia	72.1%	70.0%	74.4%

CHRONIC HEPATITIS B CARE

NATIONAL ESTIMATES

During 2022, 52,515 (25.5%) people were engaged in care for CHB, receiving either antiviral treatment or Australian guideline-based monitoring while not on treatment (defined as receiving hepatitis B viral load testing at least yearly). This proportion has improved over time, increasing from 13.7% in 2011 (Figure 8, Appendix Table A3). Although this increase was relatively rapid between 2011 and 2014, the rate of increase slowed substantially since 2015. In 2020, for the first time in a decade and presumably due to the health service impacts of the COVID-19 pandemic, a reduction in the proportion of people engaged in care for their CHB was observed. The number of individuals engaged in monitoring continued to decline during 2021, however this was offset by increases in treatment numbers, and consequently care uptake remained stable. In 2022, although the number of people engaged in care increased after previous declines, the proportion decreased due to the increase in the number of people living with CHB. The number engaged in care must increase substantially to have an impact on the total proportion in care.

Figure 8. Estimated proportion of people living with chronic hepatitis B in Australia who were engaged in care (receiving either treatment or monitoring), 2010 – 2030.



Refer to Appendix Table A3. Shaded areas show plausible ranges of estimates determined by the 10th and 90th percentiles of simulations. Future projections follow trends from 2016-2019. Future projections are subject to significant uncertainty.

It is recommended that all people living with CHB should be engaged in care[25-27], and Australia currently falls well short of meeting this recommendation. The 2022 National Strategy target of 50% was not achieved and based on current trends, this target will not be reached until 2048. Nearly double the current number (a further 50,260 people) would have needed to be in care to have reached this target by 2022. It should be noted that future projections incorporate uncertain underlying assumptions about future migration, composition of migrants by country of birth and age distribution.

Additionally, the 'engaged in care' indicator reflects only a snapshot of the proportion of people with CHB who received items of Australian guideline-based care (either monitoring, measured using viral load testing, or treatment) in a given year. Further assessment of the uptake of more frequent testing which more closely reflects current guidelines is assessed in the Viral Hepatitis Mapping Project: Hepatitis B National Report 2022[4,5,14].

STATE AND TERRITORY ESTIMATES

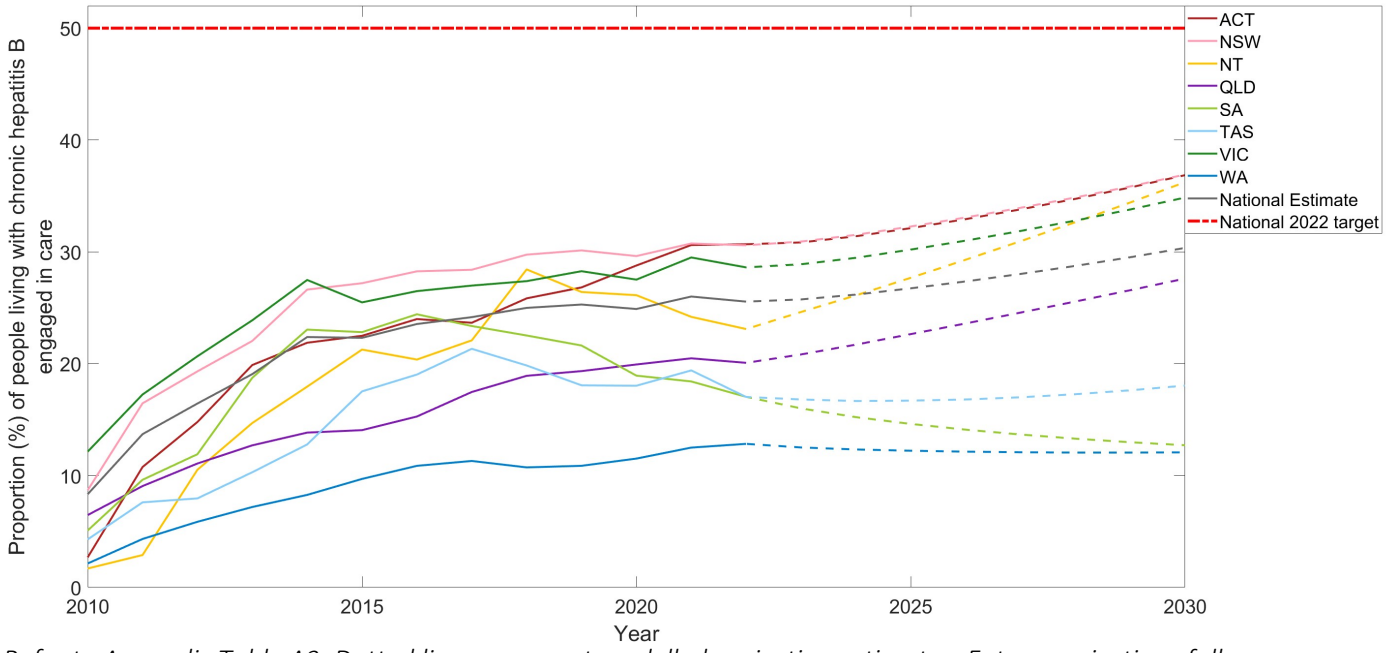
Since 2011, the proportion of people living with CHB who are engaged in care[25-27] has varied greatly between states and territories (Figure 9, Table 8). Despite this, generally the proportion of people living with CHB who were engaged in care increased in most states and territories during 2011 – 2019, in particular NT, whereas decreases were seen in SA and TAS during this period. In 2020, other jurisdictions saw a decrease in the proportion engaged in care, including NSW, NT, and VIC (Figure 9). Despite the number of people receiving care increasing in 2022, the proportion of people receiving care dropped again in 2022 in all jurisdictions aside from ACT. Aside from the impacts of COVID-19 and resulting disruptions to health care, this decrease in 2022 is driven by an increased number of people living with CHB. The number engaged in care must increase substantially to have an impact on the total proportion in care.

As estimates are derived from Medicare services data, provision of tests outside of this system can affect the proportion of people identified as in care. Anomalies in the expected number of viral load tests performed in some jurisdictions has been reported in the Viral Hepatitis Mapping Project: Hepatitis B National Report 2022[4,5]. For example, the sharp decline in monitoring uptake in SA from 2019 onwards has been identified as being due to a decline in the billing of viral load tests through Medicare, leading to viral load tests being underestimated by up to 50% in 2021 and 2022 (personal communication, SA Health 2023). As SA represents only 5% of all people living with CHB in Australia, this is unlikely to have notable impacts on national estimates of care uptake. However, if this underestimation is consistent for monitoring tests, care uptake in SA could be as high as 23.4%, increasing the care uptake ranking for SA from 7th to 4th among all states and territories. Based on comparison of treatment and viral load numbers, this issue may also be leading to underestimates of monitoring in WA and NT, based on comparison of treatment and viral load numbers.

No jurisdiction reached the 2022 National Strategy target of 50% of people living with CHB engaged in care. Following trends in treatment and monitoring numbers from 2016 to 2019, NT, ACT, NSW, and VIC will not reach this target until 2037, 2040, 2040 and 2042, respectively. All other jurisdictions will reach the 2022 target after 2048. NT saw rapid increases in the proportion of people engaged in care between 2016 to 2019, hence future projections mirror this achievement, with rapid improvements forecasted in future years. Although future projections in SA see major declines, these data are likely to be inaccurate due to provision of services outside of Medicare, as described above.

Drastic improvements need to be made across all jurisdictions to engage all people living with CHB. It can be observed that jurisdictions with a higher proportion of people living with CHB diagnosed did not always have a higher proportion engaged in care, suggesting that jurisdictions likely encounter different challenges in improving the cascade of care for CHB.

Figure 9. Estimated proportion of people living with chronic hepatitis B who were engaged in care (receiving either treatment or monitoring) by jurisdiction, 2010 – 2030.



Refer to Appendix Table A3. Dotted lines represent modelled projection estimates. Future projections follow trends from 2016-2019. Future projections are subject to significant uncertainty.
Data relating to SA may underestimate monitoring by up to 50% from 2020 onwards due to the provision of services outside of Medicare.

Table 8. Estimated proportion of people living with chronic hepatitis B who were engaged in care by jurisdiction, 2022.

State/Territory	Proportion in care	Plausible range	
		Minimum	Maximum
ACT	30.7%	28.1%	33.1%
NSW	30.6%	28.4%	33.0%
NT	23.1%	22.7%	23.8%
QLD	20.1%	19.3%	21.5%
SA*	17.0%	15.7%	18.4%
TAS	17.0%	15.6%	18.7%
VIC	28.6%	25.9%	31.3%
WA	12.8%	11.8%	13.9%
Australia	25.5%	23.7%	27.6%

** Estimates for SA may underestimate monitoring by up to 50% due to the provision of services outside of Medicare.*

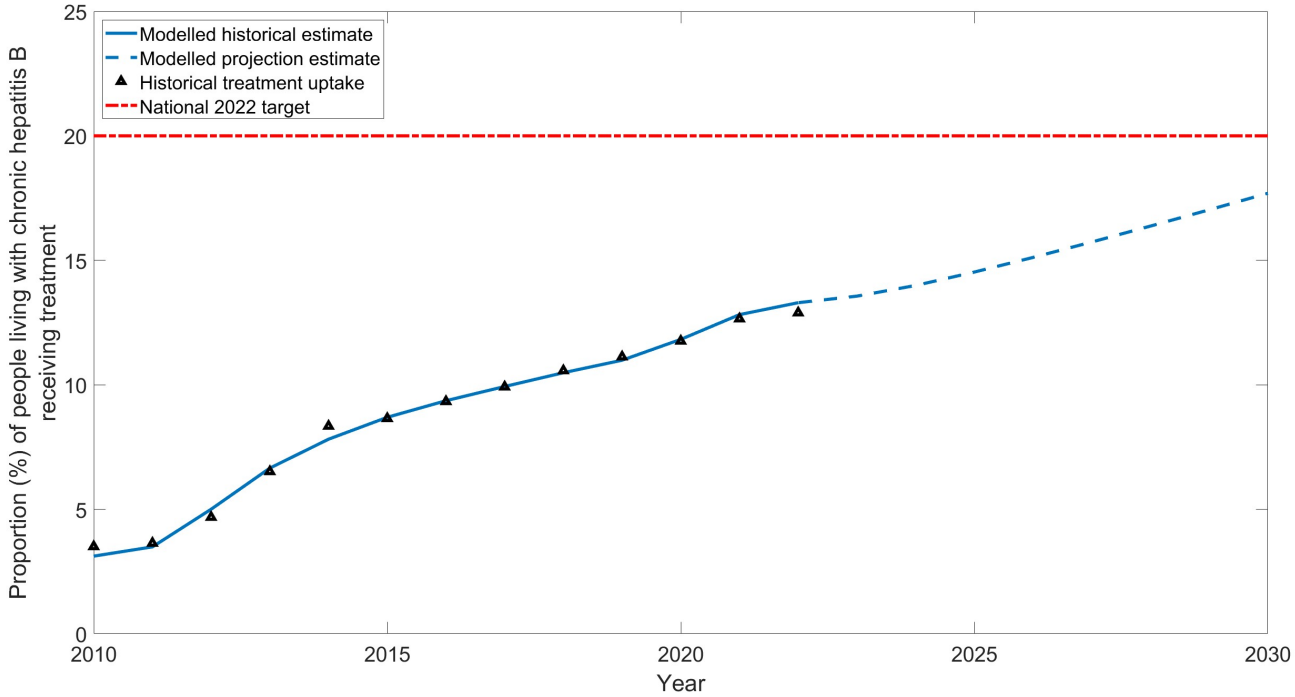
CHRONIC HEPATITIS B TREATMENT

NATIONAL ESTIMATES

During 2022, 26,504 people were dispensed antivirals for the treatment of hepatitis B through the Pharmaceutical Benefits Scheme (PBS), which is 12.9% (PR 12.0% to 13.9%) of the estimated number of people living with CHB.

Australia did not achieve the 2022 National Strategy target of 20% of people receiving antiviral treatment; an additional 14,606 people living with CHB needed to have received antiviral treatment by 2022. Based on treatment trends during 2016-2019, Australia will not reach this target until 2036. This target is an underestimation of the proportion eligible for treatment (See Chronic hepatitis B treatment eligibility section below)

Figure 10. Estimated proportion of people living with chronic hepatitis B in Australia who were dispensed drugs for the treatment of hepatitis B through the Pharmaceutical Benefits Scheme, 2010-2030.



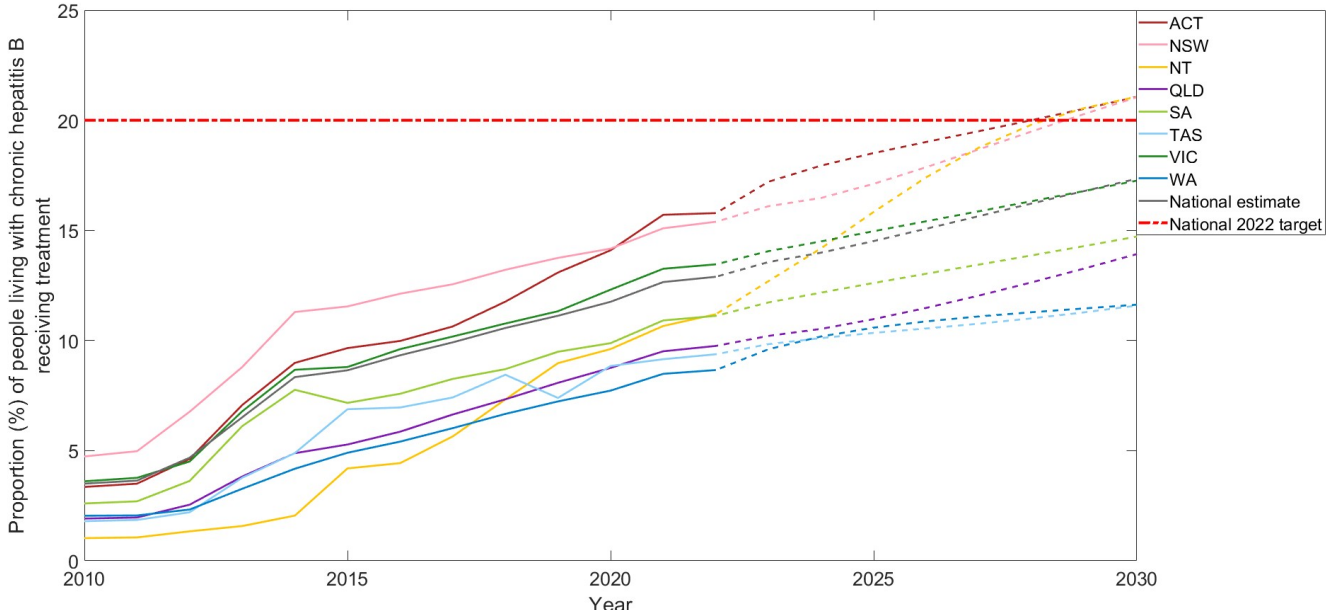
Refer to Appendix Table A4. Future projections follow trends from 2016-2019. Future projections are subject to significant uncertainty.

STATE AND TERRITORY ESTIMATES

The proportion of people living with CHB receiving antiviral treatment has increased over time in all states and territories (Figure 11, Appendix Table A4). Treatment uptake varied greatly between jurisdictions, with ACT (15.8%), NSW (15.4%) and VIC (13.5%) estimated to have the highest proportion of people with CHB receiving treatment in 2022 (Table 9). All other states and territories were below the national average (12.9%) for treatment uptake, including NT (11.2%), SA (11.1%), QLD (9.8%), TAS (9.4%) and WA (8.7%). A relatively rapid increase in treatment uptake was observed in most jurisdictions from 2010 to 2015, when the rate of increase slowed. Uniquely, NT have seen the opposite pattern over time, with substantial treatment uptake seen in more recent years compared to other jurisdictions, with increases from 2014 to 2019 (Figure 11). Notably, ACT

has observed rapid improvements in the last several years, increasing on average 1.3% yearly since 2017, compared to the national yearly average increase of 0.7% (Figure 11). In 2022, no jurisdiction reached the 2022 National Strategy target of 20% treatment uptake, with ACT and NSW projected to reach this target in 2029. NT will also reach the target in 2029 if treatment uptake continues its increasing trend.

Figure 11. Estimated proportion of people living with chronic hepatitis B who were dispensed drugs for the treatment of hepatitis B through the PBS by jurisdiction, 2010-2030.



Dotted lines represent modelled projection estimates. Refer to Appendix Table A4. Future projections follow trends from 2016-2019. Future projections are subject to significant uncertainty.

Table 9. Estimated proportion of people living with chronic hepatitis B who were dispensed drugs for the treatment of hepatitis B through the PBS by jurisdiction, 2022.

State/Territory	Proportion receiving treatment	Plausible range	
		Minimum	Maximum
ACT	15.8%	14.5%	17.0%
NSW	15.4%	14.3%	16.6%
NT	11.2%	11.0%	11.6%
QLD	9.8%	9.4%	10.4%
SA	11.1%	10.3%	12.0%
TAS	9.4%	8.6%	44.5%
VIC	13.5%	12.2%	14.7%
WA	8.7%	8.0%	9.4%
Australia	12.9%	12.0%	13.9%

CHRONIC HEPATITIS B TREATMENT ELIGIBILITY

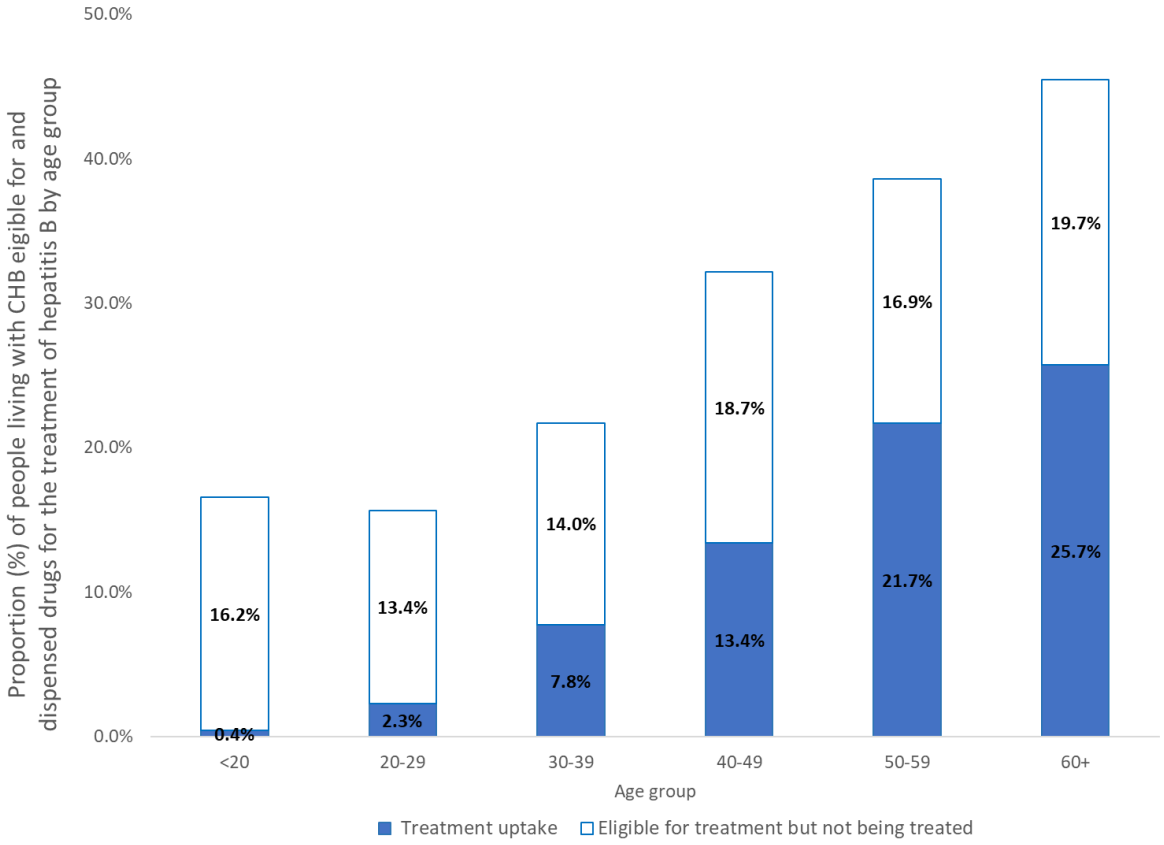
Due to the dynamic natural history of hepatitis B, not all people living with CHB require treatment. Current guidelines recommend antiviral therapy only for those in immune clearance (HBeAg-positive chronic hepatitis) or immune escape (HBeAg-negative chronic hepatitis) (see Appendix

Figure A2), or those with cirrhosis and detectable hepatitis B replication irrespective of phase[28]. Published estimates of the proportion of people living with CHB who are eligible for treatment range from 10% to 31%[2,29-33], and are influenced by hepatitis B genotype, age group, sex, and other factors. Here we generate estimates of this proportion in Australia, based on modelling of many of these parameters.

In 2022, an estimated 60,525 (PR 54,789 to 67,089) people living with CHB were eligible for antiviral treatment nationally, representing 29.4% (PR 26.7% to 32.6%) of the total. This suggests the National Strategy target of 20% of people living with CHB receiving antiviral treatment by 2022 was conservative. Based on this modelling, Australia treated 43.8% of those estimated to require treatment in 2022 and would have needed to treat an additional 34,021 people to reach everyone who was eligible.

Eligibility for CHB treatment varied according to age group, with the proportion of people living with CHB eligible for treatment increasing according to age (Figure 12), with eligibility in those less than 20 years being 16.6% and those aged 60+ being 45.4%. Treatment uptake followed a similar trend, with treatment increasing according to age. 0.4% of those aged under 20 were on treatment, compared to 25.7% of those aged 60 and above. As adverse outcome risk increases according to age, treatment is particularly important in older age groups. Among those aged 60 and above, 19.7% of people are estimated to be eligible for treatment however are not receiving treatment (Figure 12).

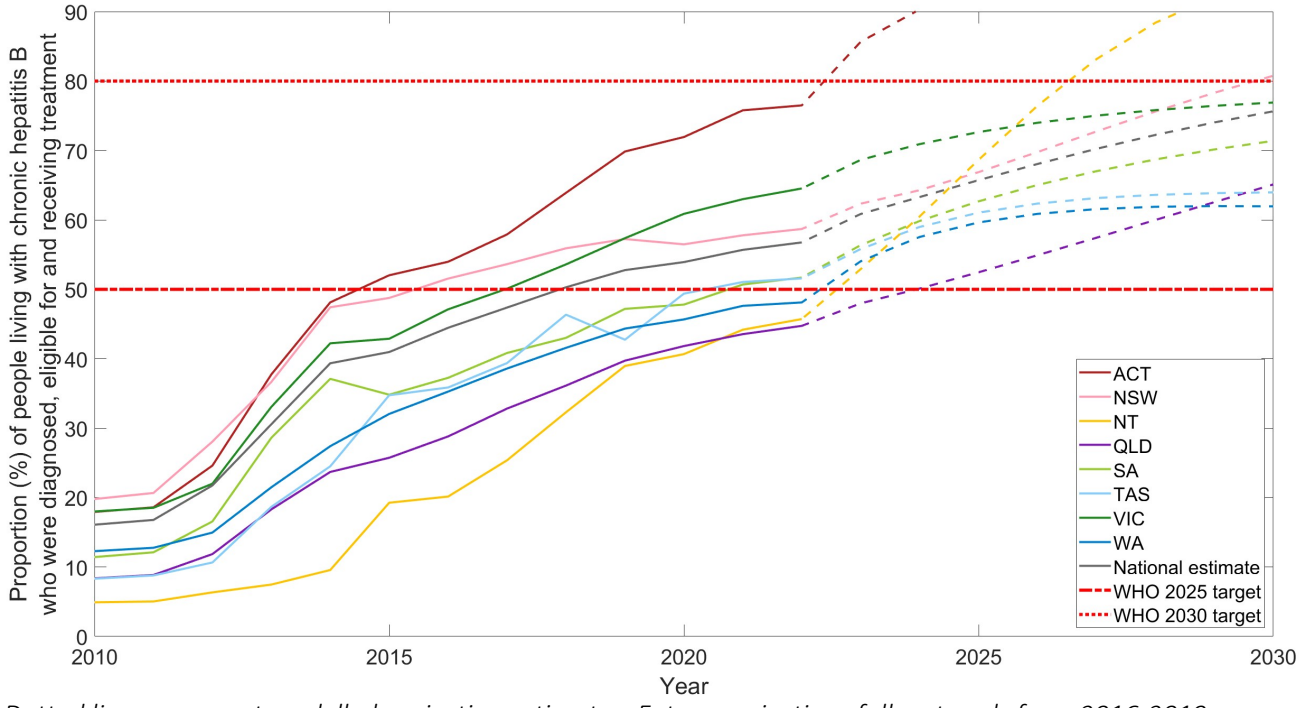
Figure 12. Estimated proportion of people living with chronic hepatitis B eligible for and dispensed drugs for the treatment of hepatitis B by age group, 2022



In 2022, NT (31.3%), NSW (29.9%) and VIC (29.6%) were estimated to have the highest proportion of people living with CHB who are eligible for treatment, followed by QLD (28.9%), WA (28.8%), SA (28.6%), ACT (28.1%) and TAS (26.2%).

With the incorporation of diagnosis into the model, we can now report against the WHO GHSS target for the proportion of people living with chronic hepatitis B who are diagnosed and eligible for antiviral treatment and are receiving treatment (Figure 13). In 2018, Australia reached the WHO GHSS target of 50% of diagnosed and eligible people with CHB treated by 2025. The national estimate in 2022 for this proportion is 56.8%. Notably, ACT, NSW, and VIC exceeded the national estimate, with proportions of 76.5%, 58.7%, and 64.5%, respectively. If trends were to remain stable based on 2016-2019 trends, it is projected that Australia will not reach the WHO GHSS target of 80% in 2030 until 2034. Meanwhile, the only three jurisdictions expected to achieve this target on schedule are ACT in 2023, NT in 2027 and NSW in 2030. It should be noted that to estimate this target in Australia, a significant number of consecutive assumptions need to be made, which results in high uncertainty in the final figure. For example, there are very likely unmeasured differences in the population that has been diagnosed compared to those not diagnosed, though an assumption has been made that the proportion of people eligible for treatment is the same across both groups. Due to the natural history of CHB, this is unlikely to be the case.

Figure 13. Estimated proportion of people living with chronic hepatitis B in Australia who were diagnosed, eligible for and dispensed drugs for the treatment of hepatitis B by jurisdictions, 2010 – 2030.



Dotted lines represent modelled projection estimates. Future projections follow trends from 2016-2019. Future projections are subject to significant uncertainty.

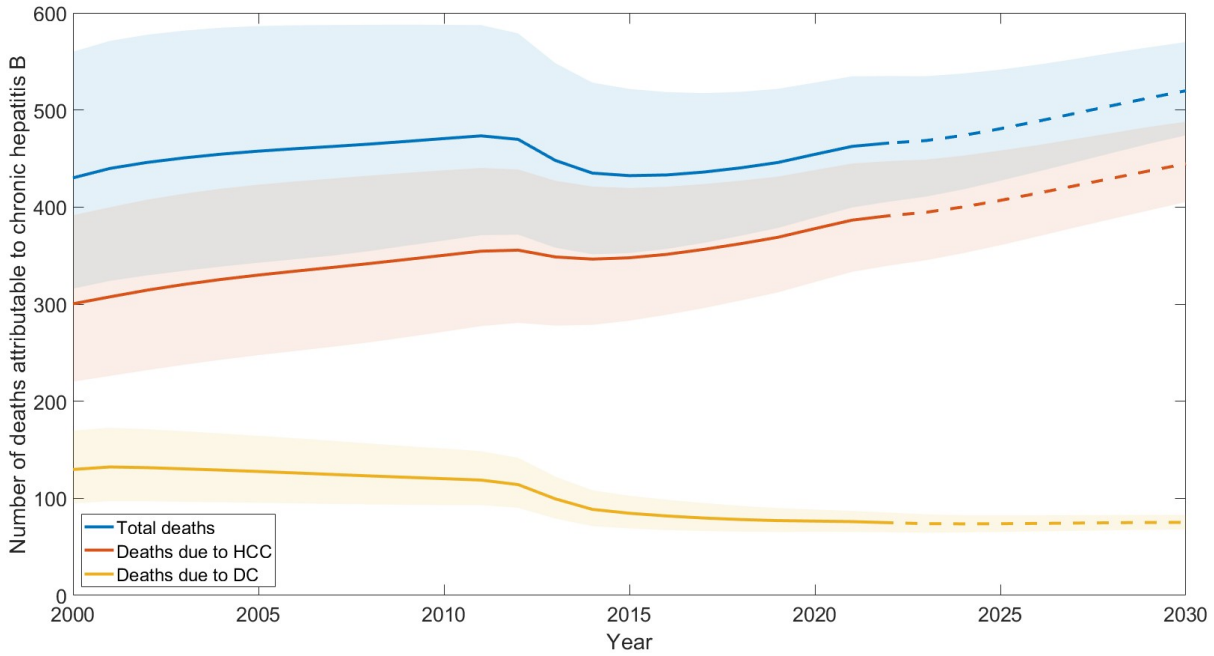
DEATHS ATTRIBUTABLE TO CHRONIC HEPATITIS B

NATIONAL ESTIMATES

In 2022, an estimated 466 people (PR 405 to 533) died due to complications of CHB in Australia, this translates to a CHB attributable mortality rate of 1.77 deaths per 100,000 total population. The total number of estimated CHB attributable deaths has changed over time, increasing from 430 in 2000 to a peak of 473 deaths in 2011, followed by a gradual decline, despite increasing population numbers. (Figure 14, Appendix Table A5). This decrease in estimated deaths is due to the introduction and scaling up of effective antiviral treatment in Australia during the last two decades, and the resulting reduction in CHB-associated mortality in those at greatest risk of adverse outcomes. In recent years, the number of deaths has plateaued and started increasing instead of continuing to decrease. This is in part due to ageing, an increasing population with CHB in Australia and treatment uptake not increasing sufficiently. The increase in deaths attributable to CHB at the end of 2022 relative to the end of 2017 was 6.9% nationally, compared to the National Strategy target of a 30% reduction in hepatitis B attributable mortality by 2022. To reach this target, the total number of CHB attributable deaths would have needed to fall to 306 deaths in 2022.

Despite increases in total number of deaths in recent years, the mortality rate has been steadily decreasing since 2004 (2.27 deaths per 100,000 total population). In 2022 the population level CHB attributed mortality rate of 1.77 deaths per 100,000 was well below the WHO GHSS target aiming for a mortality rate of 7 deaths per 100,000 by 2025 and 4 deaths per 100,000 by 2030. This target reflects the high baseline CHB mortality at a global level, and a higher baseline prevalence of CHB in most countries, and it is likely Australia has never exceeded these mortality levels. Due to this, more ambitious local targets are needed which are tailored to the Australian situation.

Figure 14. Estimated number of deaths attributable to chronic hepatitis B in Australia over time, 2000 – 2030.

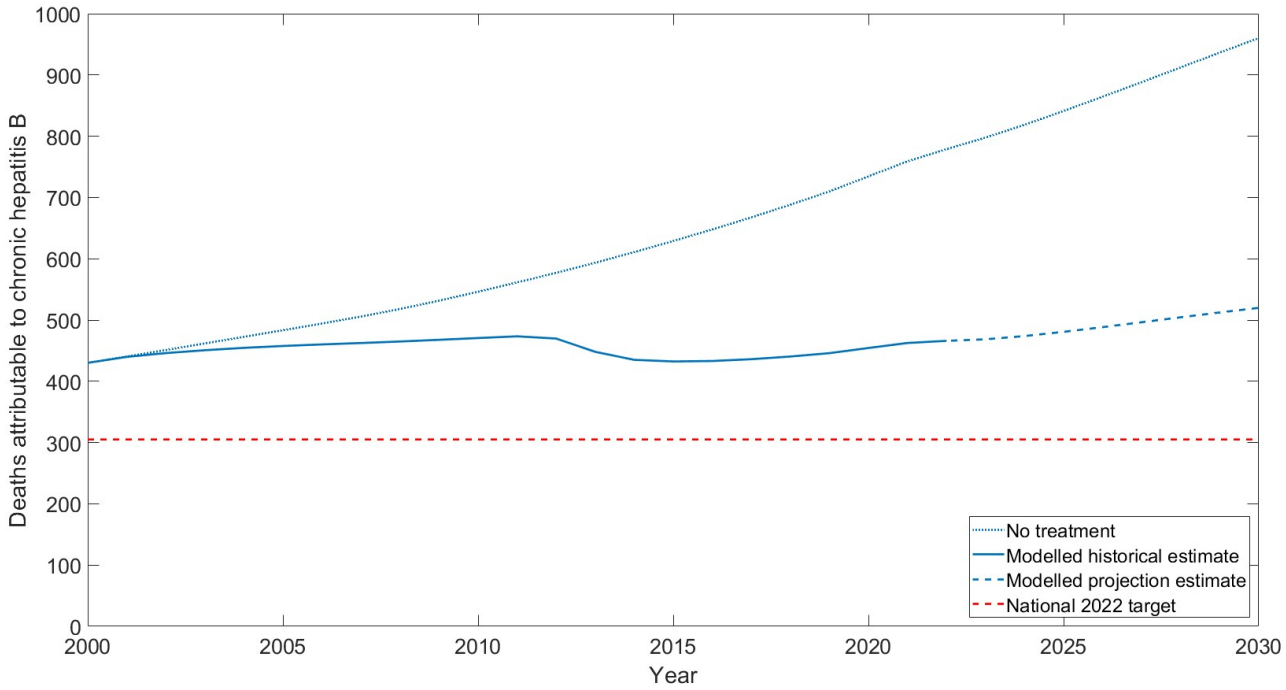


Refer to Appendix Table A5, A6, A7. Shaded areas show plausible ranges of estimates determined by the 10th and 90th percentiles of simulations. Dotted lines represent modelled projection estimates.
HCC: Hepatocellular carcinoma, DC: Decompensated cirrhosis

Deaths due to CHB are caused by the development of decompensated cirrhosis (DC) and/or hepatocellular carcinoma (HCC), the most common form of liver cancer. In Australia, 85% of estimated deaths due to CHB were attributable to HCC, which was responsible for 391 (PR 340 to 447) deaths in 2022, while 75 (PR 65 to 85) people were estimated to have died due to DC. HCC deaths decreased slightly after a peak of 356 in 2012, although numbers continued to increase in recent years. Contrastingly, the decline for DC deaths has continued after dropping from a peak of 132 in 2002 (Figure 14).

The impact of treatment in reducing the risk of death due to CHB may be more pronounced for DC compared to HCC due to the underlying clinical factors in relation to treatment impact. While antiviral treatment has been demonstrated to substantially reduce the risk of development of HCC, this effect is not immediate and antiviral therapy has limited impact on survival once HCC has already developed. In contrast, antiviral treatment not only prevents progression to cirrhosis and then to DC, but additionally can be effective even when provided late in the disease course, resulting in re-compensation of liver disease. Without the availability of antiviral treatment in Australia, it is estimated the number of attributable deaths would have continued to increase over time to 779 CHB attributable deaths estimated in 2022. Our assessment estimates that in 2022, 313 lives were saved due to treatment, with a total of 2,890 lives saved since the year 2000 following the introduction of antiviral treatment for CHB in Australia (Figure 15).

Figure 15. Estimated number of deaths attributable to chronic hepatitis B in Australia, baseline treatment vs no treatment, 2000 – 2030.

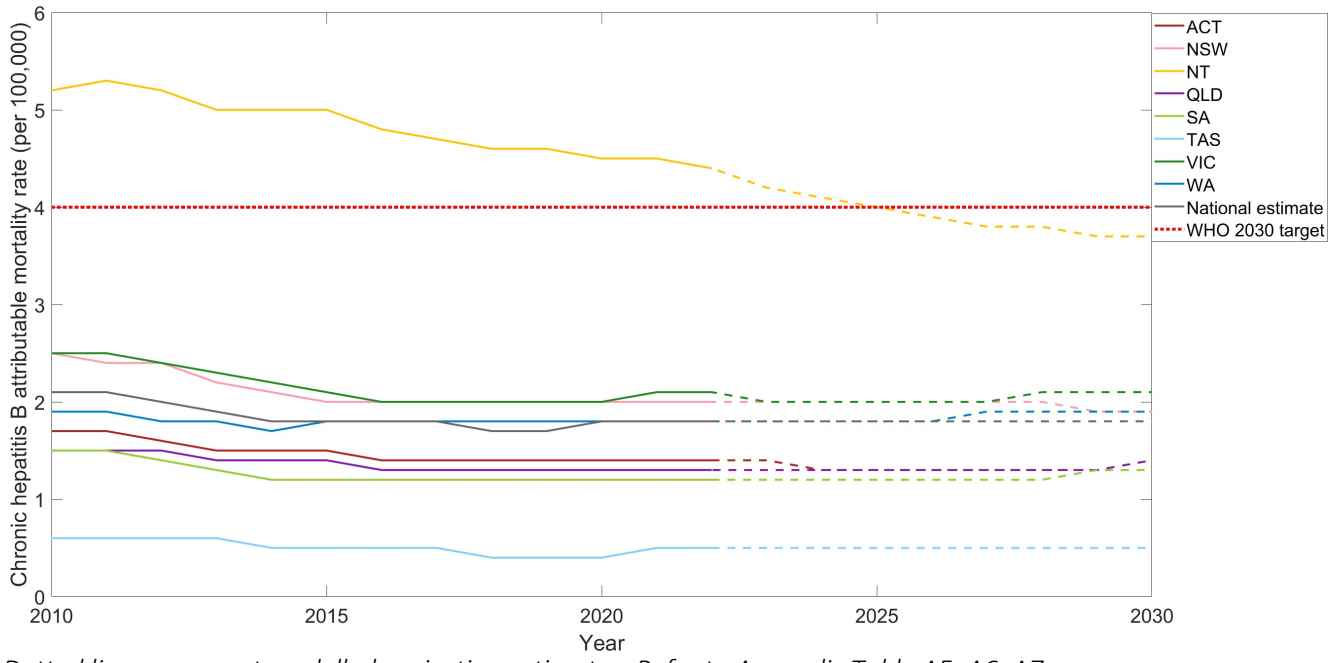


STATE AND TERRITORY ESTIMATES

In 2022, the absolute burden of disease attributable to hepatitis B was greatest in jurisdictions with the largest populations, NSW and VIC (163 and 138 deaths respectively), followed by QLD (71), WA (51) and SA (22). A smaller burden was seen in other jurisdictions, though it is difficult to reliably estimate in those with smaller populations of people living with CHB.

The CHB attributable mortality rate differs according to jurisdiction, relating predominantly to the total prevalence of CHB in the population, and to other factors such as age distribution of people living with CHB, and treatment uptake. Although some fluctuations over time have been observed, the attributable mortality rate follows a decreasing trend over time. The highest rate estimated was in NT (4.4 deaths occurring per 100,000 people), with further reductions predicted in future years. VIC (2.1 per 100,000), NSW (2.0 per 100,000) and WA (1.8 per 100,000) had a higher CHB attributable mortality rate compared to the national estimate of 1.8 deaths per 100,000, whereas ACT (1.4 per 100,000), QLD (1.3 per 100,00), SA (1.2 per 100,000) and TAS (0.5 per 100,000) had below average mortality rates (Figure 16). All jurisdictions are below the WHO GHSS 2025 target aiming for 7 deaths per 100,000 and all are on track to meet the WHO 2030 target.

Figure 16. Estimated attributable chronic hepatitis B mortality rate (per 100,000 total population) by jurisdictions 2000 – 2030



Dotted lines represent modelled projection estimates. Refer to Appendix Table A5, A6, A7.

Table 10. Estimated number of total deaths attributable to chronic hepatitis B and population numbers by jurisdiction, 2022.

State/Territory	Total deaths attributable to CHB	Plausible range		People living with CHB
		Minimum	Maximum	
ACT	<10	<10	<10	2,927
NSW	163	142	187	73,671
NT	11	10	12	4,360
QLD	71	64	76	32,744
SA	22	19	25	10,513
TAS	<10	<10	<10	1,621
VIC	138	117	162	58,268
WA	51	45	60	21,445
Australia	466	405	533	205,549

Estimates less than 10 have been suppressed due to difficulties in ensuring accuracy in small numbers.

Table 11. Estimated number of HCC deaths and DC deaths attributable to chronic hepatitis B by jurisdictions in 2022.

State/Territory	HCC deaths attributable to CHB	HCC Plausible range		DC deaths attributable to CHB	DC Plausible range	
		Minimum	Maximum		Minimum	Maximum
ACT	<10	<10	<10	<10	<10	<10
NSW	141	123	162	22	19	25
NT	<10	<10	<10	<10	<10	<10
QLD	59	53	63	12	11	13
SA	18	16	21	<10	<10	<10
TAS	<10	<10	<10	<10	<10	<10
VIC	115	97	135	23	20	27
WA	41	36	48	10	<10	12
Australia	391	340	447	75	65	85

Estimates less than 10 have been suppressed due to difficulties in ensuring accuracy in small numbers.

METHODOLOGICAL NOTES

To ensure estimates most accurately reflect the current epidemiology and clinical pattern of CHB in Australia, data inputs and assumptions are updated regularly to incorporate new information. For that reason new estimates may differ in some respects from previous outputs reported in the Kirby Institute's Annual Surveillance Reports[10], the Doherty Institute's National Viral Hepatitis Mapping Project Reports[4,5,14], and the National Surveillance for Hepatitis B Indicators Annual Reports[18].

SUMMARY OF MATHEMATICAL MODEL INPUTS

Mathematical Model Inputs	Source
Disease progression estimates	Published and grey literature, expert opinion
Australian demographic data	Australian Bureau of Statistics
Migration: Net overseas migration 1951 – 2022 2023 – 2050	 Australian Bureau of Statistics Australian Bureau of Statistics[19]
Migration: country of birth and age distribution 1951 – 1974 1974 – 1990 1991 – 2003 2004 – 2050	 Federation to Century's End Australian Bureau of Statistics Department of Social Services, Australian Bureau of Statistics Australian Bureau of Statistics
CHB prevalence by country of birth	Published literature
CHB phase distribution	Published and grey literature, expert opinion
Treatment uptake	Pharmaceutical Benefits Scheme
Vaccination uptake	Australian Immunisation Register data

MATHEMATICAL MODEL

The estimates presented in this report were derived from the recently published mathematical model[2]. The model is a dynamic, age-structured deterministic mathematical model that incorporates important demographic features such as births, migration, deaths, and aging over time. To optimise accurate representation of the transmission, epidemiology and progression of hepatitis B, the model incorporates 10 exclusive health states, representing the natural history of hepatitis B; susceptible, immune (through vaccination), acute infection, immune tolerant, immune clearance, immune control, immune escape, decompensated cirrhosis, hepatocellular carcinoma and resolved infection. Chronic hepatitis B health states have also been differentiated into no-cirrhosis and cirrhosis classifications and stratified by those receiving treatment and those not receiving treatment. This results in the model consisting of a total of 21 health states. Each health state is broken down into 18 age categories (those aged between 0 and 84 are grouped into 5-year age categories plus a final 85+ age group). Age groups were chosen to reflect the Australian population and to allow exploration of age-specific and health-state specific estimates, such as disaggregated mortality estimates for DC and HCC.

The model diagram can be found in Appendix Figure A2. Various data inputs and elements of the model are described below.

Disease progression estimates

Disease progression and transitions between each health state, including the impact of treatment on these, were generated based predominantly on a review of published and grey literature. Details of these transition estimates have been published elsewhere[2].

Transmission

A dynamic, age-adjusted measure of the force of infection is incorporated in the model to account for local transmission over time. The impact of vaccine uptake over time was modelled using the Australian Immunisation Register data by age and year. Measures of vaccine efficacy by age group were used to estimate the proportion of individuals receiving effective vaccination for hepatitis B in the Australian population.

Demographic data

The Australian Bureau of Statistics (ABS) provided the majority of the demographic data used in the model. This included total population numbers[34,35], births[34], deaths[36,37] and life tables[38] used to derive age-group mortality rates by taking the average rate across the 5 years included in each given age group.

Migration

In addition to Australia-specific demographic data, incoming migration by age and country of birth were also incorporated. Data regarding net overseas migration (NOM) produced by the ABS provided the total number of people entering the population from 1951 to 2022 as well as estimates of the proportion of future NOM entering each jurisdiction from 2023 to 2050[19]. Age and country of birth distributions within this were calculated using different sources dependent on time period and data availability:

- *2004 to 2022,* ABS NOM by country of birth and age distribution data were used to estimate the total number of people entering the population each year[39,40].
- *1991 to 2003,* ABS NOM was used to estimate the total number of people entering the population each year[39]. Department of Social Services (DSS) settlement data[41] were used to estimate the age distribution by country of birth by age by year.
- *1975 to 1990*, ABS NOM data[39] were used to estimate the total number of people entering the population each year. Combined with ABS permanent migration data by country of birth[42] these sources were used to estimate the number of migrants entering by country of birth. National age distribution data were not available prior to 1991, so data from the state of Victoria (representing 25% of Australia's population) on age distribution during 1975 to 2006 were applied as they were found to be a reasonable approximation.
- *1951 to 1974*, the Department of Immigration resource Federation to Century's End was used to determine the number of permanent settlers to Australia by country of birth[43].

Prevalence

At the start of the modelled period (1951), the baseline prevalence of the Australian population was assumed to be 0.5%[44], representing a low prevalence country. The number of people living

with CHB migrating to Australia each year was derived using the estimated prevalence of CHB according to country of birth. To account for changing age-specific source population prevalence over time (due predominantly to infant vaccination programs), we derived varying prevalence estimates across different time periods and applied these to migration data according to age group and year of arrival for country of birth for the majority of migrants to Australia. Prevalence for the top 4 countries of birth for CHB was estimated using a separate method (see 'Direct estimation of immunisation impact' section, below). Different data sources were used for different time periods:

- *1991 to 2050,* For those migrating into Australia born in 1991 or later, prevalence estimates derived for the Viral Hepatitis Mapping Project National Report 2018-2019[4] were applied. These prevalence estimates were taken predominately from local seroprevalence surveys,[45-47] supplemented with global systematic reviews[48,49]. Antenatal estimates were adjusted upwards to correct for the discrepancy in CHB prevalence by sex[50].
- *1951 to 1990,* For those migrating into Australia born prior to 1991, prevalence estimates derived by the CDC as of 2008 were applied[44]. Countries were divided into three categories, based on the prevalence during this period; low prevalence (0.5%), intermediate prevalence (5%) and high prevalence (10%). These estimates are higher compared to those during 1991-2020 which takes into account prevalence estimates in the pre-vaccination era.

Direct estimation of immunisation impact
A literature review was conducted to obtain age- and year-prevalence estimates for the 4 countries which had the highest numbers of people living with CHB in Australia - China, Vietnam, Philippines and Taiwan[4,14,48,51-55]. Specific prevalence estimates by country and year of birth were applied to incoming migrants.

Phase distribution
Individuals living with CHB migrate into Australia in different disease phases. The proportion of individuals living with CHB in each disease phase (immune tolerant, immune clearance, immune control, and immune escape) by age group were derived for different world regions using published data and expert opinion[56-58]. All source countries were categorised into three world regions (Asia/Pacific, Africa, and Other) to account for differences in natural history.

Diagnosis
Diagnosis for CHB has been integrated into the health states of the model. Diagnosis can occur at any phase of CHB, as well as HCC and DC. Only individuals who receive a diagnosis can then transition to the treatment phases. The model's new notification cases were calibrated using unspecified hepatitis B notifications sourced from NNDSS[22], which are age-structured. The number of people living with CHB who have been diagnosed was calculated by summing the diagnosed health states with the treatment health states. The proportion of people living with CHB has been calculated differently from the previous report. Now, the number of yearly diagnosed individuals with CHB acts as the numerator, with the denominator being the total annual number of people living with CHB.

It should be noted that diagnosis does not necessarily mean that the person living with CHB is aware of and understands their diagnosis and has been linked to care. It represents only a

notification to a state or territory health department following a positive diagnostic test, and merely represents the minimum requirement for potential engagement in care

Treatment

This model incorporates the impact of treatment by estimating differential uptake rates by disease phase, with proportions according to disease phase determined using expert opinion and literature reviews, which were then fitted to treatment uptake derived from PBS data.
Data obtained from PBS records were used to derive the number of people on treatment in Australia each year since 2000. It excludes individuals prescribed lamivudine or tenofovir for HIV infection in combination with other HIV antivirals and includes hepatitis B treatment during pregnancy, which was added to the PBS in May 2020.

Plausible range

The plausible ranges reported were derived by allowing the force of infection, migrant population prevalence, proportion of migrants with CHB living with cirrhosis, CHB mortality, and other disease transition estimates to vary according to prior knowledge of possible distributions[2]. In addition, for modelled future projection estimates the total number of migrants entering the population varied for 2022 – 2030 according to the short, moderate and long impact scenarios[20]. This was achieved using Latin-hypercube sampling (LHS), as described by Marino et al[59]. The national mathematical model was run using 1000 different combinations of these varied parameters (while the jurisdiction models were run using 100 different combinations of these varied parameters), which produced a range of overall estimates. The minimum and maximum estimates defined by the 10th and 90th percentiles respectively were then used to define the plausible range around the point estimate value.

Jurisdictional estimates

The national model was applied to each state and territory using state specific demographic information obtained from the ABS. Some of the data sources differed from the national model due to availability and appropriateness of data. For years when ABS NOM by jurisdiction was not available (1951 to 1971), we imputed total numbers entering the population for each jurisdiction by applying a proportion (derived from available jurisdiction NOM breakdown) to the national NOM by year. The age distribution of incoming migrants by country of birth was imputed for missing years based on the overall age distribution of permanent settlers arriving in 1991 (obtained from DSS settlement data) which were applied back to 1951.

Although the national model does not currently explicitly model the differential prevalence among Aboriginal and/or Torres Strait Islander peoples, this was incorporated into the model for state and territories where this proportionally has the greatest effect on the number of people living with CHB (QLD and NT). This also ensures that estimates in QLD and NT more accurately reflect the true population. This was incorporated by adjusting the prevalence among the proportion of Aboriginal and/or Torres Strait Islander peoples living in both jurisdictions[60-62].

Prior to 1990, Census data poorly reflect the actual number of Aboriginal and Torres Strait Islander peoples living in Australia[63], which underestimates the population and has a substantial impact on output estimates. To better reflect total population numbers in the years prior to 1990, reported populations and number of births were adjusted upwards each year in accordance with the proportion of Aboriginal and/or Torres Strait Islander population and births during the 1991 to 2016[64]. Differential phase information for Aboriginal and/or Torres Strait Islander peoples living with CHB was estimated[65] to reflect the differences in natural history. Data

were provided from the Hepatitis B Sero-Coding Project, Northern Territory Government. Further model development will incorporate adjustments for the remaining states and territories, dependent on the availability of appropriate data.
Each jurisdiction was modelled separately to adequately capture trends in the epidemiology of CHB over time. Jurisdictional estimates were then standardized to ensure the sum of indicator variables across the jurisdictions matches the modelled national estimate.

METHODOLOGY FOR INDICATORS

1: Estimating the number of people living with chronic hepatitis B in Australia

The total number of people living with chronic hepatitis B in Australia and the number according to age group and state and territory are direct outputs of the model. Prevalence of CHB was calculated using the number of people living with chronic hepatitis B as the numerator and the total population according to ABS numbers as the denominator.

2: Estimating the proportion of people living with chronic hepatitis B in Australia who have been diagnosed

The number of people living with CHB who have been diagnosed is a direct output of the model and calibrated using NNDSS unspecified hepatitis B notifications data. It was calculated by summing diagnosed health states and treatment health states within the model, to give the yearly total number of people living with CHB who have been diagnosed. The proportion of people living with chronic hepatitis B in Australia who have been diagnosed is the number of people living with CHB who have been diagnosed divided by the total number of people living with CHB in Australia.

NNDSS data may contain duplicates if individuals have been diagnosed in multiple jurisdictions, inflating the number ever diagnosed. A national linkage study has commenced under the auspices of this project which aims to quantify the extent of duplicate reporting across jurisdictions to the NNDSS for both hepatitis B and hepatitis C, allowing identification of the true number of individuals diagnosed and refining of modelled estimates. When the results of this national notifications linkage project are available the results will be incorporated into this model. In the interim, based on de-duplication efforts in NSW and VIC, a conservative estimate of 8% of national notifications representing repeat notifications has been applied in this report for the first time.

3: Estimating the proportion of people living with chronic hepatitis B who are engaged in care, receiving either treatment or monitoring

The proportion of people living with CHB who are receiving care was calculated using the number of people receiving either treatment or monitoring as the numerator and the modelled number of people living with CHB as the denominator.

The number of people receiving monitoring was obtained from Medicare Benefits Schedule (MBS) records and calculated by assessing the number of individuals who received a viral load test in a given year while not receiving treatment items in the past 12 months, in order to identify those undergoing off-treatment monitoring separately from those monitored during treatment. This number was then combined with the number of individuals who were receiving treatment, to generate the number in care. The number of people receiving treatment was obtained from

PBS records and excludes individuals prescribed lamivudine or tenofovir for HIV infection in combination with other HIV antivirals.

These data do not include services that were not provided by Medicare, such as those paid for by individual patients, or subsidised by state government services. However, previous analyses and comparison with other source data demonstrate that the vast majority of testing and treatment services for patients with hepatitis B are provided through Medicare and included in these estimates[1], with the exception of specific instances discussed and adjusted for such as in SA (see page 23).

4: Estimating the proportion of people living with chronic hepatitis B who are dispensed drugs for the treatment of hepatitis B through the Pharmaceutical Benefits Scheme

The proportion of people living with CHB who are receiving treatment was calculated using the number of people receiving treatment (obtained from PBS data) as the numerator and the modelled number of people living with CHB as the denominator.

The proportion eligible for treatment is derived by dividing the modelled number of people eligible for treatment by the modelled number of all people living with chronic hepatitis B.

5: Estimating the burden of disease attributable to chronic hepatitis B in Australia

The number of deaths attributable to CHB, and specifically due to DC and HCC, in Australia is a direct output of the model.

APPENDIX

Table A 1. Model output for the number of people living with chronic hepatitis B in Australia per year, 1970-2030.

Year	National	ACT	NSW	NT	QLD	SA	TAS	VIC	WA
1970	74745	671	25173	1129	10585	6287	1230	24151	5517
1971	75338	692	25351	1231	10666	6263	1209	24313	5611
1972	75644	712	25428	1335	10718	6218	1185	24380	5668
1973	75034	730	25200	1423	10663	6111	1149	24148	5609
1974	74671	748	25075	1514	10632	6024	1115	23980	5583
1975	74289	762	24957	1596	10546	5917	1082	23848	5580
1976	73185	766	24587	1657	10411	5749	1049	23491	5476
1977	72914	781	24611	1738	10320	5615	1017	23386	5446
1978	73442	801	25019	1833	10294	5517	988	23521	5470
1979	73971	827	25514	1920	10288	5375	957	23642	5449
1980	75356	861	26406	1991	10379	5297	932	23996	5494
1981	77463	902	27509	2047	10586	5310	913	24530	5665
1982	79897	940	28665	2122	10872	5365	897	25098	5938
1983	81530	966	29415	2182	11051	5416	877	25480	6143
1984	82268	990	29778	2253	11080	5433	858	25683	6193
1985	83428	1018	30437	2328	11149	5421	840	25979	6256
1986	85514	1055	31492	2412	11333	5431	825	26491	6475
1987	88434	1104	32946	2495	11598	5456	813	27217	6803
1988	92435	1168	34926	2580	12004	5490	801	28223	7242
1989	96843	1230	37003	2662	12535	5552	789	29307	7766
1990	100026	1286	38518	2737	12894	5580	774	30117	8120
1991	102492	1345	39748	2807	13190	5592	757	30707	8345
1992	104087	1391	40611	2863	13463	5572	737	30991	8460
1993	104117	1411	40758	2907	13546	5497	710	30814	8473
1994	103894	1432	40784	2954	13585	5407	685	30538	8509
1995	104989	1466	41468	3019	13750	5346	664	30630	8646
1996	107101	1496	42674	3091	14027	5318	648	30993	8853
1997	108435	1516	43453	3151	14267	5272	628	31140	9008
1998	109270	1537	43871	3213	14468	5210	611	31214	9146
1999	110578	1563	44513	3289	14698	5157	596	31434	9329
2000	112311	1598	45389	3342	14944	5111	575	31792	9560
2001	114776	1630	46613	3374	15328	5075	566	32317	9874
2002	117396	1660	47804	3401	15934	5047	565	32794	10191
2003	119580	1704	48570	3421	16524	5040	570	33261	10489
2004	123140	1763	49650	3456	17227	5214	620	34306	10905
2005	127742	1817	51118	3492	18052	5542	681	35627	11412
2006	132864	1869	52828	3498	18960	5925	727	37047	12010
2007	139795	1941	55104	3527	20148	6383	780	39052	12859
2008	148927	2046	57949	3617	21806	6933	844	41660	14072
2009	157312	2167	60281	3709	23461	7502	908	44130	15154
2010	162041	2236	61341	3788	24506	7872	945	45421	15931
2011	165309	2285	61897	3863	25334	8074	970	46135	16751
2012	169635	2357	62743	3962	26377	8275	999	47135	17787

2013	174623	2432	64019	4053	27414	8552	1034	48441	18678
2014	179336	2515	65552	4093	28223	8849	1063	49832	19209
2015	184075	2610	67146	4125	28867	9137	1090	51366	19735
2016	189687	2705	69016	4173	29650	9416	1135	53284	20309
2017	195201	2811	71015	4215	30429	9676	1200	55248	20606
2018	199974	2899	72621	4246	31219	9929	1290	56972	20798
2019	205201	2949	73972	4301	32164	10294	1434	58833	21254
2020	204186	2915	73196	4306	32264	10343	1470	58390	21302
2021	200876	2839	72214	4325	31834	10227	1552	56940	20945
2022	205549	2927	73671	4360	32744	10513	1621	58268	21445
2023	213332	3065	75876	4477	34268	11039	1728	60609	22270
2024	219017	3162	77370	4588	35479	11446	1829	62269	22874
2025	223423	3238	78459	4671	36491	11755	1911	63533	23366
2026	227197	3303	79352	4740	37402	12010	1984	64599	23807
2027	230373	3358	80064	4794	38218	12215	2046	65481	24198
2028	232972	3403	80599	4836	38941	12373	2096	66186	24538
2029	235018	3438	80965	4866	39577	12487	2136	66722	24828
2030	236501	3464	81156	4884	40123	12559	2165	67084	25065

Table A 2. Model output for the proportion of people living with chronic hepatitis B in Australia who have been diagnosed, 2010-2022.

Year	National (%)	ACT (%)	NSW (%)	NT (%)	QLD (%)	SA (%)	TAS (%)	VIC (%)	WA (%)
2010	70.8%	62.3%	78.8%	65.4%	74.5%	71.6%	72.7%	64.3%	54.8%
2011	70.3%	62.6%	79.0%	65.0%	71.6%	70.1%	71.1%	65.3%	52.5%
2012	69.6%	62.5%	78.9%	64.5%	68.8%	69.1%	69.8%	65.9%	50.3%
2013	69.0%	62.6%	78.4%	64.2%	66.8%	67.9%	68.5%	66.2%	49.2%
2014	68.6%	62.4%	77.8%	64.8%	65.8%	66.8%	68.0%	66.5%	49.2%
2015	68.3%	62.2%	77.3%	65.4%	65.3%	66.1%	67.7%	66.6%	49.3%
2016	68.0%	62.3%	76.8%	65.7%	64.5%	65.6%	66.5%	66.5%	49.3%
2017	67.8%	62.2%	76.3%	66.1%	64.0%	65.4%	64.8%	66.4%	50.0%
2018	68.0%	62.5%	77.0%	67.3%	64.1%	65.6%	63.1%	65.6%	51.4%
2019	68.1%	63.9%	78.3%	68.3%	64.3%	65.3%	60.3%	64.1%	52.1%
2020	70.2%	66.9%	81.5%	69.9%	66.0%	67.1%	62.7%	65.2%	53.8%
2021	72.7%	70.4%	84.3%	71.1%	68.5%	69.6%	62.8%	67.3%	56.2%
2022	72.1%	69.6%	83.9%	71.9%	68.0%	69.2%	63.6%	66.1%	56.4%

Table A 3. **Model output for the proportion of people living with chronic hepatitis B in Australia who are engaged in care, 2010-2022.**

Year	National (%)	ACT (%)	NSW (%)	NT (%)	QLD (%)	SA (%)	TAS (%)	VIC (%)	WA (%)
2010	8.3%	2.7%	8.7%	1.7%	6.5%	5.1%	4.3%	12.1%	2.1%
2011	13.7%	10.8%	16.5%	2.9%	9.1%	9.6%	7.6%	17.2%	4.3%
2012	16.4%	14.8%	19.3%	10.5%	11.1%	11.9%	8.0%	20.7%	5.9%
2013	19.1%	19.9%	22.0%	14.7%	12.7%	18.7%	10.3%	23.9%	7.2%
2014	22.4%	21.9%	26.6%	17.9%	13.8%	23.0%	12.8%	27.5%	8.3%

2015	22.3%	22.5%	27.2%	21.3%	14.1%	22.8%	17.5%	25.5%	9.7%
2016	23.5%	24.0%	28.3%	20.4%	15.3%	24.4%	19.0%	26.5%	10.9%
2017	24.2%	23.7%	28.4%	22.1%	17.5%	23.4%	21.3%	27.0%	11.3%
2018	25.0%	25.8%	29.7%	28.4%	18.9%	22.5%	19.8%	27.4%	10.7%
2019	25.3%	26.8%	30.1%	26.4%	19.3%	21.6%	18.1%	28.3%	10.9%
2020	24.9%	28.8%	29.6%	26.1%	19.9%	18.9%	18.0%	27.5%	11.5%
2021	26.0%	30.6%	30.7%	24.2%	20.5%	18.4%	19.4%	29.5%	12.5%
2022	25.5%	30.7%	30.6%	23.1%	20.1%	17.0%	17.0%	28.6%	12.8%

Table A 4. **Model output for the proportion of people living with chronic hepatitis B in Australia who are dispensed drugs for the treatment of hepatitis B through the PBS, 2010-2021.**

Year	National (%)	ACT (%)	NSW (%)	NT (%)	QLD (%)	SA (%)	TAS (%)	VIC (%)	WA (%)
2010	3.5%	3.4%	4.7%	1.0%	1.9%	2.6%	1.8%	3.6%	2.0%
2011	3.6%	3.5%	5.0%	1.1%	2.0%	2.7%	1.9%	3.8%	2.1%
2012	4.7%	4.6%	6.8%	1.3%	2.5%	3.6%	2.2%	4.5%	2.3%
2013	6.5%	7.1%	8.8%	1.6%	3.8%	6.1%	3.8%	6.8%	3.3%
2014	8.3%	9.0%	11.3%	2.1%	4.9%	7.8%	4.9%	8.7%	4.2%
2015	8.6%	9.7%	11.5%	4.2%	5.3%	7.2%	6.9%	8.8%	4.9%
2016	9.3%	10.0%	12.1%	4.4%	5.9%	7.6%	7.0%	9.6%	5.4%
2017	9.9%	10.6%	12.6%	5.6%	6.6%	8.3%	7.4%	10.2%	6.0%
2018	10.6%	11.8%	13.2%	7.3%	7.3%	8.7%	8.4%	10.8%	6.7%
2019	11.1%	13.1%	13.8%	9.0%	8.1%	9.5%	7.4%	11.3%	7.2%
2020	11.8%	14.1%	14.2%	9.6%	8.8%	9.9%	8.8%	12.3%	7.7%
2021	12.6%	15.7%	15.1%	10.7%	9.5%	10.9%	9.2%	13.3%	8.5%
2022	12.9%	15.8%	15.4%	11.2%	9.8%	11.1%	9.4%	13.5%	8.7%

Table A 5. Model output for the total number of deaths attributable to chronic hepatitis B in Australia, 2010-2021.

Year	National	ACT	NSW	NT	QLD	SA	TAS	VIC	WA
2010	471	<10	179	12	66	24	<10	137	43
2011	473	<10	177	12	67	24	<10	139	44
2012	470	<10	173	12	67	24	<10	139	45
2013	448	<10	163	12	65	22	<10	133	44
2014	435	<10	156	12	65	21	<10	128	44
2015	432	<10	155	12	65	20	<10	127	45
2016	433	<10	155	12	65	20	<10	127	46
2017	436	<10	156	12	66	20	<10	127	47
2018	440	<10	157	11	67	21	<10	129	48
2019	446	<10	158	11	68	21	<10	130	49
2020	454	<10	161	11	69	21	<10	133	50
2021	463	<10	163	11	71	22	<10	137	51
2022	466	<10	163	11	71	22	<10	138	51

Table A 6. Model output for the total number of HCC deaths attributable to chronic hepatitis B in Australia, 2010-2022.

Year	National	ACT	NSW	NT	QLD	SA	TAS	VIC	WA
2010	350	<10	135	<10	48	17	<10	103	31
2011	355	<10	135	<10	49	18	<10	104	32
2012	356	<10	134	<10	50	18	<10	105	33
2013	349	<10	130	<10	50	17	<10	103	33
2014	346	<10	128	<10	51	17	<10	102	34
2015	348	<10	128	<10	51	16	<10	102	35
2016	351	<10	129	<10	52	17	<10	102	36
2017	356	<10	131	<10	53	17	<10	104	36
2018	362	<10	133	<10	54	17	<10	105	37
2019	369	<10	135	<10	55	17	<10	107	38
2020	378	<10	137	<10	57	18	<10	110	39
2021	387	<10	140	<10	58	18	<10	113	40
2022	391	<10	141	<10	59	18	<10	115	41

Table A 7. Model output for the total number of DC deaths attributable to chronic hepatitis B in Australia, 2010-2022.

Year	National	ACT	NSW	NT	QLD	SA	TAS	VIC	WA
2010	120	<10	44	<10	18	<10	<10	34	12
2011	119	<10	42	<10	18	<10	<10	35	12
2012	114	<10	39	<10	17	<10	<10	34	12
2013	99	<10	33	<10	16	<10	<10	30	11
2014	89	<10	28	<10	14	<10	<10	27	10
2015	85	<10	27	<10	14	<10	<10	25	10
2016	82	<10	26	<10	13	<10	<10	24	10
2017	80	<10	25	<10	13	<10	<10	24	10
2018	78	<10	24	<10	13	<10	<10	23	10
2019	77	<10	24	<10	13	<10	<10	23	10
2020	77	<10	23	<10	13	<10	<10	23	10
2021	76	<10	23	<10	12	<10	<10	23	10
2022	75	<10	22	<10	12	<10	<10	23	10

Figure A 1. Estimated proportion of people living with chronic hepatitis B in each phase of infection by age group, 2022.

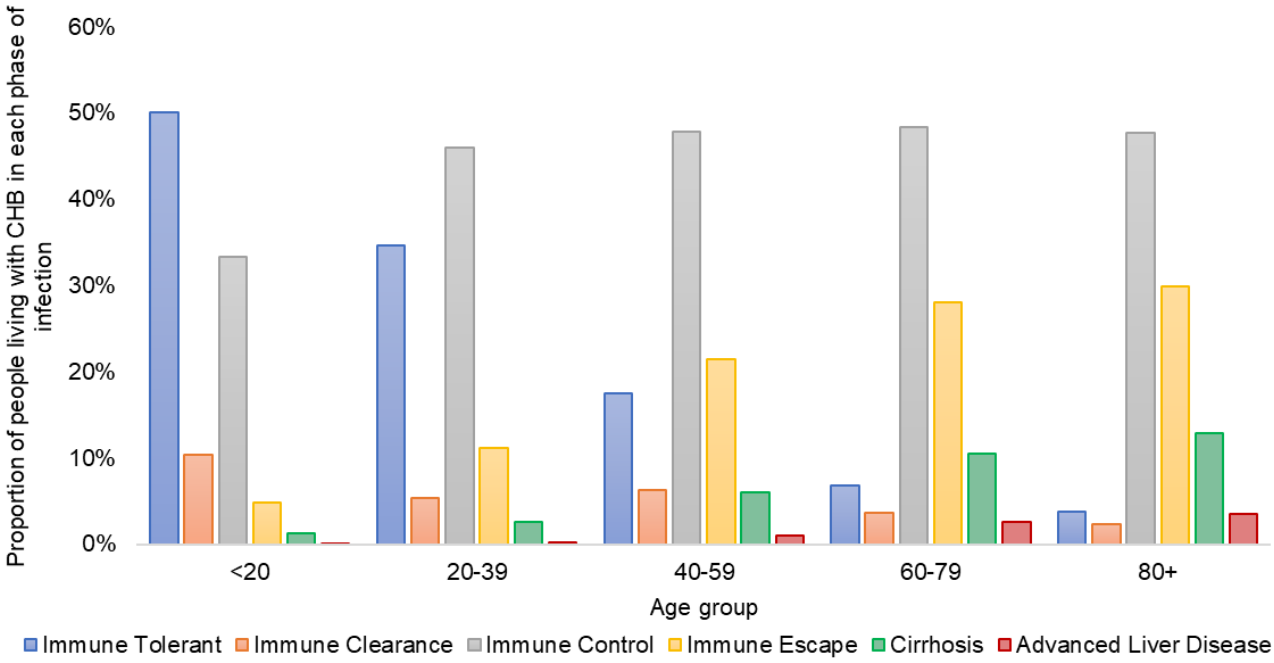
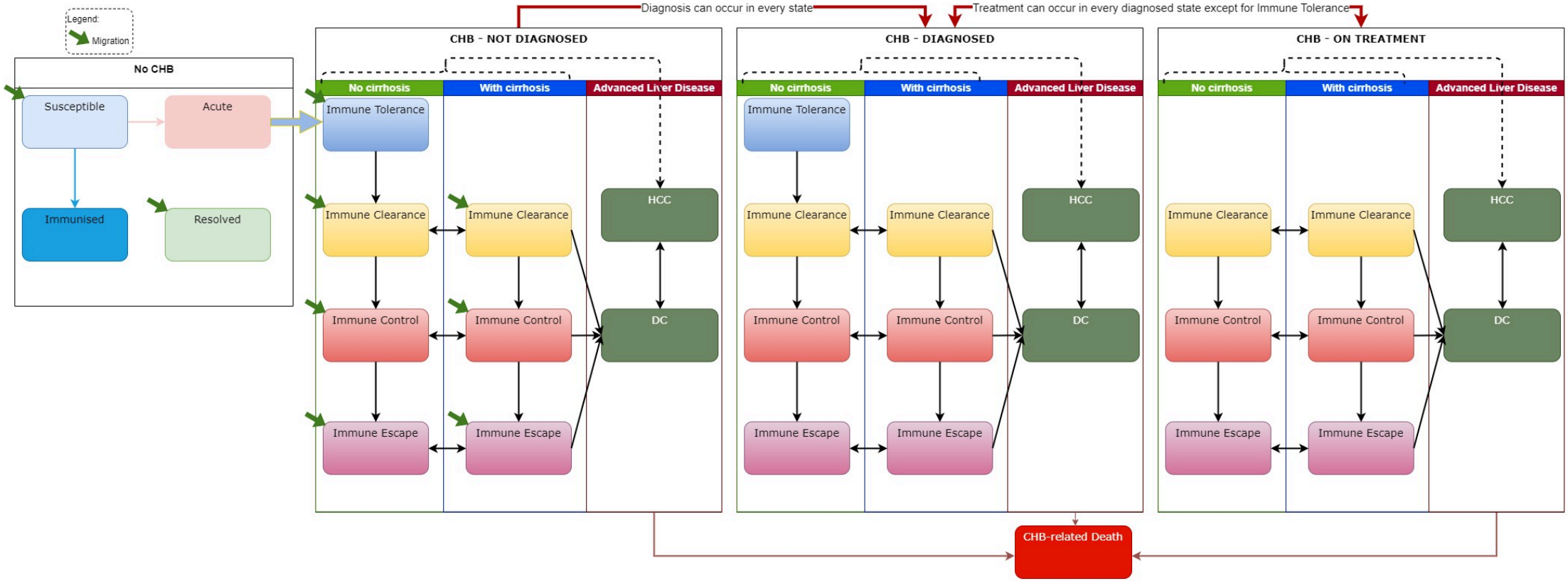


Figure A 2. Schematic diagram of the mathematical model describing the progression of hepatitis B infection and indicating key transitions.



Chronic hepatitis B phases are within the boxes. HCC = hepatocellular carcinoma; DC = decompensated cirrhosis. Coloured arrows represent transitions between states. Each health state is stratefied by age. Resolution of infection is possible from acute infection and from CHB phases and results in the transition into the resolved state.

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