

Chronic hepatitis B prevalence in Australian Aboriginal and Torres Strait Islander people before and after implementing a universal vaccination program: a systematic review and meta-analysis

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Abstract. *Background:* A higher prevalence of chronic hepatitis B (CHB) has been reported in Aboriginal and Torres Strait Islander (Aboriginal) compared with non-Aboriginal Australians. An Australian infant and adolescent hepatitis B virus (HBV) vaccination program was implemented in 2000. Meta-analysis methods will be used to examine if the pooled prevalence of CHB decreased after 2000 among Aboriginal Australians. *Methods:* Embase, Medline and Web of Science were searched from 1 January 1981 to 29 March 2018 and all issues of the Northern Territory and New South Wales Public Health Bulletins. Studies needed to report the number of individuals who were tested and tested positive for hepatitis B surface antigen (HBsAg). *Results:* There were 36 studies; 16 before and 20 after 2000; reporting 84 prevalence estimates. Population groups included: adults (14 studies), pregnant women (13 studies), prisoners (five studies) children or teenagers (10 studies) and infants (two studies). The pooled prevalence of HBsAg decreased overall (from 10.8% before 2000 vs 3.5% after 2000), in women (4.2% vs 2.2%), in males (17.5% vs 3.5%), in regional (7.8% vs 3.9%) and remote (14.4% vs 5.7%) areas, in New South Wales (12.3% vs 3.0%), in the Northern Territory (6.1% vs 5.1%), in adults (15.3% vs 4.3%) and in pregnant women (3.6% vs 2.6%). *Conclusion:* The prevalence of HBsAg decreased among Aboriginal people after 2000.

Additional keywords: Australia, hepatitis B surface antigen, hepatitis B virus, Indigenous, sexually transmissible infection.

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Introduction

Chronic hepatitis B (CHB) infection is the leading cause of liver cirrhosis and cancer globally and results in hundreds of thousands of deaths annually.¹ The hepatitis B virus (HBV) can be transmitted through sharing needles and syringes, sex without a condom or from mother to child during pregnancy or birth.² CHB infection is defined as testing positive for hepatitis B surface antigen (HBsAg) two times within a six-month period.² Progression from acute to chronic infection is influenced by the age at which an individual was infected.³ Approximately 95% of newborn babies infected with HBV

develop CHB; in contrast, only 5% of adults infected with HBV develop CHB.³ If left untreated, 15–40% of people living with CHB will develop liver related complications.^{4,5}

Aboriginal and Torres Strait Islanders (Aboriginal) are the first peoples of Australia and have a strong and resilient history.⁶ In 2016, there were an estimated 787 000 Aboriginal people; 3.3% of the Australian population.⁷ In Australia, Aboriginal compared with non-Aboriginal people have higher rates of infant mortality, cardiovascular and musculoskeletal diseases, psychological distress, chronic ear infections, tobacco smoking, unemployment; and have lower levels of home ownership,

school completion and life expectancy.^{7,8} To reduce the poor health outcomes associated with CHB infection, the Australian government has released the *Third National Hepatitis B Strategy 2018–22*.⁹ Additionally, the *Australian National Immunisation Strategy 2013–18* provides a schedule of when infants, children and adults should be vaccinated against hepatitis B and sets a target of 95% HBV vaccination coverage for infants born in Australia.¹⁰

In Australia, the prevalence of CHB is estimated to be 1%.¹¹ Aboriginal people account for 11% of people living with CHB,¹² despite comprising 3.3% of the Australian population.⁷ The incidence of poor CHB-related outcomes such as hepatocellular carcinoma (HCC) are up to eight-fold higher in Aboriginal compared with non-Aboriginal people.¹³ Clinical guidelines recommend regular monitoring of people living with CHB and treatment for those with severe liver disease;^{2,14} however, only 15% of people living with CHB are estimated to be receiving care and just 6% receive treatment (compared with the target of 15%). Although no population-level information is available regarding treatment uptake in Aboriginal Australians, treatment rates are lowest in regional and remote areas of Australia, and access disparities are likely to disproportionality affect these communities.¹⁵

The HBV vaccine can reduce perinatal transmission of HBV¹⁶ and future HBV-related deaths in endemic areas by 90%.¹⁷ In 2000, a publicly funded universal infant HBV vaccination program commenced in Australia.¹⁸ A universal vaccination program is when a government offers a vaccine free to a population with the aim to eradicate or significantly decrease the incidence of a disease and indirectly reduce the poor health outcomes or mortality associated with that disease.¹⁹ A systematic review published in 2013 reported the pooled prevalence of HBsAg in Aboriginal people had decreased from 16.7% before compared with 3.9% after 2000.²⁰ The same review reported that after 2000, the pooled prevalence of HBsAg was 0.9% in non-Aboriginal people.²⁰ Due to a lack of published studies, the review published in 2013 could not stratify the pooled prevalence of HBsAg by sex, state and territory, population groups and geographical location. However, since 2013, several new studies have been published reporting the prevalence of CHB in Aboriginal people in Australia. As a result, we aim to update the estimates reported in the previous review and stratify CHB by the above mentioned factors. Findings from our review will inform testing and management of CHB in Aboriginal people in Australia, and be included in models used to assess progress in access to care and prevention of poor health outcomes.¹²

Methods

This review was conducted according to the *Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement*.²¹

Primary and secondary outcomes

The primary outcome was the prevalence of HBsAg among Aboriginal people in Australia before compared with after the implementation of the Australian universal HBV vaccination program in 2000.

Secondary outcomes included the prevalence of HBsAg before compared with after 2000 by sex (women, men), geographical location (urban, regional, remote), state or territory (New South Wales (NSW), Northern Territory (NT), Queensland (Qld), South Australia (SA), Western Australia (WA), Victoria (Vic.), Tasmania (Tas.), Australian Capital Territory (ACT)) and population group (pregnant women, prisoners, adults, children or teenagers and infants). This review used the geographical location categories of urban, regional and remote as defined by the Australian Statistical Geography Standard (ASGS): Volume 4 - Significant Urban Areas, Urban Centres and Localities.²² Urban is defined as a significant town or city of 20 000 people or more (e.g. Sydney); regional is defined as a town located outside the urban area that provides a central point to access essential infrastructure, services, business, employment and education for local residents as well as those in surrounding smaller towns; and remote is defined as a town with limited infrastructure, services, business, employment and education for local residents.²²

Search strategy

On 29 March 2018, the first author met with a librarian at the London School of Hygiene and Tropical Medicine who specialises in literature search strategies. This meeting resulted in the identification of the appropriate electronic databases, the development of appropriate *Medical Subject Headings* (MeSH), truncation of the MeSH words and what combinations to use and when (e.g. 'OR', 'AND'). On 30 March 2018, the first author searched the electronic databases Embase, Medline and Web of Science from 1 January 1981 to 29 March 2018. On 5 April 2018, the first author searched for relevant studies in all issues of public health bulletins in those states and territories that produce them (NT and NSW). The NT Public Health Bulletin and NSW Public Health Research and Practice were included in our search due to three reasons: (1) they were included in the 2013 systematic review and to sustain consistency, we included them in this review; (2) papers submitted undergo an independent review process similar to papers submitted to journals; and (3) papers published in the NSW Public Health Research and Practice are included in results when searching through the electronic database, PubMed.

The below MeSH words were used. Table S1, available as Supplementary Material to this paper, provides a breakdown of the MeSH words, truncation and combinations used in the three electronic databases mentioned above.

- (1) Hepatitis B OR hepatitis B surface antigen OR HBV OR HBsAg; AND
- (2) Aboriginal OR Indigenous; AND
- (3) Australia

Inclusion and exclusion criteria

Studies were excluded if they reported a combined prevalence of HBsAg in Aboriginal and non-Aboriginal people, if they reported the prevalence of HBsAg in non-Aboriginal people only, were reviews, guidelines or commentaries, did not present primary data or were not in English. Surveillance reports were excluded as they do not report prevalence and to maintain consistency with the 2013 systematic review. If only the

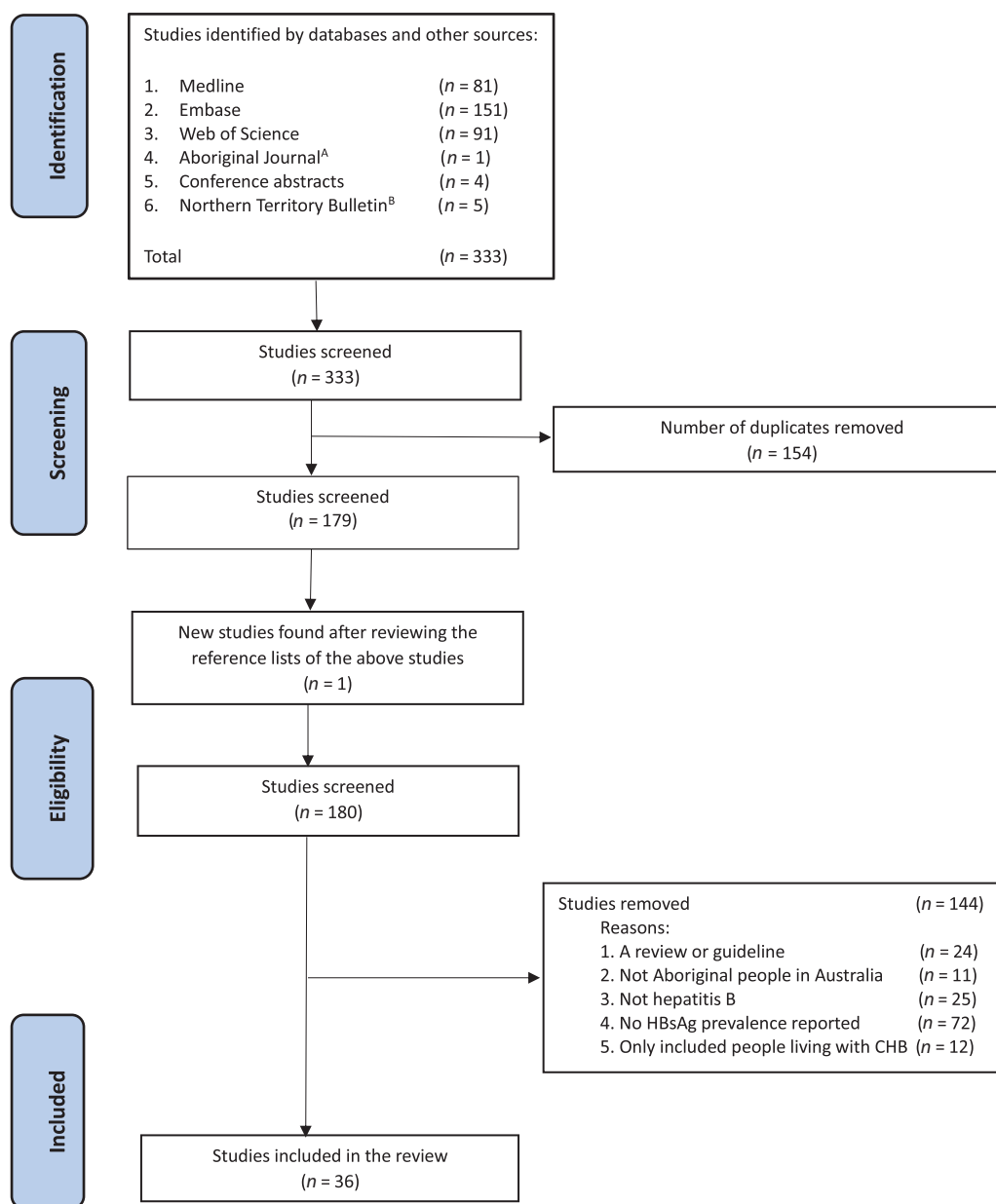


Fig. 1. Flow diagram of included studies. ^A, *Aboriginal and Islander Health Journal*; ^B, *Northern Territory Public Health Bulletin*; HBsAg, hepatitis B surface antigen; CHB, chronic hepatitis B.

abstract could be accessed, the first author contacted the first author of the paper or presentation to assess the full version. We included studies published since 1 January 1981 so that we could compare equal time-periods before and after the introduction of the universal HBV vaccination program in Australia. Reference lists of included studies were examined for additional studies (Fig. 1).

Data extraction

The studies were reviewed and information was extracted by the first author and the second author reviewed the studies to assess their inclusion. The first and second author then discussed the

included and excluded studies and came to a consensus on the final included studies. Data from each study were extracted and entered into a template in Microsoft Excel 2016²³ (Microsoft Corporation, Redmond, WA, USA) to ensure consistency of the extraction and that all data were entered in the same format. Studies were labelled as being conducted before or after 2000. For each study that met the inclusion criteria, information was extracted on: author, year the study was published, years the study was conducted, state or territory, study design, sex, age group, number of individuals testing positive for HBsAg, number of individuals tested for HBsAg, HBsAg prevalence and 95% confidence intervals (CIs). The previous systematic review of CHB in Aboriginal Australians identified several

population groups and, to maintain consistency, we used the same population groups: pregnant women, prisoners, adults, children or teenagers and infants. We defined infants as 0–1 years old and children or teenagers as 2–19 years old. If studies did not report 95% CIs, the first author calculated them using the Exact Binomial Method. The analysis was performed using STATA 15 statistical software (STATA Corporation, College Station, TX, USA).²⁴

Meta-analysis

A meta-analysis was conducted to estimate the pooled prevalence of HBsAg before compared with after 2000 stratified by sex, population group, state or territory and geographical location. Meta-analyses were conducted where there was a sufficient number of studies before compared with after 2000, using a threshold of three or more. Where sufficient studies were available in one time period but not for another in a specific subgroup, comparisons were not made, but the available prevalence estimate was reported (e.g. three or more studies reported the prevalence of HBsAg in urban areas before 2000 but not in urban areas after 2000). The meta-analysis was conducted using weighted inverse variance methods, the DerSimonian–Laird method²⁵ assuming a random-effects model. We used the I^2 to estimate the approximate proportion of total variability in point estimates that could be attributed to heterogeneity other than that due to chance.²⁶

Further information from included studies

The first author also extracted further information from each study about the selection of participants, the laboratory test used and the sample size (Table S2).

Results

Included studies

Overall, there were 36 studies reporting 84 HBsAg estimates.^{27–62} Among the 36 studies, four were conducted in urban areas,^{28,37,40,43} 10 in regional,^{30,34,38,41,44–47,49,55} seven in remote,^{27,33,35,42,52–54} 12 were conducted in multiple geographical locations or were national analyses with no breakdown by location^{29,36,39,50,51,56–62} and two did not provide enough information to determine a geographical location.^{32,43} There were two studies conducted in SA,^{27,37} four in WA,^{29,30,33,48} five in Qld,^{39,41,42,44,52} nine in NSW,^{28,32,34,38,40,43,50,55,62} 13 in NT,^{35,36,45–47,49,51,53,54,56–58,61} and two included samples from multiple states or territories.^{59,60} In total, 16 studies were conducted before^{27–42} and 20 after 2000,^{43–62} and two studies published after 2000 reported the prevalence of HBsAg before compared with after 2000.^{57,62} Two studies were conducted in schools,^{33,36} five in prisons or juvenile detention centres,^{40,48,50,55,60} eight were random samples in Aboriginal communities,^{31,32,34,35,39,41,42,54} four were analyses of stored blood specimens or laboratory data,^{27,43,58,61} seven were clinical audits of electronic hospital or Aboriginal primary healthcare service records,^{44,45,47,49,52,53,59} and eight were data analyses of notification data or were data linkage studies of notification data with midwifery datasets or analyses of sexual health clinic data.^{28,30,37,46,51,56,57,62}

The 36 studies reported prevalence estimates in several population groups including: 14 in adults,^{27,29,32,35,37,38,43,47,52,53,56,58,59,61} 13 in pregnant women,^{28,30,39,41,43–46,49,51,57,59,62} 10 in children or teenagers,^{29,32–37,41,42,54} five in prisoners,^{40,48,50,55,60} and two in infants (Table 1).^{29,34} These numbers do not total 36 because eight studies reported the prevalence of HBsAg in multiple population groups (Table 1).^{29,32,34,35,37,41,43,59} Some examples of these studies were: Harrod *et al.* (adults and pregnant women),⁵⁹ Hart (children or teenagers and adults),³⁷ Holman *et al.* (children or teenagers and adults)²⁹ and Campbell *et al.* (infants and children or teenagers).³⁴ Also, some studies reported the prevalence of HBsAg in one population group, but included a breakdown by age groups; these included, Gill *et al.* (children or teenagers by age groups)³³ and Wood *et al.* (pregnant women by age groups).⁵¹ A study by Patterson *et al.* reported the prevalence of HBsAg among Aboriginal adults in two time periods; 1983–84 and 1987–88.³⁸

Meta-analysis

Overall, the pooled prevalence of HBsAg decreased among Aboriginal people (10.8% before vs 3.5% after 2000; Fig. 2).

Sex

The pooled prevalence of HBsAg decreased among women (4.2% vs 2.2%, Fig. 3) and men (17.5% vs 3.5%, Fig. S1 available as Supplementary Material to this paper).

Geographical location

The pooled prevalence of HBsAg decreased in regional (7.8% vs 3.9%, Fig. S2) and remote (14.4% vs 5.7%, Fig. S3) areas. Before 2000, the pooled prevalence of HBsAg among Aboriginal people in urban areas was 20.5% (data not shown; insufficient studies for pooled prevalence after 2000).

State

The pooled prevalence of HBsAg decreased in NSW (12.3% vs 3.0%, Fig. S4) and the NT (6.1% vs 5.1%, Fig. S5). Among studies before 2000, the pooled prevalence of HBsAg was 4.4% in WA and 13.7% in Qld (data not shown; insufficient studies for pooled prevalence after 2000).

Population groups

The pooled prevalence of HBsAg decreased in adults (15.3% vs 4.3%, Fig. S6) and pregnant women (3.6% vs. 2.6%, Fig. S7). Before 2000, the pooled prevalence of HBsAg among children or teenagers was 9.6% (data not shown; insufficient studies for pooled prevalence after 2000). After 2000, the pooled prevalence of HBsAg among Aboriginal prisoners was 4.1% (data not shown; insufficient studies for pooled prevalence before 2000).

Further information about each study

Further information about each study can be found in Table S2. Eighteen studies reported a prevalence of HBsAg using convenient data sources such as stored blood specimens,

Table 1. Chronic hepatitis B prevalence among Aboriginal people in Australia by population group

A study may appear twice because it reported a hepatitis B surface antigen (HBsAg) prevalence in two different populations or a HBsAg prevalence in two different time periods. CI, confidence interval; N/S, not stated; NSW, New South Wales; NT, Northern Territory; Qld, Queensland; SA, South Australia; WA, Western Australia; W, women/girls; M, men

Population group	Author and year published	Years study conducted	State ^A	Study design	Sex	Age group (years)	Geographical location ^B	Number positive ^C	Number tested ^D	Prevalence (%)	95% CI
Pregnant women	Moore <i>et al.</i> 1987 ³⁰	1983–85	WA	Cross-sectional	W	N/S	Non-urban	29	816	3.6	2.4–5.1
	Panaretto <i>et al.</i> 2006 ⁴⁴	2000–03	Qld	Longitudinal	W	15–40	Regional	2	419	0.5	0.2–2.1
	Wood <i>et al.</i> 2008 ⁵¹	2002–04	NT	Cross-sectional	W	10–50	Non-urban	29	522	5.5	3.7–7.9
	Romanes <i>et al.</i> 2006 ⁴⁵	2003	NT	Cross-sectional	W	15–47	Regional	22	540	4.1	2.6–6.1
	Schultz 2007 ⁴⁶	2005	NT	Cross-sectional	W	N/S	Regional	14	432	3.2	1.8–5.4
	Schultz <i>et al.</i> 2008 ⁴⁹	2003 and 2005	NT	Cross-sectional	W	15+	Regional	36	973	3.7	2.6–5.1
	O'Sullivan <i>et al.</i> 2004 ⁴³	1998–2000	NSW	Cross-sectional	W	20–39	Urban and remote	6	266	2.3	0.8–4.8
	Hanna <i>et al.</i> 1997 ⁴¹	N/S	Qld	Cross-sectional	W	N/S	Multi	29	211	13.7	9.4–19.1
	Deng <i>et al.</i> 2017 ⁶²	N/S	NSW	Cross-sectional	W	10–55	Multi	93	11738	0.7	0.6–1.0
	Hanna <i>et al.</i> 1995 ³⁹	N/S	Qld	Cross-sectional	W	N/S	Regional/remote	3	97	3.1	0.6–8.7
	Harrod <i>et al.</i> 2014 ⁵⁹	2009–13	Multi	Cross-sectional	W	15–54	Multi	6	329	1.8	0.4–3.3
	Liu <i>et al.</i> 2012 ⁵⁷	2005–10	NT	Cross-sectional	W	N/S	Regional/remote	136	5678	2.4	2.0–2.8
	Prisoners	Britton <i>et al.</i> 1985 ²⁸	1983–84	NSW	Cross-sectional	W	N/S	Urban	6	67	9.0
van der Poorten <i>et al.</i> 2008 ⁵⁰		2002–05	NSW	Cross-sectional	M	12–19	Multi	6	179	3.4	1.3–7.1 ^E
Butler <i>et al.</i> 1997 ⁴⁰		1994	NSW	Cross-sectional	M	17–73	Urban	5	12	42.0	15.2–72.3
Templeton <i>et al.</i> 2010 ⁵⁵		2000–04	NSW	Cross-sectional	M	14–20	Regional	12	101	11.3	6.3–19.8
Gilles <i>et al.</i> 2008 ⁴⁸		2006	WA	Cross-sectional	W/M	20–50	Regional	5	155	3.0	1.1–7.4
Adults	Reekie <i>et al.</i> 2014 ⁶⁰	2004, 2007, 2010	Multi state	Cross-sectional	W/M	N/S	Multi	12	316	3.8	2.0–6.5
	O'Sullivan <i>et al.</i> 2004 ⁴³	1998–2000	NSW	Cross-sectional	W	20–39	Urban and remote	6	266	2.3	0.8–4.8
	Burrell <i>et al.</i> 1983 ²⁷	1979–82	SA	Cross-sectional	W/M	N/S	Remote	85	327	26.0	21.3–31.1 ^E
	Holman <i>et al.</i> 1987 ²⁹	May–Sept 1986	WA	Cross-sectional	W/M	N/S	Multi	27	973	2.8	1.8–4.0 ^E
	Campbell <i>et al.</i> 1989 ³²	Nov 1985	NSW	Cross-sectional	W/M	N/S	N/S	72	375	19.2	15.3–23.5 ^E
	Patterson <i>et al.</i> 1993 ³⁸	1983–84	NSW	Cross-sectional	W/M	N/S	Regional	40	236	16.9	12.3–22.3 ^E
	Patterson <i>et al.</i> 1993 ³⁸	1987–88	NSW	Cross-sectional	W/M	N/S	Regional	11	212	5.2	2.6–9.1
	Carroll and Davis 2010 ⁵²	2008	Qld	Cross-sectional	W/M	15–54	Remote	1	107	0.9	0.02–5.1
	Carroll <i>et al.</i> 2010 ⁵³	2008	NT	Cross-sectional	W/M	15–54	Remote	9	76	11.9	6.3–19.0
	Aratchige <i>et al.</i> 2012 ⁵⁶	1990–11	NT	Cross-sectional	W/M	N/S	Multi	1871	70338	2.6	2.5–2.8
	Davies <i>et al.</i> 2017 ⁶¹	1991–2011	NT	Cross-sectional	W/M	N/S	Multi	713	11 730	6.1	5.6–6.5
	Einsiedel <i>et al.</i> 2008 ⁴⁷	2000–05	NT	Cross-sectional	W/M	>15	Regional	10	209	4.7	2.3–8.6
	Einsiedel <i>et al.</i> 2013 ⁵⁸	2003–07	NT	Cross-sectional	W/M	>15	Regional/remote	49	558	12.9	6.6–11.4
	O'Sullivan <i>et al.</i> 2004 ⁴³	1998–2000	NSW	Cross-sectional	W/M	N/S	Urban	5636	281 816	2.0	1.9–2.1
	O'Sullivan <i>et al.</i> 2004 ⁴³	1998–2000	NSW	Cross-sectional	W/M	N/S	Remote	8339	104 233	8.0	1.9–2.1
	Harrod <i>et al.</i> 2014 ⁵⁹	2009–13	Multi	Cross-sectional	W/M	15–54	Multi	34	865	3.9	7.8–8.2
	Hart 1993 ³⁷	1988–91	SA	Cross-sectional	W/M	15–34	Urban	608	2555	23.8	0.7–3.9
	Gill <i>et al.</i> 1990 ³³	1988	WA	Cross-sectional	W/M	10–19	Regional	17	277	6.1	3.6–9.6 ^E
	Van Buynder <i>et al.</i> 1991 ³⁵	1990	NT	Cross-sectional	W/M	N/S	Remote	30	327	9.1	6.3–12.8
	Children and teenagers	Campbell <i>et al.</i> 1989 ³²	Nov 1985	NSW	Cross-sectional	W/M	N/S	N/S	11	89	12.0
Campbell <i>et al.</i> 1991 ³⁴		1992	NSW	Cross-sectional	W/M	0–16	Regional	43	297	14.5	3.9–31.7
Gardner <i>et al.</i> 1992 ³⁶		1992	NT	Cross-sectional	W/M	9–17	Multi	24	403	6.0	3.8–8.7
Dent <i>et al.</i> 2010 ⁵⁴		1989–90	NT	Cross-sectional	W/M	14–15	Remote	4	37	11.1	3.0–25.4
Malcolm <i>et al.</i> 2000 ⁴²		1999	Qld	Cross-sectional	W/M	14–18	Remote	25	108	26.0	17.9–35.2
Holman <i>et al.</i> 1987 ²⁹		May–Sept 1986	WA	Cross-sectional	W/M	12–19	Multi	8	177	4.5	2.0–8.7
Hanna <i>et al.</i> 1997 ⁴¹		N/S	Qld	Cross-sectional	W/M	3–7	Regional	4	239	1.7	0.5–4.2
Hart 1993 ³⁷		1988–1991	SA	Cross-sectional	W/M	15–19	Urban	8	39	20.5	9.3–36.5
Van Buynder <i>et al.</i> 1991 ³⁵		1990	NT	Cross-sectional	W/M	N/S	Remote	14	180	7.7	4.3–12.7
Infants		Campbell <i>et al.</i> 1991 ³⁴	1992	NSW	Cross-sectional	W/M	0–1	Regional	4	29	13.8
	Holman <i>et al.</i> 1987 ²⁹	May–Sept 1986	WA	Cross-sectional	W/M	0–1	Multi	7	703	1.0	0.4–2.0

^AMulti – multiple states were included.

^BMulti – multiple geographical locations.

^CNumber positive for hepatitis B surface antigen.

^DNumber tested for hepatitis B surface antigen.

^EAuthor calculated the 95% CI.

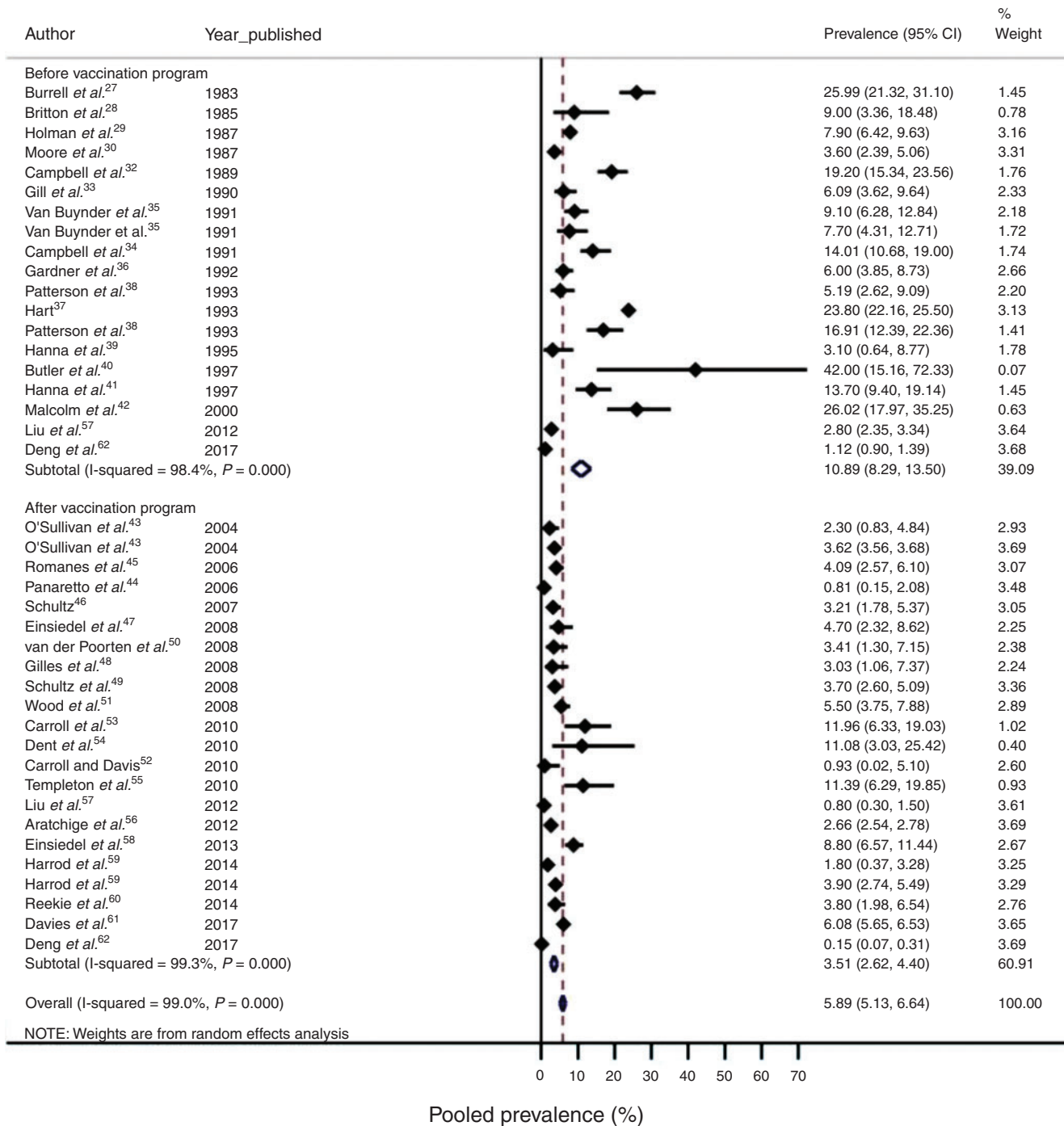


Fig. 2. Hepatitis B surface antigen (HBsAg) prevalence in Aboriginal people before compared with after 2000. CI, confidence interval. Note: a study may appear twice because it reported a HBsAg prevalence in two different populations or a HBsAg prevalence in two different time periods.

state, territory or national notification data, or midwifery, clinic or hospital data.^{27,28,30,37,43,45–47,49,51–53,56–59,61,62} These analyses increase the risk of selection bias and potentially only included those at higher risk of infection rather than a random sample of participants. The only exception of this would be large state or territory midwifery data, as a very high proportion of pregnant women in Australia are routinely tested for HBsAg in the lead up to giving birth. Of the 14 studies

that recruited individuals in their study,^{32–36,38–42,48,50,53–55,60} only five reported participation rates.^{36,40,48,50,53}

Discussion

This review provides an update of the pooled prevalence of HBsAg among Aboriginal people in Australia, with the pooled prevalence decreasing from 10.8% before to 3.5% after 2000.

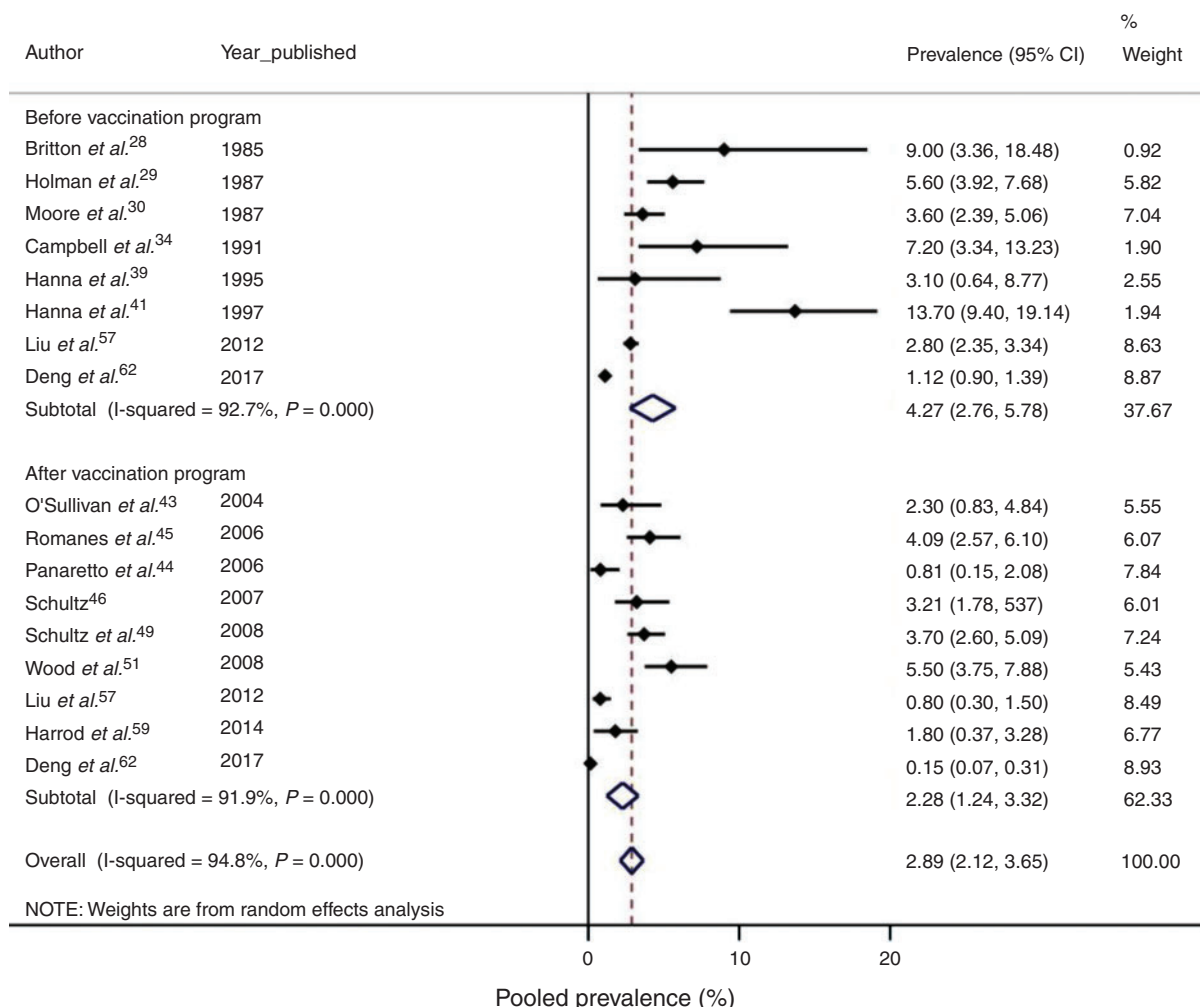


Fig. 3. Hepatitis B surface antigen (HBsAg) prevalence among Aboriginal women before compared with after 2000. CI, confidence interval. Note: a study may appear twice because it reported a HBsAg prevalence in two different populations or a HBsAg prevalence in two different time periods.

The previous review published in 2013 included 22 studies, and this review found 36 studies that strengthens the evidence base with 14 additional studies.^{28,35,37,39–41,43,47,56–62} As a result, this review was able to stratify the data by sex, state and territory and population groups. This study highlights the variation in the burden of CHB both over time (before and after 2000) and across geographic locations and subgroups. There is evidence of a reduction in the prevalence of HBsAg and that the universal vaccination program has had an effect among all population groups, most notably among adults and those living in regional areas of Australia. The findings also highlight the effect of how participants were selected in each study and how this may influence the prevalence estimate, with high heterogeneity between individual studies among most subgroups. When assessed according to population groups with sufficient data for comparison, a higher pooled prevalence was observed among men, those living in remote areas and among those living in the NT.

Before and after 2000, the pooled prevalence among men was higher than among women. This reflects the epidemiology

of hepatitis B, as a higher prevalence in men has been consistently observed in other studies.⁶³ However, the higher pooled prevalence among men could be influenced by the settings in which these studies were conducted, such as men in prison.^{40,64} The pooled prevalence among women was largely influenced by studies among pregnant women,^{51,57,62} which are less likely to be affected by bias or risk-based testing patterns given the very high uptake of antenatal screening in Australia.^{65,66} The prevalence among pregnant women after 2000 in this study (3.6%) was similar to that of a previously published systematic review (3.9%).²⁰ This supports the validity of those estimates in their usage as the current seroprevalence of CHB in the Aboriginal population.^{9,12,15,67} It also reinforces the higher prevalence of CHB in Aboriginal compared with the non-Aboriginal people in Australia, which has been estimated at <1%.^{15,20}

Our study highlights the variation in prevalence of HBsAg, ranging from 0.1%⁶² to 42.0%.⁴⁰ The study that reported the highest prevalence of HBsAg (42%) was a study conducted in 1997 in NSW in an urban prison.⁴⁰ This study had a very small

sample of 12 Aboriginal prisoners and had a high degree of selection bias as people in prison have increased risk factors for testing positive for HBsAg compared with the general population.⁶⁴ In contrast, there were four other studies among Aboriginal prisoners that had larger sample sizes, and the prevalence of HBsAg ranged between 3.0% and 11.3%,^{48,50,55,60} which is substantially lower compared with the study conducted in 1997; this highlights two factors, first that prisoners and people with a history of being in prison have a higher risk of CHB and second that the range of prevalence is varied with prison populations.

The observed higher prevalence in the NT after 2000 reflects other epidemiological evidence of the burden of CHB in Aboriginal people in that state. In the NT, the rate of liver cancer, a major adverse outcome of CHB infection, is six- to eight-fold higher in Aboriginal compared with non-Aboriginal people, and CHB is the most common risk factor.^{68,69} This effect is larger than the already elevated incidence rate ratio for Aboriginal compared with non-Aboriginal people (2.5-fold higher) for liver cancer at the national level.⁷⁰ In our study, there was also less evidence of the decline in prevalence of HBsAg in the NT compared with NSW. Another factor that might be influencing the high rates of CHB in the NT compared with NSW both before and after 2000 is the population distribution of Aboriginal people. According to the Australian Census, 48.8% of Aboriginal people in the NT live in regional or remote areas compared with 14.1% of Aboriginal people in NSW living in regional or remote areas.⁷¹ A higher prevalence may reflect historical challenges in access to effective immunisation for communities in the NT, and highlights that Aboriginal people living with CHB in regional or remote areas of the NT will need access to CHB services including treatment in regional or remote areas.⁵⁴

The smallest variation in prevalence within the population groups was among pregnant women, both between studies and during the before and after 2000 time periods. This may reflect a diminished effect of selection bias, as nearly all pregnant women receive testing for HBV and, as a result, the prevalence estimates reported among pregnant women are less likely influenced by risk-based testing for HBV. The prevalence of HBsAg has been lower in women compared with men,⁶³ and is also likely to be lower in those women included in antenatal studies (most commonly aged 25–35 years),⁷² and so may not be representative of the population overall. However, pregnant women represent a useful population group for tracking variation over time and according to geographic location due to the high participation and lack of selection biases, and are often the source of population-level serosurvey information at a global level.⁷³ The findings presented here help to quantify the differential between pregnant women and other population groups, and can be used for the purposes of adjusting estimates to better reflect the total population.¹²

Limitations

There are some limitations to be considered when interpreting our findings. Many of the studies were clinical audits conducted in Aboriginal primary healthcare services and thus the findings

could be influenced by the screening protocols in these health services. This could potentially overestimate HBsAg prevalence if clinicians are offering HBV testing based on risk factors or symptoms rather than conducting universal screening, a bias that was unable to be directly assessed given participation rates were often not reported. The effect of these biases may apply differentially according to population groups, such as sex and geographical location, and this should be considered when interpreting variations between these groups. Many of the studies were conducted in regional or remote areas, so results may not be generalisable to Aboriginal people living in urban areas. Including Aboriginal people living in urban areas is important for future studies as the 2016 Australian Census highlights that the Aboriginal population has slowly become more urbanised since 1996.^{8,71} Also, we did not include grey literature in our review. We acknowledge that there may have been some overlap of participants between studies in our review; for example, an analysis of pregnant women attending the Royal Alice Springs Hospital in the NT could have overlapped with another study that used a midwifery database of all pregnant women who gave birth in the NT.

Our review may have missed some unpublished projects or programs that were developed and implemented by individual Aboriginal communities. These local programs often focus on improving local health and wellbeing of their community rather than aiming to expand to a national program or for publication in the scientific literature through journals. The value of publishing in journals to the local Aboriginal communities may be limited given the time commitment required to publish papers and the time constraints on local staff to read journal papers. Also, Aboriginal communities disseminate and share their programs through other ways than publishing, such as personal and community relationships between communities and through relationships with Aboriginal state and national organisations that regularly visit Aboriginal communities such as the Aboriginal Health and Medical Research Council of NSW,⁷⁴ The Victorian Aboriginal Community Controlled Health Organisation,⁷⁵ the National Aboriginal Community Controlled Health Organisation^{76,77} or the Lowitja Institute.⁷⁸

This study highlights the need to address CHB in Aboriginal communities in Australia, in particular those in remote locations. Although the gap in HBV immunisation coverage between Aboriginal and non-Aboriginal children has reduced in recent years, with Aboriginal people having historically lower vaccination coverage^{66,79} and instances of vaccine ineffectiveness,⁵⁴ the effect on prevalence among Aboriginal adults in the future and those living with CHB require engagement with care to prevent adverse outcomes. Additional evidence regarding the current prevalence of HBsAg would also be valuable to further assess the representativeness of the studies assessed here, particularly in urban areas.

Although data exist regarding prevalence and immunisation coverage among Aboriginal people in Australia, there is less evidence relating to the level of engagement in CHB treatment and care. Of concern, uptake of treatment and care is substantially lower in remote areas of Australia, where the proportion of people living with CHB who are Aboriginal is higher than non-Aboriginal people.¹⁵ The available evidence regarding burden of disease strongly suggests more action is

needed to prevent adverse outcomes among affected communities.

Conclusion

Although our study suggests the prevalence of HBsAg has decreased after 2000, routine hepatitis B testing is needed to identify those with chronic infection early and provide treatment and to identify those who can be offered HBV vaccination. Coupling hepatitis B prevention education with testing and vaccination is important to not only continue the decreasing trend in HBsAg prevalence among Aboriginal people in Australia but also to help Aboriginal people to make informed decisions about their risk of HBV infection, including their sexual and injecting behaviour. This analysis also highlights the need for improved data regarding the prevalence of HBsAg among Aboriginal people, and the level of access to treatment and care for Aboriginal people living with CHB.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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