

Hepatitis A and B infection and vaccination in a cohort of homosexual men in Sydney

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ABSTRACT. *Objectives:* To determine the prevalence and incidence of hepatitis A (HAV) and B (HBV) infection and vaccination in HIV-negative homosexual men in Sydney, and associated risk factors. *Methods:* An open prospective cohort study was conducted among a community-based sample of HIV-negative homosexual men in Sydney in 2001–02. Participants underwent a face-to-face interview, regarding demographics, sexual behavioural risk factors and sexually transmitted infections, and blood samples were collected. They were followed annually. *Results:* Nine hundred and three men completed a baseline interview by the end of 2002. Among them, 68% were seropositive to hepatitis A. The seroprevalence of prior hepatitis B infection was 19%, and 53% had serological evidence of HBV vaccination. Younger men were much more likely to be seronegative, with 48% and 46% of <25-year-olds being seronegative to HAV and HBV respectively. In multivariate analysis HAV and HBV infection were associated with increasing age, greater number of lifetime sex partners and HBV infection was also associated with previous sexually transmitted infections. HAV vaccination was associated with increasing age, greater number of lifetime sex partners, overseas travel in the last year and self-reported anogenital warts. HBV vaccination was associated with higher occupational status, greater lifetime number of sex partners and previous sexually transmitted infections. *Conclusion:* Substantial proportions of gay community-attached young homosexual men are still at risk of HAV and HBV infection. This study points to a need for vaccination strategies which ensure high levels of hepatitis A and B immunity in young sexually active gay men.

Additional keywords: hepatitis A, hepatitis B, homosexuality, male.

Introduction

Compared with the general population, homosexual men are at high risk of acquiring hepatitis A and B.^{1–4} In this population, these infections are frequently transmitted through sexual contact⁵ and are preventable by currently available vaccines.

Since the early 1990s, outbreaks of hepatitis A among homosexually active men have been reported in Australia in Sydney and Melbourne,^{6,7} and also in the USA,⁸ UK^{9,10} and the Netherlands.¹¹ Hepatitis A virus (HAV) is mainly transmitted through the faeco–oral route. It is possible that the wider practice of ‘safe sex’ and the avoiding of unprotected anal sex since the HIV/AIDS epidemic may have actually put homosexual men at increased risk of acquiring HAV because of more frequent oral–anal contact.¹²

The epidemiology of hepatitis B (HBV) among homosexual men has changed markedly over the last 3 decades. Before the HIV/AIDS epidemic, up to 50–70% of homosexual men had serological evidence of past or present infection,^{13–15} and the annual incidence of HBV infection was up to 25% in the USA and the Netherlands.^{16,17} There is evidence that the incidence of HBV infection in gay men in the USA has decreased markedly since the early 1980s, associated with the adoption of safe sex and the advent of an effective HBV vaccine.¹⁸

Safe and effective vaccines for preventing HBV and HAV infection have been available since the early 1980s and the early 1990s respectively. Health authorities in developed countries, such as USA and Australia, have long recommended that homosexual men be vaccinated

against HAV and HBV,^{19,20} but some studies have reported continuing low vaccination coverage among homosexual men.^{2,14,21,22} The present study examines the seroprevalence and incidence of HAV and HBV infection and vaccination in a cohort of HIV-negative homosexual men in Sydney, and explores factors that are associated with infection and vaccination.

Methods

Participants

Participants were men in the Health in Men (HIM) cohort study, which commenced in 2001. The methods of the HIM study have been described in detail elsewhere.²³ Briefly, men eligible for HIM met the following criteria:¹ they reported having sex with other men within the previous 5 years,² they lived in Sydney or participated regularly in the gay community of Sydney, and³ they did not test HIV positive at baseline. The sample was community-based, and participants were recruited from various outdoor gay events and gay community venues. The project received ethics approval from the Human Research Ethics Committee of the University of New South Wales.

Data collection

All eligible men willing to participate underwent a face-to-face interview at baseline, and were followed with 6-monthly telephone interviews and annual face-to-face interviews. Areas covered in the questionnaire included sexual behaviour and sexual identity, self-report of specific sexually transmissible infections (STIs), history of hepatitis A and B testing and vaccination, reasons for not being vaccinated, and demographic factors. Data on the number of doses of vaccine received were not collected.

Laboratory studies

Testing for hepatitis A and B was an optional part of the study. All participants who agreed to HAV and HBV screening received pre-test counselling. A blood sample was taken at the time of the baseline interview and tested for HAV IgG and HBV markers [HBV surface and core antibodies (HBsAb and HBcAb), and HBV surface antigen (HBsAg) if there was evidence of prior infection]. Those who tested negative to either HAV or HBV were tested again at their annual follow-up interviews. Although not the main focus of this report, men were also tested for syphilis by enzyme immunoassay (ICE Murex), allowing an assessment of the accuracy of self-reported syphilis status.

Data analyses

As there is no specific serological marker which distinguishes HAV infection from vaccination, for the purposes of the data analysis those who tested HAV seropositive and reported no history of HAV

vaccination were designated as having a history of HAV infection, those who tested HAV seropositive and reported a history of HAV vaccination were designated as being HAV vaccinated, and those who tested seronegative and did not report a history of HAV vaccination were designated as susceptible. Those who reported a history of HAV vaccination and/or infection but were seronegative, and those who did not know their HAV vaccination status, were excluded from the analysis. Individuals seropositive to HBcAb were designated as having a history of prior infection, and those seropositive only to HBsAb were considered to be vaccinated.

The exact binomial method was used to calculate 95% confidence intervals (CIs) for prevalence values. Crude and adjusted analyses were performed to identify factors associated with prevalence and incidence of HAV, HBV infection and vaccination. Odds ratios and their corresponding 95% CIs were calculated for these associations. Multivariate logistic regression models were developed for the prevalence of HAV, HBV infection and vaccination. Multivariate Cox regression models were developed to examine risk factors of incident HAV, HBV infection and vaccination, allowing for other confounding factors. In these models, because of the smaller numbers of individuals in the analysis, variables were re-grouped, where possible, to reflect approximate two-tiers of exposure. All variables used in the univariate analyses were considered in the multivariate analyses. Variables were entered by the order of the magnitude of likelihood Chi-square values, until no further variables could be fitted into the models.

Results

In 2001 and 2002, a total of 903 men were recruited. The median age was 35 years, ranging from 18 to 75. Men were recruited into the study through gay community events (48%), word-of-mouth (13%), other studies (9%), gay venues, such as gay bars, sex on premises venues and gyms (8%), the Internet (6%), gay and AIDS organisations (6%), gay press (4%), clinics (4%) and other means (3%).

Prevalence of HAV seropositivity, HBV infection and vaccination

Of 903 men recruited, 867 (96%) gave their consent to screening for HAV and HBV. For HAV, 68% (95% CI 65–71%) tested positive, demonstrating that they had either a prior HAV infection or vaccination against HAV, while the remainder were seronegative to HAV.

The seroprevalence of prior HBV infection was 19% (95% CI 17–22%), and 53% (95% CI 50–56%) tested HBsAb positive only, demonstrating vaccination against HBV, and the remainder were seronegative to HBV.

Table 1. Correlation between self-report of vaccination and serological status

Self-report	HAV IgG			HBV status ^A			
	<i>n</i>	Positive	Negative	<i>n</i>	Vaccinated	Prior infection	Negative
Vaccinated	496	84%	16%	574	74%	10%	16%
Not vaccinated	307	46%	54%	230	8%	41%	50%
Don't know	64	50%	50%	62	25%	25%	50%
Total	867	588	279	866	460	168	238

^AHBV vaccination was defined as testing HBsAb positive and HBcAb negative; prior infection was defined as testing HBcAb positive; negative HBV status was defined as testing HBsAb negative and HBcAb negative.

Table 2. Univariate analysis of predictors of HAV infection and vaccination

	Total <i>N</i> = 715 ^D			HAV infection		<i>P</i> value	HAV vaccination			<i>P</i> value
	<i>n</i>	%		OR ^C	95% CI		<i>n</i>	%	OR ^C	
<i>Demographics</i>										
Age						<i>P</i> ^A < 0.001				<i>P</i> ^A < 0.001
<25 years	78	5	6	1	—		36	46	1	—
25–34 years	271	46	17	5.30	1.85–15.15		161	59	2.57	1.48–4.47
35–44 years	235	50	21	9.05	2.96–27.68		146	62	3.67	2.02–6.66
45–54 years	104	30	29	12.00	3.34–43.16		57	55	3.17	1.54–6.51
≥55 years	27	9	33	34.20	3.20–365.60		16	59	8.44	1.65–43.30
Country of birth						<i>P</i> ^B = 0.439				<i>P</i> ^B = 0.447
Australia	501	95	19	1	—		290	58	1	—
Others	211	43	20	1.22	0.74–2.00		126	60	1.17	0.78–1.75
Occupation						<i>P</i> ^B = 0.067				<i>P</i> ^B = 0.081
Managerial	137	31	23	1	—		79	58	1	—
Professional/ para professional	323	69	21	1.02	0.56–1.89		194	60	1.13	0.68–1.89
Clerical/sales person	156	28	18	0.56	0.28–1.12		82	53	0.64	0.37–1.12
Trade/plant/labour	52	5	10	0.39	0.12–1.28		36	69	1.10	0.50–2.41
Pensioner/student/ unemployed	45	7	16	0.44	0.15–1.25		24	53	0.59	0.27–1.28
Income (per week)						<i>P</i> ^A = 0.155				<i>P</i> ^A = 0.005
<\$200	41	10	24	1	—		22	54	1	—
\$200–\$499	99	19	19	0.73	0.25–2.13		54	55	0.94	0.39–2.29
\$500–\$999	274	54	20	0.76	0.29–1.97		151	55	0.97	0.43–2.15
\$1000–\$1499	147	22	15	0.58	0.21–1.63		89	61	1.06	0.46–2.47
≥\$1500	138	31	22	1.94	0.66–5.73		94	68	2.67	1.05–6.80
Overseas travel last year						<i>P</i> ^B = 0.093				<i>P</i> ^B < 0.001
No	366	73	20	1	—		192	52	1	—
Yes	349	67	19	1.48	0.93–2.34		224	64	1.88	1.30–2.72
<i>Sexual risk factors</i>										
Age of first sex with men						<i>P</i> ^A = 0.047				<i>P</i> ^A = 0.626
<13 years	131	26	20	1	—		81	62	1	—
13–15 years	159	42	26	1.09	0.54–2.21		83	52	0.69	0.38–1.26
16–17 years	106	21	20	0.72	0.33–1.60		58	55	0.64	0.34–1.21
18–21 years	198	34	17	0.70	0.34–1.41		119	60	0.78	0.44–1.37
≥22 years	121	17	14	0.54	0.24–1.24		75	62	0.77	0.42–1.43
Age of first anal sex with men						<i>P</i> ^A = 0.002				<i>P</i> ^A = 0.947
<13 years	24	8	33	1	—		13	54	1	—
13–15 years	59	17	29	0.49	0.11–2.30		31	53	0.55	0.13–2.31
16–17 years	83	27	33	0.63	0.14–2.79		41	49	0.59	0.15–2.39
18–21 years	253	43	17	0.24	0.06–1.00		147	58	0.51	0.14–1.88
≥22 years	286	43	15	0.25	0.06–1.02		180	63	0.64	0.18–2.32
Number of men had sex with in lifetime						<i>P</i> ^A < 0.001				<i>P</i> ^A < 0.001
1–10	56	5	9	1	—		26	46	1	—
11–50	151	19	13	1.67	0.56–5.02		75	50	1.27	0.67–2.42
51–200	184	27	15	3.90	1.27–12.02		121	66	3.36	1.70–6.66
201–1000	217	53	24	8.89	2.77–28.51		137	63	4.42	2.19–8.94
>1000	107	36	34	12.48	3.27–47.66		57	53	3.80	1.66–8.71
Number of men had sex with in the past 6 months						<i>P</i> ^A < 0.001				<i>P</i> ^A < 0.001
0–1	133	22	17	1	—		71	53	1	—
2–5	180	30	17	1.02	0.51–2.02		99	55	1.04	0.63–1.73
6–10	133	19	14	1.26	0.58–2.77		87	65	1.79	1.00–3.21
11–50	215	51	24	2.50	1.26–4.97		128	60	1.95	1.14–3.21
>50	54	18	33	6.71	1.98–22.69		31	57	3.58	1.26–10.20

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Table 2. (Continued)

	Total <i>N</i> = 715 ^D			HAV infection		<i>P</i> value	HAV vaccination			<i>P</i> value
	<i>n</i>	%	OR ^C	95% CI	<i>n</i>		%	OR ^C	95% CI	
Gay community involvement										
						<i>P</i> ^A = 0.301				<i>P</i> ^A = 0.546
Not at all	31	4	13	1	—		19	61	1	—
Not very	203	42	21	1.83	0.51–6.59		118	58	1.08	0.44–2.65
Somewhat	357	65	18	1.43	0.41–4.97		205	57	0.95	0.40–2.25
Very	124	29	23	2.64	0.68–10.23		74	60	1.42	0.54–3.70
Sexually transmitted infections (self-reported)										
Gonorrhoea										
						<i>P</i> ^B = 0.006				<i>P</i> ^B = 0.023
Never	474	84	18	1	—		271	57	1	—
Ever	241	56	23	1.98	1.21–3.25		145	60	1.59	1.06–2.39
Non-specific urethritis										
						<i>P</i> ^B = 0.003				<i>P</i> ^B < 0.001
Never	484	90	19	1	—		266	55	1	—
Ever	231	50	22	2.17	1.29–3.65		150	65	2.21	1.43–3.40
Sexually transmitted bowel infection										
						<i>P</i> ^B = 0.002				<i>P</i> ^B = 0.032
Never	644	119	18	1	—		373	58	1	—
Ever	71	21	30	3.51	1.48–8.31		43	61	2.29	1.05–5.00
Anogenital warts										
						<i>P</i> ^B = 0.013				<i>P</i> ^B < 0.001
Never	535	105	20	1	—		290	54	1	—
Ever	180	35	19	2.09	1.16–3.77		126	70	2.72	1.66–4.46
Genital herpes										
						<i>P</i> ^B = 0.018				<i>P</i> ^B = 0.137
Never	634	118	19	1	—		369	58	1	—
Ever	81	22	27	2.41	1.14–5.10		47	58	1.65	0.85–3.19
Syphilis serology										
						<i>P</i> ^B = 0.044				<i>P</i> ^B = 0.985
Negative	687	128	19	1	—		403	59	1	—
Positive	23	10	43	3.18	0.97–10.48		10	43	1.01	0.31–3.27

^AScore test for trend of odds.

^BTest of homogeneity.

^CCompare with those tested negative and did not report a vaccination.

^DNumbers do not always total to 715 because of small amounts of missing data.

Comparison of self-report and serological data

Overall 496 (57%) men reported that they had been vaccinated against HAV, 307 (35%) reported they had not, and 64 (7%) were not sure. For those who reported they had been vaccinated, 84% were seropositive; and for those who reported no history of vaccination, 54% were seronegative.

For hepatitis B, 574 (66%) men reported that they had been vaccinated against HBV, 230 (27%) reported they had not, and 62 (7%) were not sure. For those who reported they had been vaccinated, 74% had serological evidence of HBV vaccination; and for those who reported they had not been vaccinated, 92% were either seronegative or had serological evidence of prior infection. The correlation between self-report and serological status is shown in Table 1.

For those who were seronegative to HAV or HBV infection, 29% and 38% reported that they believed they

had been vaccinated against HAV and HBV, respectively. The main reasons reported by participants for not being vaccinated against HAV and HBV included: 'I haven't got around to it' (36% and 29%), 'I haven't even thought of it' (19% and 14%), and 'I'm unlikely to get infected' (10% and 9%).

Among men who reported never having syphilis, 1% were serologically positive to syphilis EIA; and among those who reported a history of syphilis, 54% were seropositive.

Predictors of HAV infection

Seven hundred and fifteen men were included in the analysis of risk factors for HAV infection and vaccination. Excluded were 88 men who were HAV seronegative but reported a history of either infection (8), vaccination (62) or both (18), and 64 men who did not know whether

they had been HAV vaccinated (32 HAV seronegative, 32 HAV seropositive). For the purpose of analysis, 140 men who tested positive to HAV and reported not being vaccinated against HAV were designated as having prior HAV infection. Men who tested positive and reported a history of vaccination (416) were designated as being HAV vaccinated. Men who tested negative and reported having no history of vaccination and infection (159) were designated as susceptible.

HAV infection was significantly associated with increasing age, lower age of first sex with other men, a greater number of lifetime and recent male sex partners, self-reported history of sexually transmitted infections (STIs) and positive syphilis serology (Table 2). After controlling for confounding factors, only increasing age (P trend = 0.001) and a greater number of male lifetime sex partners (P trend < 0.001) were independently associated with HAV infection (Table 3).

Predictors of HAV vaccination

Increasing age, higher income level, overseas travel in the last 12 months, a greater number of lifetime and recent male sex partners, self-reported history of gonorrhoea, non-specific urethritis, sexually transmitted bowel infection and anogenital warts were significantly associated with HAV vaccination (Table 2). In the multivariate analysis, increasing age (P trend = 0.039), overseas travel in the last 12 months

(OR = 1.85, 95% CI 1.25–2.72), a greater number of lifetime male sex partners (P trend < 0.001) and a self-reported history of anogenital warts (OR = 2.21, 95% CI 1.32–3.68) remained significant (Table 3).

Predictors of HBV infection

Increasing age, overseas travel in the last 12 months, a greater number of lifetime and recent male sex partners, lower age of first sex with another man, self-reported history of STIs and positive syphilis serology were significantly associated with prior HBV infection (Table 4). After controlling for confounding factors, increasing age (P trend < 0.001), number of lifetime male sex partners (P trend < 0.001), and self-reported history of gonorrhoea (OR = 2.02, 95% CI 1.81–3.44), sexually transmitted bowel infections (OR = 3.72, 95% CI 1.26–10.98), anogenital warts (OR = 1.98, 95% CI 1.05–3.74), and positive syphilis serology (OR = 8.46, 95% CI 1.60–44.80) were independently associated with HBV infection (Table 5).

Predictors of HBV vaccination

Increasing age, occupation, income level, number of lifetime and recent male sex partners and ever reporting all STIs considered (except syphilis) were significantly associated with HBV vaccination (Table 4). After controlling for confounding factors, higher occupational level, greater lifetime number of male sex partners

Table 3. Multivariate analysis of predictors for HAV infection and vaccination

	HAV infection			HAV vaccination		
	Adjusted OR	95% CI	P value	Adjusted OR	95% CI	P value
Age			$P^A = 0.001$			$P^A = 0.039$
<25 years	1	—		1	—	
25–34 years	3.36	1.18–9.58		1.91	1.06–3.43	
35–44 years	4.59	1.56–13.50		2.23	1.19–4.19	
45–54 years	5.62	1.76–17.98		1.81	0.84–3.88	
≥55 years	14.74	2.24–97.25		5.12	1.04–25.1	
Overseas travel last year						$P^B = 0.002$
No				1	—	
Yes				1.85	1.25–2.72	
Number of men had sex with lifetime			$P^A < 0.001$			$P^A < 0.001$
1–10	1	—		1	—	
11–50	1.25	0.40–3.86		0.84	0.42–1.66	
51–200	2.59	0.84–7.99		2.13	1.06–4.30	
201–1000	5.30	1.76–16.00		2.49	1.20–5.17	
>1000	6.24	1.89–20.65		2.07	0.87–4.91	
<i>Sexually transmitted infections (self-reported)</i>						
Anogenital warts						$P^B = 0.002$
No				1	—	
Yes				2.21	1.32–3.68	

^A P for trend.

^BTest of homogeneity.

Table 4. Univariate analysis of predictors of HBV infection and HBV vaccination

	Total N = 866 ^D			HBV infection		P value	HBV vaccination			P value
	n	%	OR ^C	95% CI	n		%	OR ^C	95% CI	
<i>Demographics</i>										
Age						$P^A < 0.001$				$P^A = 0.010$
<25 years	99	1	1	1	—		52	53	1	—
25–34 years	328	39	12				191	58	1.72	1.08–2.75
35–44 years	288	68	24	3.55	2.14–5.89		151	52	1.94	1.19–3.15
45–54 years	122	44	36	7.92	3.91–16.04		58	48	2.57	1.35–4.89
≥55 years	29	16	55	11.52	3.66–36.30		8	28	1.42	0.43–4.63
Country of birth						$P^B = 0.079$				$P^B = 0.549$
Australia	615	106	17	1	—		339	55	1	—
Others	248	61	25	1.46	0.95–2.23		120	48	0.90	0.63–1.28
Occupation						$P^B = 0.410$				$P^B = 0.005$
Managerial	169	38	22	1	—		84	50	1	—
Professional/ para professional	378	66	17	0.91	0.83–1.55		222	59	1.38	0.90–2.13
Clerical/sales person	204	39	19	0.74	0.41–1.33		100	49	0.86	0.54–1.38
Trade/plant/labour	60	14	23	1.33	0.56–3.17		33	55	1.42	0.68–2.96
Pensioner/student/ unemployed	52	10	19	0.54	0.23–1.27		19	37	0.46	0.23–0.94
Income (per week)						$P^A = 0.352$				$P^A = 0.049$
<\$200	52	11	21	1	—		21	40	1	—
\$200–\$499	114	22	19	1.18	0.47–2.92		58	51	1.62	0.77–3.42
\$500–\$999	334	64	19	1.34	0.60–2.99		183	55	2.00	1.03–3.89
\$1000–\$1499	181	32	18	1.02	0.43–2.40		92	51	1.54	0.77–3.08
≥\$1500	167	34	20	1.72	0.72–4.10		97	58	2.57	1.25–5.28
Overseas travel last year						$P^B = 0.033$				$P^B = 0.212$
No	454	78	18	1	—		240	53	1	—
Yes	412	90	22	1.54	1.03–2.30		220	53	1.22	0.89–1.68
<i>Sexual risk factors</i>										
Age of first sex with men						$P^A < 0.001$				$P^A = 0.314$
<13 years	158	46	29	1	—		78	49	1	—
13–15 years	198	47	24	0.68	0.38–1.23		100	51	0.85	0.51–1.45
16–17 years	129	22	17	0.45	0.23–0.90		71	55	0.86	0.49–1.52
18–21 years	237	43	18	0.47	0.26–0.84		126	53	0.81	0.49–1.33
≥22 years	144	10	7	0.15	0.07–0.34		85	59	0.76	0.44–1.29
Age of first anal sex with men						$P^A < 0.001$				$P^A = 0.767$
<13 years	27	12	44	1	—		10	37	1	—
13–15 years	73	17	23	0.32	0.10–1.09		34	47	0.77	0.23–2.57
16–17 years	102	31	30	0.46	0.14–1.47		43	42	0.77	0.24–2.48
18–21 years	302	61	20	0.37	0.12–1.11		172	57	1.25	0.41–3.78
≥22 years	351	47	13	0.18	0.06–0.54		195	56	0.89	0.30–2.68
Number of men had sex with in lifetime						$P^A < 0.001$				$P^A < 0.001$
1–10	67	2	3	1	—		36	54	1	—
11–50	194	17	9	3.04	0.66–13.99		96	49	0.95	0.54–1.69
51–200	222	32	14	7.48	1.68–33.38		128	58	1.66	0.94–2.96
201–1000	264	77	29	24.81	5.65–108.92		142	54	2.54	1.40–4.60
>1000	118	39	33	26.93	5.84–124.11		58	49	2.22	1.11–4.47
Number of men had sex with in the past 6 months						$P^A < 0.001$				$P^A < 0.001$
0–1	171	31	18	1	—		80	47	1	—
2–5	219	31	14	0.90	0.49–1.64		121	55	1.35	0.86–2.12
6–10	158	30	19	1.32	0.70–2.49		84	53	1.43	0.87–2.35
11–50	259	61	24	1.94	1.11–3.39		137	53	1.68	1.07–2.64
>50	59	15	25	4.84	1.71–13.71		38	64	4.75	1.89–11.96

(Continued next page)

Table 4. (Continued)

	Total <i>N</i> = 866 ^D			HBV infection			HBV vaccination			
	<i>n</i>	%	OR ^C	95% CI	<i>P</i> value	<i>n</i>	%	OR ^C	95% CI	<i>P</i> value
Gay community involvement					<i>P</i> ^A = 0.968					<i>P</i> ^A = 0.068
Not at all	37	9	24	1	—	16	43	1	—	
Not very	252	56	22	1.04	0.41–2.63	124	49	1.29	0.58–2.88	
Somewhat	430	74	17	0.82	0.33–2.03	235	55	1.46	0.67–3.18	
Very	147	29	20	1.17	0.43–3.18	85	58	1.93	0.83–4.52	
<i>Sexually transmitted infections (self-reported)</i>										
Gonorrhoea					<i>P</i> ^B < 0.001					<i>P</i> ^B = 0.018
Never	594	78	13	1	—	327	55	1	—	
Ever	272	90	33	4.45	2.88–6.89	133	49	1.57	1.08–2.28	
Non-specific urethritis					<i>P</i> ^B < 0.001					<i>P</i> ^B < 0.001
Never	608	93	15	1	—	318	52	1	—	
Ever	258	75	29	3.87	2.46–6.10	142	55	2.15	1.45–3.17	
Sexually transmitted bowel infection					<i>P</i> ^B < 0.001					<i>P</i> ^B < 0.001
Never	788	147	19	1	—	409	52	1	—	
Ever	78	21	27	5.52	2.18–14.01	51	65	4.82	1.48–17.41	
Anogenital warts					<i>P</i> ^B < 0.001					<i>P</i> ^B < 0.001
Never	662	118	18	1	—	331	50	1	—	
Ever	204	50	25	3.61	2.12–6.13	129	63	3.32	2.09–5.27	
Genital herpes					<i>P</i> ^B < 0.001					<i>P</i> ^B = 0.007
Never	775	137	18	1	—	411	53	1	—	
Ever	91	31	34	4.67	2.27–9.59	49	54	2.46	1.25–4.83	
<i>Syphilis serology</i>					<i>P</i> ^B < 0.001					<i>P</i> ^B = 0.581
Negative	831	146	18	1	—	450	54	1	—	
Positive	28	20	71	16.1	3.54–73.25	6	21	1.57	0.31–7.83	

^AScore test for trend of odds.

^BTest of homogeneity.

^CCompared with those tested negative.

^DNumbers do not always total to 866 because of small amounts of missing data.

(*P* trend = 0.005) and self-reported history of sexually transmitted bowel infections (OR = 3.42, 95% CI 1.40–8.37) and anogenital warts (OR = 2.72, 95% CI 1.69–4.40) were significantly associated with HBV vaccination (Table 5).

Incidence of HAV seroconversion and HBV infection and vaccination

For 450 men recruited in 2001, 392 (87%) completed their first year follow-up interview and serology test in 2002. Of the 100 who tested negative to HAV at baseline, 25 (25%) seroconverted to HAV, an incidence of 27.0 per 100 person-years (PY). Among these seroconverters to HAV, 22 reported being vaccinated against HAV since the last face-to-face interview and were designated as having incident vaccination. Overseas country of birth (HR = 2.96, 95% CI 1.28–6.84) and managerial/professional occupation (HR = 3.73, 95% CI 1.10–12.62) were significantly associated with incident HAV vaccination. In the multivariate analysis, overseas

country of birth (HR = 3.10, 95% CI 1.27–7.59), higher income level (*P* trend = 0.011) and a lower number of lifetime sex partners (*P* trend = 0.014) predicted HAV vaccination.

For HBV, 24 (30%) of 79 who tested negative at baseline seroconverted to HBsAb at follow-up, an incidence of vaccination of 33.8 per 100 PY. No new cases of serologically documented HBV infection were found during the first year follow-up. Those who were born overseas (HR = 3.17, 95% CI 1.42–7.08) and reporting a higher income level (*P* trend = 0.033) were significantly more likely to be vaccinated in the univariate analysis. When allowing for confounding factors, overseas country of birth (HR = 6.36, 95% CI 2.45–16.55) and higher income (*P* trend = 0.001) remained significant. In addition, overseas travel was inversely associated with incident HBV vaccination; those who reported overseas travel in the past year at baseline interview were less likely to be recently vaccinated (HR = 0.38, 95% CI 0.15–0.95).

Table 5. Multivariate analysis of predictors for HBV infection and vaccination

	HBV infection			HBV vaccination		
	Adjusted OR	95% CI	<i>P</i> value	Adjusted OR	95% CI	<i>P</i> value
Age			$P^A < 0.001$			
<34 years	1	—				
35–44 years	2.82	1.61–4.92				
45–54 years	4.11	1.94–8.73				
≥55 years	4.85	1.40–16.84				
Occupation						$P^B = 0.027$
Pensioner/student/ unemployed				1	—	
Managerial				1.81	0.87–3.76	
Professional/ para professional				2.58	1.31–5.07	
Clerical/sales person				1.67	0.82–3.37	
Trade/plant/labour				2.82	1.13–7.06	
Number of men had sex with lifetime			$P^A < 0.001$			$P^A = 0.005$
1–10	1	—		1	—	
11–50	1.91	0.40–9.14		0.74	0.41–1.34	
51–200	2.88	0.61–13.69		1.29	0.71–2.33	
201–1000	10.18	2.21–46.87		1.72	0.93–3.17	
>1000	5.54	1.09–28.12		1.32	0.63–2.76	
<i>Sexually transmitted infections (self-reported)</i>						
Gonorrhoea						
No	1	—	$P^B = 0.013$			
Yes	2.02	1.81–3.44				
Sexually transmitted bowel infection			$P^B = 0.020$			$P^B = 0.007$
No	1	—		1	—	
Yes	3.72	1.26–10.98		3.42	1.40–8.37	
Anogenital warts			$P^B = 0.026$			$P^B < 0.001$
No	1	—		1	—	
Yes	1.98	1.05–3.74		2.72	1.69–4.40	
<i>Syphilis serology</i>						
Negative	1	—	$P^B = 0.012$			
Positive	8.46	1.60–44.89				

^A*P* for trend.^BTest of homogeneity.

Discussion

Despite the ready availability of preventive vaccines, and prevention strategies targeting gay men and their doctors which encourage vaccination in this population, 32% and 28% of Sydney homosexual men in this study remained seronegative to HAV and HBV respectively. For those aged under 25 years, the proportion seronegative was higher, at 48% for HAV and 46% for HBV. Predictors of past vaccination included being older, reporting a history of STIs and reporting more sexual partners, suggesting that vaccination was being targeted to those most at risk of sexual acquisition of HAV and HBV. Among those seronegative

to infection who were followed up 1 year later, 25% were vaccinated against HAV, and 30% against HBV. Predictors of incident vaccination were markers of higher socio-economic status, including income and professional status, and being born overseas.

The main independent risk factors for having a history of infection with HAV and HBV were markers of risk of sexual transmission; older age, having more sexual partners, and reporting STIs. Older age is likely to reflect increasing years of homosexual activity. In the univariate risk analyses, early age at first sexual intercourse, perhaps indicating contact with the viruses before an opportunity for immunisation

was possible, was a risk factor for both HAV and HBV infection.

This study's design should be considered in interpreting these results. First, the study sample was community-based. Participants were recruited at a wide variety of gay community venues,²³ and the sample can be considered as broadly representative of gay community-attached men in Sydney. In contrast, studies based on clinic samples may over-represent men at high risk and may be less generalisable. Second, while a serological diagnosis of a history of HBV vaccination is possible, this is not the case for HAV. The distinction between HAV infection and vaccination was made based upon self-reported history of HAV vaccination as well as HAV serology. Some of the 80 seronegative men who reported vaccination may have truly been vaccinated, and lost HAV antibody after vaccination,^{24,25} or may be individuals who received incomplete vaccination courses, or received passive immunisation. Similarly, some of the HBV seronegative men may have been previously vaccinated. In this way, our study is likely to have slightly under-estimated vaccination rates. Third, history of past infection with STIs relied on self-report for all but syphilis. More than half those with serological evidence of syphilis reported such a history, as compared to 1% with no serological evidence. This suggests that self-report of history of STIs in our sample is reasonably reliable, and that some degree of under-reporting is likely. Thus the associations we found between the history of other STIs and HAV and HBV are likely to under-estimate the strength of association with hepatitis serological markers due to random misclassification.

The seroprevalence of HAV among men in this study is much higher than that reported in recent studies in homosexual men in the USA and Canada,^{3,4} which have reported a prevalence of around 30%. The seroprevalence was also much higher than that in the general Australian population, in which a seroprevalence of 41% has recently been reported.²⁶ This may reflect higher rates of HAV infection, vaccination, or both in our sample. However, the much higher levels of HAV seropositivity compared to HBV infection in our sample of young gay men, coupled with declining population-based rates of HAV in New South Wales,²⁷ suggests that higher rates of vaccination is the explanation of these differences.

Rates of vaccination against HBV were also much higher in our study than in similar North American samples. A survey conducted in Canada in 1996²⁸ showed that among homosexual men recruited from clinical and community settings, 20% had serological evidence of infection, and 42% of vaccination against HBV. Compared with that survey, our participants had a higher rate of vaccination. Surveys^{13,21} conducted among young homosexual men under 22 years of age in the USA found that 11–20% of these young men were infected and 3–9% were ever vaccinated. In our study, for

those men under 25, only 1% had been infected and 53% were vaccinated.

Comparing our data to previous Australian studies demonstrates a declining trend in HBV infection among homosexual men. In 1982, a sexual health clinic-based study¹ found that 61% of Sydney homosexual men had serological evidence of HBV infection and a similar survey in Sydney in 1991¹⁴ showed that the prevalence of HBV infection had decreased to 38%. The present study showed that 20% of our sample had serological evidence of a prior HBV infection. While this is consistent with a declining trend in infection, the fact that previous studies were clinic-based means the difference is likely to be an over-estimate. Consistent with previous findings,^{1,2,4,7,13,14,29} we found that increasing age was associated with HAV and HBV infection, even after controlling for sexual risk factors.

A self-reported history of certain other STIs was associated not only with HAV and HBV infection, but also with vaccination. The cross-sectional nature of the baseline data prevents us from concluding that this relationship is causal. Although a self-reported history of STIs is likely to reflect sexual risk taking, for certain STIs, the relationship remained significant in the multivariate model. The diagnoses of STIs may have led to vaccination for HAV and HBV.

Higher income level was independently associated with both HAV and HBV incident vaccination, suggesting that the cost of vaccination may act as a barrier for those to take up hepatitis vaccination, which is consistent with another study conducted in Sydney.³⁰

Previously, we have found that gay community-attached men in Australia are more likely to have ever undergone HIV testing and to have done so more recently,^{31,32} and in this analysis, gay community attachment was non-significantly associated with either HAV or HBV vaccination.

In summary, despite the ready availability of preventive vaccines, nearly one-third of all participants in this study were seronegative to HAV and HBV. Neither HAV nor HBV vaccination has been universally offered to today's young adults in Australia. HAV vaccination remains targeted at high-risk groups,²⁰ and a universal neonatal vaccination programme for HBV started in 2000.³³ An adolescent 'catch up' programme for HBV vaccination commenced in most States of Australia in 1997,²⁰ but vaccination rates remain sub-optimal. These data suggest that many young gay community-attached homosexual men will remain at risk of HAV and HBV unless effective targeted vaccination campaigns continue. Continued efforts to ensure vaccination of young gay men against HAV and HBV remain important in minimising the effects of these infections on today's generation of young gay men. As a consequence of our testing and follow-up with their doctors, about a quarter of our participants did vaccinate, indicating that an appropriate intervention which leads to testing for HAV and HBV is likely to meet with some success. Nevertheless, the unacceptably

high rate of susceptibility to HAV and HBV found in this cohort demonstrates that only universal immunisation is likely to provide high enough levels of vaccination to allow the elimination of these preventable infections.

Authorship

Fengyi Jin performed the analyses and drafted the manuscript; Andrew E. Grulich took overall responsibility for the project and assisted in the analyses and drafting of the manuscript; Garrett P. Prestage, Basil Donovan, Catherine M. Pell, Paul G. Van de Ven, Susan C. Kippax and John M. Kaldor assisted in formulating the analyses and drafting the manuscript. In Addition, Basil Donovan and Catherine M. Pell assisted with interpretation of the serological results.

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