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ALIMENTARY TRACT AND PANCREAS

Helicobacter pylori in Melbourne Chinese immigrants: Evidence for oral-oral transmission via chopsticks

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Abstract The *Helicobacter pylori* seroprevalence in a representative population of 328 Melbourne Chinese immigrants (162 men and 166 women) aged 25 years and older were studied. The population consisted of Chinese people born in China/Hong Kong ($n = 110$, 33.5%), Vietnam ($n = 79$, 24.1%), Malaysia/Singapore ($n = 102$, 31.1%), and elsewhere ($n = 37$, 11.3%). The overall seroprevalence of *H. pylori* was 59.5%; 60.5% in men and 58.4% in women. Gender specific analysis showed associations between higher seroprevalence and several socio-demographic factors; in men, age ($P < 0.0001$), lower education level ($P < 0.002$), cigarette smoking ($P < 0.042$), the use of antibiotics ($P < 0.015$) and chopsticks ($P < 0.047$), and in women, lower socioeconomical status [education level ($P < 0.030$), gross household income ($P < 0.0001$) and occupational status ($P < 0.0001$)] and use of chopsticks ($P < 0.002$). Seroprevalence differed between immigrants of various birthplaces ($P < 0.001$); those born in Malaysia/Singapore (43.1%) were lower than those born in China/Hong Kong (68.2%), Vietnam (68.4%), and elsewhere (59.5%). Immigrants of various birthplaces also differed in their pattern of socio-demographics.

Multivariate analyses showed that risk factors for *H. pylori* infection within the Melbourne Chinese immigrants were, in men, age (B = 1.081) and birthplace (B = 1.769) and, in women, household income (B = 0.541) and use of chopsticks (B = 1.654). This study suggests person-to-person transmission of *H. pylori* via the oral-oral route with ethno-specific food practices an important risk factor.

Key words: Chinese, chopsticks, ethno-specific, *Helicobacter pylori*, seroprevalence, transmission.

INTRODUCTION

Helicobacter pylori has been acknowledged recently by the Working Party Report of the World Congresses of Gastroenterology as the major pathogen causing histological gastritis.[1] This bacterium colonizes only gastric type mucosa and infection generally persists life long without therapy.[2-8] The bacterium is an important aetiological factor in peptic ulcer disease.[9-14] Several studies have shown strong association between the seroprevalence *H. pylori* infection and the gastric cancer mortality.[15,16]

Existing epidemiological studies of *H. pylori* infection have shown that there are no gender differences in *H. pylori* seroprevalence,[17,18] that the seroprevalence increases significantly with age[19-21] and is associated inversely with socioeconomic status,[22,23] and that there are differences in seroprevalence between different racial groups.[24,25]

It has been shown that there is a geographic association of *H. pylori* seroprevalence in rural Chinese populations.[15] Studies in North American ethnic populations revealed that white Americans seem to have a relatively low prevalence compared to the black, Hispanic and Chinese Americans.[22] Studies of Chinese populations worldwide have reported similar high prevalences of *H. pylori*.[26,27] These studies suggest that a racial predisposition exists but it is unclear whether this is a genetic predisposition, a geographical variation or a result of ethno-specific behaviours.

The objectives of this study were first to report the seroprevalence of *H. pylori* infection in 328 adult

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Chinese immigrants living in Melbourne and, second, to examine in this population relationships between *H. pylori* seropositivity and gender, age, socioeconomic status, birthplace, length of residence in Australia, age on arrival, cigarette smoking, consumption of alcohol, coffee and tea, use of non-steroidal anti-inflammatory drugs (NSAID), antibiotics and chopsticks at meal times.

METHODS

This study was conducted in 1990. A representative sample of 547 adult Chinese, who participated in the Melbourne Chinese Health Study in 1988–89 were recruited.[28,29] Study subjects were recruited from the Melbourne telephone directory from a list of common Chinese surnames as described in a previous study.[30] An introductory letter was sent explaining the purpose of the study, followed 2 weeks later by a telephone conversation to establish eligibility for entry to the study. Eligible subjects, aged 25 years and older and of Chinese descent (based on parental ethnicity), were invited to participate. Home interviews were conducted at the convenience of the subject.

A total of 435 subjects were contacted successfully in the 1990 survey and 341 (78%) subjects agreed to enter the study. All subjects completed a self-administered questionnaire which covered self-reported medical history for peptic ulcer disease and the use of medications. Socio-demographic data, life-style factors and dietary practices were also obtained via questionnaire. Ten millilitres of venous blood was collected, after informed consent, for *H. pylori* IgG serology. These procedures were conducted within a 4 month period, from May to August of 1990. This study reports the analysis of 328 subjects born outside of Australia. The remaining 13 subjects were Australian-born Chinese and were excluded from the analysis.

Serological methods

The enzyme-linked immunosorbent assay (ELISA) test was developed from an earlier ELISA assay specific for *H. pylori* IgG antibodies,[31] by the AMRAD Corporation (Melbourne, Australia) and has been manufactured as a commercial test kit. The antigen was derived from a pool of sonicates from 24 *H. pylori* isolates. Serum specimens and positive and negative controls were diluted 1:200 with the specimen diluent buffer. One hundred microlitres of diluted specimen and controls were added to the microtitre plates (each plate contained four positive and four negative control samples) and the plates were incubated for 30 min at 37°C in a humidified atmosphere. After six washes with wash buffer, 100 μL of horseradish peroxidase, IgG conjugate (sheep anti-human IgG) reagent was added to each well (the IgG conjugate reagent reacts with human antibodies bound to the *H. pylori* antigen). After a further 30 min of incubation, 100 μL of tetra-methylbenzidine enzyme substrate reagent was added to each well of the microtitre plate (to react with the bound horseradish peroxidase to produce a blue colour) and incubated in a dark room for 30 min at room temperature. The rate of conversion of substrate from clear to a blue colour is proportional to the amount of antibody bound to the *H. pylori* antigen. One hundred microlitres of stopping solution (H_2SO_4) was then added to terminate the enzymatic reaction. The absorbency was read within 10 min after adding the stopping solution using a 450 nm filter with a 615–620nm filter as the reference.

All serology samples were processed on the same day after all venous samples were collected; the laboratory technician was blinded to the origin of the samples. The arbitrary cut-off value for the assay was obtained by multiplying the mean of the positive controls by 0.15. Specimens with absorbency values greater than or equal to the cut-off value were considered positive for *H. pylori*.

The serological test provides a simple and non-invasive screen for the prevalence of *H. pylori* infection that has 95% sensitivity, 88% specificity and 93% accuracy. The assay has been validated against diagnostic criteria from the gold standard of culture, histology and phase contrast microscopy from endoscopic antral biopsies of infected and non-infected subjects.[31]

Table 1 Age, age on arrival and the length of stay in Australia by birthplace

	China/Hong Kong		Malaysia/Singapore		Vietnam		Other	
	Mean	s.e.m.	Mean	s.e.m.	Mean	s.e.m.	Mean	s.e.m.
Men								
Age (years)	48.3	(1.78)	42.7	(1.31)	39.6	(1.40)	46.8	(3.68)
Age on arrival	34.1	(1.98)	28.3	(1.39)	30.7	(1.44)	36.4	(4.11)
LOSIA	14.1	(1.47)	14.4	(1.17)	8.9	(0.45)	10.3	(1.55)
Total no.	55		54		37		16	
Women								
Age	45.7	(1.83)	39.8	(1.33)	37.4	(1.34)	42.6	(3.35)
Age on arrival	35.8	(2.01)	29.1	(1.22)	28.9	(1.53)	36.3	(3.49)
LOSIA	9.8	(0.88)	10.7	(1.16)	8.5	(0.58)	6.3	(0.77)
Total no.	55		48		42		21	

LOSIA, length of stay in Australia (years); s.e.m. standard error of the mean.

Table 2 Socio-demographic characteristics of the study population by birthplace

	China/Hong Kong		Malaysia/Singapore		Vietnam		Elsewhere	
	No. studied	%	No. studied	%	No. studied	%	No. studied	%
Education level (years)								
Men								
0-6	11	(20.0)	0	(0.0)	1	(2.7)	2	(12.5)
7-9	10	(18.2)	7	(13.0)	16	(43.2)	6	(37.5)
10-12	9	(16.4)	4	(7.4)	10	(27.0)	4	(25.0)
13+	25	(45.5)	43	(79.6)	10	(27.0)	4	(25.0)
Women								
0-6	20	(36.4)	2	(4.2)	12	(28.6)	7	(33.3)
7-9	5	(9.1)	9	(18.8)	12	(28.6)	5	(23.8)
10-12	20	(36.4)	12	(25.0)	9	(21.4)	6	(28.6)
13+	10	(18.2)	25	(52.1)	9	(21.4)	3	(14.3)
Household income ($A)								
Men								
0-12000	6	(11.1)	1	(1.9)	0	(0.0)	2	(12.5)
12001-22000	15	(27.8)	5	(9.3)	13	(35.1)	2	(12.5)
22001-40000	15	(27.8)	17	(31.5)	15	(40.5)	10	(62.5)
40000+	18	(33.3)	31	(57.4)	9	(24.3)	2	(12.5)
Women								
0-12000	11	(20.4)	7	(14.9)	2	(4.8)	5	(23.8)
12001-22000	13	(24.1)	3	(6.4)	18	(42.9)	3	(14.3)
22001-40000	17	(31.5)	16	(34.0)	14	(33.3)	10	(47.6)
40000+	13	(24.1)	21	(44.7)	8	(19.0)	3	(14.3)
Occupational status								
Men								
Manual	23	(41.8)	12	(22.2)	29	(78.4)	11	(68.8)
Clerical	14	(25.5)	16	(29.6)	3	(8.1)	4	(25.0)
Professional	18	(32.7)	26	(48.1)	5	(13.5)	1	(6.3)
Women								
Domestic	15	(27.3)	5	(10.4)	12	(28.6)	7	(33.3)
Manual	19	(34.5)	6	(12.5)	21	(50.0)	7	(33.3)
Clerical	12	(21.8)	10	(20.8)	2	(4.8)	5	(23.8)
Professional	9	(16.4)	27	(56.3)	7	(16.7)	2	(9.5)
Smoking								
Men								
Current	12	(21.8)	11	(20.4)	14	(37.8)	1	(6.3)
Ex-smoker	17	(30.9)	7	(13.0)	8	(21.6)	3	(18.8)
Never smoked	26	(47.3)	36	(66.7)	15	(40.5)	12	(75.0)
Women								
Current	2	(3.6)	0	(0.0)	0	(0.0)	1	(4.8)
Ex-smoker	1	(1.8)	5	(10.4)	0	(0.0)	1	(4.8)
Never smoked	52	(94.6)	43	(89.6)	42	(100.0)	19	(90.5)
Alcohol								
Men								
Weekly	20	(36.4)	13	(24.1)	10	(27.0)	3	(18.8)
Not weekly	12	(21.8)	24	(44.4)	13	(35.1)	9	(56.3)
Never drink	23	(41.8)	17	(31.5)	14	(37.8)	4	(25.0)
Women								
Weekly	2	(3.6)	4	(8.3)	1	(2.4)	1	(4.8)
Not weekly	13	(23.6)	12	(25.0)	3	(7.1)	6	(28.6)
Never drink	40	(72.7)	32	(66.7)	38	(90.5)	14	(66.7)
Coffee								
Men								
Yes	40	(72.7)	47	(87.0)	29	(78.4)	13	(81.3)
No	15	(27.3)	7	(13.0)	8	(21.6)	3	(18.8)
Women								
Yes	31	(56.4)	42	(87.5)	28	(66.7)	15	(71.4)
No	24	(43.6)	6	(12.5)	14	(33.3)	6	(28.6)

Table 2 cont.

	China/Hong Kong No. studied	%	Malaysia/Singapore No. studied	%	Vietnam No. studied	%	Elsewhere No. studied	%
Tea								
Men								
Yes	50	(90.9)	53	(98.1)	36	(97.3)	15	(93.8)
No	5	(9.1)	1	(1.9)	1	(2.7)	1	(6.3)
Women								
Yes	45	(81.8)	45	(93.8)	36	(85.7)	16	(76.2)
No	10	(18.2)	3	(6.3)	6	(14.3)	5	(23.8)
Antibiotics use								
Men								
Yes	22	(40.0)	38	(70.4)	10	(27.0)	7	(43.8)
No	33	(60.0)	16	(29.6)	27	(73.0)	9	(56.3)
Women								
Yes	24	(43.6)	36	(75.0)	11	(26.2)	7	(33.3)
No	31	(56.4)	12	(25.0)	31	(73.8)	14	(66.7)
NSAID use								
Men								
Yes	18	(32.7)	25	(46.3)	14	(37.8)	8	(50.0)
No	37	(67.3)	29	(53.7)	23	(62.2)	8	(50.0)
Women								
Yes	16	(29.1)	20	(41.7)	14	(33.3)	9	(42.9)
No	39	(70.9)	28	(58.3)	28	(66.7)	12	(57.1)
Chopstick use								
Men								
Yes	50	(90.9)	25	(46.3)	36	(97.3)	9	(56.3)
No	5	(9.1)	29	(53.7)	1	(2.7)	7	(43.8)
Women								
Yes	53	(96.4)	25	(52.1)	41	(97.6)	11	(52.4)
No	2	(3.6)	23	(47.9)	1	(2.4)	10	(47.6)

Table 3 *H. pylori* seroprevalence by age

Age group (years)	Men No.	Men Positive (%)	Women No.	Women Positive (%)	Total No.	Total Positive (%)
25–30	16	31.3	22	50.0	38	42.1
31–40	57	49.1	72	50.0	129	49.6
41–50	47	61.7	36	63.9	83	62.7
51–60	27	81.5	18	72.2	45	77.9
> 61	15	93.3	18	77.8	33	84.8
Total	162	60.5	166	58.4	328	59.5
C-M-H statistics[1]		$P < 0.0001$		NS		$P < 0.0001$

[1], Cochran–Mantel–Haenszel test of general association.

Although the serum IgG titre does not distinguish between current and past infection, many studies have reported the high correlation of seropositivity with current infection.[2–8]

Statistical methods

H. pylori infection was defined as having a positive ELISA test result. Total population and gender-specific analyses were performed using the Pearson's Chi-squared test and the Cochran–Mantel–Haenszel test of general association. Logistic regression models were performed where appropriate, using the SAS program (SAS Institute, Cary, NC, USA). Relationships between *H. pylori* infection and gender, age, socioeconomic status (education level, gross household income and occupational status), birthplace, length of residence in country of birth and in Australia, smoking habits, consumption of alcohol, coffee and tea, use of NSAID, use of antibiotics and use of chopsticks were examined. A level of 5% or less was considered significant.

Table 4 *H. pylori* seroprevalence and crude odds ratios for association[a] between *H. pylori* seroprevalence and socio-demographic characteristics by gender, and the total population

	Men			Women			Total		
	No.	(%)	O.R.	No.	(%)	O.R.	No.	(%)	O.R.
Education level (years)									
0-6	14	(92.9)	12.38	41	(73.2)	3.68	55	(78.2)	3.87
7-9	39	(53.8)	1.11	31	(64.5)	2.45	70	(58.6)	1.53
10-12	27	(81.5)	4.19	47	(57.4)	1.82	74	(66.2)	2.12
13+[b]	82	(51.2)	$P<0.002$	47	(42.6)	$P<0.030$	129	(48.1)	$P<0.001$
Household income ($A)									
0-12000	9	(92.9)	2.18	25	(84.0)	6.00	34	(82.3)	3.78
12001-22000	35	(60.0)	0.93	37	(78.4)	4.14	72	(69.4)	1.84
22001-40000	57	(57.9)	0.85	57	(43.9)	0.89	114	(50.9)	0.84
40000+[b]	60	(61.7)	NS	45	(46.7)	$P<0.0001$	105	(55.2)	$P<0.002$
Occupational status									
Domestic	–	–	–	39	(89.7)	10.94	39	(89.7)	8.57
Manual	75	(68.0)	1.67	53	(50.9)	1.30	128	(60.9)	1.53
Clerical	37	(51.4)	0.83	29	(51.7)	1.34	66	(51.5)	1.04
Professional[b]	50	(56.0)	NS	45	(44.4)	$P<0.0001$	95	(50.5)	$P<0.0001$
Smoking									
Current	38	(63.2)	1.53	3	(66.7)	1.35	41	(63.4)	1.30
Ex-smoker	35	(77.1)	3.02	7	(28.6)	0.27	42	(69.0)	1.67
Never smoked[b]	89	(52.8)	$P<0.042$	156	(59.6)	NS	245	(57.1)	NS
Alcohol									
Weekly	46	(63.0)	1.20	8	(37.5)	0.37	54	(59.3)	0.93
< Weekly	58	(60.3)	1.07	34	(50.0)	0.61	92	(56.5)	0.83
Never drink[b]	58	(58.6)	NS	124	(62.1)	NS	182	(61.0)	NS
Coffee									
Yes	129	(59.9)	0.65	116	(54.3)	0.56	246	(56.9)	0.61
No[b]	29	(69.0)	NS	50	(68.0)	NS	79	(68.4)	NS
Tea									
Yes	154	(60.4)	0.92	142	(58.4)	1.01	296	(59.5)	1.00
No[b]	8	(62.5)	NS	24	(58.3)	NS	32	(59.4)	NS
Antibiotics use									
Yes	77	(50.6)	0.45	78	(51.3)	0.57	155	(51.0)	0.51
No[b]	85	(69.4)	$P<0.015$	88	(64.8)	NS	173	(67.0)	$P<0.003$
NSAID use									
Yes	65	(64.6)	1.34	59	(50.8)	0.62	124	(58.1)	0.91
No[b]	97	(57.7)	NS	107	(62.6)	NS	204	(60.1)	NS
Chopstick use									
Yes	120	(65.0)	2.04	130	(64.6)	3.23	250	(64.8)	2.51
No[b]	42	(47.6)	$P<0.047$	36	(36.1)	$P<0.002$	78	(42.3)	$P<0.0001$

[a], Cochran–Mantel–Haenszel test of general association;
[b], comparison group; [c], O.R, odds ratio.

RESULTS

A total of 435 eligible subjects of the Melbourne Chinese Health Study were evaluated. Of these 341 (78%) agreed to be interviewed. Reported here are 328 immigrants to Australia. There were 162 (49.4%) men and 166 (50.6%) women. The study population was compatible with the 1986 census population of persons of Chinese Ancestry, on the basis of gender, age, birthplaces, citizenship status, period of residence in Australia, and statistical district of residence within Melbourne.[29]

Study subjects were born in China/Hong Kong (33.5%), Vietnam (24.1%), Malaysia/Singapore (31.1%) and elsewhere (11.3%). Table 1 shows the demographic patterns of Melbourne Chinese immigrants of various birthplace in terms of age, age on arrival and the length of stay in Australia.

The socio-demographic characteristics of the study population by birthplaces is shown in Table 2. Those born in Malaysia/Singapore had a higher education level and gross household income, with a larger percentage being professionals compared with their counterparts. In the Malaysia/Singapore group, a larger percentage used antibiotics whereas a smaller percentage used chopsticks at dinner. Table 2 also shows the difference

Table 5 Significant adjusted odds ratios for association[a] between *H. pylori* seroprevalence and socio-demographic characteristics, by gender, and the total population

	Men		Women		Total	
	B	*P*	B	*P*	B	*P*
Age	1.081	0.0002			1.056	0.0001
Household income			0.541	0.0006		
Birthplace	1.769	0.0021			1.417	0.0125
Chopstick use			1.654	0.0141	1.391	0.0313
Likelihood ratio	0.866		0.393		0.498	

[a]Factors considered in the logistic regression model included age, length of stay in Australia (age on arrival), birthplace, education level, household income, occupational status, smoking status, the consumption of alcohol, coffee and tea, the use of antibiotics, NSAID, and chopstick at dinner. These factors were eliminated sequentially until the model of best fit was established. Presented in the table are variables making a significant contribution to the model. B, adjusted odds ratio.

in socio-demographic characteristics between men and women.

The seroprevalence of *H. pylori* for the total population was 59.5%, and there was no significant gender difference (60.5% in men and 58.4% in women). The *H. pylori* seroprevalence increased with increasing age (Table 3) and was significant statistically in men ($P < 0.0001$).

The gender specific analysis (Table 4) shows the crude odds ratio and associations between the *H. pylori* seroprevalence and socio-demographic factors. Significant associations being education level ($P < 0.002$), smoking ($P < 0.042$), antibiotic use ($P < 0.015$) and chopstick use ($P < 0.047$) in men; education level ($P < 0.030$), household income ($P < 0.0001$), occupational status ($P < 0.0001$) and chopstick use ($P < 0.002$) in women.

H. pylori seroprevalence differed between immigrants of various birthplaces ($P < 0.001$); those born in Malaysia/Singapore (43.1%) had a lower prevalence than those born in China/Hong Kong (68.2%), Vietnam (68.4%) and elsewhere (59.5%). Immigrants of various birthplaces also differed in socio-demographic characteristics and the use of antibiotics and chopsticks.

Multivariate analyses using logistic regression models (Table 5) show that risk factors for *H. pylori* in men were age (B = 1.081) and birthplace (B = 1.769), and in women were household income (B = 0.541) and use of chopsticks (B = 1.654).

DISCUSSION

H. pylori infection is present worldwide [17-20, 22-27] and differs among different ethnic groups.[22,25,32-35] The population seroprevalence of this study was 59.5%, which is similar to other Chinese populations[25-27] and significantly higher than comparable Caucasian populations reported elsewhere.[22,33-35]

Knowledge of population risk factors is rudimentary. The purpose of our study was to define the epidemiology of *H. pylori* in Chinese immigrants living in Melbourne and to identify population risk factors. It was found in this study that the seroprevalence of *H. pylori* infection did not differ between gender, increase significantly with age, and was higher among the low socio-economic status in terms of education levels, gross household income and occupation. These results are consistent with previous studies.[17-23]

Although there were no gender differences in *H. pylori* seroprevalence, the pattern of infection may differ because of the gender differences in socio-demographics (Tables 2 and 4). The most striking difference was between age and socio-economic status.

In men, the seroprevalence increased with age significantly ($P < 0.0001$); while the seroprevalence also increased with age in women, this was not significant statistically partly because of the substantially high seroprevalence of 50% at the younger age group of 25–30 years. This finding is interesting; to this date, all other studies have neglected gender specific analyses, assuming that the epidemiology of *H. pylori* in men and women are similar because the respective seroprevalences are similar. Our results suggest that gender specific analysis is needed to better define the variables which affect *H. pylori* seroprevalence.

Tables 2 and 4 show the differences in socio-economic characteristics between men and women. In general, fewer women have received secondary and tertiary levels of education, fewer have a household income of A$40 000+ and fewer are professionals than their male counterparts. In women, the trend of higher socio-economic status associated with lower *H. pylori* seroprevalence is obvious, as depicted in Table 4 and is a significant variable in the epidemiology of *H. pylori* (Table 5). It is interesting that in men the effect of socio-economic status upon *H. pylori* is less apparent.

The cultural influence on social habits upon Chinese women is also interesting; less than 2% smoked regularly and 75% had never drunk alcohol.

The high seroprevalence of *H. pylori* among Chinese immigrants cannot be explained fully by age and broad socio-economic variables alone. Whether the apparent difference in susceptibility to *H. pylori* infection relates to subtle differences in exposure or to genetic factors has not been studied previously.

In this study, by careful characterization of the study population, we were able to assess environmental markers for differences in exposures such as birthplace, length of residence in country of birth and in Australia, and possible high risk behaviours such as use of chopsticks.

Chinese born in Malaysia/Singapore were shown to have a lower seroprevalence than other Chinese people. The reasons why this is so are more complex than simply birthplace. First, Chinese born in Malaysia/Singapore have a mean age of arrival in Australia younger than other Chinese (Table 1), hence the duration of exposure in the country of origin of this group of immigrants is shorter. This may be important for immigrants born in countries with higher prevalence in *H. pylori* than Australia, assuming that longer residence in the country of birth is associated with a higher chance of infection. This is a reasonable assumption when one considers studies which have shown that the seroprevalence of *H. pylori* is associated with the duration of exposure in those institutionalized[36] and in gastroenterologists.[37] The first 10 years of residence in an institution for physically and mentally handicapped was most important in defining *H. pylori* status.[34] However, without the background seroprevalence of the country of origin it is difficult to interpret this further.

Chinese born in Malaysia/Singapore also differ from other Chinese in their socio-economic status. Table 2 shows that men and women born in Malaysia/Singapore have a substantially higher level of education and household income and are chiefly professionals. Hence, birthplace, at least in part, is a reflection of socio-economic status. After logistic regression modelling comparing Chinese born in Malaysia/Singapore with Chinese born in China, Hong Kong, Vietnam and elsewhere, birthplace was found to be a significant variable in the epidemiology of *H. pylori* in men ($P < 0.0021$, Table 5).

Table 4 shows a positive association between chopstick use and *H. pylori* seroprevalence in men ($P < 0.047$) and women ($P < 0.002$). Multivariate analyses, adjusting for age and other socio-demographic factors, showed that the use of chopsticks at dinner was significant independently in women only ($P < 0.014$, Table 5). Interestingly, the use of chopsticks is also less prevalent in Chinese born in Malaysia/Singapore (Table 2). Because birthplace is a significant contributing factor in the men's model, the effect of chopstick use in men may be partly obscured.

The mode(s) of transmission of *H. pylori* is unknown. *H. pylori* has been recently identified from stool and saliva as well as from gastric juice and gastric mucosal biopsies.[38,39] *H. pylori* DNA has been reported in saliva and stool using polymerase chain reaction for detection.[39] A higher prevalence among family members[40–43] with the recognition of an identical serotype of *H. pylori* in infected subjects suggests inter-familial transmission between family members.[44] The above data suggest person-to-person transmission via the oral–oral or faecal–oral route. Different modes of transmission may exist in different ethnic groups reflecting ethno-specific differences. We demonstrated an association between *H. pylori* and chopstick use independent of other risk factors. The use of chopsticks at meal time along with centrally placed dishes is an integral part of the Chinese cultural practices.[45] This practice may predispose direct saliva transfer from person to person at the dinner table. This study supports a modification of eating practices in an attempt to modify *H. pylori* seroprevalence. Further confirmation of these findings is warranted before the recommendation that food cultural practices be changed. Other ethnic populations with similar population seroprevalence associated with these similar risk factors, such as the Japanese,[32,46] should also be reviewed.

Other factors such as cigarette smoking, where the odds ratios of *H. pylori* seroprevalence were higher among the ex-smoker than the current smoker, are likely to be an age-related finding.

In summary, this study suggests that the population risk of *H. pylori* infection within the Melbourne Chinese immigrants is associated with age, birthplace and the use of chopsticks.

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