

## Postprint

This is an Accepted Manuscript of an article published in [*Prev Vet Med*] on 13 December 2010, available online at <http://www.sciencedirect.com/science/article/pii/S0167587710003296> (paywalled).

### Please cite as:

Dhand, N. K., Hernandez-Jover, M., Taylor, M., & Holyoake, P. (2011). Public perceptions of the transmission of pandemic influenza A/H1N1 2009 from pigs and pork products in Australia. *Prev Vet Med*, 98(2-3), 165-175. Available online at

## Public perceptions of the transmission of pandemic influenza A/H1N1 2009 from pigs and pork products in Australia

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### Abstract

A cross-sectional study was conducted at the height of the pandemic influenza H1N1/09 outbreak in Australia in 2009. The objectives of the study were to evaluate public perceptions about transmission and prevention of the disease, to understand their concerns and preparedness to cope with the disease, and to investigate drivers influencing their behaviour. A questionnaire was designed and administered to 510 customers visiting 15 butcher shops in the Greater Sydney region between 26th June and 2nd August 2009. Data were analysed to estimate the proportion of people with certain perceptions and to evaluate the influence of these perceptions on two binary outcome variables: (1) whether or not people believed that avoiding pork would protect them from contracting H1N1/09, and (2) whether or not they actually made some changes to pork consumption after the outbreak. A majority of the respondents had perceptions based on fact about transmission and prevention of H1N1/09. As many as 96.8 % of the respondents believed that washing their hands frequently was likely to protect them from contracting H1N1/09. Similarly, most believed that they could contract H1N1/09 by travelling on public transport with a sick

person present (94.1%), by shaking hands with a sick person (89.2%), or by attending a community gathering (73.7%). Women were more likely than men to have factual perceptions about protective behaviours. Misconceptions regarding transmission of the disease were evident, with 21.7% believing that avoiding eating pork could protect them against H1N1/09, 11.1% believing that they could contract H1N1/09 by drinking tap water, 22.8% by handling uncooked pork meat and 15.6% by eating cooked pork. Approximately one third of respondents believed that working in a pig farm or an abattoir increased their likelihood of contracting H1N1/09 (36.9% and 32.3%, respectively). Younger people (<35 years old) were more likely to have these misconceptions than older people. Reduction in consumption of pork, ham or bacon was significantly associated with misconceptions regarding the risk of contracting H1N1/09 from eating pig meat products. It is recommended that in the event of a future disease emergency, communication activities providing factual information and targeting younger people should be used.

*Keywords:* Pandemic influenza; A/H1N1; swine flu; perceptions; concerns; behaviour; health emergency.

## **1. Introduction**

Influenza Pandemic (H1N1) 2009 (H1N1/09), spread from Mexico to more than 200 countries in 2009, resulting in more than 12,000 deaths worldwide (World Health Organisation (WHO) 2009a). The WHO initially declared the outbreak as a 'public health emergency of international concern', but subsequently upgraded the alert to that of a 'pandemic' as infection spread to other continents (Chan, 2009; WHO, 2009c). Speculation on the potential public health impacts of H1N1/09 attracted intense media attention and raised concerns among the people. This speculation was made worse by a paucity of information on the epidemiology of the disease, virulence of the virus and the potential for re-assortment.

H1N1/09 was identified early in the outbreak as containing genes from swine, avian and human influenza viruses (Kou et al., 2009). Based on this information the disease was referred to in the media as 'swine flu'. This was despite the disease being primarily a human strain of influenza, with infection of pigs only resulting from direct transmission from infected humans (CFIA, 2009; Holyoake, 2009). The naming of the disease as 'swine flu' in the beginning had major implications, including banning of the import of pigs and pig products by many countries, and destruction of all pigs by others (Vallat, 2009). This occurred despite repeated statements from WHO, the World Organisation for Animal Health (OIE), and numerous others suggesting that cooked pork products from H1N1/09 were safe to eat (WHO, 2009b). We hypothesise that despite clarifications by the WHO and the OIE, referring to the disease as 'swine flu' and persistent use of this term in the media has influenced people's perceptions about transmission of virus.

Research conducted in the early stages of the H1N1/09 pandemic in Hong Kong (Lau et al., 2009) found evidence of widespread public misconceptions about transmission of H1N1/09. These misconceptions included 6.9% of respondents believing the virus could be contracted by eating well-cooked pork, 25.3% believing it could be contracted from insect bites, and 39.5% believing it could be contracted from water sources, such as rivers and reservoirs. Research data from a European sample (Goodwin et al., 2009) collected shortly after the WHO pandemic alert 5 at the end of April 2009, found evidence that 7% had either reduced or stopped eating pork. These data concur with market research data commissioned by Australian Pork Limited (APL) in early May, 2009, in which 6% of those

sampled reported that they were much less likely to buy pork because of the outbreak (APL, 2009).

It is recommended that behavioural responses to health emergencies be recorded during the peak of the outbreak. In reality, this information is usually collected after the epidemic is over (Jones and Salathe, 2009). In this study, we sought to understand public perceptions of H1N1/09 at the height of the pandemic in Australia. In particular, our objectives were to understand: (a) public perceptions about transmission of Influenza H1N1/09, particularly on the role of pork and pork products in transmitting H1N1/09; and (b) the influence of these perceptions on avoiding consumption of pork. We anticipated that this information would enable the animal industries and the health authorities to make informed decisions in planning coordinated communication strategies in the future.

## **2. Methods**

A cross-sectional study was conducted by preparing and administering a questionnaire to a sample of customers visiting selected butcher shops in the Greater Sydney area. All procedures were approved by the human ethics committee of The University of Sydney, Australia.

### *2.1. Sample size*

A sample size of 384 was calculated to estimate the proportion of people who would have changed behaviours (e.g. stopped eating pork) with 95% confidence, assuming that the expected proportion of such people in the population was 10% and that we wished to measure this proportion with a precision of  $\pm 3\%$ . A sample size of 438 was required for making inferences, for example, to compare perceptions between men and women. This sample size provided 95% confidence of detecting a significant difference for an odds ratio of two, assuming that 10% of the respondents in the group with the lower frequency had the factor of interest. These sample sizes assumed no clustering of responses in people visiting various butcher shops. Given that there was no prior information on the presence or not of clustering or its level, we decided on a minimum sample size of 500 people, with a maximum of 50 persons to be enrolled at each butcher shop to reduce the impact of clustering.

### *2.2. Enrolment of butcher shops*

Contact details of 20 butcher shops were provided by a major pork supplier, 11 of which agreed to researchers interviewing customers visiting their shops. A further four butchers were convenience-selected to participate in the study to increase the sample size. Butcher shops were not randomly selected due to an inability to obtain a sampling frame of all butcher shops in Sydney and the need to expedite the research whilst the pandemic was still at its peak.

### *2.3. Recruitment of participants*

Four students from the Faculty of Veterinary Science, The University of Sydney administered the survey. They were informed of the objectives of the study, the procedures to approach people and instructions to complete the questionnaires in a one-day training workshop. Students were advised to follow a pre-written script to contact people, and not attempt to coerce potential participants to enrol. Entry into a lucky draw for five AU\$30 gift vouchers at each butcher shop was used to encourage customer participation.

Interviews were conducted between 26th June and 2nd August 2009, while the outbreak of H1N1/09 was at its peak (Anonymous, 2010). On a mutually agreed day, the students visited the butcher shop and approached customers entering/exiting the shop, advising them about the study being conducted. People less than 18 years of age and those unable to read or speak English were excluded from the study. If the customers agreed to participate, they were given a survey pack containing Introductory Letter, a Participant Information Statement, and the questionnaire (see section 2.4 below). The participants had

the option to complete the questionnaire either by themselves or by providing answers to the student interviewers face-to-face. Although the participants also had the option to complete the questionnaire later at a convenient time and then mail the questionnaire to the research team using the addressed envelope, few people selected this option (see section 3.1 below).

#### 2.4. Questionnaire design

A three-page questionnaire was developed to investigate public perceptions of the pandemic, in particular, people's sources of information on the H1N1/09 outbreak, their knowledge of the cause and transmission of the virus, and their concerns about potential infection as well as the influence of their perceptions on their pork consumption habits. The questionnaire, written in English, consisted of 13 questions of which eight were closed, two were semi-closed and three were open, expressed in a simple and clear format to minimize confusion and maximise response accuracy (Thrusfield, 1995; Dohoo et al., 2004).

The Introductory Letter was prepared on The University of Sydney letterhead to explain the purpose of the study and to request participation. The Participation Information Statement disclosed information about the study and highlighted that participants' responses were confidential. All three documents – the Introductory Letter, the Participant Information Statement and the questionnaire – were collated into packs to be provided to customers at butcher shops. A stamped and self-addressed envelope was included in the pack to enable participants to mail completed questionnaires back to the research team, if necessary.

Prior to implementation, the questionnaire was piloted with four people and was subsequently modified to improve interpretation. Estimated completion time for the questionnaire was 5-10 minutes. A copy of the questionnaire is available from the corresponding author on request.

#### 2.5. Data Analysis

The SAS statistical program (© 2002-2003 SAS Institute Inc., Cary, NC, USA) was used for all statistical analyses reported in this paper.

##### 2.5.1. Evaluation of perceptions

Frequencies and relative frequencies were calculated for four groups of variables: (1) perceptions about the activities likely to protect them from contracting H1N1/09; (2) their perceptions about the activities likely to predispose them to contracting the disease; (3) changes they made to pork consumption after the outbreak; and (4) their level of preparedness or concern about the outbreak. Confidence intervals (95% CI) for the proportions were calculated after adjusting for clustering due to butcher shops at which the respondents were interviewed using the SAS SURVEYFREQ procedure.

Preliminary associations of these four groups of variables with age and gender were evaluated by creating contingency tables. All these variables originally had five categories, which were collapsed into two categories (yes/no) to create binary variables for binomial logistic regression analyses. Univariable logistic regression analyses were conducted using the SAS LOGISTIC procedure assisted by UniLogistic macro (Dhand, 2010) to compare perceptions between different age and gender groups (Stokes et al., 2000). If the outcomes were significantly different at 10% level of significance (i.e.  $P < 0.1$ ), multivariable generalized linear mixed models were constructed using the SAS GLIMMIX procedure to further evaluate their associations after adjusting for each other and after accounting for expected similarity in customers visiting a particular butcher shop (Anonymous, 2005; Schabenberger, 2005). Variables with  $P$ -value  $< 0.05$  in the multivariable model were considered significant.

### 2.5.2. Association of factors with pork avoiding behaviour

Two binary outcome variables were created to evaluate factors associated with pork-avoiding behaviour. The first outcome variable AVOIDPORK characterized people who believed that avoiding eating pork would protect them from contracting H1N1/09 (yes/no – binary). The second outcome REDUCEDPORK represented people who actually made some changes to pork consumption after the outbreak (yes/no – binary). Associations of both outcomes were evaluated with ten ordinal explanatory variables including: (1) four variables representing perceptions about likelihood of transmission of H1N1/09; (2) four variables representing concerns if the disease were to become widespread; (3) one variable representing perceptions about the likelihood of contracting the disease if H1N1/09 were to become widespread; and (4) one variable representing people’s preparedness to cope with it, if they or their loved ones were to become ill with H1N1/09. In addition, respondents’ gender and age were included as potential confounders in all these analyses.

Initially, descriptive and univariable logistic regression analyses were conducted to make a preliminary evaluation of the associations between explanatory and outcome variables. The variables unconditionally associated with the outcomes at  $P < 0.25$  were tested for multicollinearity in pairs using Spearman rank correlation coefficient and Pearson chi-square test. Only one of the pair of collinear variables was selected for further multivariable analyses if substantial (Spearman rank correlation  $>0.8$ ), and significant (Pearson chi-square  $P < 0.05$ ) correlations were detected, the other variable being tested only by including in the final model. Similarly, variables with greater than 10% missing values were excluded from multivariable analyses initially, but later tested by adding to the final model.

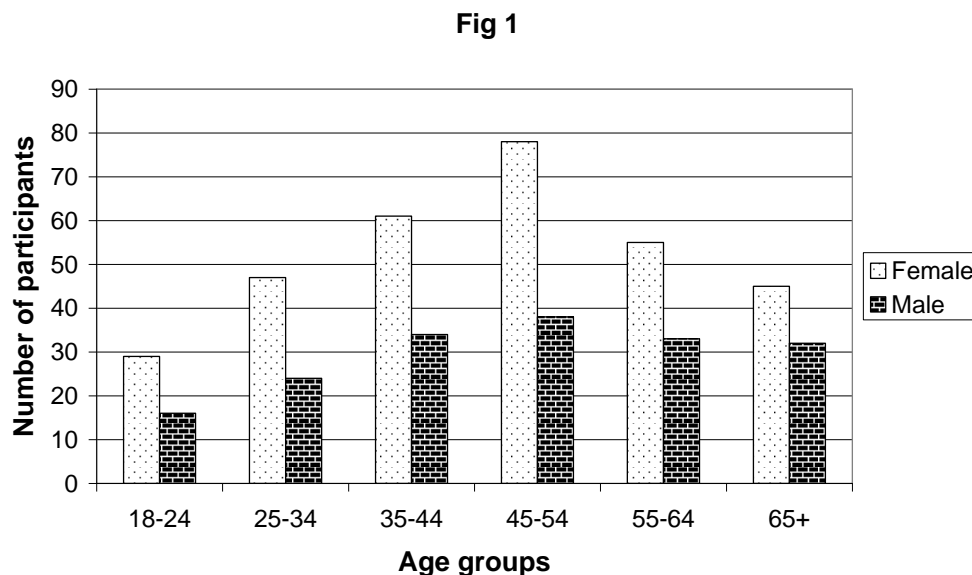
Multivariable generalised linear mixed models were constructed using a forward stepwise selection approach, with butcher shops as random effects and the variables selected based on univariable analyses as fixed effects. Variables with  $P < 0.05$  were considered significant. Age and gender were considered as potential confounders and were forced in all the multivariable models, even if found to be non-significant.

## 3. Results

### 3.1. Response rate and demographic information about respondents

A total of 510 people were surveyed at 15 butcher shops in Sydney with an average of 34 persons per shop. Most people completed questionnaires at the time of the survey, with only 28 returned through the mail. The age and gender distribution of participants is shown in Fig 1. Of the respondents for which age and gender information was available (492/510), 64.0% (315/492) were female and 36.0% were male (177/492).

**Figure 1. Age and gender distribution of participants in the study conducted in the greater Sydney region in 2009.**



Interviewers at 12 of the 15 shops prepared a list of those who declined to participate and the reasons for their refusal. In total, 207 people refused to participate in the survey at these 12 shops because they were not interested (85, 41.1%), were too busy (77, 37.2%), could not speak English well (18, 8.7%) or had other reasons (27, 13.04%). Of those who refused to participate, 79 were male and 128 were female.

### 3.2. Activities likely to protect against contracting H1N1/09

A vast majority of the respondents (96.8 %; 95% CI: 94.8%, 98.8%) believed that washing their hands frequently was likely (extremely, very or moderately) to protect them from contracting H1N1/09 (Table 1). Compared to men, women were about four times more likely to trust the protecting ability of washing hands (Table 2). However, there were no significant differences between age or gender groups in the proportion of respondents believing that avoiding crowded places, avoiding overseas travel or wearing a facemask were likely to be protective.

Just under a quarter of respondents (21.7%; 95% CI: 12.3, 31.0) believed that avoiding eating pork could protect them against H1N1/09 (Table 1) with younger people more likely to have this perception (Table 2; Fig. 2a). However, there were no significant differences in the perceptions of men and women about the protective ability of this avoidance activity.

**Table 1. Perceptions about activities likely to protect people from contracting pandemic influenza A/H1N1 2009 based on the survey conducted in Sydney, Australia in 2009.**

Activities	Extremely likely (Row %)	Very Likely (Row %)	Moderately likely (Row %)	Very unlikely (Row %)	Extremely unlikely (Row %)	Total Responses
Washing hands frequently	226 (44.8)	202 (40.1)	60 (11.9)	13 (2.6)	3 (0.6)	504
Avoiding overseas travel	99 (20.2)	174 (35.4)	129 (26.3)	76 (15.5)	13 (2.7)	491
Avoiding crowded places	95 (19.4)	207 (42.2)	135 (27.5)	47 (9.6)	7 (1.4)	491
Avoiding eating pork	16 (3.4)	40 (8.5)	46 (9.8)	130 (27.6)	239 (50.7)	471
Wearing a facemask	54 (11.2)	96 (19.9)	169 (35.0)	116 (24.0)	48 (9.9)	483

**Table 2. Association of age and gender with perceptions about activities likely to protect people from contracting pandemic influenza A/H1N1 2009. Only the significant associations are presented in the table.**

Activities	Age or Gender groups	Is the activity likely to protect from contracting H1N1/09?		<i>b</i>	SE	Odds ratio	(95% CI)	<i>P</i>
		Likely	Not likely					
<i>Washing hands frequently</i>								
	Female	312	5	1.50	0.56	4.47	(1.50, 13.30)	0.007
	Male	164	11	0.00		1.00		
<i>Avoiding eating pork</i>								
	18-24	17	28	0.65	0.47	1.91	(0.77, 4.77)	0.009
	25-34	19	50	0.17	0.42	1.19	(0.52, 2.73)	
	35-44	17	72	-0.61	0.42	0.54	(0.24, 1.25)	
	45-54	15	94	-0.82	0.43	0.44	(0.19, 1.02)	
	55-64	14	69	-0.56	0.43	0.57	(0.25, 1.33)	
	65+	16	50	0.00		1.00		

### 3.3. Activities likely to increase the risk of contracting H1N1/09

Public perceptions of the likelihood of contracting H1N1/09 virus through various activities are listed in Table 3. An overwhelming majority of respondents believed that they could contract H1N1/09 by travelling on public transport with a sick person present (94.1%; 95% CI 91.0, 97.3 %) or by shaking hands with a sick person (89.2%; 95% CI: 85.5, 92.8 %). Compared to men, women were more than two times more likely to believe in the disease-spreading ability of both of these activities but no significant differences were detected in perceptions across age groups (Table 4).

**Table 3. Public perceptions of their likelihood of contracting pandemic influenza A/H1N1 2009 through various risk activities.**

Activities	Extremely likely (Row %)	Very Likely (Row %)	Moderately likely (Row %)	Very unlikely (Row %)	Extremely unlikely (Row %)	Total Responses
Travelling on public transport with a sick person present	137 (27.7)	196 (39.6)	133 (26.9)	27 (5.5)	2 (0.4)	495
Shaking hands with a sick person	99 (20.6)	189 (39.4)	140 (29.2)	46 (9.6)	6 (1.3)	480
Swimming in a community pool	25 (5.2)	70 (14.7)	135 (28.3)	142 (29.8)	105 (22.0)	477
Attending a community gathering	41	111	189	96	26	463

	(8.9)	(24.0)	(40.8)	(20.7)	(5.6)	
Drinking tap water	6	15	31	160	257	469
	(1.3)	(3.2)	(6.6)	(34.1)	(54.8)	
Eating cooked pork	5	24	44	149	246	468
	(1.1)	(5.1)	(9.4)	(31.8)	(52.6)	
Handling uncooked pork meat	14	33	60	137	225	469
	(3.0)	(7.0)	(12.8)	(29.2)	(48.0)	
Working in a pig farm	23	61	90	129	169	472
	(4.9)	(12.9)	(19.1)	(27.3)	(35.8)	
Working in an abattoir	21	54	77	145	174	471
	(4.5)	(11.5)	(16.4)	(30.8)	(36.9)	

**Table 4. Association of age and gender with perceptions of the likelihood of contracting pandemic influenza A/H1N1 2009 through various risk activities. Only significant associations are presented in the table.**

Activities	Age and Gender classes	Can the respondents contract H1N1/09 via these activities?		<i>b</i>	SE	Odds ratio	(95% CI)	<i>P</i>
		Yes	No					
<i>Travelling on public transport with a sick person present</i>								
	Female	298	14	0.83	0.40	2.30	(1.1, 5.0)	0.036
	Male	158	15			1.00		
<i>Shaking hands with a sick person</i>								
	Female	281	23	0.94	0.30	2.56	(1.4, 4.6)	0.002
	Male	138	28			1.00		
<i>Attending a community gathering</i>								
	Female	226	69	0.43	0.22	1.53	(1.0, 2.4)	0.053
	Male	109	51	0.00		1.00		
<i>Drinking tap water</i>								
	18-24	11	34	-2.78	0.53	5.29	(1.5, 18.2)	0.005
	25-34	11	58	1.67	0.63	2.99	(0.9, 10.0)	
	35-44	15	77	1.09	0.62	3.11	(1.0, 9.9)	
	45-54	5	104	1.13	0.59	0.81	(0.2, 3.2)	
	55-64	6	72	-0.21	0.69	1.32	(0.4, 4.9)	
	65+	4	63	0.28	0.67	1.00		
<i>Eating cooked pork</i>								
	18-24	11	34	0.47	0.50	1.60	(0.6, 4.3)	0.023



25-34	18	51	0.60	0.45	1.83	(0.8, 4.4)	
35-44	12	79	-0.38	0.47	0.68	(0.3, 1.7)	
45-54	11	98	-0.54	0.47	0.59	(0.2, 1.5)	
55-64	7	71	-0.72	0.53	0.49	(0.2, 1.4)	
65+	11	55	0.00		1.00		
<i>Handling uncooked pork meat</i>							0.009
18-24	18	26	0.97	0.45	2.64	(1.1, 6.4)	
25-34	22	47	0.51	0.41	1.67	(0.8, 3.7)	
35-44	20	71	-0.04	0.40	0.96	(0.4, 2.1)	
45-54	19	90	-0.21	0.40	0.81	(0.4, 1.8)	
55-64	11	68	-0.59	0.45	0.55	(0.2, 1.3)	
65+	15	52	0.00		1.00		
<i>Working in a pig farm</i>							<0.001
18-24	30	15	1.45	0.42	4.26	(1.9, 9.8)	
25-34	30	39	0.47	0.36	1.61	(0.8, 3.3)	
35-44	32	60	0.00	0.35	1.00	(0.5, 2.0)	
45-54	30	79	-0.22	0.34	0.80	(0.4, 1.6)	
55-64	23	56	-0.21	0.36	0.81	(0.4, 1.7)	
65+	23	45	0.00	.	1.00		
<i>Working in an abattoir</i>							<0.001
18-24	27	18	1.46	0.44	4.32	(1.8, 10.2)	
25-34	28	41	0.62	0.38	1.86	(0.9, 4.0)	
35-44	27	65	-0.13	0.37	0.88	(0.4, 1.8)	
45-54	26	84	-0.21	0.37	0.81	(0.4, 1.7)	
55-64	20	59	-0.23	0.39	0.79	(0.4, 1.7)	
65+	20	46	0.00		1.00		

In relation to other potential risk activities, 48.2% (95% CI: 42.3, 54.1 %) and 73.7% (95% CI: 67.8, 79.4 %) of the respondents believed that they could contract H1N1/09 by swimming in a community pool or by attending a community gathering, respectively, with only 19.9% and 32.8% firmly (extremely or very likely) believing in this view (Table 3). While there were no differences in responses across age or gender groups for the effect of swimming in a community pool, females were about 1.5 times more likely to believe that they could contract the disease by attending a community gathering (Table 4).

Surprisingly, 11.1% (95% CI: 7.1, 15.1%) of the respondents believed that they could contract H1N1/09 by drinking tap water (Table 3). Although the responses did not vary significantly by gender, younger people were significantly more likely to have this perception (Table 4).

Around a quarter of respondents (22.8%; 95% CI 15.4, 30.3 %) believed that they could contract H1N1/09 by handling *uncooked* pork meat. By comparison, only 15.6% (95% CI: 9.4, 21.8 %) believed that they could contract H1N1/09 by eating *cooked* pork (Table 3). More than one third of the respondents believed that they could contract H1N1/09 by working in a pig farm or an abattoir [36.9% (95% CI: 29.2, 44.5 %) and 32.3% (95% CI: 23.0,

41.5 %), respectively]. Of these, about half (75/175 and 21/52, respectively) believed that this is extremely or very likely. Interestingly, younger people were generally more likely to believe that they could contract H1N1/09 through all these pig/pork related activities (Table 4; Fig. 2).

Other sources of transmission mentioned by people included: hugging or kissing, having close proximity with an infected person, sharing eating utensils or food with infected person, being directly coughed or sneezed on by an infected person, having sick people at work or school, not covering mouth/nose when sneezing and coughing, and being in communal places such as shopping centres, workplaces, childcare, etc.

### 3.4. Changes in pork consumption

Respondents were asked about the number of times they usually eat ham or bacon in a week. Of the 441 respondents to this question, 25 (5.7%) did not eat ham or bacon at all, 180 (40.8%) ate once or less than once a week, 111 (25.2%) ate 1-2 times a week, 61 (13.8%) ate 2-3 times a week, 29 (6.6%) ate 3-4 times and 35 (7.9%) more than four times a week. Similarly, 60 respondents (14.4%) did not report eating pork meat, pork sausages or other products, 195 (46.7%) reported eating such products one or less than one times a week, 96 (23.0%) 1-2 times a week, 36 (8.6%) 2-3 times a week, 21 (5.0%) 3-4 times a week and 10 (2.4%) more than four times a week.

Only 11.1% of the respondents (51/461) reported making any changes to the practice of eating ham, bacon or pork products: 4.2% (19/461) reduced their intake initially but returned to the normal eating habits later; 1.7% (8/461) reduced their intake and continued to eat less; whereas 5.2% (24/461) totally stopped eating pork and pork products. No significant differences across age or gender groups were observed in those who made or did not make any changes to their eating habits.

### 3.5. Concern about the disease and preparedness to cope

Results of the survey indicated that 80.3% (95% CI: 74.8, 85.8 %) of the respondents (407/507) believed that they were likely to catch H1N1/09 if it were to become widespread in their area. Proportions of respondents with this perception were not significantly different across gender or age groups.

About three quarters of the respondents were concerned (and about half of them extremely or very concerned) that they or their family/loved ones could get H1N1/09 or that they or their family/loved ones could become seriously ill (Table 5). Compared to themselves, the respondents were significantly more concerned about their family/loved ones getting H1N1/09 ( $P= 0.025$ ) or becoming seriously ill ( $P= 0.034$ ). However, there were no significant differences across age groups or genders in the level of concern, indicating that all age groups and both men and women were almost equally concerned.

**Table 5. Level of concern in people if pandemic influenza A/H1N1 2009 were to become widespread in their area**

Concerned that:	Extremely Concerned (Row %)	Very Concerned (Row %)	Concerned (Row %)	A little Concerned (Row %)	Not at all Concerned (Row %)	Total Responses
...they would get H1N1/09	84 (17.3)	145 (29.8)	155 (31.8)	84 (17.3)	19 (3.9)	487
...their family/loved	108	156	143	65	10	482

ones would get	(22.4)	(32.4)	(29.7)	(13.5)	(2.1)	
...they could become	93	138	132	89	31	483
seriously ill	(19.3)	(28.6)	(27.3)	(18.4)	(6.4)	
... their family/loved	120	144	127	73	20	484
ones could become						
seriously ill	(24.8)	(29.8)	(26.2)	(15.1)	(4.1)	

A vast majority of the respondents (411/506; 81.2%, 95% CI: 76.8, 85.6 %) thought that they were prepared to cope with H1N1/09 in case they or their loved ones became ill with the disease. There were no significant differences across age groups in the level of preparedness, but a significantly greater proportion of females (267/318; 84.0%) were prepared to cope with the disease than males [133/176; 75.6%; odds ratio: 1.7 (95% CI of odds ratio: 1.1, 2.7;  $P = 0.03$ )].

### 3.6. Factors influencing perceptions of pigs and pig products

#### 3.6.1. Avoiding pork (AVOIDPORK)

The results of univariable logistic regression analyses conducted to investigate associations with the outcome variable AVOIDPORK are presented in Table 6. Of the 12 explanatory variables (including two confounders: age and gender), ten were significant at the univariable level and all had  $P$ -values less than 0.25, the predetermined cut-off level for inclusion of variables into the multivariable model (Table 6). In general, those who believed that they could contract H1N1/09 by coming into contact with pigs or eating pork, those who were more concerned about their own or their family/loved ones' well being, and those who thought they were more likely to contract the disease, believed that avoiding eating pork would protect them against the disease. In contrast, those who felt they were well prepared to cope with the disease were less likely to believe this.

**Table 6. Results of univariable logistic regression analyses to investigate associations of explanatory variables with perceptions that avoiding eating pork is likely to protect people from contracting pandemic influenza A/H1N1 2009 (AVOIDPORK).**

Factors and categories		Protect		Odds-ratios	(95% CI)	$P$
		Yes	No			
<i>Likelihood of a person contracting H1N1/09 by</i>						
eating cooked pork	Extremely or very likely	23	5	39.55	(15.4, 123.1)	<0.001
	Moderately likely	34	9	32.49	(15.1, 76.7)	
	Extremely or very unlikely	40	344			
handling uncooked pork meat	Extremely or very likely	31	14	25.54	(12.4, 55.0)	<0.001
	Moderately likely	36	23	18.06	(9.5, 35.2)	
	Extremely or very unlikely	28	323			
working in a pig farm	Extremely or very likely	60	21	49.11	(24.9, 102.8)	<0.001
	Moderately likely	23	64	6.18	(3.1, 12.6)	
	Extremely or very unlikely	16	275			
working in an abattoir	Extremely or very likely	59	14	68.35	(33.3, 150.6)	<0.001

	Moderately likely	21	54	6.31	(3.2, 12.7)	
	Extremely or very unlikely	18	292			
<i>Level of concern if H1N1/09 were to become widespread in their area</i>						
that they would get it	Extremely or very concerned	67	141	4.32	(2.2, 9.3)	<0.001
	Concerned	22	129	1.55	(0.72, 3.57)	
	Not concerned or not at all concerned	10	91			
that their family/loved ones would get it	Extremely or very concerned	73	171	4.15	(1.93, 10.31)	<0.001
	Concerned	19	119	1.55	(0.65, 4.14)	
	Not concerned or not at all concerned	7	68			
that they could become seriously ill	Extremely or very concerned	70	142	4.35	(2.32, 8.82)	<0.001
	Concerned	18	109	1.46	(0.68, 3.25)	
	Not concerned or not at all concerned	12	106			
that their family/loved ones could become seriously ill	Extremely or very concerned	75	169	4.14	(2.07, 9.24)	<0.001
	Concerned	16	105	1.42	(0.61, 3.51)	
	Not concerned or not at all concerned	9	84			
<i>Perception of the likelihood of catching H1N1/09 if it were to become widespread in respondents' area</i>						
	Extremely or very likely	55	98	4.29	(2.2, 9.1)	<0.001
	Moderately likely	33	187	1.35	(0.67, 2.9)	
	A little or not at all likely	11	84			
<i>Peoples preparedness to cope with H1N1/09 if they or their loved ones became ill with it</i>						
	Very well or well prepared	25	119	0.55	(0.29, 1.03)	0.2
	Somewhat prepared	50	183	0.71	(0.41, 1.3)	
	Poorly or very poorly prepared	25	65			

There were no variables with  $\geq 10\%$  missing observations, but three pairs of variables had Spearman rank correlation coefficient of  $>0.8$ . These were: 1) concern that *they* would get H1N1/09 and that *their family/loved ones* would get H1N1/09 (Spearman rank correlation coefficient 0.89;  $P < 0.001$ ); 2) concern that *they* could become seriously ill and that *their family/loved ones* could become seriously ill (Spearman rank correlation coefficient 0.85;  $P < 0.001$ ). The first of these three pairs of variables were initially chosen for testing in

multivariable analyses. However, the remaining three variables were also tested by including in the final model one at a time but none of them was significant.

Only two variables were significant in the final multivariable generalised linear mixed model, after adjusting for potential confounders of age and gender (Table 7). Respondents who perceived that a person could contract H1N1/09 by working at an abattoir or by eating cooked pork were more likely to believe that avoiding eating pork would protect them against H1N1/09.

**Table 7. Final generalised linear mixed model constructed to investigate associations of explanatory variables with perceptions that avoiding eating pork is likely to protect people from contracting pandemic influenza A/H1N1 2009 (AVOIDPORK). Age and gender were considered as potential confounders and forced in the model.**

Variable and categories	<i>b</i>	<i>SE</i>	Adjusted		<i>P</i>
			Odds ratio	(95% CI)	
Intercept	-2.32	0.49			
<i>Likelihood of a person contracting H1N1/09 by working in an abattoir</i>					
Extremely or very likely	3.21	0.45	24.80	(10.3, 59.7)	<0.001
Moderately likely	1.33	0.41	3.77	(1.7, 8.4)	
Extremely or very unlikely	0.00		1.00		
<i>Likelihood of a person contracting H1N1/09 by eating cooked pork</i>					
Extremely or very likely	2.05	0.63	7.78	(2.3, 26.9)	<0.001
Moderately likely	2.33	0.51	10.29	(3.8, 28.1)	
Extremely or very unlikely	0.00		1.00		
<i>Age (years)</i>					0.9
18-24	-0.03	0.62	0.97	(0.29, 3.3)	
25-34	-0.31	0.60	0.73	(0.23, 2.4)	
35-44	-0.21	0.57	0.81	(0.26, 2.50)	
45-54	-0.53	0.58	0.59	(0.19, 1.84)	
55-64	-0.36	0.61	0.70	(0.21, 2.3)	
65+	0.00		1.00		
<i>Gender</i>					0.1
Female	-0.57	0.35	0.57	(0.29, 1.1)	
Male	0.00		1.00		

### 3.6.2. Changes to consumption of pork (REDUCEDPORK)

Similar to above, 10 of the 12 explanatory variables were significantly associated with the outcome REDUCEDPORK at the univariable level and had a similar direction of association as the AVOIDPORK outcome variable (Table 8). Similar variables as above were initially dropped due to significant correlations but the variable 'contract H1N1/09 by working in a pig farm' became significant when added to the final model, and was therefore retained.

Two explanatory variables were significantly associated with REDUCEDPORK at the multivariable level after adjusting for age and gender (Table 9). People who believed that they could contract the disease by working at a pig farm or by avoiding eating pork were more likely to make changes to the consumption of pork after the outbreak.

**Table 8. Univariable logistic regression analyses to investigate associations of explanatory variables with whether or not the respondents made changes to pork consumption after pandemic influenza A/H1N1 2009 (REDUCEDPORK).**

Variables and categories		Made changes		Odds-ratios	(95% CI)	P
		Yes	No			
<i>Likelihood of a person contracting H1N1/09 by</i>						
eating cooked pork	Extremely or very likely	11	14	14.52	(5.8, 36.5)	<0.001
	Moderately likely	18	23	14.46	(6.7, 31.6)	
	Extremely or very unlikely	19	351			
handling uncooked pork meat	Extremely or very likely	16	25	17.44	(7.5, 41.8)	<0.001
	Moderately likely	19	37	13.99	(6.4, 31.9)	
	Extremely or very unlikely	12	327			
working in a pig farm	Extremely or very likely	34	42	27.12	(12.3, 66.7)	<0.001
	Moderately likely	8	79	3.39	(1.2, 9.5)	
	Extremely or very unlikely	8	268			
working in an abattoir	Extremely or very likely	31	37	21.86	(10.4, 49.0)	<0.001
	Moderately likely	8	65	3.21	(1.2, 8.3)	
	Extremely or very unlikely	11	287			
<i>Level of concern if H1N1/09 were to become widespread in their area</i>						
that they would get it	Extremely or very concerned	39	171	10.83	(3.2, 67.4)	<0.001
	Concerned	9	135	3.17	(0.79, 21.1)	
	Not concerned or not at all concerned	2	95			
that their family/loved ones would get it	Extremely or very concerned	40	205	6.73	(2.0, 42.0)	<0.001
	Concerned	9	122	2.55	(0.63, 17.0)	
	Not concerned or not at all concerned	2	69			
that they could become seriously ill	Extremely or very concerned	41	169	13.34	(4.0, 82.9)	<0.001
	Concerned	8	117	3.76	(0.92, 25.3)	
	Not concerned or not at all concerned	2	110			
that their family/loved ones could become seriously ill	Extremely or very concerned	42	202	17.88	(3.8, 319.4)	<0.001
	Concerned	8	111	6.20	(1.1, 116.1)	
	Not concerned or not at all	1	86			

concerned						
<i>Peoples perception of the likelihood of catching H1N1/09 if it were to become widespread in their area</i>						
Extremely or very likely	32	123	7.29	(2.5, 31.0)	<0.001	
Moderately likely	15	202	2.08	(0.67, 9.1)		
A little or not at all likely	3	84				
<i>Peoples preparedness to cope with H1N1/09 if they or their loved ones became ill with it</i>						
Very well or well prepared	8	140	0.77	(0.26, 2.42)	0.003	
Somewhat prepared	35	187	2.53	(1.09, 6.88)		
Poorly or very poorly prepared	6	81				

**Table 9. Multivariable generalised linear mixed models to identify and quantify factors associated with the respondents making changes to pork consumption after pandemic influenza A/H1N1 2009 (REDUCEDPORK).**

Variable and categories	<i>b</i>	SE	Adjusted odds ratio	(95% CI)	<i>P</i>
Intercept	-4.83	1.07			
<i>Likelihood of a person contracting H1N1/09 by working at a pig farm</i>					
Extremely or very likely	2.62	0.71	13.78	(3.4, 55.8)	<0.001
Moderately likely	1.14	0.71	3.14	(0.78, 12.6)	
Extremely or very unlikely	0.00		1.00		
<i>Likelihood of a person contracting H1N1/09 by eating cooked pork</i>					
Extremely or very likely	2.61	0.77	13.66	(3.0, 62.1)	0.002
Moderately likely	1.52	0.74	4.59	(1.07, 19.6)	
Extremely or very unlikely	0.00		1.00		
<i>Age (years)</i>					
18-24	-1.01	1.23	0.36	(0.03, 4.1)	0.4
25-34	0.60	0.97	1.82	(0.27, 12.2)	
35-44	-0.51	1.05	0.60	(0.076, 4.7)	
45-54	0.65	0.99	1.92	(0.28, 13.4)	
55-64	1.19	1.08	3.30	(0.39, 27.6)	
65+	0.00		1.00		

<i>Gender</i>					0.8
Female	-0.10	0.54	0.90	(0.32, 2.6)	
Male	0		1.00		

#### 4. Discussion

This cross-sectional study was conducted at the height of the H1N1/2009 outbreak in Australia to evaluate public perceptions about transmission and prevention of the disease, to understand their concerns and their preparedness to cope with the disease, and to investigate drivers influencing their behaviour. This study incorporated a number of key design features to maximize the validity of the results. Firstly, conducting the study during the outbreak allowed us to obtain information on people's perceptions current at the time, rather than retrospectively (Anonymous, 2010). This approach prevented recall bias, prevalent in most retrospective studies, and avoided the influence of information available to people after the epidemic had run its course. In this respect, our study compares with those conducted by Jones and Salathe (2009) and Rubin et al. (2009). The second strength of the study was in developing a face-to-face contact with respondents, instead of conducting postal, telephone or online surveys. This is likely to have improved the response rate as well as the quality of responses by providing respondents with the opportunity to clarify any questions. Thirdly, appropriate statistical approaches were used to estimate confidence intervals and to evaluate associations after accounting for potential similarity of respondents visiting a butcher shop (clustering) rather than assuming all the observations to be independent. In addition, potential confounders were forced in the final models to obtain valid parameter estimates and standard errors. Finally, the study was completed within a short time frame (five weeks) to minimise the influence of time on the estimates.

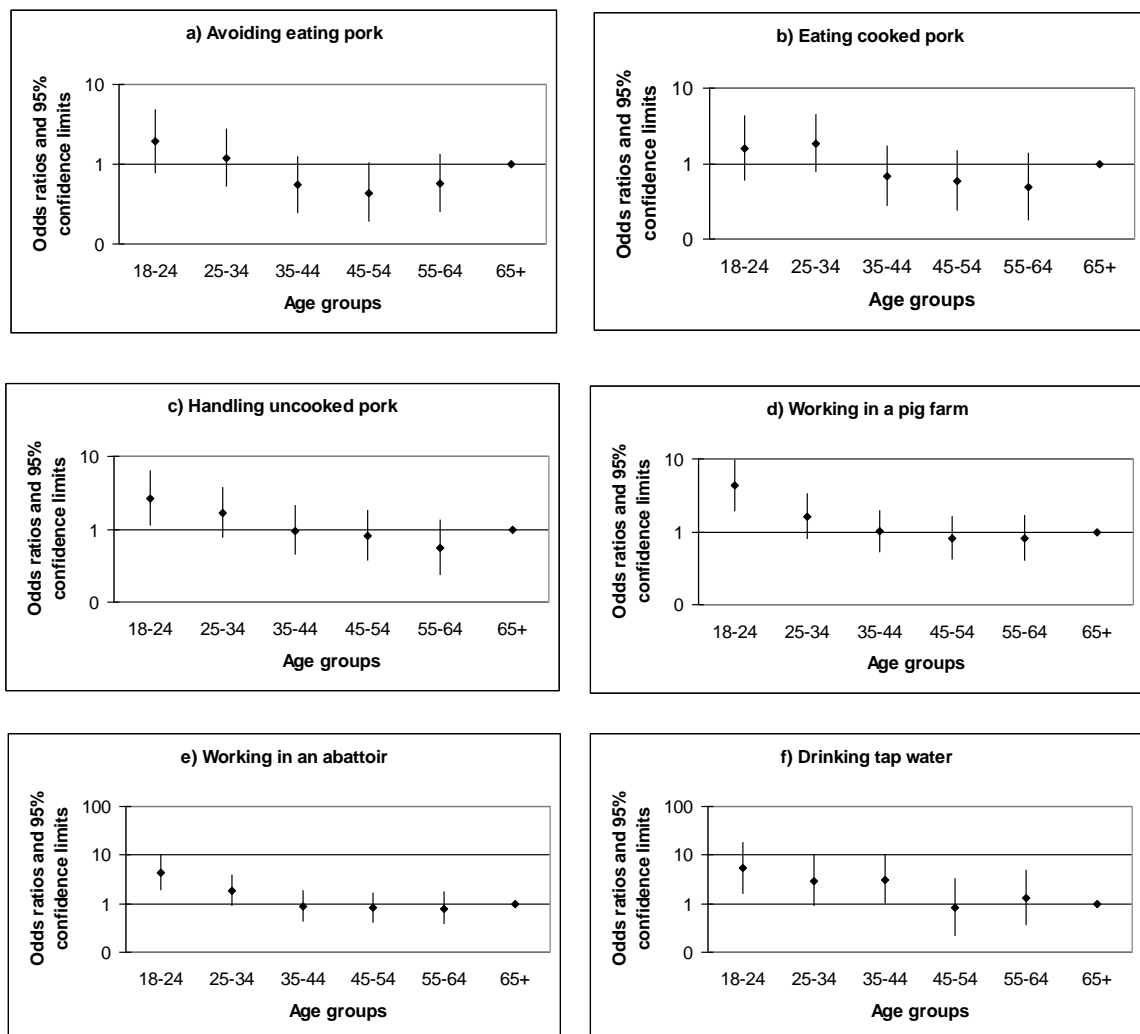
The study design had a number of limitations, inherent in most observational studies. Firstly, butcher shops were not randomly selected. However, most of the shops (11/15) were linked to one pork-supplier, with only four purposively selected to improve the sample size. As the butcher shops varied widely in location and had no other commonalities, it is likely that this sample would be representative of butcher shops in Sydney. Secondly, the sample of people interviewed in this study is unlikely to represent the total population of Sydney as the sample was comprised of only people visiting butcher shops and excluded those younger than 18 years of age and those unable to read or speak English. Therefore the results should be extrapolated and interpreted with a degree of caution. Third, many people declined to participate in the study which could have potentially resulted in selection bias. However, the proportion of males and females in those declining to participate were similar to those deciding to participate, indicating that the characteristics of respondents and non-respondents were similar.

The majority of respondents had perceptions based on fact concerning protective behaviours, i.e. they believed that washing hands, avoiding overseas travel and avoiding crowded places would protect them against contracting H1N1/09. They also believed that they could contract H1N1/09 by travelling on public transport with a sick person present, by shaking hands with a sick person or attending a community gathering. However, women were more likely than men to have perceptions based on fact regarding protective behaviours (Tables 2 and 4). The reasons for this gender difference are not clear, but possible explanations could include differences in motivating factors, such as threat perception or self-efficacy, or differences in information-seeking behaviour. Consideration of our data does not support differences in threat perception, as both men and women were similarly concerned about the impact of the H1N1/09 on themselves and their loved ones.



However, women considered themselves to be better prepared to cope with the disease suggesting that they had a greater sense of self-efficacy, possibly as a result of being better informed of the consequences. Gender differences have frequently been noted in health information-seeking behaviour; with women being more likely to seek information and having a more proactive attitude to health (Kassulke et al., 1993) and having higher levels of health information orientation and health information efficacy (Basu and Dutta, 2008; Taylor et al., 2009). Although we did not collect such data in this study, it is possible that differences in information seeking may explain this gender effect.

**Figure 2. Odds ratios and confidence intervals of the associations of age with incorrect perceptions about contracting pandemic influenza A/H1N1 2009. Note that the y-axis is on the log scale.**



Compared to themselves, respondents were significantly more concerned about their family/loved ones getting H1N1/09 or becoming seriously ill. This perception is in accordance with the results of previous studies conducted during SARS (Nickell et al., 2004). Generally, greater concern about self or family members being affected by illness, such as H5N1 avian influenza, has been found to be a significant motivating influence on actual or anticipated protective behaviour (Lau et al., 2007; Taylor et al., 2009).

As mentioned above, the majority of responses in this study regarding transmission and spread of H1N1/09 from pigs were based on fact. Only a small proportion incorrectly believed that they could avoid contracting H1N1/09 by not eating pork, ham and bacon, handling uncooked pig, working in a pig farm or working in an abattoir. No gender differences were noted in regard to these misperceptions, but young (<35 year old) people were more likely to have these misperceptions (Fig 2). Although further research would be needed to explore the reasons for such differences, there is evidence that younger people are more likely to trust mass media (Tokuda et al., 2009), and they may be less engaged in wanting to evaluate or question such information than their mature counterparts. In addition, research supports the premise that people with lower levels of knowledge are susceptible to misinformation (Hegglin et al., 2008), and it is possible that this may be pertinent to our findings. It is also possible that younger people are less exposed to messages about food safety due to their different sources of information compared to older people or because of more focus on non-communicable diseases such as obesity and cardiovascular diseases these days.

People who reported to have reduced their consumption of pork, ham or bacon were more likely to have misconceptions of the risk of contracting H1N1/09 from eating pig meat products. Our results suggest that people's concern about themselves or their families influence their behaviour, but this is not as influential as their perceptions about transmission of a disease. Therefore, while it would be useful to ensure that the public is not unnecessarily concerned about a future disease outbreak, by reducing hype or sensationalism with regard to influencing their behaviour, it would appear to be far more important to provide correct and accurate information through official channels and the media, and reduce ambiguity and misnomers.

## **5. Conclusions**

The majority of the public had generally accurate perceptions about the transmission of H1N1/09 and the measures required to protect against it, although these perceptions were significantly better in women than in men. Younger respondents were more likely to have misperceptions. People's concern about themselves or their loved ones appeared to drive changes in their behaviour during the pandemic although, when present, their misperceptions outweighed such concerns. To manage a future emergency, we recommend designing better and more effective communication programs to counteract rumours and misinformation by providing scientific information to the community, particularly focussing on sources of information trusted by younger people.

## **Acknowledgements**

The authors gratefully acknowledge the contribution of Ms Ella Herrmann, Mr Dean Powell, Ms Kathrin Schemann and Ms Jennifer Langford in conducting meetings with respondents and that of Ms Chloe Procter and Ms Ugyen Lhamo for entering data. The support and cooperation provided by butcher shop owners and the pork supplier who provided their contact details is thankfully acknowledged. The authors are grateful to the Faculty of Veterinary Science, The University of Sydney for providing funding to conduct this study. The authors sincerely thank all the participants of the study for agreeing to complete the questionnaire.

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