MAJOR ARTICLE

Community Psychological and Behavioral Responses through the First Wave of the 2009 Influenza A(H1N1) Pandemic in Hong Kong

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Background. Little is known about the community psychological and behavioral responses to influenza pandemics.

Methods. Using random digit dialing, we sampled 12,965 Hong Kong residents in 13 cross-sectional telephone surveys between April and November 2009, covering the entire first wave of the 2009 influenza A(H1N1) pandemic. We examined trends in anxiety, risk perception, knowledge on modes of transmission, and preventive behaviors.

Results. Respondents reported low anxiety levels throughout the epidemic. Perceived susceptibility to infection and perceived severity of H1N1 were initially high but declined early in the epidemic and remained stable thereafter. As the epidemic grew, knowledge on modes of transmission did not improve, the adoption of hygiene measures and use of face masks did not change, and social distancing declined. Greater anxiety was associated with lower reported use of hygiene measures but greater social distancing. Knowledge that H1N1 could be spread by indirect contact was associated with greater use of hygiene measures and social distancing.

Conclusions. The lack of substantial change in preventive measures or knowledge about the modes of H1N1 transmission in the general population suggests that community mitigation measures played little role in mitigating the impact of the first wave of 2009 influenza A(H1N1) pandemic in Hong Kong.

In April 2009, a novel influenza A(H1N1) virus emerged in Mexico and rapidly spread around the world in the first influenza pandemic of the 21st century [1]. Prior to the availability of an effective vaccine, strategies to mitigate the impact of the pandemic typically involved antiviral treatment of cases and "non-pharmaceutical" community interventions [2], with public health promotion of the use of simple but effective preventive measures such as hand hygiene and face masks [3]. Previous studies of severe acute respiratory syndrome (SARS) highlighted the need for the promotion of preventive measures to take into account background perceptions of risk and anxiety, because higher perceived risk of infection was more likely to lead to an increase of precautionary measures against infection [4, 5]. During the current pandemic, higher risk of infection and higher perceived severity of infection was associated with greater use of recommended behaviors in the United Kingdom [6]. Other studies have examined initial responses to the pandemic in Hong Kong [7], India [8], Malaysia, and Europe [9], and internationally by an internet survey [10]. In this study we investigated the psychological and behavioral responses of members of the general community in Hong Kong through the entire first wave of the 2009 influenza A(H1N1) pandemic and the factors associated with greater use of preventive measures.

Received 25 February 2010; accepted 14 April 2010; electronically published 2 August 2010.

Potential conflicts of interest: B.J.C. received funding from MedImmune Inc., a manufacturer of influenza vaccines. All other authors declare no conflict of interest.

Financial support: Research Fund for the Control of Infectious Disease, Food and Health Bureau, Government of the Hong Kong Special Administrative Region (grant PHE-01) and the Area of Excellence Scheme of the Hong Kong University Grants Committee (grant AoE/M-12/06).

The funding bodies were not involved in the collection, analysis, and interpretation of data, the writing of the article, or the decision to submit it for publication.

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The Journal of Infectious Diseases 2010;202(6):867–876

0022-1899/2010/20206-0008$15.00
DOI: 10.1086/655811

Table 1. Survey Items Addressing Psychological and Behavioral Responses to Influenza Pandemic

This table is available in its entirety in the online version of the *Journal of Infectious Diseases*.

METHODS

Participants were recruited by random-digit dialing of all land-based telephone numbers in Hong Kong, where landline telephone penetration exceeds 98% [4]. Telephone numbers were randomly generated by a computer system. Trained interviewers made telephone calls during nonworking hours to avoid overrepresentation of nonworking groups. Within households, adults (age, ⩾18 years) who lived in the house at least 5 days per week and were in the house were qualified to be randomly selected on the basis of a Kish grid. If the selected participant was busy, up to 4 follow-up calls would be made. Respondents were required to be Cantonese speaking. Unanswered calls were given 4 more follow-up calls, made at different hours and weekdays, before being classified as invalid. Verbal informed consent was obtained from all participants. Ethics approval was obtained from the Institutional Review Board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster.

Thirteen surveys were conducted in total. The survey instrument was similar across the 13 surveys and retained the same core items throughout while rotating some topical items. The instrument was based on an instrument previously used during the SARS epidemic [4]. It collected information on knowledge of modes of transmission, psychological responses to pandemic influenza, preventive behaviors, and sociodemographic characteristics and was pretested for face and content validity, length, and comprehensibility. Most responses were of the ordinal Likert-type. The time taken to complete a survey, with 100 items on average, was ~15 minutes. Additional details on the survey items are provided in Table 1.

Each of the 13 surveys was conducted over a period of 3–5 days between April and November 2009. The first survey commenced on the same evening that the Hong Kong government announced the first laboratory-confirmed H1N1 case. Table 2 shows the exact period covered by each survey and the final sample sizes and response rates. All but one survey included at least 1000 respondents, a sample size that led to a sampling error of at most ±3%. Survey 6 was slightly shorter and was conducted immediately after the first H1N1-associated death in Hong Kong on July 16.

The demographic characteristics of each survey sample were compared to reference population data provided by the Hong Kong Government Census and Statistics Department [11]. Means and proportions of survey items were directly weighted by sex and age to the general population and presented for all 13 surveys. For variables with ordinal Likert-type response scales, we first constructed stacked line plots and verified that trends were similar across the range of responses (data not shown); we then dichotomized responses above or below a threshold for final presentation.

We used multivariable logistic regression analyses to examine the factors affecting the use of preventive measures. We focused on the relationships between knowledge, perceptions, and behaviors from survey 3 onward for 2 reasons: first, because psychological responses were somewhat different in surveys 1 and 2, and second, because the local epidemic of H1N1 did not begin until survey 3 (June 9–12). Therefore, preventive behaviors reported in surveys 1 and 2 related to actions against a

Table 2. Details of 13 Cross-sectional Surveys Regarding the 2009 Influenza A(H1N1) Pandemic in Hong Kong

Survey	2009 survey period	No. of respondents successfully interviewed	Response rate, %
1	April 28 to May 1	1009	73.5
2	May 13–15	1016	68.8
3	June 9–12	1404	69.6
4	June 23–25	1001	69.1
5	July 7–10	1007	67.7
6	July 17–19	504	74.9
7	July 21–24	1007	68.9
8	August 4–8	1005	68.6
9	August 18–21	1004	71.7
10	September 8–11	1000	65.6
11	September 28 to October 2	1003	70.5
12	October 19–23	1000	72.7
13	November 9–13	1006	70.9

potential threat, whereas in survey 3 onward the behaviors related to actions against a real confirmed threat. Data from survey 6 were excluded because it was a smaller survey (in sample size), and some survey items relevant to these analyses had been removed to allow space for other items specifically investigating psychological responses to the first local death. We excluded responses on preventive behaviors from the small number of participants who reported influenza-like illness (fever plus cough or sore throat) in the 2 weeks preceding the survey (ranging from 0.2% to 1.5%), because the factors associated with the use of preventive behaviors of infectious people to reduce transmission to others are likely to differ from the factors associated with the use of preventive behaviors to protect oneself against infection.

Associations between preventive behaviors (outcome variables) and sociodemographic characteristics, knowledge on modes of transmission, and psychological responses to pandemic influenza (explanatory variables) were very consistent across surveys 3–5 and 7–13 (10 surveys in total) in separate multivariable logistic regression models for each survey (data not shown), so we specified multilevel models to estimate the average effects of each predictor across all the surveys, with a random effect to explain low-level systematic variability in the outcome variables between surveys. The multilevel models were therefore specified with individual responses (first level) nested within surveys (second level). We used multiple imputation to allow for a small proportion of missing data (no more than 6% on any predictor) and to make the best use of all available data [12]. Statistical analyses were conducted with R software, version 2.9.1 (R Development). Raw data from the study and R syntax to permit reproducible statistical analyses are available on request.

RESULTS

A total of 127,715 telephone calls were made in the 13 surveys. The overall response rate, defined as the number of participants (12,965) divided by the number of calls with eligible respondents (18,560), was 69.9% (Figure 1). Figure 2*A* shows the epidemic curve of notified cases of laboratory-confirmed H1N1 and provides a chronology of key events. Following the World Health Organization (WHO) global alert, Hong Kong health authorities initially operated under containment phase protocols, including entry screening at airports, ports and border crossings, hospital isolation of cases, tracing, and quarantine of contacts and routine antiviral prophylaxis. Once the first local case was identified on June 11, Hong Kong transitioned to mitigation phase protocols, with greater attention to public health promotion of preventive measures. All kindergartens and primary schools were closed from June 12 until summer vacation in early July [13]. Incidence peaked in September, and the first wave petered out by early November. There were 41 deaths associated with H1N1 between July 16 and November 30, 2009.

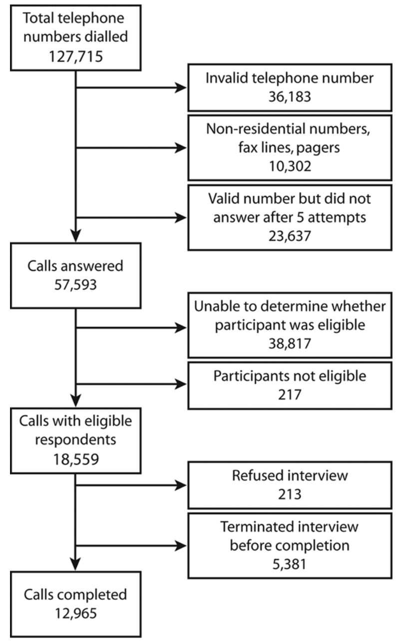

Figure 1. Flow chart of calls made, calls answered, and respondents successfully interviewed.

The state anxiety level of the general public (measured by the State Trait Anxiety Inventory) remained fairly low throughout the pandemic, without any noticeable changes (Figure 2*B*). Perceived worry if infected ("worry") gradually declined through the study period, with a slight perturbation around the time of the first H1N1-associated deaths in Hong Kong in the second half of July (Figure 2*C*). Perceived risk of infection in the following month ("absolute susceptibility") was initially high, declined in May, and temporarily rose in June as the local epidemic began, before fluctuating between 10% and 15% for the remainder of the study period. Perceived risk of infection relative to others ("relative susceptibility") remained lower throughout. Perceived severity of H1N1 compared with SARS ("severity") was high in the initial survey in April and declined to low levels by the time the local epidemic began in June.

The knowledge of the general public about the modes of transmission of H1N1 is shown in Figure 2*D*. The proportion of correct answers was high and remained relatively stable over time, with almost all respondents correctly identifying that H1N1 can be spread by droplets (median, 93%) and the majority of respondents correctly identifying that H1N1 can be spread by indirect hand contact (median, 8%) and direct hand contact (median, 62%). More than two-thirds of respondents reported the misconception that H1N1 could be spread by the oral-fecal route (median, 72%), and through the study period there was a statistically significant increase in the proportion of respondents believing that H1N1 can be spread by cold

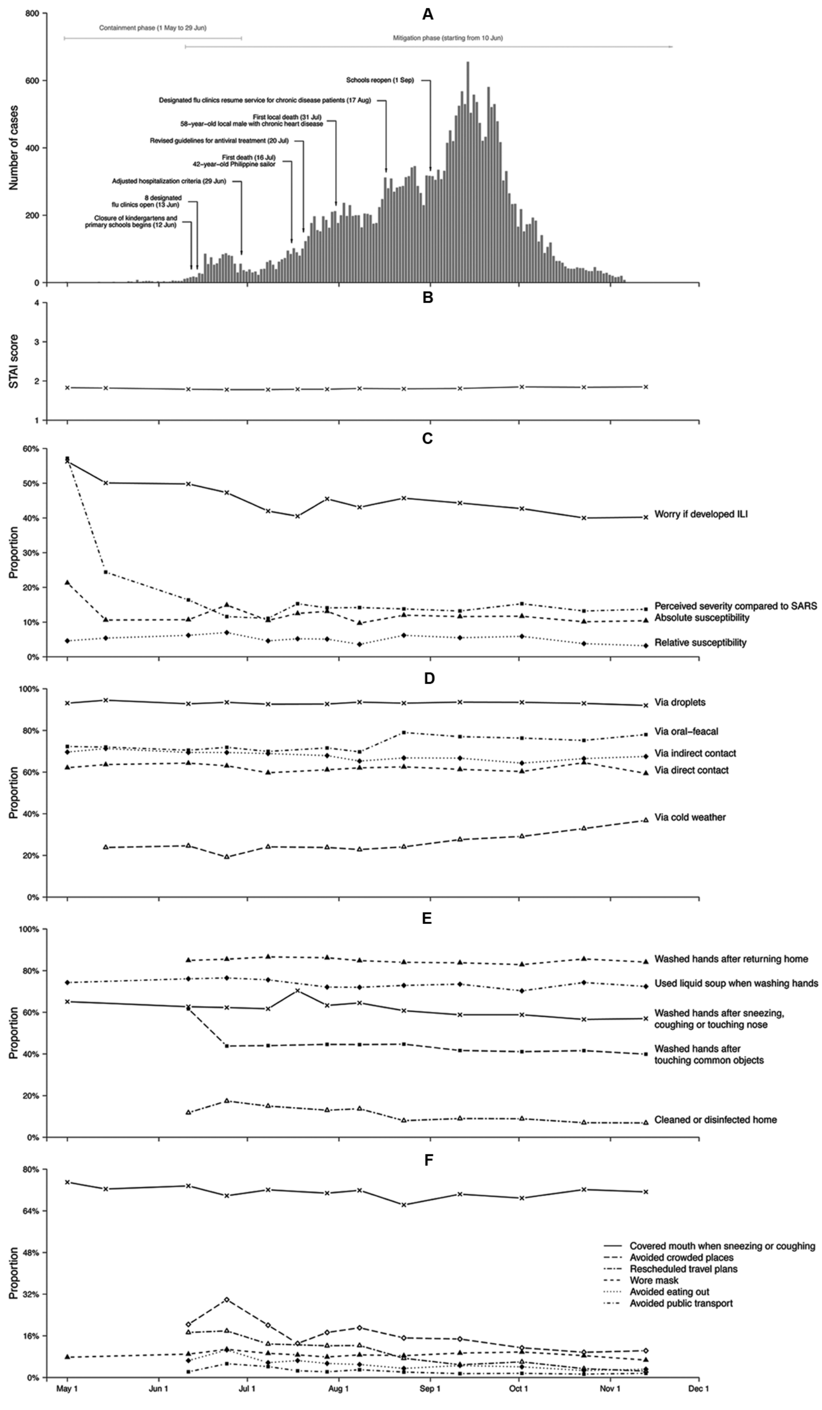

Figure 2. *A*, Number of laboratory-confirmed cases of influenza A(H1N1) by date of confirmation, Hong Kong, May through November 2009, with dates of events of interest. *B*, Mean state trait anxiety inventory (STAI) score (1 is not anxious at all, and 4 is very anxious). *C*, Proportion of respondents reporting higher worry if becoming ill (more, much more, or extremely worried), higher absolute susceptibility (certain, very likely, or likely), higher relative susceptibility (certain, much more, or more likely), and higher severity (much more or more severe than SARS). *D*, Proportion of respondents reporting "yes" to 5 possible transmission modes of H1N1. *E*, Proportion of population reporting greater personal hygiene measures (always or usually) and home disinfection in the preceding 3 days. *F*, Proportion of population reporting cough etiquette (always or usually), face mask use (always, often, or sometimes), and social distancing due to H1N1 in the preceding 3 days. Estimates shown in panels *B*–*E* have been weighted by age and sex to the Hong Kong population and are plotted at the central date of each survey. See Table 1 for additional details of the survey items.

Table 3. Factors Affecting Better Hygiene Behavior

Personal variables	Handwashing after sneezing, coughing, or touching nose	Use of liquid soup when washing hands	Handwashing after returning home	Handwashing after touching common objects	Cleaning or disin-fecting house more often
Male (n = 4026)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Female (n = 6308)	**1.29** (1.18–1.42)	**1.36** (1.24–1.50)	**1.55** (1.39–1.74)	**1.80** (1.65–1.96)	1.03 (0.90–1.18)
Age group, years					
18–24 (n = 1371)	**0.79** (0.68–0.93)	**0.48** (0.41–0.56)	**0.37** (0.30–0.45)	**0.51** (0.44–0.60)	0.95 (0.76–1.20)
25–34 (n = 1210)	**0.81** (0.69–0.96)	1.10 (0.92–1.33)	**0.76** (0.61–0.95)	**0.78** (0.67–0.91)	1.03 (0.81–1.30)
35–44 (n = 1915)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
45–54 (n = 2575)	1.03 (0.90–1.18)	**0.79** (0.68–0.91)	**0.75** (0.62–0.90)	0.93 (0.82–1.05)	**0.75** (0.62–0.92)
55–64 (n = 1787)	**1.26** (1.07–1.49)	0.87 (0.74–1.02)	**0.80** (0.65–0.98)	1.11 (0.97–1.28)	0.98 (0.79–1.21)
>65 (n = 1377)	**1.34** (1.11–1.63)	**1.28** (1.06–1.54)	0.83 (0.66–1.04)	**1.86** (1.59–2.18)	1.25 (0.98–1.58)
Educational attainment					
Primary or below (n = 1801)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Secondary (n = 5317)	1.00 (0.87–1.15)	**1.62** (1.42–1.84)	**1.32** (1.12–1.55)	**1.13** (1.00–1.27)	1.18 (0.98–1.43)
University or above (n = 3132)	0.90 (0.76–1.06)	**1.99** (1.71–2.33)	**1.47** (1.21–1.78)	1.13 (0.98–1.30)	0.89 (0.71–1.12)
Anxiety score					
Low (1.00–1.99) (n = 6303)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Medium (2.00–2.49) (n = 2992)	**0.79** (0.71–0.88)	**0.84** (0.75–0.93)	**0.83** (0.73–0.94)	**0.86** (0.78–0.94)	**1.17** (1.01–1.34)
High (2.50–4.00) (n = 795)	**0.71** (0.60–0.84)	0.85 (0.72–1.01)	**0.69** (0.56–0.84)	0.90 (0.77–1.06)	**1.41** (1.13–1.76)
Self-rated health					
Poor (n = 359)	1.01 (0.78–1.31)	0.94 (0.73–1.22)	1.35 (0.96–1.90)	0.98 (0.78–1.25)	0.82 (0.57–1.18)
Fair (n = 2763)	1.07 (0.95–1.22)	0.95 (0.84–1.08)	0.99 (0.85–1.15)	0.98 (0.87–1.09)	1.02 (0.86–1.21)
Good (n = 2796)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Very good (n = 3021)	**1.15** (1.02–1.30)	1.03 (0.92–1.17)	**1.18** (1.02–1.37)	1.08 (0.97–1.20)	0.98 (0.82–1.16)
Excellent (n = 1394)	**1.31** (1.11–1.54)	1.12 (0.96–1.30)	1.11 (0.92–1.34)	**1.22** (1.07–1.40)	1.06 (0.85–1.32)
Absolute susceptibility					
Never (n = 1173)	1.06 (0.89–1.27)	1.00 (0.83–1.19)	0.88 (0.71–1.09)	0.99 (0.84–1.16)	0.87 (0.68–1.12)
Very unlikely (n = 823)	0.99 (0.81–1.20)	0.98 (0.81–1.18)	0.87 (0.69–1.10)	0.94 (0.79–1.13)	**0.71** (0.53–0.96)
Unlikely (n = 3207)	0.91 (0.81–11.03)	0.93 (0.82–1.05)	**0.82** (0.71–0.95)	0.95 (0.85–1.06)	0.89 (0.76–1.06)
Even (n = 3384)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Likely (n = 1086)	0.93 (0.80–1.09)	0.96 (0.82–1.14)	1.12 (0.91–1.38)	1.01 (0.87–1.18)	0.84 (0.67–1.05)
Very likely or certain (n = 79)	1.15 (0.68–1.94)	1.47 (0.79–2.74)	0.86 (0.45–1.63)	**1.67** (1.04–2.67)	1.41 (0.79–2.51)
Relative susceptibility					
Not at all (n = 1586)	**1.23** (1.04–1.46)	**1.19** (1.00–1.41)	1.16 (0.95–1.42)	**1.28** (1.10–1.50)	1.24 (0.98–1.58)
Much less (n = 1654)	1.05 (0.90–1.22)	0.99 (0.85–1.15)	**1.32** (1.09–1.59)	**1.16** (1.01–1.34)	1.13 (0.90–1.42)
Less (n = 3004)	1.08 (0.94–1.23)	0.96 (0.85–1.08)	**1.17** 1.00–1.36)	1.10 (0.98–1.23)	1.15 (0.97–1.36)
Even (n = 2967)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
More (n = 445)	1.07 (0.86–1.34)	**1.28** (1.00–1.64)	1.07 (0.81–1.43)	1.04 (0.84–1.29)	**1.50** (1.13–2.00)
Much more or certain (n = 88)	1.22 (0.74–2.02)	1.68 (0.95–2.98)	1.15 (0.61–2.15)	1.34 (0.86–2.09)	**2.44** (1.45–4.10)
Severity compared to SARS					
Much less (n = 4143)	**0.69** (0.58–0.82)	**0.76** (0.64–0.89)	0.89 (0.73–1.09)	**0.79** (0.68–0.91)	**0.71** (0.57–0.88)
Less (n = 4591	0.89 (0.75–1.05)	0.89 (0.75–1.05)	0.99 (0.81–1.21)	0.97 (0.84–1.12)	0.84 (0.69–1.04)
Same (n = 961)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
More (n = 365)	1.03 (0.77–1.37)	0.93 (0.70–1.23)	1.20 (0.83–1.72)	**1.29** (1.00–1.66)	1.26 (0.91–1.75)
Much more (n = 119)	0.85 (0.55–1.33)	1.27 (0.78–2.07)	0.88 (0.52–1.50)	1.06 (0.71–1.58)	1.49 (0.93–2.40)
Worry if developed ILI					
Not at all worried (n = 1467)	0.95 (0.82–1.10)	0.93 (0.80–1.07)	0.89 (0.74–1.05)	0.89 (0.78–1.02)	0.60 (0.45–0.80)
Much less worried than normal (n = 214)	1.13 (0.82–1.54)	0.90 (0.66–1.22)	1.24 (0.82–1.87)	0.98 (0.73–1.31)	**1.93** (1.26–2.96)
Worried less than normal (n = 696)	1.18 (0.97–1.44)	**1.31** (1.08–1.59)	1.06 (0.85–1.34)	1.08 (0.91–1.29)	1.21 (0.90–1.63)
Same (n = 3257)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Worried more than normal (n = 3535)	**1.11** (1.00–1.24)	**1.14** (1.02–1.27)	1.14 (0.99–1.30)	**1.15** (1.04–1.27)	**2.28** (1.94–2.69)
Worried much more than normal (n = 681)	1.04 (0.86–1.25)	1.05 (0.86–1.27)	1.16 (0.91–1.48)	**1.37** (1.15–1.63)	**2.55** (2.00–3.24)
Extremely worried (n = 423)	1.10 (0.87–1.39)	1.06 (0.83–1.35)	**1.49** (1.06–2.08)	**1.45** (1.17–1.79)	**2.73** (2.06–3.62)
Modes of transmission					
Droplets (n = 9597)	1.16 (0.93–1.44)	1.06 (0.86–1.29)	0.95 (0.74–1.21)	1.01 (0.84–1.23)	**0.72** (0.54–0.95)
Direct contact (n = 6414)	1.05 (0.94–1.18)	**1.12** (1.00–1.25)	1.06 (0.93–1.21)	1.07 (0.97–1.18)	1.07 (0.91–1.24)
Indirect contact (n = 6987)	**1.14** (1.02–1.28)	**1.29** (1.16–1.45)	**1.38** (1.20–1.58)	**1.57** (1.41–1.74)	**1.30** (1.10–1.53)

NOTE. Responses to questions regarding behavior were "always and/or usually" vs "often and/or never." Numbers in some categories may not sum to the total (10,334) because of missing data. Data are adjusted odds ratio (95% confidence interval), unless otherwise noted. Estimates in bold are significant at $P < .05$. ILI, influenza-like illness; SARS, severe acute respiratory syndrome.

weather (median, 24%). Although influenza activity typically occurs in temperate climates during the winter, Hong Kong usually experiences 2 periods of peak influenza activity every year, with 1 peak in the winter (February to March) and 1 peak in the summer (June to July) [14]. In 2009 following the usual winter and summer influenza seasons, pandemic H1N1 incidence continued to rise through the summer and peaked in September (Figure 1). The role of seasonality in influenza transmission remains unclear [15].

As the local H1N1 epidemic increased through the summer, the adoption of various hygiene measures and face mask use was relatively stable with slightly decreasing trends, whereas social distancing declined steadily through the epidemic with statistical significance (Figure 2*E* and 2*F*). Participants avoided eating out, avoided using public transport, avoided going to crowded places, and rescheduled travel plans more often during the early stages of the pandemic.

Table 3 shows the factors associated with greater use of 5 hygienic measures, including 4 measures relating to hand hygiene, and home disinfection. Female sex and older age were generally associated with greater reported use of hygiene measures. Higher anxiety was significantly associated with lower use of all 4 hand hygiene measures but an increased probability of home disinfection. There were no consistent trends between use of hygiene measures and relative susceptibility or absolute susceptibility. Lower perceived severity was generally associated with less use of hygiene measures. Greater worry was associated with a substantially higher probability of home disinfection. Knowledge that H1N1 could be spread by indirect contact was associated with higher use of all 5 hygiene measures.

The factors associated with greater use of cough etiquette and face masks and 4 social distancing measures are shown in Tables 4 and 5, respectively. Female sex and older age were significantly associated with increased probability of reporting avoidance of crowded places and rescheduling of travel plans. Female sex was also associated with greater use of face masks and cough etiquette. Higher anxiety was associated with a lower use of cough etiquette but greater probability of all 4 social distancing measures. There was no significant association between anxiety and the use of face masks. Poorer self-rated health, higher absolute susceptibility, and higher relative susceptibility were associated with greater use of face masks. There were no consistent trends between cough etiquette or social distancing measures and relative susceptibility or absolute susceptibility. Greater worry if infected was associated with greater use of face masks and substantially greater use of all 4 social distancing measures. Knowledge that H1N1 could be spread by droplets was associated with greater use of cough etiquette but not greater use of face masks. Knowledge that H1N1 could be spread by indirect contact was associated with higher use of cough etiquette, face masks, and all 4 social distancing measures.

DISCUSSION

The WHO global alert of the 2009 influenza A(H1N1) pandemic issued on April 25, 2009, was followed by a whirlwind of media attention. Initial fears of a moderately severe pandemic with a 1968-like case fatality rate [16] declined as the mild nature of most cases [17] and the substantial degree of preexisting immunity in older age groups [18] became apparent. When local transmission was confirmed in Hong Kong on June 11, 2009, it was becoming clearer that H1N1 had similar characteristics to seasonal influenza, and most people perceived that H1N1 was not as severe as SARS and that they had a low risk of infection (Figure 2*C*). In terms of the state trait anxiety inventory score, the average anxiety level, of ∼1.8 (Figure 2*B*) was much lower than the highest value observed during the local SARS epidemic, which reached 2.5 during the peak of the Amoy Garden outbreak [4]. Local deaths and steadily increasing case numbers during the summer did not appear to lead to any substantial changes in anxiety (Figure 2*B*).

We identified unusual correlations between the epidemic curve and perceived absolute susceptibility to infection, where risk of infection was thought to be higher at the end of April and in early summer, but lower at the peak of the epidemic in September. Perceived severity compared with SARS was initially very high but declined sharply during May and remained stable at a lower level through the remainder of the epidemic (Figure 2*C*). However, ∼15% of the population continued to believe that H1N1 was the same as or more serious than SARS in spite of a case fatality rate of <1 per 1000 infections (vs 1 in 6 infections for SARS [19]) and a total of 45 H1N1-associated deaths by early December (vs 302 for SARS [19]). The lack of change in perceived susceptibility as the epidemic grew suggests that risk communication was not effective, and a more detailed study is warranted to explore the impact of risk communication from official (eg, government) and unofficial sources (eg, peer groups) on perceived risk and behavior.

A study conducted in Hong Kong in early May identified that ∼30% of the population did not know that H1N1 could be spread by direct or indirect contact [7], and we did not identify any discernible improvements in knowledge as the epidemic developed (Figure 2*D*) despite public health campaigns, particularly those focusing on personal hygiene during the mitigation phase. It is troubling that the proportion of the population believing that H1N1 can be spread by cold weather increased substantially during the epidemic.

The negative correlation between state anxiety and hygiene identified in our study (Table 3) has not been reported in previous epidemics. In studies conducted during SARS, higher anxiety was associated with greater probability of using at least

Table 4. Factors Affecting Better Cough Etiquette and Face Mask Use

Personal variables	Covered mouth while sneezing or coughing (always or usually vs often or never)	Wore a face mask (always, usually, or sometimes vs never)
Male (*n* = 4026)	1.00 (reference)	1.00 (reference)
Female (*n* = 6308)	**1.93** (1.67–2.24)	**1.36** (1.17–1.59)
Age group, years		
18–24 (*n* = 1371)	1.10 (0.84–1.45)	**0.70** (0.53–0.94)
25–34 (*n* = 1210)	**1.42** (1.05–1.92)	1.11 (0.86–1.44)
35–44 (*n* = 1915)	1.00 (reference)	1.00 (reference)
45–54 (*n* = 2575)	0.98 (0.78–1.23)	**1.22** (1.00–1.51)
55–64 (*n* = 1787)	1.07 (0.83–1.38)	0.96 (0.75–1.22)
>65 (*n* = 1377)	**0.71** (0.54–0.92)	1.00 (0.76–1.31)
Educational attainment		
Primary or below (*n* = 1801)	1.00 (reference)	1.00 (reference)
Secondary (*n* = 5317)	**1.27** (1.04–1.55)	0.93 (0.76–1.14)
University or above (*n* = 3132)	**1.62** (1.27–2.08)	0.93 (0.73–1.18)
Anxiety score		
Low (1.00–1.99) (*n* = 6303)	1.00 (reference)	1.00 (reference)
Medium (2.00–2.49) (*n* = 2992)	**0.76** (0.64–0.89)	0.93 (0.79–1.10)
High (2.50–4.00) (*n* = 795)	**0.59** (0.46–0.76)	0.99 (0.77–1.28)
Self-rated health		
Poor (*n* = 359)	1.21 (0.81–1.80)	**2.80** (2.07–3.79)
Fair (*n* = 2763)	0.90 (0.74–1.09)	**1.21** (1.00–1.46)
Good (*n* = 2796)	1.00 (reference)	1.00 (reference)
Very good (*n* = 3021)	1.09 (0.89–1.33)	0.92 (0.75–1.12)
Excellent (*n* = 1394)	1.11 (0.86–1.43)	0.99 (0.78–1.27)
Absolute susceptibility		
Never (*n* = 1173)	1.07 (0.81–1.42)	0.95 (0.71–1.28)
Very unlikely (*n* = 823)	1.03 (0.75–1.41)	0.91 (0.66–1.24)
Unlikely (*n* = 3207)	1.09 (0.87–1.35)	**0.80** (0.66–0.97)
Even (*n* = 3384)	1.00 (reference)	1.00 (reference)
Likely (*n* = 1086)	0.97 (0.75–1.26)	1.20 (0.96–1.49)
Very likely or certain (*n* = 79)	0.78 (0.36–1.66)	**2.24** (1.30–3.87)
Relative susceptibility		
Not at all (*n* = 1586)	**0.75** (0.58–0.97)	0.94 (0.72–1.24)
Much less (*n* = 1654)	0.93 (0.72–1.20)	0.91 (0.71–1.17)
Less (*n* = 3004)	0.99 (0.81–1.22)	0.89 (0.74–1.08)
Even (*n* = 2967)	1.00 (reference)	1.00 (reference)
More (*n* = 445)	1.04 (0.70–1.55)	**1.89** (1.44–2.50)
Much more or certain (*n* = 88)	1.05 (0.47–2.34)	1.05 (0.54–2.06)
Severity compared to SARS		
Much less (*n* = 4143)	**1.32** (1.03–1.69)	0.90 (0.70–1.15)
Less (*n* = 4591)	1.17 (0.92–1.49)	1.02 (0.80–1.30)
Same (*n* = 961)	1.00 (reference)	1.00 (reference)
More (*n* = 365)	1.03 (0.68–1.54)	1.39 (0.95–2.03)
Much more (*n* = 119)	0.87 (0.49–1.53)	0.48 (0.20–1.13)
Worry if developed ILI		
Not at all worried (*n* = 1467)	**0.76** (0.60–0.95)	1.19 (0.95–1.49)
Much less worried than normal (*n* = 214)	1.00 (0.59–1.68)	1.05 (0.63–1.74)
Worried less than normal (*n* = 696)	0.80 (0.60–1.07)	0.87 (0.63–1.20)
Same (*n* = 3257)	1.00 (reference)	1.00 (reference)
Worried more than normal (*n* = 3535)	1.10 (0.91–1.32)	1.00 (0.84–1.19)
Worried much more than normal (*n* = 681)	0.96 (0.71–1.30)	**1.31** (1.00–1.72)
Extremely worried (*n* = 423)	0.81 (0.58–1.15)	1.09 (0.77–1.54)
Modes of transmission		
Droplets (*n* = 9597)	**1.77** (1.35–2.33)	1.04 (0.73–1.49)
Direct contact (*n* = 6414)	0.93 (0.78–1.10)	1.00 (0.84–1.18)
Indirect contact (*n* = 6987)	**1.21** (1.01–1.45)	**1.30** (1.08–1.56)

NOTE. Numbers in some categories may not sum to the total (10,334) because of missing data. Data are adjusted odds ratio (95% confidence interval), unless otherwise noted. Estimates in bold are significant at $P < .05$. ILI, influenza-like illness; SARS, severe acute respiratory syndrome.

Table 5. Factors Affecting Social Distancing Behaviors due to H1N1

Personal variables	Avoided eating out	Avoided using public transport	Avoided crowded places	Rescheduled travel plans
Male (n = 4026)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Female (n = 6308)	0.94 (0.78–1.13)	1.12 (0.86–1.47)	**1.18** (1.05–1.32)	**1.68** (1.45–1.95)
Age group, years				
18–24 (n = 1371)	**0.49** (0.34–0.70)	**0.32** (0.18–0.58)	**0.56** (0.45–0.69)	**0.49** (0.37–0.64)
25–34 (n = 1210)	**0.64** (0.45–0.91)	**0.50** (0.29–0.85)	**0.78** (0.63–0.95)	**0.67** (0.52–0.87)
35–44 (n = 1915)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
45–54 (n = 2575)	**0.72** (0.55–0.93)	**0.60** (0.41–0.89)	0.94 (0.80–1.11)	1.03 (0.85–1.25)
55–64 (n = 1787)	1.03 (0.79–1.35)	1.00 (0.68–1.48)	**1.28** (1.08–1.53)	**1.39** (1.13–1.72)
>65 (n = 1377)	1.01 (0.74–1.39)	**1.62** (1.08–2.41)	**1.58** (1.30–1.93)	**1.56** (1.22–1.99)
Educational attainment				
Primary or below (n = 1801)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Secondary (n = 5317)	**1.45** (1.13–1.88)	1.02 (0.73–1.42)	**1.63** (1.39–1.92)	**1.60** (1.31–1.96)
University or above (n = 3132)	0.90 (0.65–1.24)	1.06 (0.71–1.59)	**1.39** (1.15–1.68)	**1.74** (1.37–2.20)
Anxiety score				
Low (1.00–1.99) (n = 6303)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Medium (2.00–2.49) (n = 2992)	**1.35** (1.11–1.64)	1.21 (0.91–1.60)	**1.15** (1.02–1.30)	**1.16** (1.00–1.34)
High (2.50–4.00) (n = 795)	**1.73** (1.31–2.30)	**1.76** (1.19–2.62)	1.19 (0.98–1.45)	1.02 (0.79–1.31)
Self-rated health				
Poor (n = 359)	1.22 (0.78–1.91)	0.96 (0.51–1.79)	0.74 (0.54–1.02)	1.28 (0.90–1.81)
Fair (n = 2763)	**1.38** (1.09–1.75)	1.11 (0.79–1.55)	0.99 (0.86–1.15)	1.01 (0.84–1.22)
Good (n = 2796)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Very good (n = 3021)	1.24 (0.97–1.58)	1.21 (0.86–1.71)	0.91 (0.79–1.05)	1.07 (0.89–1.27)
Excellent (n = 1394)	0.81 (0.57–1.15)	0.94 (0.59–1.49)	0.91 (0.76–1.10)	1.06 (0.84–1.33)
Absolute susceptibility				
Never (n = 1173)	0.91 (0.65–1.29)	0.89 (0.55–1.44)	0.96 (0.77–1.18)	0.95 (0.73–1.24)
Very unlikely (n = 823)	0.76 (0.50–1.16)	0.64 (0.34–1.21)	**0.67** (0.52–0.87)	0.79 (0.57–1.08)
Unlikely (n = 3207)	**0.74** (0.58–0.94)	0.77 (0.55–1.09)	**0.75** (0.65–0.87)	**0.80** (0.67–0.96)
Even (n = 3384)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Likely (n = 1086)	0.91 (0.68–1.21)	0.97 (0.65–1.45)	0.93 (0.78–1.12)	1.07 (0.86–1.34)
Very likely or certain (n = 79)	1.24 (0.59–2.60)	1.78 (0.69–4.59)	1.55 (0.93–2.59)	1.27 (0.68–2.38)
Relative susceptibility				
Not at all (n = 1586)	1.11 (0.80–1.55)	1.50 (0.96–2.34)	1.10 (0.89–1.37)	0.94 (0.73–1.21)
Much less (n = 1654)	1.04 (0.76–1.42)	0.98 (0.61–1.57)	**1.25** (1.04–1.51)	0.92 (0.72–1.16)
Less (n = 3004)	1.02 (0.81–1.29)	1.24 (0.88–1.74)	**1.16** (1.00–1.35)	0.97 (0.82–1.16)
Even (n = 2967)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
More (n = 445)	**1.47** (1.02–2.13)	1.53 (0.89–2.61)	**1.38** (1.08–1.78)	1.01 (0.74–1.38)
Much more or certain (n = 88)	1.78 (0.90–3.52)	1.07 (0.33–3.41)	**2.17** (1.33–3.54)	1.68 (0.96–2.97)
Severity compared to SARS				
Much less (n = 4143)	**0.55** (0.41–0.73)	0.71 (0.47–1.06)	**0.77** (0.64–0.93)	0.87 (0.68–1.10)
Less (n = 4591)	**0.65** (0.50–0.85)	0.71 (0.48–1.06)	0.91 (0.75–1.09)	0.97 (0.77–1.22)
Same (n = 961)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
More (n = 365)	0.73 (0.46–1.15)	1.24 (0.69–2.21)	**1.49** (1.12–2.00)	0.99 (0.67–1.45)
Much more (n = 119)	1.14 (0.63–2.08)	1.33 (0.61–2.87)	1.20 (0.76–1.89)	1.01 (0.56–1.81)
Worry if developed ILI				
Not at all worried (n = 1467)	0.93 (0.63–1.38)	1.10 (0.68–1.79)	**0.79** (0.63–0.98)	0.81 (0.61–1.07)
Much less worried than normal (n = 214)	1.42 (0.69–2.94)	1.44 (0.53–3.91)	1.17 (0.76–1.80)	1.50 (0.91–2.49)
Worried less than normal (n = 696)	**1.85** (1.24–2.76)	1.12 (0.59–2.13)	1.27 (0.99–1.62)	1.25 (0.92–1.69)
Same (n = 3257)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Worried more than normal (n = 3535)	**2.44** (1.91–3.12)	**1.83** (1.30–2.58)	**2.25** (1.96–2.58)	**1.94** (1.64–2.30)
Worried much more than normal (n = 681)	**2.84** (2.04–3.97)	**3.02** (1.94–4.69)	**2.98** (2.43–3.66)	**2.66** (2.07–3.41)
Extremely worried (n = 423)	**4.26** (2.98–6.07)	**3.74** (2.32–6.05)	**3.49** (2.75–4.43)	**2.89** (2.15–3.88)
Modes of transmission				
Droplets (n = 9597)	0.92 (0.60–1.42)	0.62 (0.37–1.01)	1.07 (0.82–1.40)	1.28 (0.90–1.83)
Direct contact (n = 6414)	1.07 (0.86–1.32)	1.09 (0.80–1.49)	**1.15** (1.01–1.31)	1.14 (0.96–1.34)
Indirect contact (n = 6987)	**1.63** (1.27–2.09)	**1.68** (1.17–2.42)	**1.48** (1.28–1.71)	**1.24** (1.03–1.48)

NOTE. Responses to questions regarding behavior were "always and/or usually" vs "often and/or never." Numbers in some categories may not sum to the total (10,334) because of missing data. Data are adjusted odds ratio (95% confidence interval), unless otherwise noted. Estimates in bold are significant at $P<.05$. AOR, adjusted odds ratio; CI, confidence interval; ILI, influenza-like illness.

5 of 7 preventive measures, including hand hygiene, barriers to indirect transmission, and face masks [4, 20]. A study conducted during the 2009 influenza A(H1N1) pandemic also found that increased anxiety was associated with increased hygiene, and in that study anxiety was measured by items with wording specific to H1N1 [6]. One possible explanation for our finding is that our anxiety measure was not specific to influenza and could be affected by other economic or social circumstances. In that case, individuals with higher anxiety could have pressing concerns that they considered more important than preventive measures against H1N1 infection, such as improved hygiene. However, we did observe an association between increased anxiety and increased frequency of house disinfection (Table 3). A second possibility is that we have observed reverse causality, where greater use of hygiene measures reassured individuals that they would be protected against infection, leading to lower anxiety. Additional research is warranted to explore the role of anxiety in more detail, perhaps based on formal theories of the pathways between risk perception, attitudes, emotions, and behaviors. Female sex was associated with increased use of all 4 hand hygiene behaviors, and more education was associated with increased use of 2 of the 4 [5]. We found that knowledge that H1N1 could be transmitted by indirect contact was also associated with greater use of all 4 hygiene measures (Table 3). Because approximately one-third of the population did not report knowing that H1N1 could spread by indirect contact (Figure 2), this suggests the possibility that a hygiene campaign emphasizing the risk of environmental transmission might encourage hygiene improvements. However, hygiene behaviors are habitual, and habitual behaviors can be difficult to modify without structured interventions [21].

Poorer self-rated health, higher perceived risk of infection, and greater worry if becoming ill were all associated with greater use of face masks, although there was no significant association between anxiety and the use of face masks. It is plausible to expect that greater perceived risk would lead to a greater motivation to protect against infection [5]. Face masks were worn by >75% of the population during the peak of the SARS epidemic in Hong Kong [20], and since 2003 it has not been uncommon for individuals with acute respiratory illness to don surgical masks to protect those around them [22, 23]. Another study in Hong Kong found that approximately half of the population reported that they would don a surgical mask in public places if they developed flu symptoms [7]. However, there are limited data to support the effectiveness of face masks to prevent infection [24], while the Hong Kong government did not recommend that face masks were worn in general community settings other than by individuals with respiratory illness. It appears that there was insufficient motivation through the local H1N1 epidemic to lead to widespread wearing of face masks (Figure 2).

In contrast to hygiene behaviors, we found that social distancing was significantly associated with higher anxiety (Table 5) [5, 6]. Poorer health, greater perceived risk of infection, and greater worry if becoming ill were also associated with social distancing [5]. Social distancing is a natural response to the threat of infection from other people and has long been observed during severe epidemics [25, 26] but can have significant social and economic impact [27].

Our study has a number of limitations. First, because our surveys were cross-sectional in nature, we cannot infer causal pathways from associations identified. Furthermore, our interpretation of the factors associated with preventive behaviors may suffer from reverse causality, if for example greater use of hand hygiene could have led to lower anxiety, rather than vice versa. More detailed longitudinal studies of changes in attitudes, risk perceptions, and behaviors over time would be needed to address causal relationships. Second, there could be potential selection bias away from working groups, although this should have been reduced by conducting surveys between 6:30 and 10:30 PM on working days and during weekends. Without data on the nonrespondents, we were unable to assess potential selection biases. Third, telephone surveys rely on self-reported data, and response biases such as recall bias and social conformity bias may affect some of the results. However, previous studies have found similar responses between telephone and face-to-face interviews [28], and telephone interviews have become an acceptable methodology for studying preventive behaviors during infectious disease epidemics [5]. Fourth, although we focused attention on community responses and preventive measures to prevent infection, it would be interesting to study behavioral responses when symptoms did develop. However, this was not possible with our sample size, where only 91 of 12,965 respondents reported influenza-like illness in the previous 2 weeks. Fifth, we were not able to study all potential factors that have been proposed as related to behavioral responses to epidemics, such as perceived barriers, normative pressure, and self-efficacy [5, 29]. Finally, Hong Kong's considerable experience with infectious disease epidemics in recent decades, including outbreaks of avian influenza (H5N1) and SARS [4, 30, 31], may reduce generalizability to some other settings. On the other hand, Hong Kong's experience with the H1N1 pandemic after those past experiences may provide insights into potential experiences in future emerging epidemics in other populations, following the current global H1N1 pandemic.

In conclusion, this study illustrates that the H1N1 pandemic failed to generate significant self-protective responses among the Hong Kong community. Anxiety levels showed no association with episodic events such as the first reported H1N1 death in Hong Kong or increasing incidence. This suggested that for most people H1N1 was a background phenomenon of little concern, perhaps because of the memory of SARS in 2003, and because the public were initially reassured by government actions [7]. Levels of perceived risk were low, as were self-protective behaviors; however, as other studies have typically reported, young males had the poorest hygiene and self-protective behaviors [5], suggesting that this group could be problematic in the event of a serious influenza epidemic. The lack of substantial changes in hygiene behaviors during the height of the epidemic suggests that government attempts at improving community hygiene made little contribution to the mitigation of pandemic influenza in Hong Kong. This may be because the health impacts were relatively modest, so there was little motivation for people to change their behavior, despite ongoing government promotions and media coverage. The association between social distancing and anxiety raises the possibility of unavoidable economic consequences associated with emerging infectious disease epidemics. Our results highlight the difficulty of relying on community mitigation measures during a pandemic, because habitual behaviors like hygiene may be hard to change in response to an acute epidemic. More sustained and integrated attempts should therefore be considered.

Acknowledgments

We thank Robert Chung, Karie Pang, Winnie Lee, and the team at HKU Public Opinion Programme for assistance in administering the telephone surveys. We thank Vicky Fang and Eric Lau for technical assistance. We thank Calvin Cheng, Horace Choi, Sophia Ng, Angela Shen, Teresa So, Keith Tin, Irene Wong, and Wu Peng for research support.

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