Title	A tale of two cities: Community psychobehavioral surveillance and related impact on outbreak control in Hong Kong and Singapore during the severe acute respiratory syndrome epidemic
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A TALE OF TWO CITIES: COMMUNITY PSYCHOBEHAVIORAL SURVEILLANCE AND RELATED IMPACT ON OUTBREAK CONTROL IN HONG KONG AND SINGAPORE DURING THE SEVERE ACUTE RESPIRATORY SYNDROME EPIDEMIC

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ABSTRACT

OBJECTIVES: To compare the public's knowledge and perception of SARS and the extent to which various precautionary measures were adopted in Hong Kong and Singapore.

DESIGN: Cross-sectional telephone survey of 705 Hong Kong and 1,201 Singapore adults selected by random-digit dialing.

RESULTS: Hong Kong respondents had significantly higher anxiety than Singapore respondents (State Trait Anxiety Inventory [STAI] score, 2.06 vs 1.77; $P < .001$). The former group also reported more frequent headaches, difficulty breathing, dizziness, rhinorrhea, and sore throat. More than 90% in both cities were willing to be quarantined if they had close contact with a SARS case, and 70% or more would be compliant for social contacts. Most respondents (86.7% in Hong Kong vs 71.4% in Singapore; $P < .001$) knew that SARS could be transmitted via respiratory droplets, although fewer (75.8% in Hong Kong vs 62.1% in Singapore; $P < .001$) knew that fomites were also a possible transmission source. Twenty-three percent of Hong Kong and 11.9% of Singapore respondents believed that they were "very likely" or "somewhat likely" to contract SARS during the current outbreak ($P < .001$). There were large differences between Hong Kong and Singapore in the adoption of personal precautionary measures. Respondents with higher levels of anxiety, better knowledge about SARS, and greater risk perceptions were more likely to take comprehensive precautionary measures against the infection, as were older, female, and more educated individuals.

CONCLUSION: Comparative psychobehavioral surveillance and analysis could yield important insights into generic versus population-specific issues that could be used to inform, design, and evaluate public health infection control policy measures (*Infect Control Hosp Epidemiol* 2004;25:1033-1041).

During a new epidemic such as the recent outbreak of severe acute respiratory syndrome (SARS), the focus of research and action in the medical and public health communities has often and rightly been on the identification of the responsible agent,[1] pathophysiology,[2] clinical presentation,[3] and diagnosis and treatment of the condition.[4] There have been fewer studies focusing on the epidemiology of the disease[5] and the effectiveness of various hospital infection control measures,[6] and population psychobehavioral surveillance has received almost no research coverage. However, the policy formulation and implementation of public health infection control measures deserve equal attention, and such recommendations should be grounded in a thorough understanding of the public's perceptions, beliefs, and attitudes. Standard data collection and analysis of outbreak control rarely includes information about the attitudes and perceptions of the population regarding the disease and their relevance to the agent, vector, and host epidemiologic triangle.

As medical and public health authorities worldwide prepare for a possible return of SARS, it may be useful to compare the public's responses in different cities that were similarly affected. Such comparative analyses would enable policy makers to disentangle generic issues from culture-specific concerns and the sharing of best practices that appear to have been important in successfully controlling the outbreak across different communities.

We report the results of a cross-sectional, population-based survey in two Asian communities, Hong Kong and Singapore, at the center of the epidemic to learn their populations' views and beliefs about and psychobehavioral responses to SARS.

METHODS

Respondents were recruited using random-digit dialing of all land-based telephone lines in Hong Kong and Singapore. A total of 705 adult residents in Hong Kong (18 years or older) and 1,201 in Singapore (21 years

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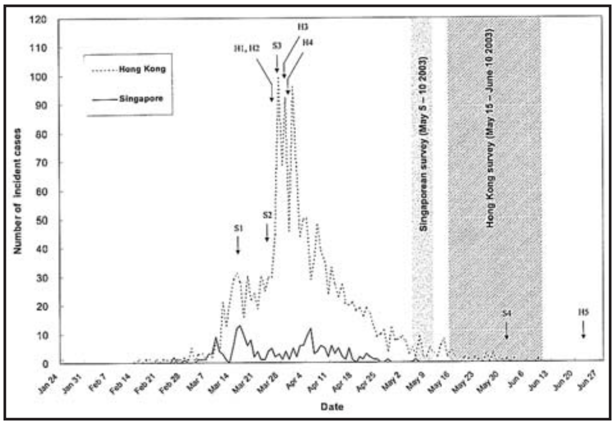

FIGURE. Epidemic curves and chronology of key events during an epidemic of severe acute respiratory syndrome (SARS) in Hong Kong (H) and Singapore (S). H1 = addition of SARS to the list of notifiable diseases (March 26); H2 = mandatory surveillance of close contacts of SARS patients at designated medical centers for screening (from March 26) or subsequently home quarantining of close contacts and restrictions on their travel out of Hong Kong (from April 10); H3 = all tertiary-care institutions, secondary schools, primary schools, kindergartens, and nurseries closed from March 29 to April 22; H4 = isolation of residents of a building in the Amoy Gardens estate, at the center of a cluster of approximately 300 cases (March 30); H5 = World Health Organization removed Hong Kong from its list of areas with recent cases of local transmission of SARS (June 23); S1 = addition of SARS to the list of notifiable diseases (March 17); S2 = home quarantining of close contacts of SARS patients (March 24); S3 = all child care centers, preschools, primary and secondary schools, junior colleges, centralized institutes, and madrasahs closed from March 27 to April 6; and S4 = World Health Organization removed Singapore from its list of areas with recent cases of local transmission of SARS (May 31).

or older) completed the survey, which was conducted from May 15 through June 10 in Hong Kong and between May 5 and 10, 2003, in Singapore (Figure). The response rates were 54.7% (705 of 1,288) and 62.3% (1,201 of 1,928) for Hong Kong and Singapore, respectively.

The figure shows that the surveys were performed toward the end of the epidemics in both cities, but Hong Kong had experienced a much more dramatic outbreak with at least three superspreading events (ie, Prince of Wales Hospital, Amoy Gardens, and Tai Po clusters) compared with Singapore. The respective epidemic curves demonstrate that the two outbreaks occurred almost contemporaneously.

The survey consisted of 60 questions, five of which had multiple parts. It was translated and back-translated from Cantonese Chinese to English in Hong Kong and from Cantonese to Mandarin, Malay, and English in Singapore as well as pretested for face and content validity, length, and comprehensibility. The questionnaire was administered in Cantonese Chinese in Hong Kong, where 95% of the local resident population was ethnic Chinese, and in Mandarin, Malay, and English in Singapore, following the language of choice of the respondents.

First, respondents were asked about their self-perceived general health status, febrile and respiratory symptoms in the past 2 weeks, and general anxiety levels using the State-Anxiety Scale of the State Trait Anxiety Inventory (STAI), originally developed in the United States[7] and subsequently validated in numerous Asian settings.[8,9] Next, we inquired about the use of health services in the previous 2 weeks. The third section examined the presence, intensity, and setting of direct and indirect contacts with diagnosed SARS cases. Fourth, we evaluated respondents' risk perception in terms of their self-perceived likelihood of contracting SARS and surviving if diagnosed as having the disease. Respondents were also asked about their beliefs about routes of transmission and confidence in physicians' ability to diagnose the disease. The penultimate section assessed the extent to which various precautionary measures were being adopted and possible changes in lifestyle practices to prevent transmission of the virus. Finally, sociodemographics of the respondents were recorded.

We determined differences in proportions between baseline demographics in the current survey and corresponding population statistics in the two cities by calculating the effect size, a standard statistical methodology, where a value of 0.1 indicates a small effect size, 0.3 a medium effect size, and 0.5 a large effect size.[10] To adjust for possible sampling biases due to sociodemographic differences between respondents and nonrespondents and to ensure that the sample was representative of the underlying general populations, we weighted the responses on the basis of the latest figures from the Hong Kong Census and Statistics Department and Singapore Department of Statistics for age, gender, and level of educational attainment. Ninety-five percent confidence intervals (CI_{95}) were generated using logistic and multinomial regression for dichotomous and multicategorical variables, respectively.

We also sought to identify predictors for greater adoption of a predefined set of precautionary measures (ie, at least five of the seven specified strategies) and health services use (defined as having visited Western, Chinese, or alternative medical practitioners in any setting during the previous 2 weeks) using multivariable logistic regression. Potential explanatory variables were anxiety level (mean STAI score), level of confidence in physicians' ability to diagnose or recognize SARS, self-perceived likelihood of contracting SARS and surviving the illness if infected, presence of symptoms, contact history, and sociodemographics.

All analyses were conducted using STATA software (version 8.0; STATA Corp., College Station, TX). Ethics approval was obtained from the institutional review board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster, which conforms to the principles embodied in the Declaration of Helsinki, and the National University of Singapore's Office of Life Sciences.

RESULTS

Characteristics of the Respondents

Table 1 compares the sample characteristics with those from the respective population census data. Most of the baseline parameters in the current survey were simi-

TABLE 1
PROPORTION OF RESPONDENTS BY SOCIODEMOGRAPHIC CHARACTERISTICS (%)

	Hong Kong			Singapore		
Characteristic	**SARS Survey (n = 705)**	**Thematic Household Survey, 2002**	**Effect Size***	**SARS Survey (n = 1,201)**	**Census, 2000**	**Effect Size***
Gender			0.14			0.02
Female	57.0	49.8		50.1	51.0	
Male	43.0	50.2		49.9	49.0	
Age, y			0.20			0.10
18 to 24 (Hong Kong)	15.3	11.6				
21 to 24 (Singapore)				8.2	8.8	
25 to 34	18.2	19.3		23.6	23.5	
35 to 44	28.8	25.3		27.1	27.0	
45 to 54	20.2	19.6		21.8	20.2	
55 to 64	9.0	10.1		11.7	10.3	
⩾ 65	8.6	14.2		7.7	10.1	
Educational attainment†			0.17			0.26
Primary or below	22.3	29.8		20.7	31.8	
Secondary	49.8	46.2		37.1	35.6	
Post-secondary	27.9	24.0		42.2	32.6	
Marital status†			0.08			0.29
Single	28.4	27.1		25.0	30.5	
Married	61.6	63.7		73.6	61.9	
Divorced or separated	3.9	2.8		0.5	5.2	
Widowed	6.1	6.4		0.9	2.5	
Employment status†			0.19			0.14
Employed	50.9	60.2		66.4	59.4	
Other	49.1	39.8		33.6	40.6	
Annual personal income†,‡ (U.S. dollars)			0.23			0.13
< 6,500	7.7	4.6		13.3	11.7	
6,500 to 13,999	22.6	28.5		27.6	30.4	
14,000 to 29,999	41.3	43.5		41.9	37.1	
30,000 to 59,999	19.4	17.3		14.0	16.7	
⩾ 60,000	9.1	6.2		3.3	4.0	

SARS = severe acute respiratory syndrome.
*A measure of the overall difference in proportions between the current SARS surveys in Hong Kong and Singapore and the Thematic Household Survey, 2002, conducted by the Census and Statistics Department, Hong Kong, and the Singapore Census, 2000, respectively. A value of 0.1 indicates a small effect size, 0.3 a medium effect size, and 0.5 a large effect size.
†Variables weighted by gender and age.
‡U.S. $1 = Hong Kong $7.80 = Singapore $1.75.

lar to the benchmark statistics as confirmed by the small effect sizes. Age, gender, and education were used to weight the sample in all subsequent analyses to improve generalizability.

Health and Emotional Status

Respondents' anxiety level, measured using the STAI 10-item scale, revealed that individuals in Hong Kong had significantly higher anxiety (mean score, 2.06 on a scale of 1 ["not anxious at all"] through 4 ["very anxious"]) compared with respondents in Singapore (mean score, 1.77; $P < .001$).

Table 2 also states that 0.5% of the Hong Kong sample and 0.9% of the Singapore sample ($P = .36$) reported persistent fever (temperature of 38°C) for at least 1 day within the previous 2 weeks, approximately half of whom (0.2% and 0.4%; $P = .47$) also had cough or dyspnea. This combination of symptomatology would qualify these respondents as possibly "eligible" for a SARS diagnosis during an acute outbreak.[11] Hong Kong respondents reported significantly higher prevalences of headache, dyspnea, dizziness, rhinorrhea, and sore throat compared with respondents from Singapore, but none of these (except for dyspnea) are cardinal symptoms of SARS; in fact, their presence may well suggest an alternative diagnosis.[12]

TABLE 2
SYMPTOMATOLOGY AND ANXIETY LEVEL*

	Hong Kong (CI_{95})	Singapore (CI_{95})	P
Physical symptoms in the previous 14 days (%)			
Fever	0.5 (0.2–1.0)	0.9 (0.4–2.2)	.36
Chills	1.4 (0.7–2.8)	1.7 (0.9–3.1)	.73
Headache	14.7 (12.1–17.7)	5.0 (3.9–6.5)	< .001
Myalgia	4.5 (3.3–6.1)	3.7 (2.6–5.2)	.37
Cough	9.9 (7.8–12.4)	8.4 (6.9–10.2)	.31
Difficulty breathing	1.0 (0.5–2.1)	0.4 (0.1–1.0)	< .05
Dizziness	5.6 (3.9–8.1)	1.5 (1.0–2.4)	< .001
Coryza	11.8 (9.5–14.6)	7.0 (5.6–8.7)	< .001
Sore throat	11.3 (9.0–14.0)	4.5 (3.4–5.9)	< .001
Fever and cough or difficulty breathing	0.2 (0.1–0.5)	0.4 (0.1–2.8)	.47
Mean anxiety level, STAI score	2.06 (2.03–2.10)	1.77 (1.74–1.79)	< .001

CI_{95} = 95% confidence interval; STAI = State Trait Anxiety Inventory.
*Adjusted for gender, age, and educational attainment.

When the prevalence rates of these five symptoms that were different between Hong Kong and Singapore were adjusted for anxiety level (ie, STAI score), they decreased by between 7% and 23% in the Hong Kong sample but did not change at all (ie, to one decimal point) for respondents in Singapore. Given the much higher anxiety levels of the population in Hong Kong, this finding may in part explain the concomitantly larger proportion of its respondents giving a positive response regarding these symptoms, which could have been at least partially psychosomatic.

Extent of Direct and Indirect Contacts With Diagnosed Cases and Willingness to Be Quarantined

Most (92.3% in Hong Kong and 96.7% in Singapore) of the respondents reported no contact history, whereas 0.2% in Hong Kong and 0.3% in Singapore had direct, non-close contact and 4.1% in Hong Kong and 1.5% in Singapore had indirect contact (ie, "contact with a direct contact") with a confirmed case. The remaining 3.4% in Hong Kong and 1.5% in Singapore believed they might have been exposed to a possible SARS patient or to contaminated objects (ie, fomites).

There appeared to have been a similarly high degree of civic willingness to comply with potential quarantine procedures, which were in place for both communities at the time of the survey, if respondents were to come into contact with SARS patients. Of the respondents from Hong Kong and Singapore, 93.2% (CI_{95}, 91.0% to 94.9%) and 91.8% (CI_{95}, 90.0% to 93.3%; P = .27), respectively, were willing to be quarantined if there was close contact (eg, household or intimate relationships), and 74.4% (CI_{95}, 70.9% to 77.7%) and 71.7% (CI_{95}, 68.9% to 74.2%; P = .22), respectively, would be compliant for non-close or social contact.

Knowledge and Beliefs About SARS

Most of the respondents in both cities (86.7% in Hong Kong vs 71.4% in Singapore; $P < .001$) knew that SARS could be transmitted by person-to-person droplet nuclei, although fewer (75.8% in Hong Kong vs 62.1% in Singapore; $P < .001$) knew that fomites were a possible source. These are the two main routes of transmission confirmed by the Centers for Disease Control and Prevention and the World Health Organization. However, 40.9% of the respondents in Hong Kong and slightly more than half of those in Singapore (50.9%) thought that the infection could be transmitted via the airborne route ($P < .001$), which remains a possible but not frequent mode of transmission.[11] Overall, Hong Kong residents were more knowledgeable about the routes of transmission in terms of the total number of correct responses ($P < .001$) (Table 3).

Table 3 also states that 23.0% of respondents in Hong Kong and 11.9% in Singapore believed that they were "very likely" or "somewhat likely" to contract SARS during the current outbreak ($P < .001$). This proportion remained the same even after excluding those who reported any contact (direct or indirect) with a SARS case-patient. Singapore residents were more confident about physicians' ability to diagnose or recognize SARS (29.5% reported that they were "very confident") than were Hong Kong residents (only 16.1%; $P < .001$). However, the corresponding proportions feeling "not very confident" or "not at all confident" were similar between the two cities. More than one-tenth believed they were unlikely to survive SARS if they contracted it. A case-fatality rate of 15% to 20%[5] had been widely reported in Hong Kong and Singapore up to the time of the survey, whereas the final case-fatality ratios were 17.1% in Hong Kong and 13.9% in Singapore.[13]

Precautionary Measures

Table 4 lists the respective proportions of respondents who reported practicing each of seven measures to prevent acquiring SARS, directed against the two main modes of transmission of person-to-person droplet spread and fomites. There were large differences between Hong Kong and Singapore for six of the seven measures (ie, except for washing hands with soap and water). For example, most of the Hong Kong respondents reported that they would cover their mouths when sneezing or coughing (94.4%) and wash their hands afterward (85.6%) as well as after touching possible contaminated objects (81.2%), whereas the corresponding proportions for Singapore were 83.6%, 72.6%, and 48.3%, respectively. Only approximately half of the Hong Kong respondents (47.7%) used serving utensils during meals compared with just more than one-fourth (27.3%) of the Singapore respondents; this is particularly important in Chinese or Asian cultures where dishes are commonly shared with everyone at the table. Most striking was the extent of face mask wearing in the two populations: 79.0% in Hong Kong versus 4.1% in Singapore. Finally, at least two-thirds of the Hong Kong sample, but only 12.6% of the Singapore sample, had practiced at least five of the seven preventive measures to improve personal hygiene.

Predictors for the Adoption of Precautionary Measures and Health Services Use

Tables 5 and 6 detail the logistic regression results for greater adoption of precautionary measures against SARS (at least five of seven items) and for higher health services use, respectively.

Level of anxiety, as measured on the STAI scale, demonstrated a positive dose-response gradient with the adoption of personal protective measures, especially in Hong Kong where statistical significance was achieved ($P < .01$). Recent physical health, as proxied by acute respiratory or febrile symptoms, or contact history with SARS patients were not associated with the adoption of precautionary measures. Risk perception in terms of a higher self-perceived likelihood of contracting SARS was a positive predictor in Hong Kong (odds ratio [OR], 1.53; CI_{95}, 0.99 to 2.38), although the results were equivocal for Singapore (OR, 1.24; CI_{95}, 0.83 to 1.87). Other belief variables such as the level of confidence in physicians to diagnose SARS and the likelihood of surviving SARS did not appear to be predictive. Greater knowledge about the transmission routes of SARS, on the other hand, predicted the adoption of more precautionary measures, at least in Hong Kong (OR, 2.09; CI_{95}, 1.39 to 3.13). The lack of a strong and statistically significant association at the .05 level for Singapore may reflect the much lower prevalence of adoption of personal protective measures (Table 5). In terms of sociodemographics, males were much less likely to adopt comprehensive precautionary measures against SARS. There were generally positive dose-response gradients with increasing age and level of educational attainment in both cities, where the former relationship was stronger in Singapore and the latter in Hong Kong. To assess whether anxiety level helped to explain the association between risk perception and use of preventive measures, we re-analyzed the model omitting the STAI score as an independent variable. We found that the OR estimates for the two self-perceived likelihood factors did not change appreciably, thus confirming that anxiety was not a significant intermediary causal factor.

As Table 6 reflects, the presence of symptoms was the only robust predictor for higher health services use. Respondents' health-seeking behavior did not appear to have been influenced by extraneous factors such as risk perception, anxiety level, or contact history. However, younger, male respondents were less likely to seek formal healthcare services.

DISCUSSION

This population-based, representative, cross-national survey revealed substantial differences in knowledge, beliefs, emotional status, and use of personal protective measures between two similarly developed, industrialized Asian cities at the tail end of the recent SARS epidemic. There were also commonalities such as similar

TABLE 3
KNOWLEDGE AND BELIEFS ABOUT SEVERE ACUTE RESPIRATORY SYNDROME* (%)

	Hong Kong	Singapore	*P*
Knowledge			
Routes of transmission			
Droplets			< .001
Agree	86.7	71.4	
Disagree	4.2	16.9	
Don't know	9.1	11.7	
Airborne			< .001
Agree	40.9	50.9	
Disagree	47.3	37.7	
Don't know	11.8	11.4	
Fomites or contact by touch			< .001
Agree	75.8	62.1	
Disagree	16.5	28.1	
Don't know	7.7	9.9	
No. of correct answers to routes of transmission			< .001
0	6.6	11.3	
1	15.0	26.7	
2	42.2	43.3	
3	36.2	18.7	
Beliefs			
Level of confidence in physicians' ability to diagnose or recognize SARS			< .001
Very confident	16.1	29.5	
Somewhat confident	66.7	52.2	
Not very confident	12.0	12.6	
Not at all confident	0.7	1.3	
Don't know	4.5	4.3	
Likelihood of contracting SARS during the current outbreak			< .001
Very likely	0.3	3.0	
Somewhat likely	22.7	8.9	
Not very likely	49.5	39.3	
Not likely at all	14.3	30.7	
Don't know	13.2	18.1	
Likelihood of surviving SARS if contracted			< .001
Very likely	13.4	21.6	
Somewhat likely	61.0	41.8	
Not very likely	9.9	11.2	
Not likely at all	1.9	2.2	
Don't know	13.8	23.2	

SARS = severe acute respiratory syndrome.
*Adjusted for gender, age, and educational attainment.

TABLE 4
ADOPTION OF PRECAUTIONARY MEASURES TO PREVENT TRANSMITTING AND CONTRACTING SEVERE ACUTE RESPIRATORY SYNDROME* (%)

Measure	Hong Kong (CI_{95})	Singapore (CI_{95})	P
Covering mouth when coughing or sneezing	94.4 (92.5–95.9)	83.6 (81.1–85.8)	< .001
Using serving utensils during meals	47.7 (43.8–51.6)	27.3 (24.7–30.1)	< .001
Washing hands with soap	82.1 (78.9–84.9)	82.1 (79.6–84.3)	.98
Washing hands immediately after sneezing, coughing, or rubbing nose	85.6 (82.7–88.1)	72.6 (69.8–75.2)	< .001
Wearing mask	79.0 (75.7–82.0)	4.1 (3.1–5.4)	< .001
Adopting precautionary measures after touching possible contaminated objects	39.6 (35.8–43.5)	14.4 (12.4–16.6)	< .001
Washing hands after touching possible contaminated objects	81.2 (78.0–84.0)	48.3 (45.4–51.3)	< .001
Practicing at least 5 of the 7 above precautionary measures	69.4 (65.7–72.9)	20.1 (17.8–22.6)	< .001

CI_{95} = 95% confidence interval.
*Proportion of respondents reporting the adoption of the precautionary measure always or most of the time adjusted for gender, age, and educational attainment.

reported levels of civic compliance with public health control and quarantine directives, as well as predictors of greater adoption of preventive measures and use of health services that were in broad agreement across the two populations. The findings from the regression analysis suggest that effective public health action to curb the transmission of the SARS coronavirus, in this case partially achieved through enhanced personal hygiene and health protective measures, is likely dependent on the public's knowledge and psychological responses (ie, anxiety level) and the prevailing perceptions of the community at large. The data also show that there were sociodemographic subgroups that were less likely to take personal protective steps against the infection or to seek care. A particular strength of the study is that respondents were interviewed during an actual outbreak compared with other similar studies of infectious disease epidemics or bioterrorism attacks in which hypothetical questions were usually posed.

Because the survey was conducted near the conclusion of the outbreak, knowledge indices would be expected to be at their highest given the cumulative effects of sustained promotion of health practices through the mass media in both cities. Nonetheless, there were still significant knowledge gaps in terms of the routes of transmission of the SARS coronavirus, to a greater extent in Singapore than in Hong Kong. In addition, respondents' risk perception as indicated by their perceived likelihoods of contracting and surviving SARS was exaggerated and overly pessimistic when benchmarked against the overall probabilities based on the case-fatality rate (Table 7). This could potentially be explained by a combination of knowledge deficits and excessive anxiety generated by the outbreak, although the current analyses preclude us from drawing definite conclusions.

The stage of the epidemic at which we conducted the survey could have affected our observations regarding the public's behavioral responses. Singapore's lower use of preventive measures might arguably have been due to the lower number of daily case counts. Singapore and Toronto both experienced a bimodal distribution of incident cases. Moreover, the Hong Kong survey was performed toward the conclusion of the outbreak as well, but a much larger proportion of respondents reported continued vigilance in taking preventive measures. If it is assumed that this observed cross-sectional pattern was representative of the entire epidemic in both cities and if the potential for ecologic fallacy is cast aside, it appears that factors other than the overall level of personal protection undertaken by a community were largely responsible for the different extents of the respective outbreaks in Hong Kong and Singapore (Table 7, Figure). For instance, the impact of the two massive superspreading events at the Prince of Wales Hospital (n = 239) and Amoy Gardens (n = 329) in Hong Kong (where the former "seeded" the latter) might have dominated over the likely much smaller effects of community transmission (where one infected individual typically spread the disease to three others in the absence of any preventive measures [ie, basic reproduction number = 2.7]),[13] which in turn would have been dependent on the public's collective adoption of personal preventive measures. This hypothesis, if substantiated, underlines the often stochastic or random nature of such epidemics.

Our findings raise several important implications for public health and infection control professionals in Hong Kong and Singapore as well as internationally. First, our data highlight the central role of the public health messages in providing appropriate advice and education during this SARS epidemic. The results revealed that, even by the tail end of the epidemic, there were significant gaps in the public's knowledge about SARS and associated issues such as route of transmission and risk perception. There are clearly areas where health education efforts should be improved.

Second, there has been much theoretical consideration of anxiety as either a facilitator or a barrier for promoting the optimal adoption of precautionary measures. Empiric findings from this study confirm that the population's attitudes and perception of events are important indices that should be closely monitored in a mass out-

TABLE 5
PREDICTORS FOR GREATER ADOPTION OF PRECAUTIONARY MEASURES AGAINST SEVERE ACUTE RESPIRATORY SYNDROME

	Hong Kong*		Singapore*	
Predictor	Adjusted OR (CI_{95})†	*P* for Linear Trend	Adjusted OR (CI_{95})†	*P* for Linear Trend
Anxiety level (mean 10-item STAI score)		< .01		.65
Low (1 to 1.99)	1		1	
Medium (2 to 2.49)	1.28 (0.86–1.92)		0.94 (0.66–1.36)	
High (2.50 to 4)	2.24‡ (1.27–3.97)		1.19 (0.76–1.87)	
Level of confidence in physicians' ability to diagnose or recognize SARS		-		-
Very confident/confident	1		1	
Not confident/don't know	1.23 (0.77–1.95)		0.77 (0.53–1.13)	
Likelihood of contracting SARS during the current outbreak		-		-
Not very likely/not likely at all/don't know	1		1	
Very likely/somewhat likely	1.53 (0.99–2.38)		1.24 (0.83–1.87)	
Likelihood of surviving SARS if contracted		-		-
Very likely/somewhat likely/don't know	1		1	
Not very likely/not likely at all	0.98 (0.57–1.70)		0.79 (0.49–1.25)	
Febrile and respiratory symptoms		-		-
None	1		1	
Any febrile or respiratory symptoms	0.91 (0.63–1.33)		0.98 (0.69–1.41)	
Fever and cough or difficulty breathing	NA§		NA§	
Contact history		-		-
None	1		1	
Contact with a suspected or diagnosed case	1.03 (0.56–1.89)		1.27 (0.64–2.53)	
SARS knowledge on routes of transmission		-		-
≤ 1 correct answer	1		1	
2 or 3 correct answers	2.09‖ (1.39–3.13)		1.27 (0.92–1.73)	
Gender		-		-
Female	1		1	
Male	0.54‖ (0.38–0.77)		0.50‖ (0.37–0.67)	
Age, y		.08		< .01
18 to 24	1		1	
25 to 34	1.17 (0.64–2.14)		1.39 (0.69–2.80)	
35 to 44	1.67 (0.95–2.92)		1.79 (0.89–3.62)	
45 to 54	1.34 (0.74–2.44)		1.90 (0.93–3.89)	
55 to 64	0.88 (0.43–1.83)		2.67¶ (1.23–5.82)	
≥ 65	2.94‡ (1.30–6.65)		2.66¶ (1.12–6.28)	
Educational attainment		< .001		.79
Primary or below	1		1	
Secondary	1.80¶ (1.08–2.97)		1.37 (0.90–2.08)	
Post-secondary	2.74‖ (1.52–4.97)		1.15 (0.72–1.83)	

OR = odds ratio; CI_{95} = 95% confidence interval; STAI = State Trait Anxiety Inventory; SARS = severe acute respiratory syndrome; NA = not applicable.
*Five or more precautionary measures adopted.
†ORs were adjusted for other variables in the model.
‡$P < .01$.
§ORs were not estimated due to co-linearity (n = 1 in Hong Kong and n = 7 in Singapore for adopting at least 5 of the 7 precautionary measures).
‖$P < .001$.
¶$P < .05$.

break situation such as SARS, as they can be highly predictive of key behavioral outcomes.

As would be anticipated, younger, less educated males, the traditional risk takers, were least likely to use preventive measures to protect themselves and others against SARS. This was consistently observed in both the

TABLE 6
PREDICTORS FOR HIGHER HEALTH SERVICES USE

Predictor	Hong Kong* Adjusted OR (CI_{95})†	Hong Kong* *P* for Linear Trend	Singapore* Adjusted OR (CI_{95})†	Singapore* *P* for Linear Trend
Anxiety level (mean 10-item STAI score)		.31		.42
Low (1 to 1.99)	1		1	
Medium (2 to 2.49)	0.65 (0.36–1.20)		0.92 (0.60–1.39)	
High (2.50 to 4)	1.54 (0.82–2.86)		1.38 (0.84–2.26)	
Level of confidence in physicians' ability to diagnose or recognize SARS		-		-
Very confident/confident	1		1	
Not confident/don't know	1.44 (0.82–2.52)		1.06 (0.71–1.59)	
Likelihood of contracting SARS during the current outbreak		-		-
Not very likely/not likely at all/don't know	1		1	
Very likely/somewhat likely	0.61 (0.32–1.15)		1.02 (0.64–1.63)	
Likelihood of surviving SARS if contracted		-		-
Very likely/somewhat likely/don't know	1		1	
Not very likely/not likely at all	1.51 (0.74–3.07)		1.01 (0.62–1.63)	
Febrile and respiratory symptoms		-		< .001
None	1		1	
Any febrile or respiratory symptoms	4.94‡ (2.78–8.76)		3.02‡ (2.13–4.29)	
Fever and cough or difficulty breathing	NA§		17.75‡ (3.17–99.41)	
Contact history		-		-
None	1		1	
Contact with a suspected or diagnosed case	0.90 (0.35–2.35)		1.46 (0.75–2.84)	
SARS knowledge on routes of transmission		-		-
≤ 1 correct answer	1		1	
2 or 3 correct answers	0.54‖ (0.30–0.95)		0.91 (0.64–1.30)	
Gender		-		-
Female	1		1	
Male	0.42¶ (0.24–0.73)		0.59¶ (0.43–0.82)	
Age, y		< .01		.27
18 to 24	1		1	
25 to 34	1.40 (0.56–3.47)		0.98 (0.50–1.92)	
35 to 44	0.88 (0.36–2.13)		1.16 (0.58–2.29)	
45 to 54	2.89‖ (1.21–6.92)		1.15 (0.57–2.32)	
55 to 64	1.67 (0.53–5.31)		1.46 (0.67–3.20)	
≥ 65	5.23¶ (1.70–16.06)		1.32 (0.55–3.15)	
Educational attainment		.24		.22
Primary or below	1		1	
Secondary	1.97 (0.90–4.32)		0.72 (0.45–1.13)	
Post-secondary	1.73 (0.71–4.24)		0.70 (0.43–1.16)	

OR = odds ratio; CI_{95} = 95% confidence interval; STAI = State Trait Anxiety Inventory; SARS = severe acute respiratory syndrome; NA = not applicable.
*For higher health services use.
†ORs were adjusted for other variables in the model.
‡$P < .001$.
§ORs were not estimated due to co-linearity (n = 1 in this case for higher health services use).
‖$P < .05$.
¶$P < .01$.

Hong Kong and the Singapore samples. Perhaps targeting health promotion messages through intermediaries such as female significant others (eg, mothers, wives, or girlfriends) who are more health conscious and risk averse would be worth exploring in an attempt to raise the level of preventive measures used by this vulnerable subgroup.

TABLE 7
SEVERE ACUTE RESPIRATORY SYNDROME MORBIDITY AND MORTALITY STATISTICS IN HONG KONG AND SINGAPORE*

Location	2002–2003 Mid-Year Population (Million)	Cumulative No. of Cases			Cumulative No. of Deaths	
		Male	Female	Total	Total	Case-Fatality Rate (%)
Hong Kong	6.816	778	977	1,755	299	17.0
Singapore	4.171	77	161	238	33	13.9

*Sources: World Health Organization, Hong Kong Census and Statistics Department, and Singapore Department of Statistics.

Reassuringly, we also noted that only those with symptoms were more likely to seek medical attention and that other factors such as risk perception and anxiety level did not significantly influence healthcare use, suggesting there was little detectable panic or irrational use of health services in both cities, a phenomenon not uncommonly seen in large outbreaks that could easily and quickly overwhelm the surge capacity of any health system. However, this observation could also have been due to general avoidance of healthcare facilities by the public to minimize exposure to such high-risk areas and healthcare personnel.

The principal limitation of this rapid survey during the SARS outbreak is that it was administered during a single period of time, thus the stability of the responses is unknown. However, we have collected both repeated cross-sectional, time series data and prospective panel data at various points during the epidemic in Hong Kong. The analysis of this longitudinal data set can potentially track possible psychobehavioral changes as the epidemic evolved and evaluate the macro impact of policy decisions. In addition, the use of structural equation modeling linking different psychobehavioral variables to better delineate the causal chain of events deserves further examination. The further exploration of the public's beliefs and their interplay with traditional health beliefs and practices in Asia[14] would be a useful adjunct in understanding the population psychobehavioral responses as documented here. Such qualitative research should be a high priority to prepare for future large-scale epidemics. Finally, we should be cautious in interpreting the absolute values of the STAI scores because normative values in the interepidemic period for the two populations surveyed are currently lacking.

The current study demonstrates that the promotion of preventive measures must take into account background perceptions of risk and psychological responses in the community at large. Population psychobehavioral factors in these two Asian epicenters may well have affected the risk for transmission. Comparative psychobehavioral surveillance and analysis can yield important insights into generic versus population-specific issues that could be used to inform, design, and benchmark public health infection control policy measures.

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