Longitudinal Assessment of Community Psychobehavioral Responses During and After the 2003 Outbreak of Severe Acute Respiratory Syndrome in Hong Kong

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Background. In previous literature, the stability and temporal evolution of psychobehavioral responses to an outbreak remained undefined, because of the exclusively cross-sectional nature of such study designs.

Methods. Using random-digit dialing, we sampled 4481 Hong Kong residents in 6 population-based surveys that were conducted at different times during and after the 2003 outbreak of severe acute respiratory syndrome (SARS).

Results. Respondents' State-Trait Anxiety Inventory score (range, 10–40) showed a decreasing temporal trend, from a high mean value of 24.8 during the peak of the Amoy Gardens outbreak to a postepidemic mean baseline value of 14.5. Those who perceived a higher likelihood of contracting or dying of SARS had significantly higher anxiety scores. Female respondents, individuals aged 30–49 years, and individuals with only a primary education or less were predisposed to greater anxiety. There was a positive dose-response gradient between anxiety level and uptake of personal protective measures. Males respondents, individuals at the extremes of age, and individuals with lower educational levels were less likely to engage in self-protective behavior. The presence of symptoms was the only consistent predictor for greater use of health services. There was remarkable stability in the magnitude and the direction of associations between predictors and outcomes over time.

Conclusions. Our findings can assist in modifying public service announcements in the future, which should be tailored to psychobehavioral surveillance intelligence to achieve the desired behavioral outcomes. Future research should explore the use of more-sophisticated techniques, including structural equation modeling and game-theoretical frameworks, to analyze population psychology and behavior, and it should integrate such findings with transmission dynamics modeling.

Standard data collection in outbreak control rarely includes information about the psychological responses of the population to the disease and the relevance of such responses to the agent-vector-host epidemiological triangle. All too often, the host is considered from a purely biological viewpoint, and research efforts are concentrated on understanding the mechanistic aspects of the disease, with little regard for the potentially much larger impact of environmental or human behavioral factors on the transmission dynamics of the causative agent.

We have previously documented the psychosocial impact of severe acute respiratory syndrome (SARS) during the peak of the 2003 Hong Kong epidemic and have shown that individuals who had a heightened sense of risk perception, as well as moderate anxiety levels, were more likely than others to take personal protective measures against infection [1]. Such straightforward protective measures against droplet and contact transmission proved reasonably effective for individual protection [2] and, in the aggregate on the public health level, are now generally acknowledged to have

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been at least partly responsible for effectively bringing the outbreak under control worldwide [3–5]. Thus, psychobehavioral surveillance during infectious disease outbreaks plays an important role and can inform risk communication messages to the general public.

Since reporting our cross-sectional findings during the acute outbreak of SARS in Hong Kong, China [1], we have performed a comparative analysis in Singapore and Hong Kong, attempting to disentangle generic issues from culture-specific concerns [6]. Other research teams from Hong Kong, Canada, and mainland China also implemented similar psychobehavioral surveillance protocols for the general public [7], health care workers [8–10], quarantined individuals [11], human resources specialists [12], and rural residents [13]. However, because of the exclusively cross-sectional design of all previous surveys, an important limitation concerning the stability and temporal evolution of psychobehavioral responses remains. Therefore, to aid planning for a possible return of SARS or, more generally, for an outbreak of other infectious diseases, we report a longitudinal analysis of 6 representative, population-based surveys of Hong Kong residents conducted at different times during and after the 2003 outbreak.

METHODS

Respondents were recruited using random-digit dialing of all land-based telephone lines in Hong Kong, where telephone penetration exceeds 98% of households. A total of 4481 adult (age, ⩾18 years) residents of Hong Kong completed the surveys conducted at different times throughout the SARS epidemic in 2003 and during the postepidemic period. Table 1 shows the exact periods covered by the surveys, the total number of sampled individuals, the number of respondents, and the corresponding response rates for each of the 6 surveys. Surveys 1 and 1.1 and surveys 2 and 2.1 were separate pairs of prospective cohort surveys. Survey 1.1 involved the prospective follow-up of the respondent cohort from survey 1.0, and survey 2.1 involved the prospective follow-up of the respondent cohort from survey 2.0. The remainder of the surveys were cross-sectional surveys. Survey 1.1 was almost contiguous with survey 2.0, and survey 2.1 was almost contiguous with survey 3.0. Therefore, pairing cohort-based designs with cross-sectional designs allowed us to examine the potential differences in response between a survey using a repeated cross-sectional design and one using a truly longitudinal design. Survey 4.0 was performed independently to gauge the postepidemic population standards.

The questionnaire, which was similar across all 6 surveys (with the exception of survey 4.0, for which some questions were omitted), consisted of 60 questions in total, 5 of which had multiple parts. It was pretested for face and content validity, length, and comprehensibility. The final version of the questionnaire was administered in Cantonese Chinese in a region where 95% of the local resident population was ethnic Chinese. In the first section of the questionnaire, respondents were asked about their self-perceived general health status, febrile and respiratory symptoms experienced in the past 2 weeks, and general anxiety levels with use of the locally validated State-Anxiety Scale of the State-Trait Anxiety Inventory (STAI) [6, 14–16]. The second section of the questionnaire inquired about the use of health services in the previous 2 weeks. The third section of the questionnaire investigated the presence, intensity, and setting of direct and indirect contacts with individuals with diagnosed cases of SARS. The fourth section of the questionnaire evaluated the respondents' risk perception in terms of their self-perceived likelihood of contracting SARS and of survival if infected. Respondents were also asked about their beliefs concerning routes of transmission and their confidence in their physicians' ability to diagnose the disease. The penultimate section of the questionnaire assessed the extent to which various precautionary measures were being adopted. Lastly, sociodemographic data of the respondents were recorded.

Table 1. Sample details of 6 surveys regarding severe acute respiratory syndrome (SARS) conducted during the outbreak of SARS in Hong Kong, China, 2003.

Survey	No. of respondents successfully enumerated/ no. of respondents sampled	Response rate, %	Start date	End date
1.0	840/1099	76.4	29 Mar 2003	6 Apr 2003
1.1	480/840[a]	57.1	11 Apr 2003	1 May 2003
2.0	361/469	77.0	16 Apr 2003	23 Apr 2003
2.1	272/361[b]	75.3	22 May 2003	1 Jul 2003
3.0	706/1291	54.7	16 May 2003	10 Jun 2003
4.0	2574/3615	71.2	1 Dec 2003	30 Dec 2003

[a] Subset of the 840 respondents sampled in survey 1.0
[b] Subset of the 361 respondents sampled in survey 2.0

We determined proportional differences between baseline demographic characteristics in each survey and in a general household survey conducted in 2002 (commissioned by the Hong Kong Government Census and Statistics Department) by calculating the effect size. The effect size is determined using a standard statistical methodology, in which a value of 0.1 indicates a small effect size, 0.3 indicates a medium effect size, and 0.5 indicates a large effect size [17]. To adjust for possible sampling biases caused by sociodemographic differences between respondents and nonrespondents and to ensure that the sample was representative of the ethnic Chinese population of Hong Kong, we weighted the responses on the basis of the latest figures from the Hong Kong Census and Statistics Department for age, sex, and education level. As a sensitivity analysis, we tested whether the unadjusted results obtained using data from all subjects were different from the adjusted results.

We generated mean STAI scores (with associated 95% CIs) stratified by beliefs about SARS and by sociodemographic data across the 6 surveys to map the temporal evolution of the population's psychological status. We plotted the STAI scores graphically for the overall population by date of survey response and superimposed the daily number of new SARS cases and the ratio of cumulative deaths to cumulative cases (or the "naive" case-fatality ratio [18] that was commonly adopted throughout most of the epidemic by the World Health Organization [WHO] and US Centers for Disease Control and Prevention), as per government public service briefings during the epidemic. Initial exploration of the temporal pattern of STAI scores suggested a biphasic linear association between STAI scores and calendar date of response. Thus, in the regression analysis, STAI scores were regressed on calendar date, beliefs about SARS, and demographic characteristics, with adjustment for the clustering effect and for age, sex, and level of education attained. The inflection point was determined by the maximum likelihood method.

Next, we computed respondents' knowledge about routes of transmission, number of precautionary measures adopted to prevent transmission of and infection with SARS, and self-perceived likelihood of contracting and surviving SARS. We also sought to identify predictors for greater adoption of the government's recommended precautionary measures (defined as at least 5 of the 7 specified strategies listed in figure A1 in the Appendix [online only]) and higher use of health services by multivariable logistic regression.

All analyses were conducted using Stata software, version 8.0 (Stata). Ethics approval was obtained from the Institutional Review Board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster. Verbal informed consent was sought before proceeding with the telephone interview.

RESULTS

Figure 1 shows the 2003 SARS epidemic curve, the timing of the 6 different surveys, and a chronology of key related events in Hong Kong. Table A1 in the Appendix (online only) compares respondent characteristics between surveys and benchmarked against values for the general population.

Anxiety levels (STAI scores). Respondents' anxiety level (determined according to the STAI 10-item scale score and ranging from 10 to 40) showed a clear temporal trend of decrease, from a high mean value of 24.8 during the peak of the Amoy Gardens outbreak to a postepidemic mean baseline value of 14.5 as the epidemic tailed off. Figure 2 shows that population anxiety levels closely mirrored the daily reported SARS incident case count. However, there was little detectable relationship between the population anxiety level and the reported, naive case-fatality ratio, which continued to climb throughout the epidemic (because of censoring at the time of analysis, the outcome is unknown for a nonnegligible proportion of patients). This suggests that the population anxiety level was more affected by the number of new cases, which was clearly decreasing by the time that survey 1.0 was completed, as opposed to the apparent case-fatality ratio associated with the disease.

Table 2 presents mean STAI scores for different sociodemographic strata and compares mean STATI scores for those who held different beliefs about the disease. Table A2 in the Appendix (online only) integrates the temporal pattern with adjustment for personal beliefs and sociodemographic characteristics in a regression model to demonstrate the respective associations with STAI anxiety scores. Those who perceived a higher likelihood of contracting or dying of SARS had significantly higher anxiety scores. Female respondents, those aged 30–49 years, and individuals with only a primary education or below were also predisposed to greater anxiety.

Uptake of precautionary measures and knowledge and beliefs about SARS. There was clearly a stepped increase in the extent of adopting personal protective measures from the time of survey 1.0 (conducted at the time that the superspreading cluster of Amoy Gardens was emerging) to the time of the other 4 surveys that were conducted during the rest of the epidemic (surveys 1.1, 2.0, 2.1, and 3.0). We subsequently observed a large decrease in the postepidemic survey (survey 4.0) because the threat of SARS no longer loomed (figure A1 in the Appendix; online only).

Knowledge regarding the route of transmission progressively improved during and after the epidemic. The percentage of correct responses improved from <20% of answers in survey 1.0 to ~40% in the next 4 surveys (conducted later during the epidemic) and reached a high of >70% by December 2003 (survey 4.0).

Approximately 40% of respondents believed that they were "very likely" or "somewhat likely" to contract SARS in surveys 1.0, 1.1, and 2.0, but this decreased to 20%–30% by the end of the epidemic. Figure A1 in the Appendix (online only) also shows that 70%–80% of respondents believed they were "very likely" or "somewhat likely" to survive SARS if infected, compared with an observed survival ratio of 82.8% (i.e., a case-fatality ratio of 17.2%) [19]. The proportion of people responding that they would be "very" or "somewhat" likely to survive generally decreased as the epidemic progressed, with a marked stepped decrease between surveys 1.1 and 2.0 (conducted from 11 April to 1 May) and surveys 2.1 and 3.0 (conducted from 16 May to 1 July). This perhaps reflects the wide dissemination of the true case-fatality ratio after a large upward revision from 5% to 15% on 7 May 2003 by the WHO (on the basis of findings from Donnelly et al. [18] that were released on the same day online).

Predictors for the adoption of precautionary measures and health services use. Table 3 shows adjusted ORs and 95% CIs associated with different predictors for greater adoption of precautionary measures, determined on the basis of logistic regression of contemporaneous variables in each cross-sectional

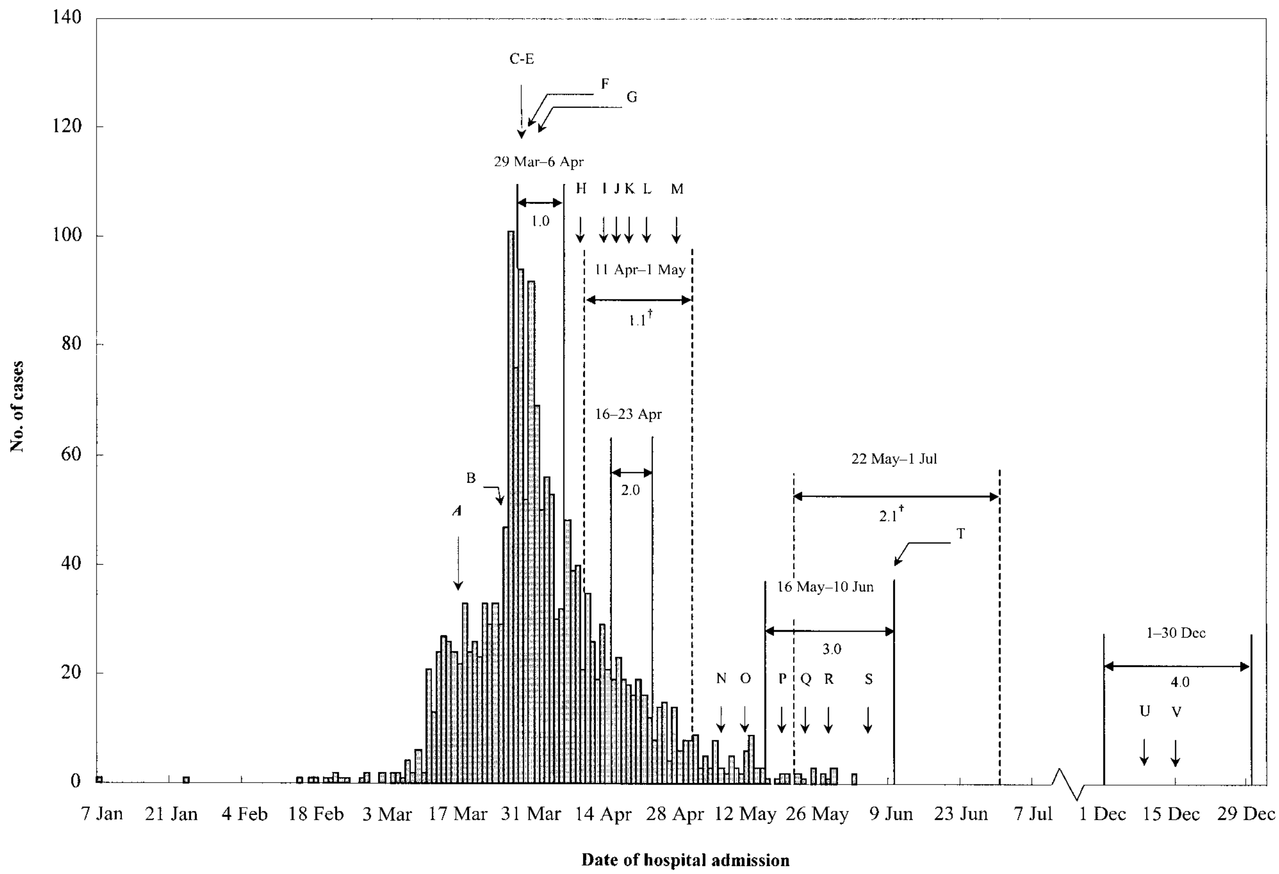

Figure 1. Severe acute respiratory syndrome (SARS) epidemic curve, timing of surveys, and chronology of key events in Hong Kong, China, during the course of the SARS outbreak and after. Survey 1.1 was a prospective longitudinal follow-up of the respondent cohort from survey 1.0, and survey 2.1 was a prospective longitudinal follow-up of the respondent cohort from survey 2.0. A, public service announcements about personal protection (17 March); B, addition of SARS to the list of notifiable diseases and requests for close contacts of case patients to attend designated medical centers for screening until the later introduction of mandatory home quarantine (26 March); C, 2-week suspension of schools' session (29 March); D, 2-week suspension of universities' session (29 March); E, introduction of health declarations for all incoming residents and visitors (29 March); F, isolation of residents of a building in the Amoy Gardens estate, at the center of a cluster of ~300 cases (30 March); G, subsequent move of residents of Amoy Gardens estate to rural isolation camps for 10 days (31 March); H, home quarantining of close contacts and restrictions on their travel out of Hong Kong (10 April); I, new public announcements urging symptomatic people to seek medical attention (15 April); J, body temperature checks for all air passengers (17 April); K, 2-day city-wide cleanup campaign (19–20 April); L, form 3–7 resume classes after a 3-week break that began on 29 March (22 April); M, form 1 and 2 students resume classes (28 April); N, World Health Organization (WHO) revises case-fatality ratio upwards on the basis of the release of Hong Kong epidemiological findings in *The Lancet.* (7 May); O, resumption of classes for primary 4–6 students (12 May); P, resumption of classes for lower primary and kindergarten students (19 May); Q, WHO lifts its travel advisory against Hong Kong (23 May); R, "Team Clean" is launched to keep the city hygienic (28 May); S, Centers for Disease Control and Prevention lift the travel advisory against Hong Kong (5 June); T, US State Department lifts travel note against Hong Kong (10 June); U, H9N2 human infection is found in a 5-year-old child in Hong Kong (9 December); V, South Korea reports an outbreak of influenza H5N1 infection in chicken (15 December).

survey. For surveys 1.1 and 2.1, we also regressed the dichotomous outcome on predictors in the previous survey (either survey 1.0 or survey 2.0) to test whether the prediction obtained with use of repeated cross-sectional surveys is similar to results obtained from a truly prospective design. The results generally held true. Except in survey 1.0, the results of which indicated that individuals who had a moderate level of anxiety were most likely to adopt more precautionary measures against SARS, we found that there was a positive dose-response gradient between anxiety level and adoption of personal protective measures, although it failed to achieve statistical significance towards the tail end of the epidemic. Self-perceived likelihood of contracting or surviving SARS did not predict personal protective behavior in any of the surveys. Knowledge about SARS predicted greater uptake of protective interventions in 2 surveys (surveys 1.1 and 2.0) although not in the other 4 surveys. Male respondents were consistently much less likely to adopt comprehensive precautionary measures against SARS. An inverted U-shaped relationship describes the association between age and adoption of precautionary measures, although statistical significance was

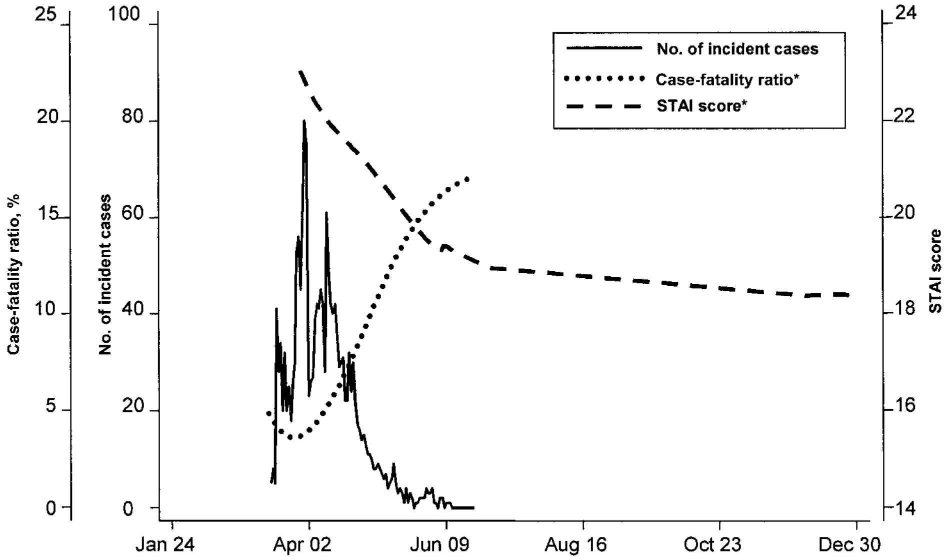

Figure 2. Temporal evolution of population anxiety levels, expressed as mean State-Trait Anxiety Inventory (STAI) scores, and daily incidence of cases and deaths due to severe acute respiratory syndrome (SARS) as reported in public service announcements. Case-fatality ratio is determined by dividing the cumulative number of deaths due to SARS by the cumulative number of cases of SARS. *The curve was smoothed by Lowess method. The observed mean STAI score ranges from 14.5 to 24.8. Because of the smoothing process, the minimum and maximum scores in the figure (18.4 and 23.1, respectively) do not coincide with these observed values.

not consistently met in all age groups. There were strong, positive gradients associated with a higher level of educational attainment. To assess whether anxiety level was an intermediary in moderating the effects of risk perception on the uptake of precautionary measures, we reanalyzed the model while omitting the STAI score as an independent variable and found that the OR estimates for the 2 self-perceived likelihood factors did not change appreciably (data not shown), thus confirming that anxiety was not a significant moderating factor.

On the other hand, the presence of symptoms was the only robust and consistent predictor for higher health services use across all 6 surveys (table A3 in the Appendix; online only). There were no substantial (statistically significant) differences in the results between the adjusted (weighting for age, sex, and education level) and unadjusted analyses.

DISCUSSION

Our longitudinal analysis allowed for the examination of temporal stability in survey responses and their evolution throughout the latter half of the epidemic (extending to 6 months post hoc). It also enabled the prosecution of important determinants of psychological distress, adoption of precautionary measures, and health-seeking behavior, with potential application in early identification of those subgroups requiring more intervention in the event of a similar outbreak.

Taken together with our previous cross-national comparison with Singapore [6] and other similar studies from Hong Kong, Toronto, and mainland China [7–13], the current findings highlight several consistent themes. First, the adoption of self-protective measures can effectively reduce the risk of infection [2], although applicability outside of the hospital setting remains to be proven. Our results demonstrate that anxiety levels were highly predictive of uptake, the effect being most consistent and strongest during the acute phase of the epidemic. In turn, anxiety levels were strongly associated with the intensity of the outbreak and closely mirrored the daily number of new cases. Clearly, taking the psychological temperature of the population (e.g., using STAI scores to measure anxiety levels) during an outbreak can be a useful indicator of key behavioral outcomes (e.g., face-mask wearing). Public service announcements, which apparently influenced population anxiety levels during the SARS outbreak, can in the future be tailored to psychobehavioral surveillance intelligence to achieve the desired behavioral outcomes, although the feasibility and effectiveness of such public service announcements should be tested. Of note, knowledge about SARS was not consistently or strongly associated with the uptake of personal protective interventions, suggesting that dissemination of knowledge alone is unlikely to have a substantial impact on behavior. Instead, public health providers should focus on other aspects of risk perception and communication. To further disentangle the interrelationships between anxiety, knowledge, beliefs, and sociodemographic characteristics, techniques such as structural equation modeling should be tried in the future. Such an approach allows for the empirical confirmation of a preliminary theoretical model or of presently postulated observations.

Table 2. Mean State-Trait Anxiety Inventory (STAI) scores during the outbreak of severe acute respiratory syndrome (SARS) in Hong Kong, China, 2003.

Variable	Mean STAI score (95% CI), by survey					
	Survey 1.0	Survey 1.1	Survey 2.0	Survey 2.1	Survey 3.0	Survey 4.0
Beliefs about SARS						
Likelihood of contracting SARS during the current outbreak						
Not very likely/not likely at all	21.4 (20.9–21.9)	20.7 (20.1–21.3)	20.1 (19.4–20.9)	18.0 (17.5–18.6)	20.4 (20.0–20.8)	18.6 (18.1–19.1)
Very likely/somewhat likely	23.2 (22.5–23.9)	23.2 (22.4–24.0)	21.7 (20.7–22.8)	20.5 (19.3–21.7)	21.6 (20.9–22.4)	17.5 (17.0–18.0)
Likelihood of surviving SARS if infected						
Very likely/somewhat likely	22.1 (21.6–22.5)	21.7 (21.2–22.2)	20.6 (20.0–21.2)	18.3 (17.8–18.9)	20.6 (20.2–21.0)	18.0 (17.7–18.4)
Not very likely/not likely at all	22.9 (20.4–25.4)	21.6 (19.9–23.3)	23.8 (19.7–27.8)	19.3 (17.6–21.0)	21.8 (20.7–22.8)	19.7 (18.4–20.9)
Knowledge of routes of transmission						
Wrong answer	22.3 (21.8–22.8)	21.8 (21.2–22.5)	21.1 (20.3–21.9)	18.7 (18.0–19.3)	21.1 (20.5–21.6)	18.9 (18.4–19.5)
Correct answer	21.2 (20.3–22.1)	21.4 (20.7–22.2)	20.0 (19.1–21.0)	18.3 (17.5–19.0)	20.2 (19.7–20.8)	18.0 (17.5–18.4)
Sex						
Female	23.4 (22.8–24.0)	22.6 (22.0–23.3)	21.7 (20.9–22.6)	18.6 (18.0–19.3)	21.0 (20.5–21.5)	18.2 (17.6–18.8)
Male	20.8 (20.3–21.4)	20.8 (20.0–21.5)	19.7 (18.8–20.5)	18.4 (17.6–19.2)	20.4 (19.9–21.0)	18.2 (17.8–18.6)
Age, years						
18–24	20.6 (19.7–21.5)	19.2 (18.0–20.5)	20.1 (18.9–21.3)	18.0 (17.0–19.1)	19.9 (19.0–20.8)	18.6 (18.1–19.1)
25–34	22.7 (21.7–23.7)	21.4 (20.3–22.5)	20.6 (19.3–21.9)	17.7 (16.6–18.8)	19.6 (18.8–20.3)	18.3 (17.8–18.7)
35–44	23.5 (22.7–24.2)	22.5 (21.5–23.6)	21.5 (20.5–22.5)	18.9 (17.8–20.1)	20.6 (19.9–21.3)	18.5 (18.2–18.9)
45–54	22.2 (21.2–23.1)	22.7 (21.7–23.8)	21.2 (19.4–23.0)	18.7 (17.5–19.9)	21.8 (21.0–22.7)	18.2 (17.6–18.7)
55–64	21.5 (20.2–22.7)	21.9 (20.4–23.5)	20.7 (18.7–22.7)	19.9 (18.0–21.9)	21.8 (20.2–23.3)	17.7 (16.5–18.9)
⩾65	20.5 (19.0–22.0)	21.0 (19.6–22.4)	19.3 (17.7–21.0)	18.0 (16.9–19.0)	20.8 (19.8–21.9)	17.6 (15.5–19.7)
Education level						
Primary or below	22.0 (21.1–23.0)	22.4 (21.4–23.5)	20.6 (19.3–21.8)	18.9 (17.9–19.9)	21.9 (21.0–22.7)	17.6 (16.5–18.7)
Secondary or matriculation	22.3 (21.8–22.8)	21.5 (20.9–22.2)	20.9 (20.2–21.7)	18.2 (17.5–18.9)	20.3 (19.9–20.8)	18.7 (18.4–18.9)
Tertiary or above	21.7 (20.8–22.6)	20.9 (19.9–21.9)	20.3 (18.8–21.8)	18.7 (17.5–19.9)	19.9 (19.2–20.6)	17.8 (17.4–18.2)

NOTE. Mean values are weighted by sex, age, and education level. STAI score ranges from 10 to 40.

Second, social marketing should be focused on certain subgroups that were consistently less likely to adopt precautionary measures. There is a growing body of literature that examines variations in risk attitudes across the sociodemographic spectrum [20] from which infectious disease control research should draw. Although these variables are generally immutable (at least in the short term during an epidemic), a deeper understanding of the root causes of such differential risk perception and behavior can help inform the development of dissemination strategies directed at different subgroups. It is important to identify effective strategies that can be used to induce self-protective behaviors in groups such as young male subjects, so that these strategies can be utilized when required (e.g., during epidemics) and thereby increase the effectiveness of health protection programs.

Third, it is reassuring that, even in the face of a massive outbreak caused by an unknown agent, the Hong Kong public was able to resist seeking care indiscriminately; only symptomatic individuals and, to a lesser extent, those with a positive contact history presented to formal care. However, we note that, at the peak of the epidemic, irrational beliefs about the disease (e.g., mistakenly perceiving the probability of survival to be "not very likely" or "not likely at all" despite the overall survival ratio of 82.8% in the Hong Kong epidemic [19]) and excessive anxiety were also associated with higher health services use. However, it is also plausible that the public avoided health care facilities because of the risks of nosocomial spread, which accounted for 49.3% of all SARS cases [20].

The utility of such psychobehavioral surveillance data can be enhanced through quantitative risk and decision science analysis and integration with biomathematical modeling. More specifically, there is burgeoning interest in using a game-theoretical framework to analyze population behavior [21, 22]. Game theory attempts to predict individual and group behavior in situations in which the expected payoff of strategies used by individuals depends on the strategies adopted by others [23]. Integrating this with transmission dynamics modeling has the potential to yield new insights explaining population decision-making with respect to the adoption of self-protective measures, travel, and social behaviors that collectively determine population mixing, all of which have an impact on the effective reproductive number and, thus, on the course of an epidemic. For example, Bauch and Earn [22] have recently quantified how risk perception influences expected vaccine uptake and coverage levels and what role is played by the epidemiological characteristics of pathogens. This follows on previous work

Table 3. Predictors for greater adoption of precautionary measures during the outbreak of severe acute respiratory syndrome (SARS) in Hong Kong, China, 2003.

	Adjusted OR (95% CI), by survey							
Variable	Survey 1.0	Survey 1.1	Survey 1.1[a]	Survey 2.0	Survey 2.1	Survey 2.1[b]	Survey 3.0	Survey 4.0
Anxiety level (STAI score)[c]								
Low (10–19)	1	1	1	1	1	1	1	1
Medium (20–24)	2.92 (1.89–4.50)[d]	1.98 (1.14–3.47)[e]	2.63 (1.43–4.84)[f]	1.07 (0.57–2.03)	1.70 (0.84–3.45)	0.87 (0.42–1.81)	1.40 (0.94–2.09)	0.76 (0.56–1.03)
High (25–40)	1.86 (1.23–2.80)[f]	3.45 (1.71–6.95)[d]	2.95 (1.56–5.60)[d]	1.50 (0.69–3.26)	0.88 (0.23–3.35)	1.04 (0.43–2.51)	2.29 (1.29–4.04)[f]	1.48 (0.78–2.80)
Beliefs about SARS								
Likelihood of contracting SARS during the current outbreak								
Not very likely/not likely at all	1	1	1	1	1	1	1	1
Very likely/somewhat likely	1.31 (0.93–1.86)	1.28 (0.76–2.14)	1.10 (0.66–1.82)	1.25 (0.67–2.34)	1.31 (0.51–3.42)	1.42 (0.70–2.84)	1.66 (1.04–2.65)[e]	1.10 (0.78–1.57)
Likelihood of surviving SARS if infected								
Very likely/somewhat likely	1	1	1	1	1	1	1	1
Not very likely/not likely at all	1.38 (0.61–3.16)	1.81 (0.56–5.85)	2.61 (0.79–8.63)	1.04 (0.28–3.91)	1.16 (0.43–3.11)	1.09 (0.20–5.80)	0.95 (0.54–1.69)	1.06 (0.49–2.26)
Knowledge of routes of transmission								
Wrong answer	1	1	1	1	1	1	1	1
Correct answer	1.11 (0.72–1.70)	1.69 (1.01–2.83)[e]	0.94 (0.50–1.76)	2.23 (1.22–4.08)[f]	1.89 (0.97–3.66)	0.91 (0.46–1.8)	1.38 (0.95–2.01)	1.13 (0.81–1.57)
Sex								
Female	1	1	1	1	1	1	1	1
Male	0.43 (0.30–0.61)[d]	0.57 (0.34–0.95)[e]	0.60 (0.35–1.01)	0.39 (0.23–0.67)[d]	0.62 (0.33–1.15)	0.58 (0.31–1.10)	0.55 (0.38–0.79)[d]	0.51 (0.38–0.69)[d]
Age, years								
18–24	0.44 (0.26–0.76)[f]	0.33 (0.15–0.72)[f]	0.32 (0.15–0.69)[f]	0.75 (0.31–1.84)	0.41 (0.16–1.08)	0.37 (0.14–0.98)[e]	0.67 (0.38–1.17)	0.72 (0.54–0.96)[e]
25–34	0.66 (0.40–1.10)	1.22 (0.56–2.66)	1.27 (0.56–2.84)	0.52 (0.24–1.16)	0.57 (0.22–1.47)	0.46 (0.18–1.19)	0.79 (0.45–1.38)	1.08 (0.83–1.40)
35–44	1	1	1	1	1	1	1	1
45–54	1.06 (0.64–1.75)	1.36 (0.64–2.85)	1.34 (0.64–2.78)	1.08 (0.46–2.52)	2.09 (0.66–6.62)	1.87 (0.62–5.67)	0.89 (0.53–1.51)	1.02 (0.76–1.38)
55–64	0.83 (0.44–1.54)	1.91 (0.68–5.34)	1.73 (0.60–4.98)	1.84 (0.54–6.20)	0.67 (0.19–2.37)	0.78 (0.21–2.89)	0.49 (0.26–0.93)[e]	1.27 (0.77–2.08)
⩾65	0.84 (0.43–1.66)	1.24 (0.48–3.21)	1.23 (0.45–3.36)	0.84 (0.31–2.24)	0.8 (0.24–2.74)	0.72 (0.22–2.38)	1.38 (0.66–2.88)	0.65 (0.25–1.67)
Education level								
Primary or below	0.37 (0.23–0.60)[d]	0.36 (0.18–0.73)[f]	0.36 (0.18–0.74)[f]	0.43 (0.20–0.94)[e]	1.01 (0.37–2.71)	0.98 (0.38–2.52)	0.57 (0.35–0.94)[e]	1.56 (1.10–2.21)[e]
Secondary or matriculation	1	1	1	1	1	1	1	1
Tertiary or above	1.85 (1.22–2.79)[f]	3.65 (1.91–6.98)[d]	3.48 (1.82–6.65)[d]	1.24 (0.60–2.57)	2.11 (0.93–4.82)	2.17 (0.91–5.18)	1.52 (0.95–2.43)	1.02 (0.80–1.29)

NOTE. Greater adoption refers to adoption of ⩾5 (out of 7) precautionary measures.

[a] The greater adoption of precautionary measures in survey 1.1 was regressed on the predictors in survey 1.0

[b] The greater adoption of precautionary measures in survey 2.1 was regressed on the predictors in survey 2.0

[c] State-Trait Anxiety Inventory (STAI) score ranges from 10 to 40.

[d] $P < .001$. ORs were adjusted for all variables in the models.

[e] $P < .05$.

[f] $P < .01$.

evaluating different schemes to prepare for the potential reintroduction of smallpox (which has been eradicated globally through mass vaccination) [21].

Three potential limitations of our study should be mentioned. The first concerns the uncertain temporality of association between variables, and the second concerns the potential for ecologic fallacy (bias that may occur because an association that is observed on an aggregate level does not necessarily represent the association that exists at an individual level). With the exception of the regression results of surveys 1.1 and 2.1, the other analyses were cross-sectional in nature, and, therefore, reverse causality cannot be ruled out for the mutable variables, although the magnitude and direction of association determined on the basis of repeated cross-sectional surveys were generally similar to results obtained from the 2 surveys that used a prospective cohort design (i.e., surveys 1.1 and 2.1). Although our findings and the findings of other studies [1, 6–13] suggest strong temporal correlations between different stages of the epidemic, associated public policy interventions, and psychobehavioral indices, our ecologic-level inferences are by no means definitive and must be interpreted with caution regarding cause-and-effect relationships. Lastly, our findings, being from a single epicenter, may not be generalizable to populations in other regions of the world.

During an epidemic, 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 and the pathophysiology, clinical presentation, diagnosis, and treatment of the disease. Policy formulation and implementation of public health control measures, however, deserve equal attention, and such recommendations should be grounded in a thorough understanding of the public's perceptions, beliefs, attitudes, and general psychology. This present inquiry demonstrates that the promotion of protective health practices must take into account background perceptions of risk and anxiety levels in the community-at-large. The psychological responses of the population in this Chinese community are shown to be an important potential vector for the transmission of SARS.

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