We discuss crisis prevention and management during the first 3 months of the severe acute respiratory syndrome (SARS) outbreak in Singapore. Four public health issues were considered: prevention measures, self-health evaluation, SARS knowledge, and appraisal of crisis management. We conducted telephone interviews with a representative sample of 1,201 adults, ≥21 years of age. We found that sex, age, and attitude (anxiety and perception of open communication with authorities) were associated with practicing preventive measures. Analysis of Singapore’s outbreak improves our understanding of the social dimensions of infectious disease outbreaks.

An outbreak of severe acute respiratory syndrome (SARS) began in Guangdong, China, on November 16, 2002. The first three SARS cases in Singapore were confirmed on March 6, 2003. By May 5, a total of 204 cases, including 27 deaths, had been confirmed. The last case was isolated on May 11, and by July 30, the end of the outbreak, 205 patients had recovered and 33 had died (1).

Since SARS infection may come from ordinary contact with acquaintances, colleagues, or strangers, outbreaks can trigger anxiety and influence public perception of susceptibility, causing serious economic and social disruption. The need for health information and for crisis management by public health authorities is also high. We examine four areas of public reaction to the SARS outbreak in Singapore: preventive practices, perception of self-health, knowledge of SARS, and appraisal of SARS crisis management.

Materials and Methods

Sample

We interviewed a representative stratified random sample of 1,202 adults (≥21 years of age). To minimize personal contact during the outbreak, participants were interviewed by telephone instead of face-to-face. The residential telephone sampling covered 90% of households in Singapore. The response rate was 62.3%, and the sampling error ±3.5% (Table 1). We used Random Digit Dialing+1, a system commonly used in public health studies, to capture unlisted telephone numbers (3).

Data Collection

We modified and expanded a structured questionnaire provided by researchers from the Department of Community Medicine, University of Hong Kong (A.J. Hedley, T.H. Tan, G.M. Leung, B.H.Y. Chan, S.Y. Ho, L.M. Ho, unpub. data). The modified questionnaire (Appendix online at http://www.cdc.gov/ncidod/EID/vol10no2/03-0418_app.htm) was translated into Mandarin, Malay, and English; interviews were conducted from May 5 to May 10, 2003. Factor analysis and logistic regression (SPSS for Windows [Version 11.5]) examined trends among four factors (SARS prevention, perception of self-health, knowledge of SARS, and perception of health authorities’ crisis management). We also assessed how prevention measures correlated with other factors, including respondents’ demographic characteristics.

Preventive Measures

Eight questions focused on respondents’ prevention practices in the 3 days before the interview. We constructed a composite index indicating the total number (from 0 to 8) of preventive measures taken. A dichotomous indicator of preventive behavior was calculated based on the mean number of precautions taken (4.68): “low” (≤5) versus “high” (>6).

Self-Health Perception

Three sets of questions addressed respondents’ perception of their own health. The first set covered nine physical health complaints. We created a composite index of symptoms by adding all instances of health complaints over the previous 2 weeks. This index was 0 to 7 in our study since no one reported having more than seven of the nine symptoms.

The second set was a “frame of mind” index fashioned after B.A. Thyer’s Clinical Anxiety Scale (4). Scores for
Table 1. Demographic characteristics of study and total population

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Study population</th>
<th>Total population†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethnicity</td>
<td>No. (%) (1,201 total)</td>
<td>No. (%) (3,263,200 total)</td>
</tr>
<tr>
<td>Chinese</td>
<td>900 (75.0)</td>
<td>2,505,400 (76.8)</td>
</tr>
<tr>
<td>Malay</td>
<td>172 (14.0)</td>
<td>453,600 (13.9)</td>
</tr>
<tr>
<td>Indian</td>
<td>82 (7.0)</td>
<td>257,800 (7.9)</td>
</tr>
<tr>
<td>Other</td>
<td>47 (4.0)</td>
<td>46,400 (1.4)</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21–29a</td>
<td>233 (19.0)</td>
<td>480,191 (20.4)</td>
</tr>
<tr>
<td>30–39</td>
<td>313 (26.0)</td>
<td>613,944 (26.1)</td>
</tr>
<tr>
<td>40–49</td>
<td>312 (26.0)</td>
<td>575,674 (24.5)</td>
</tr>
<tr>
<td>50 and older</td>
<td>343 (28.0)</td>
<td>681,282 (29.0)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>599 (49.9)</td>
<td>1,630,293 (49.9)</td>
</tr>
<tr>
<td>Female</td>
<td>602 (50.1)</td>
<td>1,632,916 (50.1)</td>
</tr>
</tbody>
</table>

†Ref. 2., p. viii–ix.
†Total population figures refer to ages 20–29 years.

positive items were 1 (not at all) to 4 (very much); negative item scores were reversed, so lower total scores indicated higher anxiety. The scale had an Alpha reliability coefficient of 0.8244.

The third set addressed respondents’ perceived susceptibility to SARS. Scores were 4 (very likely) to 0 (don’t know). On the basis of the average score (1.5; standard deviation [SD] 1.01), we created a dichotomous variable to contrast respondents who believed they were susceptible to contracting SARS (scores 3 and 4) with those who did not (scores 0–2).

Knowledge of SARS

Three questions tested SARS knowledge. Responses were scored 0 (incorrect) or 1 (correct); a composite index indicated the number of correct answers, from none correct (0) to all three correct (3).

Appraisal of Crisis Management

Four sets of questions addressed respondents’ appraisal of crisis management, but we discuss the three most relevant. The first set of five questions (Alpha reliability 0.8136) assessed opinions on information distribution. Scores were 1 (very negative) to 6 (very positive). On the basis of the mean score (4.83; SD 0.617), we calculated a dichotomous index: negative appraisal (scores ≤4.7) versus positive appraisal (scores ≥4.8).

The second set of questions addressed openness of communication. Scores were 1 (very negative) to 6 (very positive). By using the sample’s mean score (4.31; SD 1.25), this variable was dichotomized into “disagreement” (scores 1–3) and “agreement” (scores 4–6).

The third set referred to the public’s acceptance of quarantine regulations. The scores were dichotomized into “agreement” (1) versus “no agreement” and “don’t know” (2).

Results

Responses to the survey questions are summarized in Table 2. Variables were examined by using odds ratios (ORs) at 95% confidence intervals (CI). The statistically significant ORs are reported in Table 3 with their respective level of significance from the Mantel-Haenszel common odds ratio estimates.

Recommended preventive measures were not practiced uniformly. The most practiced measures 3 days before the interview were using soap when washing hands (81%) and washing hands after sneezing, coughing, or clearing the nose (72%). The least practiced measure was wearing a mask over the mouth. A total of 4% wore masks, and most did so only when visiting a clinic or hospital or when the mask was part of a uniform (as in healthcare workers). The index of preventive measures indicates that most people (69.3%) took some preventive measures.

Respondents' perception of their health was generally positive. A relatively low proportion (22.4%) of respondents reported having any of our nine physical health complaints over the previous 2 weeks, and fewer than 1% reported the three classic symptoms of SARS (fever ≥38°C, cough, rapid breathing). The mean number of health complaints reported in our sample was 0.369 (SD 0.828). The survey also showed low anxiety; only 2.9% of respondents reported high anxiety. The mean anxiety score was 3.23 (SD 0.48). Most respondents (68%) thought they were not very likely or not likely at all to contract SARS, and 18% were not sure of their likelihood. Those who thought they were likely to get the disease reported slightly more anxiety. Of the three aspects of health perception, only anxiety was associated with taking precautions (OR 0.93; 95% CI 0.757–0.978). In the high-anxiety group, 34% followed six or more of the eight preventive measures, in contrast to 28% of respondents who had low anxiety.

Regarding knowledge of SARS, the sample correctly answered an average of 1.722 (SD 0.922) of 3 questions on SARS transmission. Approximately 63% answered two or more questions correctly; 11.7% did not answer any questions correctly.

Respondents had a generally high opinion of authorities’ crisis management. More than 80% thought official information was accurate, clear, sufficient, timely, and trustworthy, and 72% were prepared to accept a 10-day quarantine, even in the absence of SARS symptoms or close contact with a SARS patient. Of the three crisis management aspects, one had significant influence on preventive action: respondents’ opinion of authorities’ openness to communication. People who thought that authorities were open to communication were more inclined to practice six or more of the eight SARS preventive measures (OR 0.909; 95% CI 0.855 to 0.966) than those who thought they had no chance to express their
Three demographic characteristics were associated with taking preventive measures against SARS: sex, age, and estimated years of formal education. Women were more inclined (OR 0.770; 95% CI 0.689 to 0.861) than men (OR 1.339; 95% CI 1.166 to 1.539) to take preventive measures; this finding is consistent with other studies on health behavior in Singapore (5,6). People >35 years of age were more inclined to take preventive measures (OR 1.365; 95% CI 1.123 to 1.658). The association with education disappeared when controlled for sex.

**Discussion**

Information regarding the SARS outbreak was widely distributed by the media and government; while this information was essential to keep the public informed of the
risks for infection and preventive measures, it also could increase anxiety. However, we found low levels of anxiety in Singapore, and few reported health complaints. Reporting health complaints was not associated with taking precautions against SARS, possibly because the nine symptoms of SARS covered in our questionnaire are associated with other common diseases in Singapore (e.g., dengue fever, the incidence of which was 86.2 per 100,000 in May 2003) and are not usually deemed serious. In fact, familiarity with symptoms was a key initial obstacle in preventing SARS spread in hospitals (7) and remains an impediment to raising community alertness.

In our sample, anxiety appeared to motivate preventive behavior; those in the highest anxiety group took more precautions. However, anxiety was not associated with the perceived likelihood of contracting SARS. The low percentage of respondents who viewed SARS as a personal risk (14%, compared to 22% found in a similar survey in Toronto [8]) could be explained by the fact that healthcare workers were among the first SARS patients. By the time the interviews began, two physicians had died, and two hospitals had clusters of cases. Lay respondents (those with no contact with hospitals or healthcare workers) may have perceived SARS an occupational hazard.

Distribution of SARS information and prevention advice in Singapore increased rapidly over the 2 months preceding the interviews. All types of media were used, including a public television channel, the “SARS Channel,” established to give current and comprehensive information on world infection trends and Singapore’s situation. The Ministry of Health provided SARS information on its Web site (9), taking advantage of the fact that, as of December 2001, Singapore had 1.9 million Internet subscribers (out of 3.3 million population) (10). Of respondents, 20.7% were able to correctly answer all three SARS questions, and these did not differ in the practice of preventive measures from those who had less SARS knowledge. The absence of a correlation between knowledge and behavior confirms that knowledge of a disease is not sufficient to trigger preventive action (5,6,11–13).

Table 3. Practice of SARS preventive measures, 3 days before interviews

<table>
<thead>
<tr>
<th>Variable</th>
<th>No.</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal health evaluation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symptoms in past 2 weeks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>932</td>
<td>1.012</td>
<td>0.947 to 1.082</td>
</tr>
<tr>
<td>One or more</td>
<td>269</td>
<td>0.960</td>
<td>0.766 to 1.203</td>
</tr>
<tr>
<td>Anxietyb</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate or high (score ≤3.25)</td>
<td>544</td>
<td>0.861</td>
<td>0.757 to 0.978</td>
</tr>
<tr>
<td>Low anxiety (score &gt;3.25)</td>
<td>657</td>
<td>1.140</td>
<td>1.031 to 1.283</td>
</tr>
<tr>
<td>Perceived likelihood of SARS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not likely</td>
<td>1,034</td>
<td>1.031</td>
<td>0.979 to 1.085</td>
</tr>
<tr>
<td>Likely</td>
<td>167</td>
<td>0.833</td>
<td>0.621 to 1.118</td>
</tr>
<tr>
<td>Knowledge of SARS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two or fewer correct answers</td>
<td>952</td>
<td>1.012</td>
<td>0.950 to 1.079</td>
</tr>
<tr>
<td>Three correct answers</td>
<td>249</td>
<td>0.954</td>
<td>0.753 to 1.079</td>
</tr>
<tr>
<td>Appraisal of crisis management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality of official information</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below average (negative)</td>
<td>290</td>
<td>1.164</td>
<td>0.928 to 1.460</td>
</tr>
<tr>
<td>Above average (positive)</td>
<td>911</td>
<td>0.955</td>
<td>0.893 to 1.020</td>
</tr>
<tr>
<td>Have chance to express opinionb</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>271</td>
<td>1.434</td>
<td>1.115 to 1.846</td>
</tr>
<tr>
<td>Agree</td>
<td>930</td>
<td>0.909</td>
<td>0.855 to 0.966</td>
</tr>
<tr>
<td>Agreeable to quarantine when non-close contact with SARS-infected person and no symptoms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>860</td>
<td>0.969</td>
<td>0.899 to 1.045</td>
</tr>
<tr>
<td>Do not agree or don’t know</td>
<td>341</td>
<td>1.084</td>
<td>0.888 to 1.323</td>
</tr>
<tr>
<td>Demographic characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Years of formal educationd</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;10</td>
<td>686</td>
<td>0.909</td>
<td>0.821 to 1.006</td>
</tr>
<tr>
<td>&gt;10</td>
<td>515</td>
<td>1.143</td>
<td>0.985 to 1.325</td>
</tr>
<tr>
<td>Sexc</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>599</td>
<td>1.339</td>
<td>1.166 to 1.539</td>
</tr>
<tr>
<td>Female</td>
<td>602</td>
<td>0.770</td>
<td>0.689 to 0.861</td>
</tr>
<tr>
<td>Agec (y)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;35</td>
<td>391</td>
<td>1.365</td>
<td>1.123 to 1.658</td>
</tr>
<tr>
<td>≥35</td>
<td>809</td>
<td>0.872</td>
<td>0.806 to 0.943</td>
</tr>
</tbody>
</table>

aSARS, severe acute respiratory syndrome; OR, odds ratio; CI, 95% confidence interval.
bAsymptotic significance (2-sided) ≤0.05.
cAsymptotic significance (2-sided) ≤0.001.
dAsymptotic significance (2-sided) ≤0.10.
Since SARS appeared unexpectedly, healthcare experts were uncertain how to control the epidemic. Consequently, assessing public opinion of authorities’ crisis management in our survey was relevant to Singapore. Of the aspects we examined, only public opinion of authorities’ openness to communication was correlated with taking preventive measures. The other two aspects (information dissemination and acceptance of quarantine regulations) did not affect preventive action, probably because of their very positive rating.

The public’s highly positive assessment of Singapore authorities’ crisis management is distinctive. History shows that epidemics are politically perilous to governments as, among other things, they challenge their resolve, efficiency, and state of readiness (14). Political leaders of other SARS-affected Asian countries witnessed this principle directly. The SARS outbreak in Singapore appears to have worked in an opposite way: it corroborated the usefulness of public health and environmental regulations. In addition, this study’s findings parallel the population’s response to quarantine and other restrictive measures, confirming previous observations of a relatively high level of social discipline in the population (15,16).

Conclusion
Singapore was taken out of the official list of SARS-infected countries by the World Health Organization on May 30, 2003. The epidemic has left the crisis phase and entered a new phase, normalization and vigilance. As a new disease, SARS demands continuous scrutiny on all fronts, from the laboratory to the homes of the people.

Acknowledgments
We express our appreciation to the persons who consented to be interviewed for this study; John Wong, Director of the National University of Singapore–Office of Life Sciences, who facilitated the grant application; Calvin Fones, David Koh, and Paulin Straughan for their comments and suggestions on the questionnaire; two anonymous reviewers for their constructive feedback; and A.J. Hedley for sending us the questionnaire his research team applied in Hong Kong (April 2003) and suggesting that we apply it in Singapore.

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References

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Appendix (Online Only)

Questionnaire given to SARS survey respondents

Preventive measures

1. “Did you cover your mouth with a paper tissue or handkerchief when sneezing or coughing?”
   Responses (a) Always

2. “Did you cover your mouth with your bare hand when sneezing or coughing?”
   Responses (b) Most of the time

3. “Did you wash your hands after sneezing, coughing, or cleaning your nose in the past three days?”
   Responses (c) Sometimes

4. “Did you use soap or liquid hand-wash when washing your hands in the past three days?”
   Responses (d) Not at all

5. “Did you wear a mask over your mouth in the past three days?”

6. “Did you use serving utensils (chopsticks or spoons) for shared food when joining others over the past three days?”

7. “In the past three days, when touching objects that might possibly carry the SARS virus [e.g., door handles, buttons in the lifts], did you take preventive measures (e.g., pressing lift buttons with tissue paper)?”

8. “In the past three days, after touching objects that might possibly carry the SARS virus [e.g., door handles, buttons in the lifts], did you wash your hands as soon as possible?”

Personal health evaluation

Physical health complaints

“In the past 2 weeks, have you had any of the following symptoms?”

1. Persistent high fever of 38°C (100.4°F) or higher, lasting for a day or more
   Responses (a) Yes

2. Feeling cold

3. Headache

4. Having aches all over the body

5. Cough

6. Rapid breathing

7. Dizziness

8. Running nose

9. Sore throat
   Responses (a) Very much

Frame of mind
1. “Thinking of the way you feel these days, would you say you feel at ease?” (b) Quite
2. “Thinking of the way you feel these days, would you say you feel contented?” (c) Just a little
3. “Thinking of the way you feel these days, would you say you feel comfortable?” (d) Not at all
4. “Thinking of the way you feel these days, would you say you feel relaxed?”
5. “Thinking of the way you feel these days, would you say you feel happy?”
6. “Thinking of the way you feel these days, would you say you feel frightened?”
7. “Thinking of the way you feel these days, would you say you feel nervous?”
8. “Thinking of the way you feel these days, would you say you feel anxious?”
9. “Thinking of the way you feel these days, would you say you feel indecisive?”
10. “Thinking of the way you feel these days, would you say you feel confused?”

Perceived susceptibility to SARS
“How likely do you think it is for you to contract SARS?”
(a) Very likely
(b) Likely
(c) Not very likely
(d) Not likely at all
(e) Don’t know

Knowledge of SARS
1. “In your opinion, is SARS transmitted through saliva droplet transmission?” (a) Yes
2. “In your opinion, is SARS transmitted through airborne transmission?” (b) No
3. “In your opinion, is SARS transmitted through hand-contact transmission?” (c) Don’t know

Appraisal of Crisis Management
Official Crisis Information
1. “With regards to the distribution of information by the health authorities to the public in Singapore, do you agree or disagree that it has generally been accurate?” (b) Disagree
2. “With regards to the distribution of information by the health authorities to the public in Singapore, do you agree or disagree that it has generally been clear?” (c) Not sure, but probably disagree
3. “With regards to the distribution of information by the health authorities to the public in Singapore, do you agree or disagree that it has generally been sufficient?” (d) Not sure, but probably agree
4. “With regards to the distribution of information by the health authorities to the public in Singapore, do you agree or disagree that it has generally been timely?” (e) Agree
(f) Strongly agree
5. “With regards to the distribution of information by the health authorities to the public in Singapore, do you agree or disagree that it has generally been trustworthy?”

**Openness of Communication**

“Do you agree or disagree that you have had the chance to express your personal views and concerns to the authorities if you wanted to?”

(a) Strongly disagree
(b) Disagree
(c) Not sure, but probably disagree
(d) Not sure, but probably agree
(e) Agree

**Acceptance of Regulations**

“If you did not develop symptoms of SARS after having nonclose contact with someone diagnosed with SARS, would you agree to be quarantined for 10 days?”

(a) Agree
(b) Don’t agree
(c) Don’t know