

Immediate and Sustained Psychological Impact of an Emerging Infectious Disease Outbreak on Health Care Workers

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Objective: To assess the immediate and sustained psychological health of health care workers who were at high risk of exposure during the severe acute respiratory syndrome (SARS) outbreak.

Methods: At the peak of the 2003 SARS outbreak, we assessed health care workers in 2 acute care Hong Kong general hospitals with the Perceived Stress Scale (PSS-10). One year later, we reassessed these health care workers with the PSS-10, the 21-Item Depression and Anxiety Scale (DASS-21), and the Impact of Events Scale-Revised (IES-R). We recruited high-risk health care workers who practised respiratory medicine and compared them with nonrespiratory medicine workers, who formed the low-risk health care worker control group.

Results: In 2003, high-risk health care workers had elevated stress levels (PSS-10 score = 17.0) that were not significantly different from levels in low-risk health care worker control subjects (PSS-10 score = 15.9). More high-risk health care workers reported fatigue, poor sleep, worry about health, and fear of social contact, despite their confidence in infection-control measures. By 2004, however, stress levels in the high-risk group were not only higher (PSS-10 score = 18.6) but also significantly higher than scores among low-risk health care worker control subjects (PSS-10 score = 14.8, $P < 0.05$). In 2004, the perceived stress levels in the high-risk group were associated with higher depression, anxiety, and posttraumatic stress scores ($P < 0.001$). Posttraumatic stress scores were a partial mediator of the relation between the high risk of exposure to SARS and higher perceived stress.

Conclusions: Health care workers who were at high risk of contracting SARS appear not only to have chronic stress but also higher levels of depression and anxiety. Front-line staff could benefit from stress management as part of preparation for future outbreaks.

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Clinical Implications

- One year after the outbreak, health care workers who were at high risk of contracting SARS had elevated levels of stress, depression, and anxiety.
- Mental health measures should be available to identify and limit psychological morbidity in this high-risk group.
- This information should guide preparedness planning for future infectious disease outbreaks.

Limitations

- Data were obtained by self-report because health care workers were in isolation wards during the first study assessment and because there were issues about stigmatization and legal compensation at the time of the second assessment.
- We could not formally evaluate the specific psychometric properties of our questionnaire on the psychological effects of SARS.
- Owing to the anonymous nature of the data collection, we could not pair individuals at the 2 time intervals.

Key Words: *severe acute respiratory syndrome, outbreak, health care workers, stress, Hong Kong*

Effective containment of infectious disease outbreaks has become a global health imperative.¹ Cocirculation of animal and human viruses may allow the exchange of genetic material and create a new virus with potential to trigger a serious pandemic.^{2,3} The 1918 Spanish influenza virus killed over 20 million individuals and could recur today with increased virulence.⁴ In April 2005, unlabelled samples of the H2N2 virus, responsible for more than 1 million deaths in 1957, were inadvertently couriered to 5000 laboratories in 19 countries and subsequently needed swift destruction.⁵ The experience of SARS, more cases of avian influenza in Asia and Europe, and the threat of person-to-person transmission of influenza A (H5N1),⁶ in combination with contemporary air travel, mean that the threat of another pandemic is serious.⁷ In such an event, health care workers will no doubt be affected and possibly infected as they care for their patients. Health care workers comprised almost 50% of SARS cases in 2003, making the SARS outbreak a rehearsal for the next great influenza pandemic.⁸ “History tells us that protection against a viral pandemic will always depend on the availability of a local cadre of skilled public-health workers.”^{9, p 1372}

The courage of health care workers during the 2003 SARS outbreak did not make them immune to anxiety or stress, despite the fact that, at the time of the outbreak, the stress levels of high-risk workers did not appear to differ from those of the community.¹⁰ However, possible longer-term, residual psychological impacts and morbidity have not been previously evaluated. We therefore undertook the first study to investigate the sustained psychological impact of the outbreak on health care workers in 2 acute care general hospitals. We sought to examine changes in perceived stress among high-risk health care workers over time, from the height of the outbreak in 2003 to 1 year after. In 2004, we extended our study to more formally characterize the psychological health of health care workers. We sought to determine whether posttraumatic stress associated with risk of exposure to SARS among high-risk health care workers contributed to their

perceived stress levels in 2004. Such information could help alleviate or prevent future psychiatric morbidity in health care workers and could contribute to an overall strategy of advanced preparedness for future pandemics.

Methods

During the peak period of hospital admissions for SARS (mid-April to mid-May 2003), we distributed questionnaires containing the PSS-10¹¹ to health care workers (that is, doctors, nurses, and health care assistants) in 2 acute care general hospitals in Hong Kong. Health care workers from respiratory medicine departments were considered high-risk because they were front-line workers for patients with novel infectious respiratory diseases. Health care workers who did not work in respiratory medicine departments were recruited as low-risk health care worker control subjects. The questionnaires were self-administered and brief because research personnel could not interview high-risk participants who were in isolation wards along with all other suspected SARS patients. To facilitate systematic recording of psychological responses, study subjects could select any of 40 possible psychological responses (16 positive and 24 negative) and rate their confidence in infection-control measures. This portion of the instrument was deemed to have face validity by an expert panel of 5 psychiatrists and 5 physicians.¹⁰ Questionnaires were anonymous to guarantee confidentiality. The study was approved by the local institutional review board. Questionnaires from isolation wards were quarantined for 72 hours and scrutinized for contamination before data entry.

In 2004, 1 year after the outbreak, health care workers from the same clinical teams in the wards from the 2 hospitals were again invited to characterize their psychological state by completing the PSS-10, the DASS-21,¹² and the IES-R.¹³ Once again, all questionnaires were brief, self-administered, and anonymous.¹⁰ This feature of our study meant that, although the groups were made up of essentially the same individuals, we were unable to follow up change in individual participants from the first assessment to the second. This was unavoidable because we needed to ensure absolute anonymity in the face of stigma and ongoing compensation lawsuits.

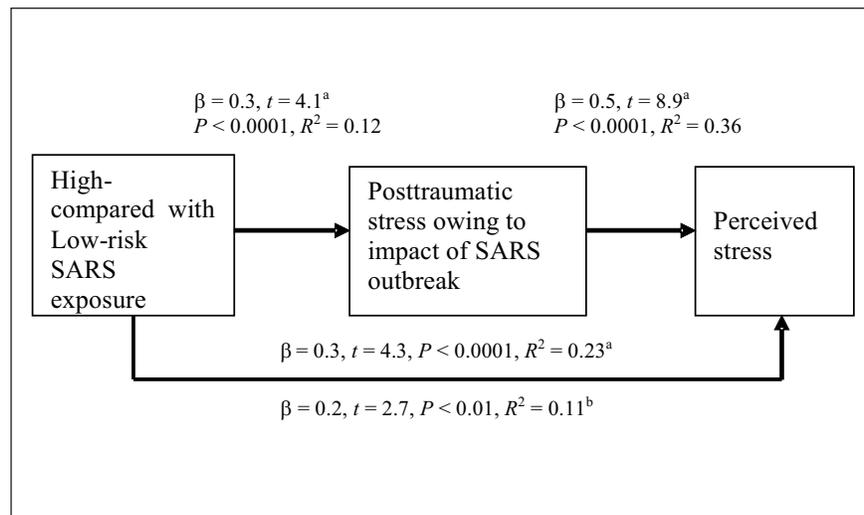
Statistical Analysis

Group comparisons of nominal variables were analyzed by chi-square test, ordinal variables by Mann–Whitney *U* tests, and interval variables by *t* tests. Bonferroni’s correction was made for multiple comparisons. We used 2-way ANOVA to compare groups on differences in perceived stress across time. We calculated Spearman’s rho for correlations with the PSS-10 score or for psychological responses. We conducted hierarchical multiple regression analyses based on Baron and Kenny’s criteria¹⁴ to test the mediation model (Figure 1), in which posttraumatic stress associated with risk of exposure to

Abbreviations used in this article

ANOVA	analysis of variance
DASS-21	21-item Depression Anxiety Stress Scales
IES-R	Impact of Events Scale-Revised
PSS-10	10-item Perceived Stress Scale
SARS	severe acute respiratory syndrome
SD	standard deviation

Figure 1 Mediation model of risk of exposure, posttraumatic stress owing to the impact of SARS outbreak, and perceived stress



^aRegression analysis with age and education level as covariates

^bRegression analysis with the impact of SARS outbreak, age, and education level as covariates

There was a significant effect of mediation by the impact of SARS outbreak;

Sobel test ($z = 3.6, P < 0.0001$)

SARS was hypothesized to mediate the effect of perceived stress levels in 2004. According to Baron and Kenny's¹⁴ criteria for testing the mediation effect, mediation is evidenced when a predictor is significantly related to the mediator, when the mediator is significantly related to the dependent variable, and when the relation between the predictor and the dependent variable is significantly reduced when the mediator is included in the analysis. In the present study, we tested a mediation model (Figure 1) in which difference in perceived stress between the high- and low-risk health care workers was mediated by the IES-R¹³ scores measuring posttraumatic stress owing to the impact of the SARS outbreak. As the predictor variable, we entered risk group (high-risk, compared with low-risk, health care workers); as the dependent variable, we entered the perceived stress as measured by PSS-10.

Results

Subjects

In 2003, we discarded incomplete or unclear questionnaires, leaving 210 (79%) of a total 266 valid. We also excluded 30 health care workers who had a suspected or confirmed diagnosis of SARS and 4 who had a history of psychiatric illness, leaving 176 health care workers. The final sample included 106 high-risk health care workers (who worked in SARS isolation units) and 70 low-risk health care workers (who worked in psychiatric inpatient units). We matched groups on age, sex, and education level (see Table 1).

In 2004, we again invited health care workers to participate. As was the case with the first survey, we excluded incomplete or unclear questionnaires, which left 184 of a total of 280 (66%) valid questionnaires. This follow-up sample comprised 71 high-risk health care workers and 113 low-risk health care workers. The 2 groups were matched on sex and education level but differed significantly in age ($\chi^2 = 9.80, P < 0.05$); therefore, we controlled for age in the group comparisons of the 2004 data (see Table 1). As Table 1 shows, in 2003 and 2004, the groups were unevenly distributed in terms of age ($\chi^2 = 73.70, P < 0.001$) and education level ($\chi^2 = 15.87, P < 0.05$) but not in terms of sex ($\chi^2 = 4.21, P$ not significant). Hence, when we compared high-risk and low-risk health care workers across the time point, we controlled for age and education level as possible confounding variables

General Stress Levels

In 2003, both high-risk and low-risk health care workers had equally high perceived stress levels as measured by the PSS-10 ($t_{164} = -1.36, P = 0.176$). Their mean PSS-10 scores (17.0, SD 5.66, for high-risk subjects and mean 15.9, SD 4.68, for low-risk subjects) were higher than the normative value of 13 in a US community sample (for reference, the community normative PSS-10 values for life events included unemployment = 16.5, separation = 16.6, and work disability = 19.9¹¹). For high-risk workers only, PSS-10 ratings were significantly correlated with age (Spearman's rho = -0.26, $P < 0.01$,

Table 1 Comparison of high- and low-risk health care workers in 2003 and 2004

Variable	2003		2004	
	High-risk (n = 106)	Low-risk (n = 70)	High-risk (n = 71)	Low-risk (n = 113)
	n (%)	n (%)	n (%)	n (%)
Age (years)				
30 to 40 ^a	60 (56.6)	31 (44.3)	29 (40.8)	35 (31.0)
41 to 50	39 (36.8)	31 (44.3)	13 (18.3)	42 (37.2)
Female sex	75 (70.8)	53 (75.7)	47 (66.2)	71 (62.8)
Education(at least secondary level) ^b	100 (94.4)	64 (91.4)	71 (100.0)	111 (98.2)

^a $P < 0.05$ for 2004 health care workers only
^b $P < 0.05$ for 2003 and 2004 health care workers

Table 2 Stress levels in 2003 and 2004

Instrument	2003		2004	
	High-risk	Low-risk	High-risk	Low-risk
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
PSS-10 total	17.0 (5.7)	15.9 (4.7)	18.6 (4.9)	14.8 (5.0)
DASS-21 total	—	—	16.4 (12.7)	8.3 (7.5)
DASS-21 Depression	—	—	4.9 (4.8)	2.2 (2.6)
DASS-21 Anxiety	—	—	4.9 (4.3)	2.1 (2.5)
DASS-21 Stress	—	—	7.2 (4.8)	4.1 (3.2)
IES-R total	—	—	17.2 (14.2)	9.3 (11.2)

Bonferroni-corrected); they did not interact with education level for either group.

Psychological Effects of SARS in 2003

In 2003, total negative psychological responses correlated with PSS-10 ratings in both high-risk (Spearman's $\rho = 0.5$, $P < 0.05$) and low-risk (Spearman's $\rho = 0.6$, $P < 0.05$) health care workers, but overall, both groups selected a significantly higher percentage of positive (35.8%) responses (such as "unity with others," "civic-mindedness," and "bravery"), compared with negative (14.6%) responses ($t_{174} = 12.5$, $P < 0.05$). However, high-risk health care workers selected a significantly higher percentage of negative responses (17.4%), compared with low-risk subjects (10.4%) ($t_{173} = -2.8$, $P < 0.005$). A higher percentage of high-risk health care workers reported fatigue (70.3%, compared with 22.1% of low-risk workers; $\chi^2 = 37.9$, $P < 0.05$), poor sleep (30.2%, compared with 7.4%; $\chi^2 = 12.7$, $P < 0.05$), worry about health (57.3%, compared with 41.2%; $\chi^2 = 4.1$, $P < 0.05$), and fear of social contact. (41.7%, compared with 23.5%; $\chi^2 = 5.8$, $P < 0.05$). In 2003, 84% of high-risk health care workers felt confident in

infection-control practices, compared with only 64% of low-risk health care workers ($\chi^2 = 8.2$, $P < 0.05$).

Difference in Stress Levels Between 2003 and 2004 (Table 2)

Counterintuitively, perceived stress remained the same from 2003 to 2004 for both high-risk health care workers ($F_{1,170} = 1.35$, P not significant) and their low-risk colleagues ($F_{1,164} = 2.84$, P not significant). However, further analysis with 2-way ANOVA showed that, although there was no significant time main effect for either group, a significant time \times risk level interaction effect was found. This indicated that the change in perceived stress from 2003 to 2004 was significantly different for the 2 groups ($F_{1,336} = 4.61$, $P < 0.05$), with a general trend toward a decrease over time for low-risk health care workers and an increase over time for high-risk health care workers.

High-Risk Health Care Workers Remained Highly Stressed After the Outbreak

In 2004, perceived stress levels were significantly higher among high-risk health care workers (mean score 18.56, SD 4.91) than among low-risk control subjects (mean score

14.81, SD 5.02) ($F_{1,175} = 18.33, P < 0.001$). Among high-risk health care workers, perceived stress was not associated with age or education level but was higher among men (mean score 20.39, SD 5.62) than women (mean score 17.63, SD 4.75) ($t_{67} = 2.25, P < 0.05$). In low-risk health care workers, perceived stress was not associated with sex or education level but was significantly correlated with age (Spearman's $\rho = -0.26, P < 0.01$, Bonferroni-corrected). Among both the high- and low-risk groups, there were no differences in perceived stress levels among doctors, nurses, and other health care workers.

In 2004, the stress response of the high-risk health care workers was characterized in more detail. This revealed substantially higher DASS-21 Depression subscale scores (mean 4.89, SD 4.75) and DASS-21 Anxiety subscale scores (mean 4.85, SD 4.25) for high-risk, compared with low-risk, health care workers (mean DASS-21 Depression subscale score 2.17, SD 2.57; mean DASS-21 Anxiety subscale score 2.07, SD 2.50) ($F_{1,178} = 21.31, P < 0.001$ for the Depression subscale; $F_{1,176} = 21.54, P < 0.001$ for the Anxiety subscale). Generally, PSS-10 scores were significantly and positively correlated with the DASS-21 Depression subscale (Spearman's $\rho = 0.67, P < 0.001$), the DASS-21 Anxiety subscale (Spearman's $\rho = 0.62, P < 0.001$), and the DASS-21 total scores (Spearman's $\rho = 0.72, P < 0.001$, all Bonferroni-corrected); thus, perceived stress was associated with higher levels of depression, anxiety, and general psychological distress.

Is Higher Stress Partly Mediated by Contact With SARS?

In an attempt to explain the persistently elevated stress levels in high-risk health care workers, we examined the possible contribution of contact with SARS. We tested a mediation model (see Figure 1) in which the difference in perceived stress between the high- and low-risk health care workers was mediated by the IES-R¹³ scores measuring posttraumatic stress owing to the impact of the SARS outbreak. We performed a series of hierarchical multiple regression analyses using Baron and Kenny's¹⁴ criteria. In each of the analyses, we entered age and education level into Block 1 as covariates. In the first regression analysis, IES-R scores were regressed onto risk group. Risk group was found to be a significant predictor of IES-R scores ($\beta = 0.31, t = 4.08, P < 0.001, R^2 = 0.116$). PSS-10 scores were then regressed onto IES-R scores. IES-R was found to be a significant predictor of perceived stress ($\beta = 0.54, t = 8.94, P < 0.001, R^2 = 0.361$). Finally, the effect of risk group on perceived stress was reduced when both risk group and IES-R were entered into the regression analyses (from $\beta = 0.31, t = 4.32, P < 0.0001$ when only risk group was entered into the regression equation to $\beta = 0.20, t = 2.67, P < 0.01$ when both risk group and IES-R scores were entered). The result of the Sobel test showed that the

mediation effect was significant ($z = 3.61, P < 0.001$). All 3 of Baron and Kenny's criteria were satisfied, indicating that posttraumatic stress owing to the impact of the SARS outbreak could account for the difference in perceived stress between high-risk and low-risk health care workers. However, since risk group was still a significant predictor of perceived stress even after the IES-R scores were entered into the final regression, posttraumatic stress owing to the impact of the SARS outbreak was only a partial mediator; the difference in perceived stress between high-risk and low-risk health care workers could have been influenced by other factors that were not included in the present study.

Discussion

This is the first study to report that, despite similar perceived stress levels between high-risk and low-risk health care workers in 2003, high-risk health care workers remained highly stressed 1 year later. There was a significant relation between the latter and higher DASS-21 Depression scores, DASS-21 Anxiety scores, and IES-R score for posttraumatic stress associated with risk of exposure to SARS.

The SARS outbreak in 2003 imposed particular constraints on this type of research. Subjects worked in isolation wards; thus, the questionnaire had to be brief, self-administered, and anonymous.¹⁰ This design encouraged participation and minimized stigma.¹⁶ We did not formally evaluate the psychometric properties of psychological responses to the outbreak¹⁰ because it was soon contained by mass quarantine. Health care workers reported more positive than negative responses to the outbreak, but we do not believe that this is likely to be a result of questionnaire artifact. Although, compared with low-risk control subjects, significantly more high-risk health care workers reported fatigue, sleep deprivation, worry about health, and fear of social contact, they expressed more confidence in infection-control practices. We believe this was instrumental in their coping with a novel pathogen because, during the outbreak, high- and low-risk health care workers had equivalent stress levels that were also comparable to those of the local community.¹⁰

One year later, the persistence of elevated stress levels for high-risk health care workers was unexpected. One explanation is that the health care workers sampled in 2003 and 2004 were not exactly the same group. Although the anonymity of the questionnaire made this kind of sampling unavoidable, the rate of questionnaire return was fair and suggests considerable overlap between the groups sampled at each time point. There were some differences in education level and age, which we attempted to control for in our analysis. However we did not previously find any relation between education level and perceived stress among health care workers.¹⁰ We therefore

believe that the persistence of elevated stress levels among high-risk health care workers is real.

Compared with the low-risk health care workers, the elevated stress levels among high-risk health care workers in 2004 was consistent with a substantially higher DASS-21 Anxiety score, DASS-21 Depression score, and IES-R posttraumatic contact with SARS score. Our study included a control health care worker group, making it unlikely that the elevated stress was attributable to the caregiver role.¹⁷ Alternative explanations for this pattern of results include health care workers' ongoing adverse experiences during SARS, both locally¹⁸ and in Toronto, Ontario.¹⁹ Our study suggests that the experience of working in proximity with SARS did confer a persistent detrimental effect, as posttraumatic stress associated with high risk of exposure to SARS was found to be at least partially responsible for the persistence of elevated stress levels in 2004. We noted that high- and low-risk health care workers had similar stress levels in 2003 but that, 1 year later, the stress levels of high-risk health care workers significantly exceeded those of their low-risk counterparts. One possible explanation is that high-risk health care workers might have displayed "denial" during the outbreak, causing their psychological distress to be minimized during that time. This is plausible, given their high rate of confidence in infection-control practices, compared with that of their low-risk colleagues. Although it is true that they received more training in infection control, their confidence was arguably disproportionate to the real threat that they were facing, to the efficiency with which SARS is transmitted, and to the large number of health care workers infected while caring for SARS patients. In other words, confidence in infection control possibly diminished the collective sense of threat and thus conferred a protective function and minimized stress levels. A year after the outbreak, stress levels decreased in low-risk health care workers but increased in high-risk health care workers. This decompensation in high-risk health care workers could be a rebound effect as the imminent threat ended and denial was lessened. This is also possibly the result of a sense of frustration arising from the high-risk group's not having received particular recognition for their contribution, or it could even be the result of anticipating new outbreaks to combat after SARS.

Whatever the reason for the reported high stress levels among high-risk health care workers in 2004, our findings are a cause for concern. Chronic stress may erode immunologic mediators,¹⁷ increase risk of influenza and cytokine production,²⁰ and decrease antibodies.²¹ We do not know to what extent such physical ramifications affected our health care workers. Stress can also impair cognitive functioning and task performance.²² Whether the chronic stress endured by front-line health care workers might impair their effectiveness in a future pandemic is of concern. It is speculated that such

individuals could benefit from routine psychological training, scheduled rest periods, flexible staffing resources, and even pandemic rehearsal.

Conclusion

Our data suggest that stress persists 1 year after an epidemic is over. This indicates that stress management for front-line health care workers is integral to a protocol for outbreak preparedness. This would enhance infection-control measures and patient care in the face of a future pandemic.

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Résumé : L'effet psychologique immédiat et prolongé du début d'épidémie d'une maladie infectieuse sur les travailleurs de la santé

Objectif : Évaluer la santé psychologique immédiate et prolongée des travailleurs de la santé qui étaient à haut risque d'exposition durant l'épidémie du syndrome respiratoire aigu sévère (SRAS).

Méthodes : Au plus fort de l'épidémie du SRAS en 2003, nous avons évalué les travailleurs de la santé de 2 hôpitaux généraux de soins actifs de Hong Kong, à l'aide de l'échelle de stress perçu en 10 items (PSS-10). Un an plus tard, nous avons réévalué ces travailleurs avec la PSS-10, l'échelle de dépression et d'anxiété en 21 items (DASS-21) et l'échelle des répercussions d'événements révisée (IES-R). Nous avons recruté des travailleurs de la santé à risque élevé qui pratiquaient la médecine respiratoire et nous les avons comparés avec des travailleurs de la médecine non respiratoire, qui formaient le groupe témoin de travailleurs de la santé à faible risque.

Résultats : En 2003, les travailleurs de la santé à risque élevé avaient des niveaux de stress élevés (score à la PSS-10 = 17,0), lesquels ne différaient pas significativement des niveaux du groupe témoin de travailleurs de la santé à faible risque (score à la PSS-10 = 15,9). Un plus grand nombre de travailleurs de la santé à risque élevé déclaraient de la fatigue, un mauvais sommeil, des inquiétudes pour leur santé, et la crainte des contacts sociaux, malgré leur confiance dans les mesures de contrôle de l'infection. En 2004, cependant, les niveaux de stress du groupe à risque élevé étaient non seulement plus hauts (score à la PSS-10 = 18,6) mais aussi significativement plus élevés que les scores du groupe témoin de travailleurs de la santé à faible risque (score à la PSS-10 = 14,8, $P < 0,05$). En 2004, les niveaux de stress perçu du groupe à risque élevé étaient associés avec des scores de stress plus élevés de dépression, d'anxiété et post-traumatique ($P < 0,001$). Les scores de stress post-traumatique étaient un médiateur partiel de la relation entre le risque élevé d'exposition au SRAS et un stress perçu élevé.

Conclusions : Les travailleurs de la santé qui étaient à risque élevé de contracter le SRAS semblent avoir non seulement un stress chronique mais aussi des niveaux élevés de dépression et d'anxiété. Les employés de première ligne pourraient bénéficier de gestion du stress dans le cadre de la préparation à d'autres épidémies.