Int J Public Health (2017) 62:1051–1058
DOI 10.1007/s00038-017-1036-8

ORIGINAL ARTICLE

Self-efficacy and barriers to disaster evacuation in Hong Kong

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Received: 7 June 2017 / Revised: 14 August 2017 / Accepted: 11 September 2017 / Published online: 20 September 2017

Abstract
Objectives To investigate specific challenges to Hong Kong's capacity for effective disaster response, we assessed perceived barriers to evacuation and citizens' self-efficacy.
Methods Global positioning system software was used to determine random sampling locations across Hong Kong, weighted by population density. The resulting sample of 1023 participants (46.5% female, mean age 40.74 years) were invited to complete questionnaires on emergency preparedness, barriers to evacuation and self-efficacy. Latent profile analysis and multinomial logistic regression were used to identify self-efficacy profiles and predictors of profile membership.
Results Only 11% of the sample reported feeling prepared to respond to a disaster. If asked to evacuate in an emergency, 41.9% of the sample cited significant issues that would preclude them from doing so. Self-efficacy was negatively associated with barriers to disaster response so that participants reporting higher levels of self-efficacy cited fewer perceived barriers to evacuation.
Conclusions Hong Kong has established effective strategies for emergency response, but concerns regarding evacuation and mobilisation remain. The findings indicate that improving self-efficacy for disaster response has potential to increase evacuation readiness.

Keywords Disaster preparedness · Self-efficacy · Decision-making · Evacuation · Natural disaster · Asia

Introduction

Climate change will bring significantly increased risk of disaster for the highly urbanized coastal cities of South East Asia (van der Keur et al. 2016). Hong Kong is among those facing the greatest threat (Swiss Re 2014). Although tropical cyclones, storm surge and floods are frequent occurrences in the region, emergencies are likely to become more complex as climate change interacts with Hong Kong's high population density, mass transport expansion and an ageing population. These predictions have led the Hong Kong government and local agencies to explore the community's capacity to respond to a major disaster.

The local community's capacity to respond is critical in the initial moments after a disaster strikes. The dependence on local response may last a few days in the case of most disasters and sometimes longer when access is limited by geography, distance, or inaction (Chan 2013). Individuals must be prepared to protect their families and homes, cope with significant food, water or energy

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restrictions, or evacuate (Abramson and Redlener 2013; Chan 2013). Evacuation decision-making is a complex interaction between the characteristics of warning information, risk perception and personal attributes of the recipient (Lindell and Perry 2012; Paton 2003). Accordingly, it is vital that public policy is informed by evidence on the psychological processes underpinning individual and household preparedness for disaster response (Dash and Gladwin 2007).

The social cognitive theory of disaster response suggests that self-efficacy is a central mechanism by which individuals are able to self-regulate behaviour during or following exposure to trauma (Benight and Bandura 2004). To adequately respond to an emergency, an individual must believe that their actions will create effective change. Self-efficacy, an individual's belief in their ability to exert control over events in their life (Bandura 1991), has been associated with superior disaster preparedness knowledge and behaviour, as well as post-disaster recovery in a range of populations (Benight et al. 2009; Demuth et al. 2016). In wild-fire risk areas in Oregon, residents with higher reported self-efficacy engaged in significantly more risk reduction behaviours than those with lower self-efficacy (Martin et al. 2009); and in Cambodia, residents with higher self-efficacy were more likely to have an emergency plan or evacuation kit in anticipation of climate change related catastrophes (Ung et al. 2015). Similarly, a qualitative study of adult Chinese-speaking migrants in the US suggested that self-efficacy played an important role in how effectively people sought help during a disaster (Yip et al. 2013). For coastal residents in hurricane-prone areas in the U.S., exposure to traumatic experiences during prior hurricanes was associated with lower levels of self-efficacy (Demuth et al. 2016). In turn, lower self-efficacy appeared to decrease early intentions to evacuate in future emergencies (Demuth et al. 2016); suggesting that negative experiences lowered individuals' capacity to respond effectively in future. Self-efficacy perceptions have also predicted psychological outcomes following disasters, after controlling for the effects of age, gender, income, education, threat of death and loss of resources (Benight et al. 2009).

There has been little examination of the role of self-efficacy perceptions in understanding how individuals decide to evacuate in high-density Asian cities. Thus, with the aim of improving urban disaster preparedness, the current study explored the relationship between self-efficacy and perceived barriers to evacuation readiness in Hong Kong. We hypothesised that Hong Kong residents with higher levels of self-efficacy would report fewer perceived barriers to evacuation.

Methods

Participants and study setting

The Hong Kong Disaster Preparedness Scoping Study was conducted in 2015 to determine citizens' perceived and actual preparedness across a range of potential emergencies (Lam et al. 2017). Global positioning system (GPS) software was employed to identify 1533 random locations across Hong Kong's 18 districts, weighted by population density. The number of GPS points surveyed in each district was designed to be proportional to the district population, guided by data from the Census and Statistics Department (Census and Statistics Department 2012). The 2011 Census indicated that the Hong Kong population was 7.07 million. The randomly generated GPS points included 300% oversampling to account for inaccessible locations. To avoid systematic bias in the sample by surveying all points in a district at a certain time period (i.e., surveying all points within the financial district during work hours would create a bias against office workers), GPS points within each district were randomly allocated to the available data collection time slots, varying by day and time over a 17 day period.

Research assistants worked in pairs and were deployed to each of the GPS location points. The research assistants were fluent in both Chinese and English, and were instructed to approach every passer-by, to minimize selection bias, and invite them to participate in the survey. At each location, two participants were invited to take part in the study. Participants chose to either complete the questionnaires on an electronic tablet, or have the research assistants read the questions aloud. Each location was accessed within a specified time limit. Research assistants would move on to the next location if no eligible participants had been recruited within 1 h, or only one participant in 2 h.

The participant sample comprised 1023 Hong Kong residents, assessed at 516 GPS locations. Of the 1032 residents invited to participate, nine people declined. All participants gave verbal informed consent prior to commencement of the questionnaire. Participants received a HK $50 (approximately US $6.45) supermarket token for their time. Research protocols received approval from the Institutional Review Boards of the Harvard T. H. Chan School of Public Health and The University of Hong Kong/Hospital Authority Hong Kong West Cluster.

Measures

The survey was available in both English and Cantonese, and collected via KoBoToolbox, an online software

platform designed for gathering data in real-time. All data were de-identified. Two Cantonese-speaking university personnel not directly involved in the study conducted translation and back-translation of the measures. Demographics, including age, gender, monthly income, and household composition were assessed at the beginning of the questionnaire.

Self-efficacy

Self-efficacy was assessed using the General Self-Efficacy Scale (GSES). The GSES consists of 10-items which measure self-reported general self-efficacy (Schwarzer and Jerusalem 1995). Items (e.g., I can usually handle whatever comes my way) are scored on a 4-point Likert scale, where individuals rate items as "not true at all (1)" to "exactly true (4)", with scores ranging from 10 to 40, and higher scores indicating higher self-efficacy (Schwarzer and Jerusalem 1995). Internal consistency in the current sample was high ($\alpha = 0.87$). The GSES has been translated into 32 languages including Chinese, and was found to have good internal reliability in Chinese samples ($\alpha = 0.92$) (Cheung and Sun 1999). Scores were correlated with general health, anxiety and depression among 74 Chinese adults in Hong Kong (Cheung and Sun 1999).

Evacuation response barriers

The survey collected information about which barriers would prevent them from evacuating in case of a disaster. Participants were asked to state whether one or more of the items applied to them. Evacuation items covered barriers to departure such as disability or mobility, fear of theft, and lack of options for an evacuation destination.

Data analysis

T tests, ANOVA and Chi-square analyses were used to study the relationship between self-efficacy and the demographic characteristics of the sample. There were no missing data on items of the General Self-Efficacy Scale (GSES).

This study aimed to identify groups of individuals who shared profiles of responses on the GSES, showing higher or lower levels of self-efficacy. Latent profile analysis (LPA) is a person-centred form of finite mixture modelling, used to identify unobserved latent variables, which represent sub-groups of individuals within cross-sectional data (Marsh et al. 2009; Muthén 2010). LPA estimates a model for the population from which sample data is taken, and an individual's probability of belonging to a certain group is estimated. The analysis classifies individuals into independent and uncorrelated latent classes, where the optimal number of classes is chosen based on a combination of fit statistics (Pastor et al. 2007). MPLUS 6 (Muthén 2010) was used to conduct the analysis.

Fit statistics included the Bayesian information criteria (BIC; Marsh et al. 2009) which measures the parsimony of the model, where a lower BIC indicates better model fit. Log-likelihood values were also calculated to determine better model fit (Pastor et al. 2007) while the Vuong–Luo–Mendell–Rubin likelihood ratio test (LMR-LRT) and the parametric bootstrapped likelihood-ratio test (BLRT) assessed the statistical significance of changes in models indicating fit via increasing number of classes (Marsh et al. 2009). Finally, posterior probabilities (probability of membership in the most likely class) and entropy (a measure of the quality of classification into classes) were examined in the model with the most reliable statistics.

Multinomial logistic regression was then conducted in MPLUS (Muthén 2010) to explore variables associated with group membership. Having at least one barrier (yes = 1, no = 0) in evacuation was used as an independent variable predicting group membership in the multinomial logistic regression. Since age and gender were associated with self-efficacy in this sample, they were also included as predictors in the regression model. Monthly income was not included as a predictor as it was significantly associated with both age and gender.

Results

The sample comprised 1023 participants, of which 46.5% were female and the mean age was 40.74 years (SD 16.61). Reported monthly income ranged from less than HK$2000 to more than HK$60,000. The mean number of people per household was 3.40. According to the latest census results, men were slightly over represented in the sample, and residents that lived alone were under-represented (Census and Statistics Department 2012).

General self-efficacy

Total self-efficacy scores measured by the GSES in this sample ranged from 10 to 30 (mean score = 25.18, SD = 5.30). The mean self-efficacy score for males (25.75) was significantly higher than females (24.52; $t = -3.72$, $p < 0.01$), and higher self-efficacy scores were negatively correlated with age ($r = -0.10$, $p < 0.01$). A one-way ANOVA showed that self-efficacy was significantly associated with monthly income (F (12) = 3.38, $p < 0.01$); while higher monthly income was associated with both younger age ($r = -0.19$, $p < 0.01$), and male gender (χ^2 (12) = 24.02, $p < 0.05$, phi = 0.18).

Evacuation barriers

One in ten respondents (11%) reported feeling prepared to respond to a disaster. In the event of a disaster, 85.2% of respondents rated receiving information on evacuation as very important. Identification of evacuation barriers varied across the sample; 58.1% of participants reported no barriers to evacuation, 21.6% did not know where to go in the event of an evacuation, 13.6% reported disability or mobility problems, 8% worried about theft, looting, or property damage, and 4.3% would not evacuate even if asked to. Higher monthly income decreased odds of identifying evacuation barriers [ExpB = 0.94 ($B = -0.06$, SE = 0.02), $p < 0.05$, 95% CI 0.90–0.99]; and there were no associations between evacuation barriers and age or gender. Evacuation barriers were negatively correlated with self-efficacy ($r = -0.111$, $p < 0.001$).

Self-efficacy profiles

Table 1 presents fit statistics for the Latent Profile Analysis model. The number of classes being tested stopped increasing when the LMR-LRT became non-significant. Beginning with a one-class model, successive models showed improved fit until the five-class solution was tested. The four-class solution (see Fig. 1) was chosen as the best fitting model based on the indices described in Table 1.

Figure 1 shows that the four profiles spanned the range of self-efficacy ratings. The majority of respondents were grouped in the med-high (40.7%) and med-low (41.3%) self-efficacy profiles, while 10.5% reported high self-efficacy and 7.6% were grouped in the lowest self-efficacy profile. Evacuation barriers, with the exception of disability and mobility issues, were reported with increasing frequency from the highest to lowest self-efficacy profiles (see Table 2). There were significant differences between self-efficacy groups for concerns about theft ($\chi^2 = 11.0$, $p < 0.05$) and evacuation destination ($\chi^2 = 10.8$, $p < 0.05$), but no significant differences for mobility issues ($\chi^2 = 0.17$, $p > 0.05$) and evacuation refusal ($\chi^2 = 4.25$, $p > 0.05$). Self-efficacy was significantly correlated with participants' reports of feeling prepared to respond in a disaster ($r = 0.120$, $p < 0.001$).

Variables associated with group membership

A multinomial regression analysis conducted in MPLUS explored the relationship between perceived evacuation barriers and their association with self-efficacy group membership. After accounting for age and gender, individuals in the lowest self-efficacy (SE) group [ExpB = 2.08, (logB = 0.73, SE = 0.36), 95% CI 4.22–1.03, $p = 0.044$] and med-low SE group [ExpB = 2.05, (logB = 0.72, SE = 0.26), 95% CI 3.42–1.23, $p = 0.006$], were more likely to identify barriers to evacuation than individuals in the Highest SE group. This finding suggests that perceiving barriers to evacuation was associated with lower self-efficacy.

Discussion

Perceived barriers to disaster evacuation were associated with lower levels of self-efficacy in a community survey of Hong Kong residents. Across four profiles of self-efficacy scores, those who reported a lower perception of their ability to engage in effective action identified greater concerns with evacuating. These findings augment previous investigations of self-efficacy and evacuation readiness (Demuth et al. 2016; Martin et al. 2009; Thompson et al. 2017; Ung et al. 2015; Yip et al. 2013), and extend the evidence base to include populations living in high-density urban settings in Asia. Individual self-efficacy will determine whether a person chooses to engage in a coping behaviour, how much effort they expend in this behaviour, and how long the effort will be sustained (Bandura 1977, 1991). People with low self-efficacy may choose not to engage in a coping behaviour, or give up quickly

Table 1 Latent profile analysis fit indices for the General Self-Efficacy Scale, Hong Kong 2015 ($N = 1023$)

Number of classes	1	2	3	4	5
Log-Likelihood value	−12010.62	−10813.49	−10505.55	−10411.55	−10320.64
Adj. BIC	24096.32	21743.37	21168.79	21022.09	20881.56
Entropy	–	0.84	0.83	0.82	0.84
Posterior probabilities	–	0.94, 0.95	0.93, 0.91, 0.92	0.85, 0.90, 0.90, 0.93	0.87, 0.89, 0.89, 0.88, 0.92
LMR-LRT	–	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p = 0.027$
BLRT	–	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$

Adj. BIC adjusted Bayesian Information Criteria, *LMR-LRT* Vuong–Luo–Mendell–Rubin likelihood ratio test, *BLRT* parametric bootstrapped likelihood-ratio test

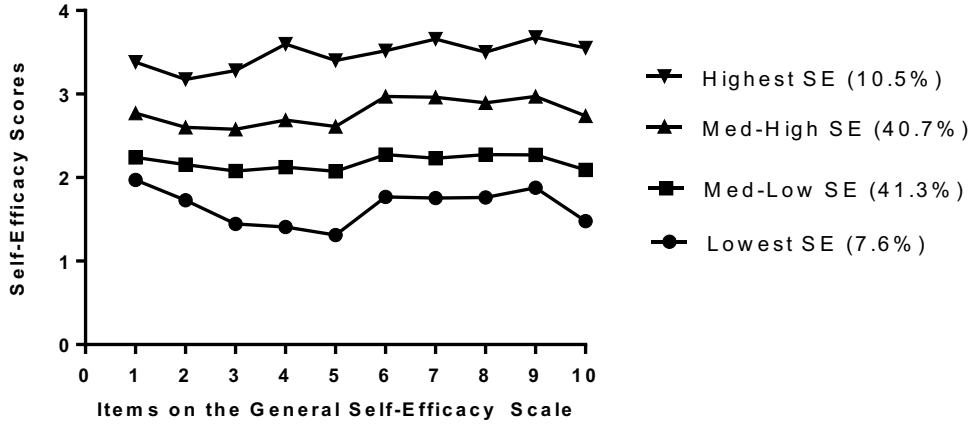

Fig. 1 Four latent profiles emerging from the 10-item General Self-Efficacy (SE) Scale assessed in the Hong Kong Disaster Preparedness Scoping Study, 2015

Table 2 Self-efficacy profile characteristics for the Hong Kong Disaster Preparedness Scoping Study, 2015

	Highest self-efficacy (n = 107, 10.5%)	Med-high self-efficacy (n = 416, 40.7%)	Med-low self-efficacy (n = 422, 41.3%)	Lowest self-efficacy (n = 78, 7.6%)
Age, mean (SD)	41.09 (15.21)	38.77 (15.99)	41.62 (17.26)	46.60 (16.99)
Gender (females), n (%)	47 (43.2%)	168 (40.4%)	213 (50.5%)	48 (61.5%)
Identified evacuation barriers	30 (28%)	155 (37.3%)	194 (46%)	36 (46.2%)
Disability or mobility as an evacuation barrier	14 (12.6%)	58 (13.5%)	59 (14%)	8 (13.3%)
Theft or looting as an evacuation barrier	2 (1.8%)	30 (7%)	42 (10%)	8 (13.3%)
Not knowing where to evacuate	15 (13.5%)	83 (19.3%)	110 (26.1%)	13 (21.7%)
Evacuation refusal	3 (2.7%)	21 (5%)	15 (3.5%)	5 (8.3%)

The identified evacuation barriers variable excluded those who stated "there are no barriers to evacuate"

SD standard deviation

because they do not believe they are capable of achieving their goal (Bandura 1977; Meilstrup et al. 2016). In this way, higher self-efficacy may drive people to prepare for disasters and make early decisions about evacuation response, because they believe that their efforts will result in effective action. Our findings lend support to the hypothesis that self-efficacy is an important indicator of individual decision making, and that perceptions of barriers to disaster response co-vary with self-belief.

Yet to some extent, these findings mask the complexity of mobilizing urban populations in the event of an emergency. Recent disasters have highlighted the hidden social, geographical and political challenges in large-scale evacuation. Hurricane Sandy in New York caused the death of 97 people (Abramson and Redlener 2013), many by drowning within buildings (Centers for Disease Control & Prevention 2013), displacement of thousands, and the evacuation of two hospitals under dangerous conditions (one hospital heeded early warnings and evacuated prior to the storm's arrival)(Powell et al. 2012). Similarly, extensive flooding during Hurricane Katrina killed 1100 people and forced the evacuation of thousands (Jonkman et al. 2009). Minority groups and the elderly were particularly vulnerable (Eisenman et al. 2007). Reflection on both events revealed that it was not a dearth of resources that hindered effective disaster response but instances where communication, coordination and fast decision-making (at both institutional and household levels) were lacking (Abramson and Redlener 2013; Eisenman et al. 2007).

Hong Kong is a highly populated harbour city, with few options for large-scale evacuation in the event of a major complex disaster. Most residents live in high-rise apartments, in close proximity, and those with mobility difficulties are dependent on elevators powered by the electrical grid to evacuate from their homes. While the public transport system is well developed, an emergency would stretch its capacity and damaged infrastructure would leave millions stranded. The city has one airport, which is accessible by only one bridge road and a railway, and there

is insufficient marine transport capacity to evacuate the population of more than 7 million people by sea within a short period of time. In a super typhoon or citywide flood, the only viable option for residents would be to travel by land across the border into mainland China. Individual barriers to evacuation and a low awareness of disaster risks make the planning and execution of large-scale evacuation more complex.

The current findings present three possible interpretations. First, participants may have reported a level of confidence in evacuation that reflected their prior experiences. Most Hong Kong residents would not have experienced a disaster that required evacuation from the city (although some may have been required to seek shelter away from home), and so those with higher self-efficacy may have reported confidence with the required actions for a minor emergency, that may not be applicable in a major disaster (Becker et al. 2017). In contrast, those reporting lower general self-efficacy may have more accurately identified the range of barriers that prevent effective evacuation and indicated their concern and uncertainty about vacating the city. Participants reporting lower self-efficacy were more likely to be female, older in age, and have lower monthly income, all factors previously associated with lower likelihood to evacuate (Thompson et al. 2017). Participants' concerns in responding to disaster included a lack of evacuation options, unclear pathways to safety and poor mobility or disability, which reflect a real threat in the case of elderly residents (Christensen et al. 2013), and people with disabilities or obesity (Powell et al. 2012).

Second, it may be the case that perceptions of personal self-efficacy do not translate to response behaviours. To date, only one study has prospectively assessed whether expectation to evacuate correlated with actual behaviour (Kang et al. 2007). In response to Hurricane Lili, expectations reported prior to the disaster converted to evacuation for 68% of participants (Kang et al. 2007), but whether psychological factors directly influenced evacuation behaviours has not been investigated. Well-established evidence suggests that reported self-efficacy predicts future actions and performance across a range of health behaviours (Maddux 2013). Less is known about its role in predicting disaster mobilisation (Thompson et al. 2017).

Third, people with higher self-efficacy may have recognized the complex barriers to evacuation and developed a plan to overcome them. Although evacuation decisions represent complex cognitive processes, growing evidence suggests that self-efficacy plays an important role in individual-level response (Benight et al. 2009). As personal decision-making in disasters becomes increasingly influenced by traditional media and social media (Dash and Gladwin 2007; Morss et al. 2016) an understanding of individual factors will reveal important avenues to urban preparedness.

Disasters occur quickly and often with little warning. It is critical that the majority of the city's populations are able to mobilise quickly, freeing up resources to cater to citizens who require additional assistance. Ongoing disaster preparedness training, community education and simulation drills have potential to increase individuals' awareness of appropriate action to take during an emergency and improve self-efficacy (Allen 2006; Ronan et al. 2015). Building capacity within the community may also serve to manage expectations about the extent of assistance likely to be received during hazards (UNISDR 2010). Community managed initiatives with repeated reinforcement have demonstrated important effects in increasing individuals' sense of control and improving safety behaviours in disaster contexts, including evacuation (Edirne et al. 2011; UNISDR 2010); and developing strong community networks serves to improve wellbeing in the aftermath of disaster (Gibbs et al. 2016). Conversely, a lack of preparedness for disasters can result in adverse impacts on the psychological wellbeing of individuals and communities (Ronan and Johnston 2006).

Limitations

There are several important study limitations to consider. First, the assessment was conducted as a self-report questionnaire, and thus respondents may have over-reported or under-reported their level of disaster preparedness and ability to evacuate due to social desirability, inexperience, or a lack of awareness. Second, despite efforts to recruit a representative sample of Hong Kong residents, there is a discrepancy between the study sample and Hong Kong's latest census data (Census and Statistics Department 2017). The study sample comprises a slightly higher proportion of males, and a younger population, who may be more likely to report intent to evacuate (Thompson et al. 2017). However, given the size of the sample, we believe that the findings give some indication of attitudes within the population and have important implications for community preparedness efforts and disaster management in Hong Kong.

Conclusions

Hong Kong has substantial experience in responding to emergencies. Mitigation of the SARS epidemic (2003), Lan Kwai Fong Stampede (1993) and the Lamma Ferry collision (2012) have resulted in the creation of targeted response agencies, state-of-the-art protocols, and new laws to protect the people of Hong Kong from physical, psychosocial, and financial harm (Leaning et al. 2015).

However, despite these improvements, the city's population may not be suitably prepared for a complex large-scale emergency (Chan et al. 2016; Lam et al. 2017). A realistic, clear and comprehensive strategy with inherent flexibility for evacuation (Powell et al. 2012) will need to be determined by the Hong Kong government in the coming years (Lam et al. 2017). Evacuation warnings are evolving and government agencies will need to engage in new methods for communicating risk to the population. Real-time disaster information is increasingly being accessed via social media, websites, and television (Steinberg et al. 2016), and thus multifaceted strategies to warn communities of the need to evacuate will be vital. Efforts to improve community mobilisation by providing clear information on disaster response protocols, evacuation strategies and routes, and establishing an information hub that is readily accessible by the population, may have potential to improve residents' safety and future disaster resilience.

Acknowledgements The study received funding from The Hong Kong Jockey Club Charities Trust, and the first author was supported by a National Health and Medical Research Council Early Career Fellowship and Curtin Research Fellowship. We wish to acknowledge the support of the Hong Kong Jockey Club Disaster Preparedness and Response Institute and the valuable contributions of Kai Hsaio, Kevin Hung, Derek Lam, May Yeung, Eva Lam, Celeste Tang, and our research assistants. We extend our heartfelt gratitude to the participants of the study.

Compliance with ethical standards

Conflict of interest The authors report no conflicts of interest.

Ethical approval The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. Ethical approval was received from the Harvard T. H. Chan School of Public Health Institutional Review Board and Hong Kong University Research Ethics Committee.

Informed consent Informed consent was obtained from all individual participants included in the study.

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