ORIGINAL RESEARCH

Assessment of the Health Impacts of the 2011 Summer Floods in Brisbane

Katarzyna Alderman, MPH, Lyle R. Turner, PhD, and Shilu Tong, PhD

ABSTRACT

Objective: To assess the effects of the 2011 floods in Brisbane, Australia, on residents' physical and mental health.

Methods: Residents who had been affected by the floods completed a community-based survey that examined the direct impact of flooding on households and their perceived physical and mental health. Outcome variables included overall and respiratory health and mental health outcomes related to psychological distress, sleep quality, and posttraumatic stress disorder (PTSD). Multivariable logistic regression was used to examine the association between flooding and perceived health outcome variables, adjusted for current health status and sociodemographic factors.

Results: Residents whose households were directly affected by flooding were more likely to report poor overall (Odds Ratio [OR] 5.3; 95% CI, 2.8-10.1) and respiratory (OR 2.3; 95% CI, 1.1-4.6) health, psychological distress (OR 1.9; 95% CI, 1.1-3.5), poor sleep quality (OR 2.3; 95% CI, 1.2-4.4), and probable PTSD (OR 2.3; 95% CI, 1.2-4.5).

Conclusions: The 2011 Brisbane floods had significant impact on the physical and psychosocial health of residents. Improved support strategies may need to be integrated into existing disaster management programs to reduce flood-related health impacts, particularly those related to mental health. (*Disaster Med Public Health Preparedness*. 2013;7:380-386)

Key Words: floods, disaster management, mental health, vulnerable populations, climate change

Floods have been the most common type of disaster globally, responsible for almost one-half of all victims of natural disasters and for economic losses of nearly US $185 billion during the past decade.[1] Flood events are expected to increase in frequency and intensity due to rising sea levels and more frequent and extreme precipitation events as climate change continues.[2] Increasing levels of urbanization may expose more people to flooding events,[3] increasing the global burden of disease, morbidity, mortality, and social and economic disruptions and placing pressure on health services.[4] These health impacts can depend on geographic and socioeconomic factors, as well as population vulnerability.[3,4] For instance, it has been observed in previous flooding disasters that direct trauma exposure,[5-12] female gender,[9,10] and older age[10,13-15] can increase the odds of negative health outcomes after floods. Effective policies to reduce and prevent flood-related morbidity and mortality are contingent on comprehensive impact assessments of the affected populations, and policies will be more effective if they are based on location-specific evidence.[3]

In December 2010 and January 2011, the Australian state of Queensland experienced its largest rainfall event since 1974. The resultant flooding claimed the lives of 35 people through drowning in the floodwaters, and caused damage to more than 29 000 homes and businesses; the estimated total economic losses were more than $5 billion.[16] The floods severely affected more than 78% of the state, and had an impact on more than 2.5 million people. In particular, the floods had a significant impact on South East Queensland, including the state capital of Brisbane.[17] The Brisbane river peaked at 4.46 m, which caused significant flooding throughout the city.

Given the devastation caused by these floods, and the climate projections of an increasing frequency of such events in the future, research of the health impacts of floods is needed to improve disaster management and response planning. We conducted a community-based survey from July to August 2011 to assess the effects of recent floods on both the physical and mental health of residents in Brisbane.

METHODS

Study Population

Residents of 12 electorates (Blair, Bonner, Brisbane, Griffith, Groom, Lilley, Moreton, Oxley, Petrie, Rankin,

Ryan, and Wright) identified as having been affected by the flooding were sampled. The names and addresses of individuals were obtained from the Australian Electoral Commission database for Queensland. A random representative sample of 3000 residents (18 years and older) from these electorates was drawn from the database. Because each electorate contained neighborhoods that were directly and indirectly (eg, neighbors suffered direct impact of the flood, surrounding roads were cut off) affected by the floods, individuals who did not feel directly affected were treated as a comparison group.

Data Collection

An invitation letter was sent to all selected residents 2 weeks before the survey was sent. The letter explained the purpose of the survey and what was involved in its participation. The main questionnaire, accompanied by a participant letter and prepaid reply envelope (survey package), was mailed to all potential participants (ie, those who did not decline participation or whose mail was not returned to sender) on July 22. A reminder postcard was mailed 1 week later to all participants who received the survey questionnaire but had not responded. Finally, 3 weeks after mailing the reminder, a replacement survey package was sent to all nonrespondents. Ethical approval for this study was obtained from the Human Research Ethics Committee of the Queensland University of Technology.

Exposure Measures

The impact of flooding on households was recorded by the general question, "Has your household been directly impacted by the 2011 floods?" *Direct impact* was defined as the house or apartment where the resident lived (including any of the following: living area, outside property, and/or vehicles) has been affected by the flood waters. Specific questions were also asked regarding the extent of impact, including damage to outside property, living space, removal of parts of household, damage to vehicles, and friends or relative moving in for at least 48 hours as a result of the floods.

Outcome Measures

Standard epidemiologic instruments for assessing mental health were employed. The Kessler 6 scale[18] and the posttraumatic stress disorder-civilian checklist (PCL-C)[19] have been validated and applied in numerous studies conducted in Australia. The Groninger Sleep Quality Scale (GSQS) has been used to assess patients suffering from seasonal depression disorder, shift workers in population-based studies in Finland,[20] and survivors of a firework disaster in the Netherlands.[21] Psychosocial impact was measured through psychological distress (short version of Kessler 10, Kessler 6, scored 8 or above), probable posttraumatic stress disorder (PTSD) (PCL-C scale, scored 44 or above), and sleep quality (GSQS 10-item version, scored 3 or higher on selected postflood items). In addition, both general health and respiratory health were assessed with pre- and postquestions designed by the researchers. Perceived general and respiratory health was assessed with a 5-point Likert scale to the following question: "Compared to before the recent floods, how would you rate your overall health/breathing now?"

Covariates

Sociodemographic variables that have been reported previously to mediate the relationship between flood exposure and psychosocial health outcomes were also measured. These included age and gender,[9,10] socioeconomic status (measured through education and employment),[6,7,22] and existing medical problems.[5,8] The last was assessed with a binary response (Yes/No) to the following question: "Do you suffer from any of the following conditions: cardiovascular disease, high blood pressure, diabetes, alcoholism, chronic kidney disease, liver disease, neurological disease, respiratory disease, cancer, depression, dementia, infectious disease, injury, arthritis and other muscular conditions, or physical disability?" In addition, home ownership status (rent or own) was assessed with the following question "Do you rent or own the house/apartment you live in?"

Statistical Analyses

Descriptive analysis was undertaken for each variable. We compared the prevalence of perceived general (including respiratory health) and mental health symptoms including general psychological distress, PTSD, and sleep quality between flooded and nonflooded populations. The Kruskal–Wallis test, a common nonparametric test used to evaluate associations between multiple categorical variables, was used to detect associations between the outcome and independent variables. Multivariable logistic regression was used to assess the effect of reported flood impact on residents' perceived physical and mental health after adjusting for the following variables: gender, age, employment status, education, whether the person rented or owned their place of residence, and the presence of 1 or more existing medical problems. To compare the results, analysis was also performed by replacing employment and education with income. Little difference was found in the results, however, so employment and education were used. All analyses were conducted in SAS V9.2.

RESULTS

Response Rate

We mailed invitations to 3000 residents, and received back 960 completed survey questionnaires (32% response rate). Of 2040 individuals who did not complete the survey, the reasons for nonparticipation were known for less than 15% (306 people). Reasons included undeliverable mail (5.9%), active refusal due to lack of interest or feeling that the study was irrelevant (5.8%), and temporary unavailability due to age, sickness, travel, or other reasons, including death (1.5%). A blank survey was returned by 46 (1.5%) people.

Characteristics of Respondents

Women constituted 52% of the study sample, and were slightly more likely than men to participate in the survey

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TABLE 1

Characteristics of Survey Respondents (N = 960)

Variable	Category	No. of Respondents (%)[a]
Age groups, y	18-24	67 (7.0)
	25-44	269 (28.0)
	45-64	419 (43.6)
	≥65	204 (21.3)
Gender	Male	419 (43.6)
	Female	541 (56.4)
Income	<$26K	159 (16.6)
	$26K-$52K	220 (22.9)
	$52K-$78K	164 (17.1)
	$78K-$165K	288 (30.0)
	>$165K	88 (9.2)
Marital status	Single	159 (16.6)
	Married or de facto	674 (70.2)
	Divorced/separated	82 (8.5)
	Widowed	42 (4.4)
Employment status	Employed (part/full/self)	587 (61.1)
	Family caretaker	67 (7.0)
	Retired	200 (20.8)
	Permanently sick or disabled/student/unemployed/other	65 (6.8)
Education status	Less than high school	66 (6.9)
	High school	330 (34.4)
	Some college/undergraduate degree	351 (36.6)
	Graduate degree	186 (19.4)
Country of origin	Australia	757 (78.9)
	Asia	77 (8.0)
	Europe, United States, Canada	101 (10.5)
	Africa	11 (1.1)
	Other	14 (1.5)
Language spoken at home	English or English & another language	882 (91.9)
	Other European language only	11 (1.1)
	Asian only	25 (2.6)
	Other	42 (4.4)

[a] Percentages in some variables do not total 100% due to missing values.

(38% of all approached women vs 33% of all men participated) (Table 1). The mean age of respondents was 51 years (SD = 16.5 years); those aged 45 years and older were overrepresented (65%) among the respondents.

Impact of Flooding

The descriptive results show that adverse perceived physical and mental health outcomes were associated with reported direct flood impact and the presence of existing health problems (Table 2).

Direct flood impact was a significant risk factor for poor reported general and mental health status, even after adjusting for gender, age, employment, education, and the existence of current health problems (Table 3). People who reported direct flood impact also tended to report worse overall health (Odds Ratio [OR] 5.3; 95% CI, 2.8-10.1) and respiratory health (OR 2.3; 95% CI, 1.1-4.6), higher psychological distress (OR 1.9; 95% CI, 1.1-3.5), more problems with sleeping (OR 2.3; 95% CI, 1.2-4.4), and a higher probability of PTSD (OR 2.3; 95% CI, 1.2-4.5).

In terms of important subgroups of the population, respondents with underlying health problems were more likely to report worse overall (OR 2.9; 95% CI, 1.5-5.7) and respiratory (OR 2.6; 95% CI, 1.4-4.9) health, suffering increased psychological distress (OR 4.4; 95% CI, 2.7-7.4), problems with sleeping (OR 3.3; 95% CI, 1.8-6.2), and probable PTSD (OR 2.9; 95% CI, 1.5-5.5). Female respondents reported worse overall health postflood as compared to male respondents (OR 2.2; 95% CI, 1.1-4.2). Also, renters, as compared to home owners, were more likely to report worse respiratory health, along with sleeping problems (OR 2.6; 95% CI, 1.4-4.6) and probable PTSD (OR 2.6; 95% CI, 1.4-4.7). Age and socioeconomic status (measured via both employment and education level and income) had little effect on health outcomes.

DISCUSSION

To our knowledge, this was the first study to assess the health impacts of the 2011 floods in the greater Brisbane area through a community-based survey. We found that direct

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TABLE 2

Number of Respondents (%, rounded)[a] Reporting Physical and Mental Health Outcomes According to Different Covariates[b]

Category	Reported existing medical problems			Reported direct flood impact			Gender			Age, y				
	Yes	No	P[f]	Yes	No	P[f]	Male	Female	P[f]	18-24	25-44	45-64	≥65	P[f]
Overall health	483	450	**<.0001**	99	825	**<.0001**	411	521	.17	67	265	408	192	.09
Worse than before flood	48 (9.9)	16 (3.6)		22 (22.2)	41 (5.0)		21 (5.1)	43 (8.2)		2 (3.0)	17 (6.4)	33 (8.1)	12 (6.2)	
Same	425 (88.0)	415 (92.2)		74 (74.8)	758 (91.9)		378 (92.0)	461 (88.5)		63 (94.0)	232 (87.6)	367 (89.9)	177 (92.2)	
Better than before flood	10 (2.1)	19 (4.2)		3 (3.0)	26 (3.1)		12 (2.9)	17 (3.3)		2 (3.0)	16 (6.0)	8 (2.0)	3 (1.6)	
Respiratory health	492	453	**.007**	100	833	0.23	417	527	.2	67	269	414	194	.91
Worse than before flood	44 (8.9)	18 (4.0)		12 (12.0)	47 (5.6)		21 (5.0)	41 (7.8)		4 (6.0)	17 (6.3)	29 (7.0)	12 (6.2)	
Same	436 (88.6)	423 (93.4)		83 (83.0)	767 (92.1)		386 (92.6)	472 (89.6)		61 (91.0)	244 (90.7)	376 (90.8)	177 (91.2)	
Better than before flood	12 (2.5)	12 (2.6)		5 (5.0)	19 (2.3)		10 (2.4)	14 (2.7)		2 (3.0)	8 (3.0)	9 (2.2)	5 (2.6)	
Psychological stress[c]	490	456	**<.0001**	99	836	**.004**	413	532	.65	66	269	413	197	.8
Low-moderate risk (K6 < 8)	393 (80.2)	430 (94.3)		77 (77.8)	736 (88.0)		362 (87.7)	461 (86.7)		56 (84.9)	232 (86.3)	359 (86.9)	175 (88.8)	
High risk (K6 ≥ 8)	97 (19.8)	26 (5.7)		22 (22.2)	100 (12.0)		51 (12.3)	71 (13.3)		10 (15.1)	37 (13.7)	54 (13.1)	22 (11.2)	
Poor sleep quality[d]	499	461	**.0001**	100	848	**.0005**	419	540	.42	67	269	419	204	.11
No sleep issues (Score < 4)	442 (88.6)	440 (95.4)		83 (83.0)	789 (93.0)		382 (91.2)	500 (92.6)		64 (95.5)	249 (92.6)	376 (89.7)	193 (94.6)	
Sleep issues (Score ≥ 4)	57 (11.4)	21 (4.6)		17 (17.0)	59 (7.0)		37 (8.8)	40 (7.4)		3 (4.5)	20 (7.4)	43 (10.3)	11 (5.4)	
PTSD score[e]	492	449	**<.0001**	99	830	**.0005**	412	528	.95	67	267	409	197	.48
Low risk (<44)	439 (89.2)	433 (96.4)		83 (83.4)	777 (93.6)		382 (92.7)	489 (92.6)		64 (95.5)	244 (91.4)	377 (92.2)	186 (94.4)	
High risk (≥44)	53 (10.8)	16 (3.6)		16 (16.2)	53 (6.4)		30 (7.3)	39 (7.4)		3 (4.5)	23 (8.6)	32 (7.8)	11 (5.6)	

Category	Property			Employment					Education				
	Rent	Own	P[e]	Employed	Housekeeper or Family Caretaker	Retired	Disabled/ Student/ Unemployed/ Other	P[e]	Uncompleted High School/ Other	High School	Uncompleted University	Completed University	P[e]
Overall health	199	721	.59	576	67	188	64	.3	87	318	343	185	.79
Worse than before flood	18 (9.1)	45 (6.3)		34 (5.9)	8 (11.9)	11 (5.8)	4 (6.3)		8 (9.2)	17 (5.4)	27 (7.9)	12 (6.5)	
Same	168 (84.4)	660 (91.5)		524 (91.0)	57 (85.1)	175 (93.1)	56 (87.4)		77 (88.5)	294 (92.4)	301 (87.7)	168 (90.8)	
Better than before flood	13 (6.5)	16 (2.2)		18 (3.1)	2 (3.0)	2 (1.1)	4 (6.3)		2 (2.3)	7 (2.2)	15 (4.4)	5 (2.7)	
Respiratory health	203	728	.29	582	67	191	65	.44	88	324	348	185	.76
Worse than before flood	18 (8.9)	43 (5.9)		36 (6.2)	7 (10.4)	16 (8.4)	3 (4.6)		5 (5.7)	20 (6.2)	23 (6.6)	14 (7.6)	
Same	179 (88.2)	667 (91.6)		532 (91.4)	56 (83.6)	172 (90.1)	59 (90.8)		80 (90.9)	295 (91.0)	316 (90.8)	168 (90.8)	
Better than before flood	6 (3.0)	18 (2.5)		14 (2.4)	4 (6.0)	3 (1.5)	3 (4.6)		3 (3.4)	9 (2.8)	9 (2.6)	3 (1.6)	
Psychological stress[c]	200	733	**.001**	583	66	193	64	**<.0001**	90	321	349	186	.33
Low-moderate risk (K6 < 8)	160 (80.0)	651 (88.8)		523 (89.7)	54 (81.8)	171 (88.6)	42 (65.6)		79 (87.8)	274 (85.4)	301 (86.2)	169 (90.9)	
High risk (K6 ≥ 8)	40 (20.0)	82 (11.2)		60 (10.3)	12 (18.2)	22 (11.4)	22 (34.4)		11 (12.2)	47 (14.6)	48 (13.8)	17 (9.1)	
Poor sleep quality[d]	204	741	**<.0001**	587	67	200	66	.45	93	330	351	186	.94
No sleep issues (score < 4)	173 (84.8)	695 (93.8)		540 (92.0)	62 (92.5)	188 (94.0)	58 (87.9)		86 (92.5)	294 (89.1)	325 (92.6)	177 (95.2)	
Sleep issues (score ≥ 4)	31 (15.2)	46 (6.2)		47 (8.0)	5 (7.5)	12 (6.0)	8 (12.1)		7 (7.5)	36 (10.9)	26 (7.4)	9 (4.8)	
PTSD score[e]	200	728	**<.0001**	579	66	192	64	.08	90	320	346	185	.69
Low risk (<44)	170 (85.0)	690 (94.8)		545 (94.1)	60 (90.9)	180 (93.8)	55 (85.9)		84 (93.3)	294 (91.9)	319 (92.2)	175 (94.6)	
High risk (≥44)	30 (15.0)	38 (5.2)		34 (5.9)	6 (9.1)	12 (6.2)	9 (14.1)		6 (6.7)	26 (8.1)	27 (7.8)	10 (5.4)	

[a] Missing values excluded.

[b] P value of Kruskal-Wallis test for significant association between row and column classifications of each variable combination.

[c] Kessler scale.

[d] Groninger Sleep Quality Scale.

[e] Posttraumatic stress disorder-civilian checklist (PTSD; PCL–C) scale.

[f] Significant at .05 level.

TABLE 3

Association Between Health Outcomes and Direct Flood Impact, Existing Medical Problems and Sociodemographic Variables

Variables	Worse Overall Health Since Floods	Worse Respiratory Health Since Floods	Increased Psychological Distress	Problems With Sleeping	Probable PTSD
Direct flood impact					
No (reference)	1	1	1	1	1
Yes	**5.3 (2.8, 10.1)[a]**	**2.3 (1.1, 4.6)**	**1.9 (1.1, 3.5)**	**2.3 (1.2, 4.4)**	**2.3 (1.2, 4.5)**
Existing health problems					
No problems (reference)	1	1	1	1	1
Problems	**2.9 (1.5, 5.7)**	**2.6 (1.4, 4.9)**	**4.4 (2.7, 7.4)**	**3.3 (1.8, 6.2)**	**2.9 (1.5, 5.5)**
Property type					
Own (reference)	1	1	1	1	1
Rent	1.2 (0.6, 2.5)	**1.9 (1.0, 3.6)**	1.4 (0.9, 2.4)	**2.6 (1.4, 4.6)**	**2.6 (1.4, 4.7)**
Gender					
Male (reference)	1	1	1	1	1
Female	**2.2 (1.1, 4.2)**	1.6 (0.9, 2.9)	1.2 (0.8, 1.8)	1.1 (0.6, 1.8)	1.2 (0.7, 2.2)
Age, y					
18-24 (reference)	1	1	1	1	1
25-44	1 (0.2, 5.2)	0.6 (0.2, 1.9)	0.9 (0.4, 2.2)	2.3 (0.5, 11.2)	2.0 (0.5, 7.5)
45-64	1.1 (0.2, 5.6)	0.6 (0.2, 2.0)	0.6 (0.3, 1.6)	3.0 (0.6, 13.8)	1.4 (0.4, 5.4)
≥65	1.1 (0.2, 7.0)	0.3 (0.1, 1.5)	0.5 (0.2, 1.6)	1.6 (0.3, 9.7)	0.7 (0.1, 3.9)
Employment					
Employed (Reference)	1	1	1	1	1
Housekeeper/caretaker	1.5 (0.6, 3.7)	1.5 (0.6, 3.8)	1.6 (0.8, 3.3)	0.7 (0.2, 2.0)	1.1 (0.4, 3.0)
Retired	0.9 (0.3, 2.8)	0.5 (0.1, 1.8)	**3.5 (1.8, 6.8)**	1.0 (0.4, 2.5)	2.0 (0.8, 4.8)
Disabled/student/unemployed/other	0.8 (0.3, 2.5)	1.9 (0.7, 5.1)	1.1 (0.5, 2.4)	0.7 (0.3, 2.1)	1.6 (0.5, 4.7)
Education					
High school (reference)	1	1	1	1	1
Completed university	1.5 (0.6, 3.5)	1.5 (0.7, 3.3)	0.8 (0.4, 1.5)	0.5 (0.2, 1.1)	1 (0.4, 2.2)
Less than high school/other	2 (0.7, 6.0)	0.9 (0.3, 3.1)	1.2 (0.6, 2.8)	0.6 (0.2, 2.0)	1.6 (0.6, 4.4)
Uncompleted university	1.8 (0.9, 3.7)	1.3 (0.7, 2.5)	1.1 (0.7, 1.9)	0.6 (0.3, 1.1)	1.0 (0.5, 2.0)

[a] Odds ratios and 95% CI. Values are adjusted for all variables in table.

flood impact had significant effects on both perceived physical and mental health outcomes among residents in flood-affected areas.

Our results confirmed previous findings that reported elevated physical and mental health problems for those who had experienced direct flood impact. For instance, in agreement with a UK study,[23] we found that affected residents experienced negative general health symptoms. In other studies of communities in England that were affected by flooding, a 2- to 5-fold increased prevalence of mental health symptoms was found in people whose houses were flooded versus control subjects.[5,24] Similarly, we found that reporting a direct flood impact was associated with at least a 2-fold increased risk, measured via sleep disturbance, general psychological distress, and symptoms of probable PTSD.

Flood exposure in this study was measured through questions about the level of perceived flood impact on the household. Other authors have noted that perceived health concerns related to floods may be as important a predictor of elevated psychological health outcomes as actual flood damage.[24] While it was beyond the scope of this study to conduct an objective assessment of flood-related household damage, future research should measure flood impact through both objective (ie, a physical household damage survey) and subjective (ie, assessment of perceived impact) measures.

Consistent with earlier findings, our study revealed that health outcomes may be exacerbated for various subgroups of the population.[5-12,15,25,26] In particular, women and individuals with poor baseline health are at higher risk of worse health outcomes following floods. We found that respondents with underlying health conditions reported worse general and respiratory health, as well as psychological distress, problems with sleeping, and symptoms of PTSD.

In addition, previous studies have revealed that the inability to maintain stable medication intake during flood events may be a contributing factor to flood-related worse health outcomes.[14,25] It was also observed that renters, as opposed to home owners, reported worse respiratory health postflood, and were almost 3 times more likely to suffer from sleep problems and symptoms of probable PTSD. While the focus herein was on the health

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effects of direct flood impact, these findings indicate that further studies should examine the relationship between health outcomes following floods and factors such as home ownership status, neighborhood, and type of dwelling, as well as preexisting medical conditions.

Limitations

Limitations of the study should be acknowledged. First, the survey was conducted 6 months after the flood, and therefore the results may not reflect longer term (ie, greater than 6 months) health impacts. Second, selection bias may be an issue if only individuals who felt most affected chose to respond to the survey. However, while the questionnaire was sent to flood-affected areas, only about 12% of respondents reported being directly affected by flooding. Those who were affected by the floods may therefore be under-represented. Third, the information used in this study was based solely on self-reported data. Thus information bias was inevitable to some extent. Fourth, the extent of direct trauma, a major risk factor for worse health outcomes after floods, was only partially assessed. Indirect exposures (ie, witnessing the flooding of a neighborhood, media coverage of events, economic loss, impact on a respondent's relationships), other flood-related health outcomes such as earache and gastrointestinal problems[26] and infections[27] were not assessed. Finally, the extent and type of coping strategies employed by the community,[9] and the relationship between these and the reported health outcomes were not assessed. Moreover, as data relating to the total flood-impacted population was unavailable, we were unable to make comparisons with the total impacted population.

CONCLUSIONS

The results of our study confirm that, in the 6 months after the 2011 Queensland floods, flood-related damage was found to have a significant negative effect on the perceived general, respiratory, and mental health of affected residents. These findings may have important implications for public health policy, suggesting that to mitigate the health impacts of floods, appropriate care and monitoring should be provided to all those who have been or otherwise have felt affected by the floods. The results underscore the importance of targeting public health messages before, during, and after flood events to all members of the general public, particularly those groups (eg, women, individuals with underlying medical conditions, and renters) that are at a higher risk of worse health outcomes.

While most short-term health impacts of floods are well documented in this and other studies, longer-term impacts need to be better understood.[3,4,7,28] We recommend that repeated assessments be conducted in this study population to understand changes in health outcomes over time.

In the next 20 years, Australia and many other parts of the world are likely to experience an increased frequency of extreme weather events such as floods. Populations located in coastal and lowland areas are particularly vulnerable to extreme weather events. As these areas become more urbanized, more frequent flooding threatens health by affecting access to safe drinking water, secure shelter, and public health infrastructure. These events directly and indirectly contribute to increased morbidity and mortality. Understanding the short- and long-term health impacts of floods and identifying communities most at risk remain imperative. The results of this study may therefore help improve the resilience of populations to cope with the impacts of future flood events, particularly in terms of mental health effects, through the development of appropriate surveillance strategies within existing public health and disaster management programs.[29]

About the Authors

School of Public Health and Social Work, Institute of Health and Biomedical Innovation, Queensland University of Technology, Brisbane, Australia (Drs Turner and Tong and Ms Alderman); and School of Public Health, Anhui Medical University, Hefei, Anhui, China (Dr Tong).

Address correspondence and reprint requests to Shilu Tong, PhD, School of Public Health and Social Work, Institute of Health and Biomedical Innovation, Victoria Park Rd, Kelvin Grove, QLD 4059 Australia (e-mail: s.tong@qut.edu.au).

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