The health effects of flooding: social research results from England and Wales

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ABSTRACT

This paper presents interview survey data by social scientists using established health measures on the health effects of flooding for residents in 30 locations in England and Wales. Firstly, it examines the extent to which flooded residents reported suffering physical and psychological health effects during and after the event. Secondly, it explores the issue of whether these effects were long-lasting by comparisons with the general population and with those at risk but not flooded. In the study, about two thirds of the flood victims were found to have scores on the General Health Questionnaire-12 scale indicative of mental health problems (scores of 4+) at their worst time after flooding. The evidence of the study also suggests that some flood victims suffered long term mental health effects as a result of their experience of flooding. The study examines the influence of a wide range of factors: characteristics of the flood event, types of property, and socio-demographic and the intervening factors such as the extent of family or community support that may explain the health effects of flooding. It finds that a complex set of social and other factors are involved and that some factors susceptible to human intervention such as having adequate flood insurance cover are important factors in the stress experienced by flood victims.

Key words | flooding, flood risk management, General Health Questionnaire-12, physical health, psychological health, social characteristics

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INTRODUCTION

Flooding is one of the most widespread climatic hazards that poses multiple risks to human health and yet, as Few *et al.* (2004) note in their recent comprehensive review, there has been only limited systematic research on the health outcomes of flooding. Hajat *et al.* (2003) also highlight the dearth of good quantitative data available on the health effects of flooding, resulting in the uncertainty about the full range of potential health impacts. There is now growing general concern regarding the longer-term impacts of climate change on human health, including flooding (Intergovernmental Panel on Climate Change 2001; World Health Organisation (WHO) 2002).

A recent Foresight study on future flooding in Britain (Evans *et al.* 2004) indicates that more people are likely to be at risk in the future which makes the systematic examination of the impact of floods on human health more urgent. Bennet's (1970) study of the 1968 Bristol Floods was the first and, for a long time, the only controlled UK investigation of the impact of flooding on people's health. It showed that morbidity and mortality rates were increased significantly over a twelve month period for those flooded compared to those unaffected. Other UK research has highlighted the significance of the 'intangible impacts' of flooding, including the health impacts (Parker *et al.* 1983; Green *et al.* 1985). Recent small-scale qualitative studies in five English communities indicated that some flood victims attribute physical symptoms and ill health to the flood experience, as well as suffering considerable psychological trauma (Tapsell *et al.* 1999; Tapsell & Tunstall 2000; Tapsell & Tunstall 2001, Tapsell *et al.* 2002; Tapsell *et al.* 2003). A study in Lewes, East

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Sussex, UK (Reacher *et al.* 2004) has offered the first recent systematic examination of the health impacts of flooding in England through a comparison of reported gastro-intestinal and other illness and mental health in flooded and non-flooded households. It showed strikingly the scale of psychological distress experienced by flooded adults as compared to the non-flooded using the well established General Health Questionnaire (GHQ-12) scale as a measure administered nine months after the flood event.

RESEARCH AIMS AND METHODS

Study aims

The research reported in this paper was carried out as part of a major project funded by the Department for the Environment, Food and Rural Affairs (Defra) in England which had the wider aim of developing a robust, yet simple to use, methodology so that the intangible impacts on human health and well-being of flooding could be accounted for in assessing the benefits of flood risk management measures. A full report on the research and the methods used is given in Risk and Policy Analysts Ltd (RPA)/Flood Hazard Research Centre (FHRC) *et al.* (2004).

The study aimed:

- to establish the nature and extent of short and long term physical and psychological health effects of flooding on flooded residents in England and Wales;
- to examine whether the health of flood victims was worse than that of non-flooded residents in flood risk areas and also than that of the general population;
- to examine the factors that influenced the health outcomes of flood victims.

Survey methods

Survey sample

The main survey covered 30 varied locations affected by different fluvial flood events since January 1998, in seven out of eight Environment Agency Regions in England and Wales. A full probability sampling procedure was not possible without extensive pre-screening because accurate lists of flooded residential addresses are not available to provide a sampling frame. The Environment Agency generally only holds information on properties, both residential and non-residential, within areas at risk from flooding. Therefore, following some pre-screening, interviewers were provided with a limited number of such property addresses at which to achieve a target quota of 'flooded' and 'at risk' interviews at each location to reduce the scope for interviewer selection bias. The number of responses achieved at each location was close to the target and the following face-to face interviews were obtained:

- a 'flooded' sample – 983 interviews with adults aged 18 and over whose homes had been flooded above floor level including flooding to halls, basements and cellars but excluding outhouses and garages;
- an 'at risk' sample – 527 interviews with residents aged 18 and over 'at risk' in the same areas but who had not experienced flooding while resident there.

The few flooded respondents (14%) affected by more than one flood since January 1998 were asked to focus their replies on the 'worst flood' they had experienced in that period.

Interview schedules and fieldwork

Initially, the appropriateness and applicability of survey questions and of four self-completion health scales (Short Form-12, Ware, Kosinski & Keller 1996; General Health Questionnaire -12, Goldberg & Williams 1988; Impact of Event Scale, Horowitz *et al.* 1979; Post Traumatic Stress Scale, Scott & Dua 1999) were tested for use with flood victims through a series of five focus groups. Interview schedules were then developed and the use of the health scales was further tested through two phases of pilot interviews with 72 and 53 respondents respectively, and through 11 in-depth interviews.

The main survey was carried out from November 2002 through to January 2003. Trained, briefed and well supervised interviewers from the market research company, MORI, and a structured survey instrument were used to control possible interviewer bias. One adult only was interviewed at each address to avoid clustering effects. The 'flooded' questionnaire took on average 48 minutes to complete; the 'at risk' questionnaire took on average 23 minutes.

Data processing and analysis

The questionnaires were checked and the data entered by MORI. Further checks were carried out by the researchers. The data analysis was undertaken by RPA and FHRC mainly using the Statistical Package for Social Scientists (SPSS).

Health measures used in the main survey

The World Health Organization's definition of good health as 'a state of complete physical, mental and social well-being, not merely the absence of disease and infirmity' was used to guide the study (World Health Organization 1948). Therefore, measures of mental health states as well as self-reported physical symptoms were included based on the qualitative and pilot research, three measures were selected for use in the main survey.

GHQ-12

This scale is well established and widely used for measuring psychological distress. (Goldberg & Williams 1988). Both flooded and 'at risk' respondents were asked to answer the GHQ-12 questions in terms of 'how your health has been over the past few weeks' (GHQ-12 current).

In order to capture health effects experienced by people at the time of, and following the flooding, but which they may no longer experience, flooded respondents were asked to complete the GHQ-12, for a second time retrospectively with reference to how their health was when the health effects from the flooding were most severe' (GHQ-12 worst time). In order to establish when the 'worst time' occurred, at an earlier point in the interview respondents were asked 'At what stage during or after the flooding were the health impacts the most severe or worst for you personally. Please think about health in the broadest sense to include physical, mental and social well being'. Two thirds recalled experiencing the most severe health effects early on, within three months of the event, perhaps as they were coming to terms with the impact of the event on their lives and property.

Following a number of studies examining the possibility of modifying self-report and clinical interview procedures to identify worst time or life-time prevalence of mental illness (Schwartz & Zuroff 1979; Bromet *et al.* 1986; McGuffin *et al.* 1986), Power (undated, 1988) undertook research to develop a 'worst ever' version of the 28 item General Health Questionnaire (GHQ-28). The GHQ-28 scores relating to a 'worst ever' episode that could have occurred months or years earlier in life were found to have good reliability when retested after six months. However, there is no example of the GHQ-12 being adapted for a 'worst ever' use and it was not possible to test the reliability of 'worst time' use of the GHQ-12 in this study.

The GHQ-12 was scored by two methods in this study. The commonly used GHQ scoring (score 0–12), simply differentiates between those with and without symptoms by scoring the first two response categories as zero (no symptom) and the third and fourth response categories as one (symptom) for each of the 12 items. In the GHQ-12 Likert scoring used in the regression analyses, the four response categories are scored 0,1,2,3, to produce a more differentiated Likert scale score from 0 to 36. Current GHQ scores were calculated for the 83% of the flooded respondents and for the 92% of those at risk that responded on all items.

Post Traumatic Stress Scale (PTSS)

Post Traumatic Stress Scale (PTSS) (Scott & Dua 1999), a relatively new scale for measuring stress in relation to a traumatic event, has been shown to be reliable and valid. It is designed as a diagnostic tool to categorise whether or not subjects are suffering from Post Traumatic Stress Disorder (PTSD) and can provide measures of the frequency, severity and duration of individual symptoms and symptoms overall. For this study, the wording of the introduction was modified to cover 'effects that you may have experienced as a result of flooding' rather than 'the traumatic event' and the symptom items were altered to focus on the experience of flooding. The scale is concerned with present feelings and behaviours in relation to the traumatic event of the flood. It is, therefore, closely related to the flood event and involves, to some extent, a backward look towards the flood event. Thus, it offers a measure of present mental health status more specifically related to the flood event than the current GHQ-12.

In the version of the scale questionnaire used in the survey, there are 17 symptom items in total: five concerned with 're-experiencing the event', seven with 'numbing and

avoidance', five with 'hyper arousal'. The flooded household survey respondents were asked about their frequency of experiencing the symptoms (scored 0–4) and the distress of the symptoms (scored 0–4). The PTSD intensity score, suggested by Scott & Dua (1999) as a good method for interpreting symptoms, was used in the analysis of the flood victims. This score is derived as the sum of the frequency × distress scores for each of the 17 question items. Thus the overall possible score can range from 0–272. The PTSD Intensity score was calculated for 74% of the respondents who completed all the question items.

Self-reported health effects checklists

These checklists were built up from the descriptions of health effects which participants attributed to flooding in earlier qualitative studies (Tapsell *et al.* 1999; Tapsell & Tunstall 2001) and in the focus groups for this research. As there appears to be a time dimension associated with certain health effects resulting from flooding (Parker *et al.* 1987; Tapsell *et al.* 1999), respondents were asked about physical health effects experienced during and immediately after the flooding and in the weeks and months following the flooding. The health checklist categories are not mutually exclusive. They reflect the descriptions commonly used by lay people rather than formal clinically defined categories. All those who reported any health problems in response to the checklists were asked whether they had consulted a doctor about any of the problems and had received any treatment.

RESULTS

Health effects at the time of flooding

Self-reported physical and psychological heath effects

The majority of flooded respondents (59%) attributed some physical health effects to the flood. More people experienced such effects, particularly shock, during or immediately after the flood than reported them in the weeks and months following flooding (Table 1). Flood victims generally attribute later physical health problems to the effects of exposure to cold and contaminated flood waters, living in cold and damp conditions and the physical effort and stress associated with the clean-up and recovery process (Tapsell *et al.* 1999; Tapsell & Tunstall 2001).

Psychological effects were much more commonly reported after flooding than physical ones, with anxiety when it rains the most frequently mentioned symptom (Table 1). However, physical and psychological effects can be interlinked in complex ways (Reacher *et al.* 2004). Schnurr (2001) summarized recent literature on the relationship between exposure to traumatic stressors, such as floods, and a variety of physical health outcomes. In our study, reporting a number of psychological effects by flood victims was quite strongly associated with reporting physical effects, particularly immediate effects, perhaps because of the prevalence of symptoms of shock (Pearson Correlation 0.57), and also with the longer term physical effects (Pearson Correlation 0.45) and with the worst time GHQ-12 scores (Pearson Correlation 0.58).

A minority of flood victims (23%) consulted a doctor about these illnesses, injuries and psychological effects which they attributed to the flood event and 20% received treatment from the doctor.

GHQ-12 for the worst time of the flooding

The 'worst time' GHQ-12 scores indicate a very pervasive experience of anxiety and distress at the time when the impact of the flooding was at its height (Table 2). As many as 64% of the flood victims had a worst time score of 4 or more, conventionally taken as indicative of psychological distress, compared with 25% with this score at the time of the interview (Goldberg & Williams 1988; Erens & Primatesta 1999) (Table 2). The GHQ-12 scores given in the survey were overall significantly higher for the worst time of the flood as compared with the current scores for health at the time of the interview (paired sample t test: $t = -24.745$; $df = 793$, $p < 0.001$).

However, simple comparisons mask complex patterns of change over time. The health of most flood victims (56%), as measured by the GHQ-12, had improved over the varied length of time since the flood event. However, nearly a fifth (19%) recorded no change in their GHQ-12 scores at the worst time and currently. A quarter of the respondents (25%) had experienced deterioration in their health since

Table 1 | Self-reported physical and psychological health effects: flooded sample

Self-reported health effects

Physical health effects experienced during or immediately after the flooding	No	%	Physical health effects experienced in the weeks and months following flooding	No	%	Psychological Health effects	No	%
Shock	327	33	Gastro-intestinal illness/upset stomachs	96	10	Anxiety when it rains	543	55
Cold, coughs, flu, sore throats or throat infections	194	20	Stiffness in joints	91	9	Increased stress levels	353	36
Headaches	116	12	Respiratory/chest illness e.g. asthma, pleurisy	79	8	Sleeping problems	245	25
Exposure to chemicals and contaminants in flood waters	81	8	High blood pressure	76	7	Flashbacks to the flood	170	17
Injuries due to over exertion during the flood e.g. sprains/strains, heart problems	65	7	Skin irritations e.g. rashes, dermatitis etc	55	6	Increased tension in relationships e.g. more arguing	152	16
Skin irritations e.g. rashes	71	7	Heart problems	27	3	Mild depression	140	14
Injuries e.g. cuts and bruises due to being knocked over by flood water	44	5	Muscle cramps	22	2	Difficulty in concentrating on tasks	127	13
Hypothermia	21	2	Sprains and strains	24	2	Mood swings/bad moods	126	13
Electric shock	5	.5	Cuts and bruises	24	2	Lethargy/lack of energy	93	10
			Insect or animal bites	19	2	Moderate depression	92	9
			Erratic blood sugar levels (diabetics)	21	2	Anger/tantrums	91	9
			Kidney or other infections	8	1	Panic attacks	82	8
						Nightmares	64	7
						Increased use of alcohol/drugs	64	7
						Severe depression	45	5
						Thoughts of suicide	13	1
Other	38	4	Other	27	2	Other	11	1
None of the above	452	46	None of the above	658	67	None	279	28
Mean number of symptoms including none as zero	1.0			0.6			2.5	
Number of respondents	983		Number of respondents	983		Number of respondents	982	

the flood event. In a few cases, this was attributed to the long term effects of the flooding, for example, a distressing heart condition which the respondent believed; he had developed as a result of the flood event. For others, intervening circumstances unconnected with the flood had lead to their greater anxiety and distress. The study did not include measures to control for other factors at the time of the flood and occurring after it that might have affected their mental or physical health.

Current health: longer term health effects of flooding

A key question for research is: do flood victims suffer from lasting and longer term mental health problems as a result of flooding? In this study, longer term refers to years rather than months. Anxiety and depression are found in the general population; therefore, it is necessary to compare 'the flooded' with others.

Current GHQ-12 scores of the flooded compared with the 'at risk' sample

Those who had had their homes flooded were significantly more likely than those at risk to have high current GHQ-12 scores (Table 3). However, the 'at risk' sample was not matched with the flooded sample although drawn from the same areas. There were some statistically significant, if not very substantial, differences between the samples. Those at risk were somewhat younger, more likely to rent and to have moved in recently than the flooded. However, significant differences were found between the flooded and those at risk in all the age groups apart from those aged 60 or more (Table 3). Furthermore, there were significant differences in current GHQ-12 scores of the flooded and 'at risk' samples when gender, social class, length of residence (< 5 years) and tenure were taken into account.

Current GHQ-12 scores of the flooded results from the Health Survey for England 1998

The Health Survey for England 1998 results showed some variation in GHQ-12 scores for men and women and with age. Therefore, the comparison with the current health data for flood victims is presented separately for men and women in different age groups (Table 4). Making a direct comparison between the two sets of data is problematic because the geographical areas covered, the age limits to the surveys and sample sizes were different and there may be other differences, for example, in social class composition, that are not controlled. The findings in Table 4 indicate that more of those who had experienced flooding, when gender and age were taken into account, had high current GHQ-12 scores (4 + scores) than the national average for England.

Post traumatic stress effects

To establish whether the flood was experienced as a traumatic event, as a first question in the PTSS, respondents were asked 'As the result of the flood, did you personally experience intense fear, helplessness or horror'. For over two fifths of those answering, the flood was a traumatic event and thus a possible source of PTSD. Women and those in poor health prior to the flood were more likely to experience the flooding as traumatic. Experiencing flooding in this way was also significantly associated with a reported fast speed of onset of flooding, the belief that the flood waters were contaminated and depth of flooding (Table 5).

The PTSD Intensity scores for the flood victims ranged from 0 to 221 with a mean score of 21.1. A small proportion of flood victims (15%) reported suffering from mild to moderate or more severe symptoms of post traumatic stress as measured by the PTSD Intensity score. Ten individuals suffered from stress levels that may, according to the PTSS Manual (Dua & Scott 2001), be characterized as 'high' (PTSD Intensity score 148–209) and a further four individuals showed 'extreme' stress levels (PTSD Intensity score 210–272). Not surprisingly the high PTSD Intensity scores were concentrated among those who reported experiencing the flood as a traumatic event (Table 5). Beck & Franke (1996) report that 15–20% of people studied after natural disasters are found to have symptoms of PTSD and other studies have shown long term health effects of natural disasters (e.g. Caldera *et al.* 2001).

At the time of the research with flooded households, there were few studies using the PTSS scale, and no UK studies with which the results could be compared. Therefore, comparison was made with the PTSD Intensity scores obtained by Scott & Dua (1999) in their research to establish the reliability and validity of the scale. The flood

Table 2 | Worst time and current GHQ-12 according to the maximum depth of main room flooding: flooded sample

	Maximum depth of main room flooding					
	None	**< 9 cm**	**10–39 cm**	**40–79 cm**	**> 79 cm**	**All**
GHQ-12 Worst time[a]	%	%	%	%	%	%
0	49	28	19	15	16	21
1–3	21	15	16	15	16	16
4–8	21	29	33	32	31	31
9–12	10	28	33	37	38	33
Total						
Number of respondents	72	87	233	218	197	807
GHQ-12 mean score	2.7	4.9	5.8	6.2	6.2	5.6
GHQ-12 likert mean score	13.5	16.7	18.3	19.2	19.8	18.3
GHQ-12 Current[b]						
0	73	62	50	48	48	52
1–3	14	22	25	25	24	24
4–8	3	12	18	19	19	17
9–12	10	5	7	8	9	8
Total						
Number of respondents	70	86	237	219	199	811
GHQ-12 Mean score	1.4	1.5	2.1	2.3	2.4	2.1
GHQ-12 Likert Mean score	11.3	12.1	12.42	12.82	13.4	12.6
% of sample flooded to this depth (N = 980)	9%	11%	30%	27%	24%	Mean depth 55 cms

[a]GHQ-12 worst time by maximum depth of main room flooding: Chi-Square = 53.91; df = 12; $P < 0.001$.
[b]GHQ-12 current by maximum depth of main room flooding: Chi-Square = 25.32; df = 12; $P < 0.05$.

victims had a lower mean PTSD intensity score (21.1) than the PTSD group of Vietnam war veterans diagnosed as suffering from PTSD (mean score 222.6) and a lower score than a group attending professional counseling for trauma-related incidents (mean score 43.4). However, they had a higher score than the non-trauma group who nonetheless worked in trauma-related occupations but who had never been diagnosed as suffering from PTSD or received professional counseling (mean score 11.0). Flood victims who experienced the flood as traumatic had a mean score of 39.6 close to that of the counseling group.

In this research with flood victims, the correlations between the PTSD Intensity and current GHQ-12 Likert were strong (Pearson Correlation = 0.65 compared with the correlation of 0.71 found by Scott & Dua, 1999) indicating that the two scales were capturing some of the

Table 3 | Current GHQ-12 scores for flooded households and for those at risk by age group

	18–39 (a)	40–49 (b)	50–59 (c)	60 +	All (d)
At risk	%	%	%	%	%
0	65	73	63	61	66
1–3	26	20	25	25	24
4–8	6	7	4	11	7
9–12	3	1	7	4	3
Number of respondents	224	77	71	105	485
Flooded					
0	58	53	50	49	52
1–3	22	20	23	28	24
4–8	16	17	16	17	17
9–12	4	10	11	7	8
Number of respondents	176	177	177	283	814

(a) For 18–39 age group, current GHQ-12 by at risk or flooded: Chi-square = 10.71; df = 3; $P = <0.05$
(b) For 40–49 age group, current GHQ-12 by at risk or flooded: Chi-square = 14.05; df = 3; $P = <0.01$
(c) For 50–99 age group, current GHQ-12 by at risk or flooded: Chi-square = 7.87; df = 3; $P = <0.05$
(d) For all, current GHQ-12 by at risk or flooded: Chi-square = 42.23; df = 3; $P = <0.001$

same psychological states. The PTSD Intensity scores and the GHQ-12 Likert scores for the worst time of the flooding were also quite strongly correlated (Pearson Correlation = 0.57) which is not surprising since the PTSS responses relate back to the flood event.

Factors influencing health effects

Bi-variate analyses indicated that many of the 34 variables included in the study exerted some influence upon the health effects of flooding. Three sets of factors were examined.

- the flood event characteristics (such as the depth, duration, frequency of flooding, speed of onset, contamination of flood waters, the number of rooms/main rooms flooded, warning time and years since the flood);
- socio-demographic variables (such as income, social grade, living alone or in households with children, long-term illness, length of residence, employment, car ownership, awareness of flood risk and educational level);
- factors associated with the recovery period which might serve to exacerbate or mitigate the stress arising from flooding (such as problems dealing with builders and insurance, having to leave home and the help received).

In order to identify the key variables, a backwards regression analysis was carried out for each of the key measures of health effects and is presented in Table 6. The cut-off point for significance was generally taken as the 0.05 level.

It was hypothesised that the current health status of flood victims would depend to some degree upon the health and stress effects experienced at the worst time of flooding as the correlation between the GHQ-12 Likert scores for these two periods was moderately strong (Pearson Correlation 0.54). Therefore, the worst time scores were included in the model for current health as measured by the GHQ-12 Likert score (Table 6) When the worst time GHQ-12 Likert scores were excluded, a model with markedly less explanatory power emerged (N = 735, $R^2 = 0.13$, Adj. $R^2 = 0.12$). It contained the five factors (apart from GHQ-12 worst time scores) included in the model in Table 6 and two additional factors: evacuation and only one variable relating to the flood characteristics, the contamination of the floodwaters.

DISCUSSION

Health effects at the time of flooding

In asking about health effects of flooding at the time of flooding (in the GHQ-12 worst time application and through the self reporting checklists), we were asking respondents to think back to events that had happened at least a year earlier. Most respondents (562 or 58%) had been flooded by events that happened between two and two and a half years before the survey (between July-December 2000 including the autumn 2000 floods). Another substantial group (252 or 26%) had experienced events four to five years earlier (between January-December 1998, including the Easter 1998 floods). Problems of recall and of the influence of current health status on recall might be

Table 4 | Current GHQ-12 score by age and gender in the Health Survey for England 1998 and for flooded households in England and Wales in 2003

HSE 1998: Current GHQ-12 score by age and sex[1]

GHQ-12 Score	16–24 %	25–34 %	35–44 %	45–54 %	55–64 %	65–74 %	75 + %	Total %
Men								
0	60	60	62	66	67	71	57	63
1–3	30	28	25	21	20	19	26	24
4 +	10	12	14	13	13	11	16	13
Women								
0	45	53	57	56	60	60	52	55
1–3	34	29	24	24	26	26	30	27
4 +	22	18	20	19	14	15	18	18
Flooded survey respondents: Current GHQ-12 score by age and sex								
Men								
0	63	65	56	58	47	63	59	56
1–3	38	17	21	20	24	21	27	22
4 +	0	17	24	23	29	16	15	22
Women								
0	57	48	55	55	42	48	46	49
1–3	14	25	23	23	26	27	28	25
4 +	29	27	23	23	32	25	26	26
Flooded								
Men N	8[2]	23	72	66	76	38	34	317
Women N	7[2]	48	106	95	106	73	61	496

[1]In Health Survey for England: Number of respondents: Men 6802, Women 8254.
[2]18–24 age group for flooded households.

expected to arise in this retrospective data collection (Power undated). However, because being flooded is such a salient event for most people, respondents did not appear to have difficulty in reporting how their health was affected during and after the flooding. It was not possible within the scope of the survey research to test the reliability of the survey responses over time. However, in qualitative research which followed health effects that participants attributed to flooding over a four year period (Tapsell *et al.* 2003) participants showed good recall and were generally found to be consistent in their reporting. It was also not possible in this study to validate the self reported effects

Table 5 | Experience of flood trauma and PTSD Intensity score by the maximum depth of main rooms flooding and gender: flooded households

	None	<9 cm	10–39 cm	40–79 cm	>79 cm	All	Male	Female	Flood trauma	No Flood trauma
Experience of flood trauma	%	%	%	%	%	%	%	%		
Flood trauma	21	36	41	53	50	44	32	52		
No Flood trauma	79	64	59	47	50	56	68	48		
PTSD intensity score	%	%	%	%	%	%	%	%	%	%
0: no symptoms	47	27	23	15	11	21	27	16	4	35
1–20: very low	41	47	47	52	52	49	47	50	40	56
21–41: low	6	16	17	13	17	15	15	15	24	8
42–82: mild	3	8	9	13	12	10	7	12	20	2
83 or higher: moderate/high/extreme	3	3	4	7	8	5	3	7	12	*
Total										
Number of respondents	66	77	216	201	185	747	292	455	326	421
Mean PTSD intensity score	8.8	15.9	18.3	24.4	27.1	21.1	16.0	24.3	39.6	8.5

PTSD intensity score by maximum depth of main room flooding: Chi-square = 53.38; df = 16; $P < 0.001$
PTSD intensity score by gender: Chi-square = 18.49; df = 4; $P < 0.001$
PTSD intensity score by experience of flood trauma: Chi-square = 225.58; df = 4; $P < 0.001$
Experience of flood trauma by maximum depth of main room flooding: Chi-square = 30.82; df = 4; $P < 0.001$
Experience of flood trauma by gender: Chi-square = 30.82; df = 4; $P < 0.001$

against clinical records or to compare the results for the time of flooding with those from a control group. Thus, the survey data represent the beliefs of the survey respondents about the effects of the flooding on their health.

The retrospective use of the GHQ-12 to apply to the worst time of flooding constitutes a new and not yet validated approach that deserves further testing and validation. However, it is striking that two thirds of the flood victims were found by this measure to have experienced significant psychological distress (worst time GHQ-12 score of 4 +) at the time when their health was perceived by them to be most seriously affected by the flood event.

Current health effects

Other qualitative research that has followed up the flood victims over more than four years suggests that although the physical health effects resulting from floods appear to be relatively short lived, the psychological impact may be long lasting (Tapsell *et al.* 2003). This study shows that the majority of flood victims reported experiencing an improvement in their mental health and well-being as measured by the GHQ-12 since their worst time after the flooding. However, it was not possible, in this study to explore possible confounding factors that may have affected changes in health.

The proportion of high GHQ-12 scores for the flooded found at the time of the interviews some years after flooding in this study, were lower than those found for the flooded in Lewes at nine months after the flood event (4 + score: 25% compared with 48% in Lewes). The proportion with high worst time GHQ-12 scores, reflecting health in the weeks and early months after the flood in this study (64%) was higher than in Lewes. The differences in the time since the

Table 6 | Regression analyses: flooded households

Parameter	Unstandised coefficient B	Standardised Beta	t value	P
Multivariate regression analysis for GHQ-12 Likert score at the worst time				
N = 507, $R^2 = 0.26$, R^2 adj. = 0.24				
Constant	15.77		10.30	.000
Problems with insurers/ loss adjustors (rated on a scale no problem 0 to 10)	0.62	0.27	6.56	.000
Gender (M = 1, F = 0)	−2.24	−0.14	−3.55	.000
Prior health (1 = poor, to 5 = excellent)	−1.02	−0.14	−3.34	.000
Uninsured £ Losses (as ln (U + 1)	0.34	0.13	3.25	.001
Evacuation (No = 0, Yes = 1)	2.15	0.13	3.09	.002
Time to get back to normal (weeks)	0.04	0.12	2.89	.004
Contaminated of flood waters (Yes = 1, No = 0)	2.20	0.11	2.66	.008
Rented accommodation (No = 0, Yes = 1)	2.36	0.09	2.21	.027
Warning time ln (WT + 1)	−0.26	−0.09	−2.20	.028
Aged 65 + (Yes = 1, No = 0)	−1.26	−0.07	−1.71	.089
Multivariate Regression analysis for Currrent GHQ-12 Likert scores				
N = 733, $R^2 = 0.34$, R^2 adj. = 0.33				
Constant	9.51		10.95	.000
GHQ-12 Likert for worst time	0.34	0.50	15.55	.000
Prior health (1 = poor, to 5 = excellent)	−0.71	−0.14	−4.49	.000
Time to get back to normal (weeks)	0.01	0.08	3.31	.010
Area house prices (1 = high to 5 = low)	−0.26	−0.08	−2.44	.015
Problems with insurers/ loss adjustors (rated on a scale no problem, 0 to 10)	0.10	0.07	2.10	.036
Help received (0–50)	−0.05	−0.06	−1.89	.059
Multivariate regression analysis for PTSD Intensity scores (ln (PTSS + 1)				
N = 629, $R^2 = 0.26$, R^2 adj. = 0.24				
Constant	2.13		8.43	.000
Problems with insurers/ loss adjustors (rated on a scale: no problem, 0 to 10)	0.11	0.26	7.12	.000
Prior health (1 = poor, to 5 = excellent)	−0.27	−0.19	−5.40	.000

Table 6 | (*continued*)

Parameter	Unstandised coefficient B	Standardised Beta	t value	P
Gender (M = 1, F = 0)	−0.46	−0.15	−4.32	.000
Evacuation (No = 0, Yes = 1)	0.38	0.12	3.16	.002
Depth in cms (max. depth in main rooms)	0.0029	0.12	3.11	.002
Warning time ln (WT + 1)	−0.054	−0.10	−2.68	.008
Time to get back to normal (weeks)	0.0045	0.09	2.53	.012
Vulnerable housing (No = 0, Yes = 1)	0.44	0.09	2.31	.021
Contaminated of flood waters (Yes = 1, No = 0)	−0.33	0.08	2.27	.024
Aged 65 + (Yes = 1, No = 0)	−0.27	−0.08	−1.99	.047

event as well as differences in the flood events may account for this. For the non-flooded, the proportions with high GHQ-12 scores were similar (10% in this study compared with 12% in Lewes) (Reacher *et al.* 2004).

The findings of this study suggest that the effects of flooding on the mental health of some victims are enduring and not just short term. The reports of consultations and treatment for health effects attributed to flooding also suggest that floods add significantly to the burden placed on medical services, as well as potentially disrupting the capacity of health care systems to respond to health crises (Ohl & Tapsell 2000).

However, this study has several limitations. Undertaken with flood victims at least a year and in most instances some years after a flood event, the study is inevitably one of survivors: those who did not die or move away following flooding. There is a need for a large scale longitudinal study that will follow flood victims and appropriate controls from the first few weeks after flooding over a number of years and draw on clinical records and diagnoses to provide more systematic evidence of mental and physical health, morbidity and mortality over time as a result of flooding. In addition, such a study would be able to take into account confounding factors for mental ill health.

Factors influencing health and stress effects

This study examined a wide range of explanatory factors and the levels of explanation offered by the regression models that emerged (Table 6) were reasonable by social science standards. The variables in the models were not highly intercorrelated. All but two of the variables (age 65 + and area house prices) influenced the health scores in the expected direction. The models presented are conventional additive ones but the possibility of interactions and interdependence between some variables, for example, gender and prior health was considered in the analysis. Much of the variance in the health effects of flooding remained unexplained. Therefore, there is a need for further research to investigate other factors such as personality, life history and community characteristics, organization and support that may be influential.

Flood event characteristics

Varied flood events were included in the study to allow the effect of flood characteristics on health and stress to be examined in the analysis. Bivariate analyses showed that the worst time and the current GHQ-12 scores (Table 2), and the PTSD Intensity scores (Table 5) were significantly associated with the maximum depth of main room flooding which

ranged from 0–544 centimetres with a mean of 55 centimetres). However, depth of flooding played only a small part in explaining the health and stress effects in the regression analyses (Table 6). Some of the explanatory variables that were included, to some degree, reflected flood depth, for example, having to evacuate and length of time to get the house back to normal (Correlation between evacuation and disruption and the depth of main room flooding (Pearson Correlation 0.32 and 0.26 respectively). However, many variables apart from flood depth such as insurance cover, and the efficiency of insurers and builders may explain evacuation behaviour and length of time taken to recover from flooding.

The belief held by 77%, that the flood waters were polluted did feature as an explanatory variable in some models (Table 6). Studies have highlighted the fears and anxieties felt in the immediate aftermath of events such as flooding about the possible health risks, for example, from diseases such as hepatitis, typhoid and Weil's disease posed by exposure to contaminated flood waters. These anxieties can be exacerbated by late or conflicting advice or lack of guidance from the authorities regarding these concerns (Tapsell *et al.* 1999; Tapsell & Tunstall 2001).

The apparent insensitivity to the nature and magnitude of the stimulus, the flood event, suggests that individuals perceive and experience flood events of a given magnitude very differently. This is suggested by the way which individuals varied widely in the health and stress they experienced with similar depths of flooding (Table 2). It is clearly, therefore, important to include in studies measures of the subjective intensity of the individual's experience of the flood event.

Length of time since the flood event

There were very weak correlations between the months elapsed since the flooding and the PTSD Intensity and current GHQ-12 scores and there were slight but significant associations between these variables when grouped. However, the time elapsed in years since the flood event did not emerge as an explanatory factor in the regression analyses relating to current health and stress. This may be because much of the recovery in health occurred in the first year or two after the flood event not covered by our interviews.

Flood warnings

Only 23% of respondents reported receiving a warning of flooding in the study. A log transformed version of the variable for amount of warning time in hours was used in the regression analyses because of the large number of zeros for warning time. This had a small effect in reducing the health and stress impacts of flooding suggesting that investing in improvements to warning systems may yield some health benefits. Since the flood events of Easter 1998 in England and Wales, in which very few flood victims received any warning, major efforts have been made to enhance the flood warning dissemination system by the Environment Agency and a new Flooding Warnings Direct service is being launched in 2006 with a much greater capacity to deliver warning messages in a large-scale flood event using a wide range of communications channels such as the telephone, internet, e-mail, and mobile phone and text messages.

Socio-demographic factors

This research examined whether individuals with certain characteristics were more likely to be vulnerable to adverse health impacts from flooding as have other studies of disasters (Steinglass & Gerrity 1990; Buckle *et al.* 2000).

Gender. Research has shown that floods and other disasters can impact upon men and women in different and distinct ways (Enarson & Hearn-Morrow, 1998; Fordham 1998; Morrow 1999; Tapsell & Tunstall 2000). In this study, women suffered markedly more than men at the worst time of flooding. Qualitative research suggests that this is because women have the main responsibility for, and probably, a greater emotional investment in the home than men and also usually have the key responsibility for the care of children and the elderly in the home and for getting the home back to normal after a flood (Tapsell *et al.* 2003). Women may also be more ready to admit to feelings of stress, anxiety and depression and to seek medical help in the aftermath (Tapsell & Tunstall 2001).

Health status. A single self reported measure of respondents' health status prior to the flood event was used in the study (scale 1 = poor health, to 5 = excellent health). This

was a significant factor in both short and long term health and stress effects with those reporting poor prior health experiencing more serious health effects. Clearly this factor would warrant more detailed consideration in future studies.

Housing and social factors. The small category (11% of respondents) renting property experienced more health effects at the time of the flood than those owning or buying. Owning a home can be regarded as (and has been used in some deprivation indices) an indicator of income and economic resources that may help flood victims to cope with the effects of flooding. Furthermore, only 59% of renters compared with 92% of home owners had any form of contents insurance to help with replacing damaged items. The experience of recovering from flooding is different for property owners who have the responsibility but also control over putting their dwelling back in order while those renting are dependent on others to carry out structural repairs. Living in vulnerable housing (a ground floor flat, bungalow or caravan) as compared with housing with an upper floor for a refuge occupied by most (91%) of flood victims, had a small influence on stress levels experienced as a result of flooding.

Age. Finally, age had some influence albeit a very weak one. Counter-intuitively, but in line with some indications from qualitative focus group research (Tapsell *et al.* 1999; Tapsell & Tunstall 2000), those aged 65 and over had significantly lower worst time GHQ Likert scores than younger people (mean 16.67 compared with mean 18.64 for the younger people, $t = -3.36$, df 808, p .001). This age group, of course, covers a wide range of people from fit younger retirees to the very elderly. Whether the old people remaining in their homes after flooding are the survivors with others, more severely affected, having died, moved away or into residential care, or whether there are generational effects at work, many older people having gone through the trauma of the Second World War, is unclear. Furthermore, as there is an association between poor prior health and age, this variable may take account of the elderly in poor health.

Factors associated with the recovery period

Insurance issues. The results highlight the importance of what happens in the recovery period after a flood event to the anxiety and stress suffered even in the short term. They confirm what emerged in our qualitative studies (Tapsell *et al.* 1999; Tapsell & Tunstall 2000; Tapsell & Tunstall 2001) that the role of the insurance industry and way that its personnel deal with flood victims are crucial in mitigating or exacerbating the trauma of a flood. In the UK, the insurance industry rather than government has provided the main mechanism through which households and businesses are compensated for flood losses. Private insurance against flood losses has until recently been available to all households as part of general household structure and contents policies. However, as a result of recent severe flood events, the industry has begun to adjust its policy and has withdrawn its undertaking to provide universal flood insurance regardless of the risk. Problems with insurers and loss adjustors emerged as the most significant factors explaining the health and stress effects suffered after flooding. Having adequate insurance cover reduced stress, and incurring uninsured losses added to the health effects at the worst time.

Evacuation and disruption. The experience of 64% of flooded respondents in having household member(s) move out of the home, for example, to stay with relatives, in rest centres, in rented property, or confined in caravans in the front garden also added to the health and stress effects. Finally, the length of time it took to get the house back to normal after the flood (an average of 27 weeks but ranging from no time at all to 200 weeks) was another explanatory factor in which the efficiency of builders and insurers may play a part.

Social support. It is interesting that in this study, social resources in terms of the amount of help received from outside the home were only a very minor factor in longer term health effects (Current GHQ12). A score from 0–50 was computed for the amount of help received (scored from 0 = none, to 5 = all the help I needed) from ten different sources including family outside the home, neighbours, and local authorities. The mean score was 10 indicated that only

limited sources and amounts of help were involved. Informal sources of help: family, neighbours and friends rather than local authorities and other agencies were the main support cited. Qualitative studies in England show that flood victims often feel isolated and neglected by the authorities in the aftermath of flooding (Tapsell *et al.* 1999; Tapsell & Tunstall 2001).

Research from the United States has indicated that providing increased social support can significantly lower illness burdens after disasters (Lutgendorf *et al.* 1995). However, earlier studies of flooding in England, have not revealed any effects upon the impacts of flooding including the reported health and overall effects as a result of the extent and nature of social support received (Ketteridge & Green 1994).

CONCLUSIONS

This study provides sufficient evidence for locations in England and Wales that flooding has impacts on the physical health at the time of flooding and, more particularly, on the mental health of the flood victims in both the short and long term, to indicate that the topic merits further systematic investigation.

A complex set of social and other factors appear to be involved in the susceptibility of people to the health and stress effects of flooding. There is some evidence in the study that the way the aftermath of flooding is handled by community and professional agencies, for example, those responsible for flood warning, evacuation and guidance on water contamination can have a significant impact on mental health outcomes.

If in the future, flood events become more common and extreme, improving the services available to flood victims at the time of a flood event and in the recovery period may be important in improving their mental health and thence in reducing the burden on medical services. Penning-Rowsell *et al.* (2004) outlined a number of recommendations that arise from related research concerning pre-event planning in terms of warning provision, and post-event care of those who might suffer health deterioration in floods and their aftermath. Few of these recommendations have yet been built into flood preparedness planning, either in the UK or elsewhere, thus indicating the need for more coherent and 'joined up' strategies for flood impact minimization. It is certainly important for these strategies to take the health effects, particularly the mental health effects, of flood events seriously.

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