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Post-traumatic stress disorder in participants of foot-and-mouth disease epidemic control in Miyazaki, Japan, in 2010

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ABSTRACT. Foot-and-mouth disease (FMD) occurred in Miyazaki, Japan, in 2010, and 290,000 animals were culled. This paper describes the mental distress of the volunteers who had been dispatched to Miyazaki for disease control two years after the epidemic. It also assesses risk factors for post-traumatic stress disorder (PTSD). A participatory appraisal and self-administered questionnaire survey were conducted in 2012 for those who were dispatched to Miyazaki in 2010. The Impact of Event Scale-Revised (IES-R) was used as an indicator of PTSD, and univariate and multivariable analyses were performed. Of the 875 respondents, 1.3% had higher IES-R scores than the cut-off point (25), which is suggestive of PTSD. Mental stresses during and soon after FMD control and after two years were described. Four risk factors associated with high IES-R scores were found: transporting culled animals ($P<0.01$), stress during FMD control ($P<0.01$) and at the time of the survey ($P<0.01$), and lack of someone to talk to about FMD-associated stress at the time of the survey ($P<0.01$). Veterinarians, livestock technicians and clerical officers involved in FMD control still suffer from mental stress two years later. Public services should provide an opportunity for them to consult with mental health specialists. These findings should be used to better prepare workers who deal with infectious diseases of animals, especially when they must be culled. The establishment of a collaborative framework between veterinary and mental health services is recommended.

KEY WORDS: culling, foot-and-mouth disease, IES-R, mental health, Miyazaki, PTSD

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An outbreak of foot-and-mouth disease (FMD) caused by the serotype O-virus was confirmed in Miyazaki, Japan, on April 20, 2010. FMD is one of the most contagious diseases of mammals. The disease affects domestic cloven-hoofed animals as well as more than 70 species of wild animals, and is characterized by fever, lameness and vesicular lesions on the tongue, feet, snout and teats [4]. In order to retrieve FMD-free status [19], immediately after the first detection of the disease in Miyazaki, control measures, such as movement restriction, culling animals on FMD-detected farms and intensification of biosecurity measures, were implemented by the local authority. However, the affected areas were the most densely populated areas for both cattle and pig farms in Japan [6], and the number of infected premises rapidly increased. On April 26, veterinarians, livestock technicians and clerical officers dispatched from other prefectural governments, and the Japanese government, universities, the Japan Veterinary Medical Association, private companies and Farmers' Mutual Aid Associations started to participate in control of the disease. Emergency vaccination using O-type vaccine (O1 Manisa) was implemented between May 22 and 26, and a total of 126,000 animals on 1,066 farms were vaccinated [13], after which the FMD outbreak became controlled. Until the final occurrence on July 4 2010, 292 outbreaks were confirmed, and 288,649 animals, including vaccinated animals, on 1,304 farms were culled [12]. The total numbers of people dispatched to Miyazaki Prefecture for disease control from the government, prefectures, Self-Defense Force and police force were 14,500, 5,000, 18,500 and 28,000, respectively [12].

It is known that culling animals in controlling FMD epidemics affects the mental health of veterinarians and farmers who lose animals [3, 5, 14, 17]. However, quantitative psychological epidemiology had not yet been conducted on participants of FMD control program, and this would be the first report worldwide. The purpose of this study was to understand psychological epidemiology of veterinarians, livestock technicians and clerical workers dispatched from several institutes to Miyazaki for FMD control in 2010. In order to quantify the degree of stress, an indicator of post-traumatic stress disorder (PTSD), Impact of Event Scale-Revised (IES-R) [2] was used. Hereafter, the reasons of stress and risk factors for PTSD are described.

MATERIALS AND METHODS

Participatory appraisal: A participatory appraisal [10] was conducted in May 2012 for two hours, by one facilitator

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and three veterinarians who were dispatched to Miyazaki to control the FMD epidemic, to design a questionnaire. Prior to the appraisal, all three veterinarians were interviewed individually and were confirmed to have enough understandings on the stress from several different disease control activities in Miyazaki. In this appraisal, participants were encouraged to freely express their views about mental stress, and a facilitator recorded their descriptions on sticky-notes during the discussion. These descriptions were categorized into groups after the discussion and digitized using Microsoft Excel.

Questionnaire survey of mental health: As a pilot study, a self-administered questionnaire was designed based on the participatory appraisal results and was tested using five veterinary volunteers who were dispatched from prefectures other than Miyazaki for FMD control. A digitized, password-secured questionnaire was distributed through the Ministry of Agriculture, Forestry and Fisheries; the Ministry of Education, Culture, Sports, Science and Technology; prefectural governments; and the Japan Veterinary Medical Association (see Supplementary file 1). Questionnaires were collected electronically at the National Center for Psychiatry and Neurological Research between October and December 2012.

The contents of the questionnaire included personal attributes, affiliations, activities engaged in during the disease control, mental stress and whether the participant was able to talk to someone about the stress from the work. Intensity of mental stress at the time of the survey was measured using IES-R.

Impact of Event Scale-Revised (IES-R): IES-R is comprised of 22 items falling into three categories of PTSD associated symptoms (i.e., eight intrusion items, eight avoidance items and six hyperarousal items (see Supplementary file 2)). It evaluates the severity of stress on a 5-point scale (from 0 to 4) during the previous seven days. The IES-R is used as an indicator of PTSD, with its cut-off score between 24 and 25. When the total IES-R score exceeds the cut-off score and the scores of the above-mentioned three categories are high, it is suggestive of PTSD, whereas a high score in one or two of the three categories suggests partial PTSD which is still of clinical concern [2].

Statistical analysis: Statistical analyses were performed using statistical software R, version 3.0.1. In the univariate analysis of the IES-R scores at the time of survey in 2012, the effects of sex, participation in the different activities in FMD control, types of the farms engaged in, and having someone to talk to were tested using the Wilcoxon Rank Sum Test. The IES-R score was compared between age categories (20s, 30s, 40s, 50s and 60 years old) and between affiliation categories using Generalized Linear Models (GLMs) with quasi-Poisson errors. In the multivariable analysis, model simplification was performed using GLM with quasi-Poisson errors choosing the IES-R score as the response variable and factors with P value less than 0.2 in univariate analyses as explanatory variables.

The proportion of those who talked about stress among those who had stress was compared between different time points using Chi-square test.

Table 1. The affiliations of the respondents and mean IES-R score

Affiliations	Respondents	(%)	Mean IES-R	*P*-value
Government	486	55.5	2.4	–
Prefecture	353	40.3	3.5	<0.01*
University	24	2.7	3	0.6
Private company	4	0.5	7.3	0.06
Private veterinary clinics	4	0.5	0	0.98
Retired	4	0.5	0.3	0.5
Total	875	100		

*Statistical significance (P<0.05) compared to 'Government'.

RESULTS

Personal attribution and affiliations: The number of respondents was 875. The questionnaire was distributed electronically by the organizations dispatched their personnel, the number of people received it, and the response rate was unknown. Out of the total respondents, 1.3% (11 respondents) had intense mental stress (IES-R>=25). The respondents included 804 men (92.0%) and 70 women (8.0%). Female respondents had a significantly higher IES-R score (4.8) than males (2.7; P=0.02). Mean age was 45.8 years old, and the age group of 30−50 years old predominated. The mean IES-R scores were not significantly different among these age groups (P=0.27).

Table 1 shows respondents' workplace affiliations and mean IES-R scores. The majority of respondents were public officers: national government (55.5%) and prefecture (40.3%) employees. During the FMD outbreak, a large number of veterinarians belonging to Farmers Mutual Aid Associations participated in the disease control, but they did not participate in the present survey. P-values in Table 1 show the comparisons in the level of IES-R between 'Government' and the rest of the categories. Prefectural officers had significantly higher scores (3.5; P<0.01) compared to government officers, and there was no difference between government officers and the rest of the affiliations. Among the 486 government officers, 395 (81.3%) were clerical officers, who for the most part did not have a background in veterinary medicine or experience dealing with animals.

Transition in the reasons for distress before, during and after disease control: Before being dispatched to Miyazaki, the most common reason for mental stress was lack of information about the expected activities in Miyazaki (n=241, 27.5%). For some participants, the date of dispatch was changed (n=59, 6.7%), and 2.9% (n=25) had trouble with their home institutions about attending the FMD control effort.

Five stresses during FMD control were identified: chain of command, culling, human relationships, physical injury/accident, and restriction of activities due to biosecurity (Table 2). Confusion in the chain of command was noted frequently among respondents. The most common reason identified for mental stress was disrupted information transfer (25.0%). The other commonly experienced stresses were troubles with farmers (14.2%) and physical injuries and accidents of

Table 2. The reasons of mental stress during the FMD control (n=875)

The reasons of mental distress	Respondents experienced	(%)
A. Chain of command		
Disrupted information transfer on the tasks and schedules	219	25
Confusion in the chain of command in a farm during culling	161	18.4
Confusion among the national, prefectural and municipal chains of commands	134	15.3
B. Culling		
Troubles on the methods of culling	58	6.6
Mental or physical reactions refusing to cull animals	50	5.7
C. Human relationship		
Troubles in conversations with famers	124	14.2
Troubles during clinical FMD detection in farms vaccinated	100	11.4
Conflicts between participants except for yourself	55	6.3
Conflicts among participants at dinner time	54	6.2
Troubles cause by the difference of sex	39	4.5
Conflicts between a participant and yourself	32	3.7
Felt discriminated between veterinarians and livestock technicians	31	3.5
D. Physical stress		
Injury/accident of other participant	90	10.3
Injury/accident of yourself	6	0.7
E. Restriction of activities due to biosecurity		
Restriction in entrance to the hotel due to biosecurity	15	1.7
Restriction of communication with family/home institution	10	1.1
Restriction of the use of cloths and belongings	8	0.9

Table 3. Activity engaged during disease control and IES-R score (n=875)

	Number engaged in	(%)	Sex ratio	Mean IES-R		*P*-value
				Engaged	Others	
Culling	430	49.1	10	3.7	2	<0.01*
Disinfection of barns	326	37.3	20.7	3.4	2.5	<0.01*
Disinfection of vehicles [a)]	266	30.4	28.4	2.2	3.1	<0.01*
Burial	103	11.8	Only male	3.5	2.8	0.05
Epidemiological survey	47	5.4	3.7	4.5	2.8	0.3
Health check of animals	40	4.6	7	2.8	2.9	0.4
Transporting animals culled	38	4.3	37	4.6	2.8	0.04*
Vaccination	34	3.9	10.3	3.7	2.8	0.1
FMD diagnosis	34	3.9	7.5	2.2	2.9	0.1

a) Preventive factor. *Statistical significance (P<0.05).

other participants (10.3%).

Although not ranked high, 5.7% experienced mental or physical reactions resulted in refusal to cull animals. Stress due to gender difference was answered by 4.5% of the respondents. It was revealed that there was discrimination between veterinarians and livestock technicians, for example, priority in access to clothes or activities engaged in (3.5%). Restriction to assure biosecurity was stressful to fewer participants (Table 1E).

After returning home from Miyazaki, 27 respondents experienced indifference about the FMD outbreak in their home institution (3.1%, not shown in table). Twenty-one respondents (2.4%) felt anxiety due to fear of being a source of a new outbreak. Participants in FMD control were ordered to stay home for a week before returning to the office, and 19 respondents (2.2%) were stressed because of this. Some participants disclosed sensitive issues experienced during culling on the Internet, and 13 respondents (1.5%) were stressed from the thoughtless scandalization. Nine respondents commented in the free description section that they felt guilty about having killed animals.

Activities engaged in during the FMD control: Table 3 shows the activities engaged in during the disease control and IES-R scores. *P*-values show the test significance of IES-R scores between those who engaged in the activity and the others. The most common activities were culling (49.1%), disinfection of barns (37.3%) and disinfection of vehicles (30.4%). In terms of gender, female veterinarians tended to engage in activities not associated with culling, such as epidemiological surveys, animal health checks and

Table 4. Types of farms engaged in during the disease control and IES-R score (n=875)

Type of farm	Respondents		IES-R		*P*-value
	n	(%)	Engaged	Others	
Pig farm	454	51.9	3.2	2.4	<0.01*
Beef cattle integrated farm	444	50.7	3.4	2.2	<0.01*
Beef cattle breeding farm	402	45.9	3.7	2.2	<0.01*
Dairy farm	199	22.7	3.1	2.8	0.4
Goat farm	31	3.5	3.8	2.8	0.3
Sheep farm [a)]	9	1	0.7	2.9	<0.01*

a) Preventive factor. *Statistical significance (P<0.05).

FMD diagnosis (see lower sex ratios).

The activities significantly associated with high IES-R scores were culling (P<0.01), disinfection of barns (P<0.01) and transporting culled animals (P=0.04). Although the P-value was just above the significance level (P=0.051), mean IES-R score of those who engaged in burial of the animals slaughtered was notably high compared to those who did not. In contrast, disinfection of vehicles was associated with low IES-R scores (P<0.01).

In relation to workplace affiliations, common activities for government officers were disinfection of vehicles (n=250, 51.4%), disinfection of barns (213, 43.8%) and culling (143, 29.4%), whereas those activities for prefectural officers were culling (262, 74.2%), disinfection of barns (110, 31.2%) and interviews (40, 11.3%; data not shown in tables). The proportion of respondents engaged in culling was significantly higher among prefectural officers (74.0%) compared to government officers (29.4%, x^2=162.5, df=1, P<0.01). Among the activities listed in Table 3, the proportion of clerical officers among those who attended was highest for disinfection of vehicles (237/266, 89.1%), burial (80/103, 77.7%) and transporting culled animals (29/38, 76.3%; data not shown in tables).

Types of farms: Table 4 shows the types of farms engaged in during the disease control and mean IES-R scores. P-values show the test significance of IES-R scores between those who engaged in the activity and the others. Large proportions of respondents were at pig farms (51.9%), beef cattle integrated farms (50.7%) and beef cattle breeding farms (45.9%). The mean IES-R score was significantly higher among those who were at pig farms (3.2), beef cattle integrated farms (3.4) and beef cattle breeding farms (3.7) compared to those who were at other types of farms (2.4, 2.2 and 2.2, respectively; P<0.01). Among them, the highest IES-R score was for those who were at beef cattle breeding farms. The mean IES-R score was significantly lower among those at sheep farms (0.7) than those at other farms (2.9, P<0.01).

Mitigating effect of consultation for stress: At all time periods, respondents who had stress showed significantly higher IES-R scores than those without stress (P<0.01; Table 5). The proportion of respondents with mental stress was highest during FMD control (48.2%). Stress significantly decreased soon after finishing (37.6%, x^2=18.4, df=1, P<0.001) and even more so by the time of the survey in 2012 (11.5%, x^2=152.6, df=1, P<0.001).

Of those who had mental stress, the proportion who had someone to talk to about stress was not significantly different between the period of working on FMD control (63.4%) and soon after (66.6%, x^2=0.6, df=1, P=0.4). However, the proportion significantly declined from soon after finishing the FMD control work (66.6%) to the time of the survey in 2012 (43.3%, x^2=15.9, df=1, P<0.001), and the number of respondents with stress was greatly reduced in 2012 (Table 6). During and soon after FMD control, IES-R scores were not significantly different between those who had someone to talk to (4.1 and 5.2) and those who did not have (5.3; P=0.2 and 5.7; P=0.7, respectively). However, those who did not have someone to talk to had significantly higher IES-R scores (11.0) than those who had someone to talk to (6.6) in 2012 (P=0.04; Table 6).

Multivariable analysis results: A multivariable GLM included factors with the P value less than 0.2 in univariate analysis: being female; government and prefectural officers (private companies were excluded due to the small number); engaged in culling, disinfection of barns, disinfection of vehicles, burial of culled animals, transportation of culled animals, vaccination, and FMD diagnosis; worked at pig, beef integrated, and beef cattle breeding farms; experiencing stress related to FMD work during the epidemic, soon after, and in 2012; and did not have someone to talk to about stress in 2012.

Four risk factors remained in the final model: transporting culled animals, felt stressed during FMD control and at the time of the survey, and did not have someone to talk to about FMD-related stress at the time of survey (Table 7).

In order to better understand the reason why transporting culled animals was a risk factor for higher IES-R, the association of being a clerical officer as a confounding factor was further examined. The mean IES-R score of clerical officers (2.2) was significantly lower than that of the others (3.4; P<0.001, Wilcoxon Rank Sum test). However, among those who transported culled animals, the mean IES-R score of clerical officers (4.8, n=29) was not significantly different from the others (3.8, n=9; P=0.37). Removal of the factor of being a clerical officer from additionally performed multivariable GLM, selecting IES-R score as a response variable, and transporting culled animals (slope of log=0.67; P=0.01) and being a clerical officer (slope of log= –0.50; P<0.001) as explanatory variables changed the slope for transporting animals by 25.3% (slope of log=0.50, (0.67–0.50)/0.67=0.253), and this suggested moderate confounding for being a clerical officer.

DISCUSSION

This study investigated mental stress of veterinarians, livestock technicians and clerical officers dispatched to Miyazaki prefecture two years after attending the FMD control in 2010, in order to understand the long-term mental health effects of culling large numbers of animals. It is known that recovery from PTSD depends on individual resilience, and

Table 5. Mental stress related with FMD during, soon after disease control, and at the time of survey

Period	Had stress / responded	(%)	IES-R		*P*-value
			Had stress	No stress	
During FMD control	391/811	48.2	4.6	1.1	<0.01*
After FMD control	311/827	37.6	5.4	1.4	<0.01*
At the time of survey	97/843	11.5	9	2.1	<0.01*

*Statistical significance (P<0.05).

Table 6. Mitigating effect of talking about stress to someone

Period	Had someone to talk to / Had stress	(%)	IES-R		*P*-value
			Had someone	Did not have	
During FMD control	248/391	63.4	4.1	5.3	0.2
After FMD control	207/311	66.6	5.2	5.7	0.7
At the time of survey	42/97	43.3	6.6	11	0.04*

*Statistical significance (P<0.05).

Table 7. Multi-variable analysis results

Variable	Estimate	SE	*P*-value
(Intercept)	0.58	0.32	0.08
Transported animals culled	0.93	0.34	<0.01*
Had stress during FMD control	1.01	0.26	<0.01*
Had stress related with FMD at the time of survey	1.38	0.25	<0.01*
Did not have someone to talked to about stress at the time of survey	0.64	0.21	<0.01*

SE: stands for standard errors. *Statistical significance (P<0.05).

the symptoms can persist several years after the traumatic events among some individuals [11]. Moreover, delayed PTSD may appear in some individuals more than one year after such traumatic events [1].

Our study showed that 1.3% of the respondents had higher IES-R scores than the cut-off point suggesting PTSD, which might be caused by the stress of FMD control. Multivariable analysis identified four risk factors associated with high IES-R score, which endorsed the association between the stress in controlling FMD and poorer mental health status. Having FMD-associated mental stress during the disease control and at the time of the survey were risk factors for high IES-R score. In considering relieving such stress, talking to someone had a significant mitigating effect at the time of the survey. This has also been reported in the U.K. [17]. In our study, IES-R scores were not significantly different between those who had someone to talk to and those who did not during and soon after the disease control effort. This might be due to the common practice of disclosing stress while it is still intense, which has been shown from the data; a larger proportion of respondents talked to someone about their stress during (63.4%) and soon after the disease control (66.6%, Table 6). On the contrary, the majority of participants did not experience persistent effects after two years, and it might have become difficult to disclose this distress to others. Therefore, policy supports may be necessary for persistent or delayed PTSD cases caused by participating in FMD control.

Another risk factor in the multivariable analysis was transporting culled animals from the farms to burial yards. Additional statistics have shown the existence of a confounder, i.e., being a clerical officer. The mean IES-R score of clerical officers was significantly lower than the other volunteers. However, the task of transporting culled animals may have been highly stressful for the clerical officers who did not have experience of dealing with animals. From a personal communication with veterinary officers at Miyazaki Prefecture, it was found that the drivers of trucks transporting culled animals were hired drivers, but the clerical officers worked on loading and unloading carcasses. According to the qualitative statements reported in locally published reports, many cattle breeding farmers requested that culled cows and their calves be buried together and place an offering of *sho-chu* whisky and a wreath; the task, transporting culled animals involved continuous exposure of the clerical officers to the farmers' grief. Also, transporting culled animals from infected premises could potentially cause further spread of the FMD virus, and special attention to biosecurity may have caused high stress.

In interpreting the multivariable analysis results, a caution must be paid to the fact that culling animals was not a risk factor for a high IES-R score in this study. The intensive stress of culling animals among veterinarians in the FMD outbreak in Miyazaki in 2010 has already been described in several qualitative locally published reports. This distress was derived from the conflict with their vocational pride to

save animals, which has been reported from the FMD outbreak in the U.K. in 2001, as well [5, 15, 17]. On the other hand, all the veterinarians must have known that they would have to cull animals when they volunteered, and they might have been determined to some extent.

There are some factors which should not be ignored, among which were significant in univariate analysis, but did not remain in the multivariable results. Females have been reported to be susceptible to traumatic events in several papers [1, 2, 5, 9, 17], and in our participatory appraisals, it was mentioned that there were no separate changing rooms or gender-sensitive environments. Sex ratios in the activities engaged in during FMD control suggested that some considerations were paid to this. Regarding types of animals, being engaged in disease control at pig farms and beef cattle farms might have been difficult, because (1) the numbers of pigs were great and the screaming of animals was intense, where animal welfare could not necessarily be achieved, (2) dealing with large beef cattle poses the risk of physical injury and (3) small-scale beef cattle breeding farm workers have much affection toward the animals. Being engaged at sheep farms was a preventive factor; however, the numbers of sheep farms, and those who engaged in culling were not great, and culling them did not have a significant effect on the mental health of veterinarians.

In terms of methodology, the participatory appraisal was conducted with only three individuals. However, all these participants were well-informed and were considered as key-informants [10]. Therefore, findings from the appraisal were regarded to be robust. Regarding the questions associated with mental stress the participants experienced two years prior to the survey, there may have been recall bias, and this is a limitation. Another limitation is that a question regarding the stress of culling animal itself was not asked. In fact, some respondents provided such comments in the free comment section. However, this paper has provided detailed and useful records regarding the stress associated with FMD control. This was accomplished due to the timely collaboration between veterinary and psychiatry research teams. Such multi-sector collaboration is called One Health [7], which is critically important in control of zoonotic disease (diseases and infections that are naturally transmitted between vertebrate animals and humans [8, 18]). This study showed its practicability in the area of mental health as well. A manual for health practitioners in animal disease control was recently published in Japan [16]. We wish such collaborations would be adopted widely by veterinary and health authorities for better preparedness for non-zoonotic animal disease epidemics that involve culling animals for disease control.

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