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Analysis of factors associated with hesitation to restart farming after depopulation of animals due to 2010 foot-and-mouth disease epidemic in Japan

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ABSTRACT. An outbreak of foot-and-mouth disease (FMD) occurred in Miyazaki Prefecture, Japan, in 2010. This epidemic was controlled with culling and vaccination, and resulted in the death of nearly 290,000 animals. This paper describes the factors associated with hesitation to restart farming after the epidemic. A questionnaire survey was conducted to assess the mental health of farmers one year after the end of the FMD epidemic in affected areas, and univariate and multivariable analyses were performed. Of 773 farms which had answered the question about restart farming, 55.4% (428/773) had resumed or were planning to resume operation. The farms hesitated restarting were characterized by small scale (P=0.06) and having multiple sources of income (P<0.01). Personal attributes associated with hesitation to restart were advanced age of the owner (P<0.01), with someone with bad physical conditions (P=0.04) and small family size (P<0.01). Factors related to disease control during the epidemic that were associated with hesitation to restart were vaccination of animals (P<0.01), not assisting with culling on other farms (P<0.01), and higher satisfaction with information provided by the government (P=0.02). We found that farmers hesitated to resume farming because they had a limited labor force, had an alternative business or were mentally distressed during disease control.

KEY WORDS: culling, foot-and-mouth disease, mental health, restart farming

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Foot-and-mouth disease (FMD) virus causes a highly contagious disease in cloven-hoofed animals, including cattle, swine, wild boar, water buffalo, goats, sheep and some wild animals [2].

FMD is controlled mainly by culling animals that are infected or suspected of infection, because of its high contagiousness and great economic impact due to reduced productivity [6]. World Organisation for Animal Health (OIE) member countries can regain FMD-free status three months after slaughtering all animals with or without emergency vaccination, or when all vaccinated animals have not been slaughtered, six months after the last case or the last vaccination (Chapter 8.8, Article 8.8.7 −Recovery of free status) [21].

Culling of livestock during an epidemic causes a psychological impact on farmers, because such events are traumatic and emotionally shattering [4]. After the 2001 UK FMD outbreak, psychological effects were observed in farmers in affected areas: they reported negative feelings including distress, fear of a new disaster and loss of trust in the government and control measures [14, 18]. Affected farmers in the Netherlands in 2001 experienced post-traumatic stress; risk factors were identified as higher age and lower education [17].

The first FMD case in Miyazaki Prefecture was confirmed in a beef cattle reproduction farm on 20 April 2010. On 4 May 2010, FMD was confirmed in a large pig farm, and the number of cases rapidly increased. On 19 May 2010, vaccination with culling was announced by the Japanese Government, and vaccination began on 22 May 2010. The last case was detected on 4 July 2010 [19]. Ultimately, 292 premises were identified as infected, and about 290,000 livestock, including vaccinated animals, were slaughtered over a period of three months [19].

In June 2010, the Mental Health and Welfare Center in Miyazaki Prefecture performed a survey of farmers with infected animals to monitor their mental health. The survey used telephone interviews during the outbreak in order to avoid fueling the spread of FMD by farm visits from health workers [9]. One year after the end of the FMD epidemic, Miyazaki Prefecture assessed the health status of affected farmers via direct visits. The rate of restarting farming was reported to be 62% in 2013 [13]. The aim of the present study was to identify the factors associated with resumption of livestock farming after the 2010 FMD outbreak from the view point of farmers' characteristics including their mental health and farm characteristics. The findings of the present study will also benefit any country that wishes to improve preparedness for infectious disease outbreaks in animals.

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MATERIALS AND METHODS

Study areas: This study was conducted in the affected areas during the 2010 FMD epidemic, including Kawaminami, Kijo, Miyazaki, Saito, Shintomi, Takanabe and Tsuno in Miyazaki Prefecture, Japan (Fig. 1).

Questionnaire survey: Between August 2011 and January 2012, health workers from city and town council offices visited all farms in the study areas who lost animals either because their premises were infected or their animals had to be vaccinated. In the epidemic, not only cattle and pig but also goat, sheep, boar and water buffalo were slaughtered. In this study, the farms which health workers from city and town council offices visited were cattle, pig and boar farms. During these visits, farmers were interviewed using a structured questionnaire. All of the responses were recorded on paper by interviewers and were digitized into a spreadsheet (Microsoft® Excel).

The questionnaire was jointly designed by health and veterinary professionals, in order to understand farmers' mental health status, factors associated with severe mental illness (SMI) and factors associated with hesitation to restart farming. The scope of the questions included personal attribution, types and characteristics of farm operations, whether the farm was an infected farm or a vaccinated farm, occurrence and control of FMD, status of resumption of farming, socio-economic status, and physical and mental health status (Table 1). The questionnaire included questions about the level of satisfaction ("dissatisfied very much"=1 to "satisfied very much"=5) with the information and support provided by the government during the epidemic on how to prevent FMD and financial supports (see Supplementary Table 1).

Ethics were examined and approved by the ethical committee of the National Center of Neurology and Psychiatry (number A2014-155).

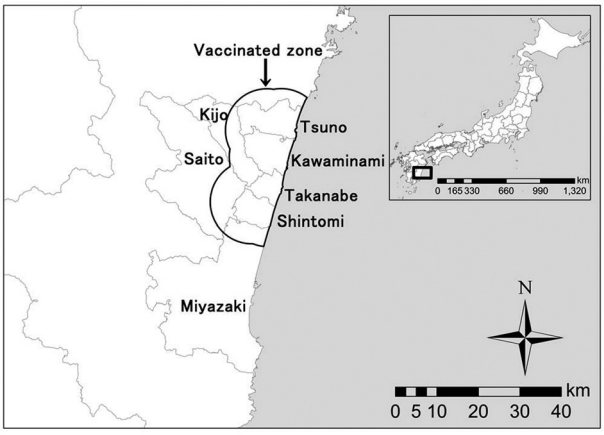

Fig. 1. A map showing administrative units in Miyazaki Prefecture where this study was conducted, and vaccinated zone.

Measurement of mental stress: The status of mental distress was assessed by the Japanese version of the Kessler (K6), which is an internationally used assessment scale of mental health status. Assessment using K6 is based on the answers to six questions about depressive and anxiety symptoms that a person experienced [7]. Each scored on a five-point scale ("none of the time"=0 to "all the time"=4). The total score can range from 0 to 24, and the cut-off point for SMI is 13. This cut-off point equalizes false positives and false negatives, with a sensitivity of 0.36 and a specificity of 0.96 [8]. The Japanese version has been already standardized [3].

Data cleaning and integration of individual-level responses into farm-level data: Data cleaning was performed,

Table 1. Contents of the questionnaire

Categories	Contents	Name of model which includes
Personal attribution	Administrative unit	All model
	Name, age and sex of respondents, family structure and farm owner	Personal attributes model
Farm operation	Animal species, farm size, type of operation and number of employees	Farm characteristics model
	Status of restarting farming	Response variable
Occurrence and control of FMD	Status of farm as to infected or vaccinated	FMD model
	Date and place of occurrence, vaccination, culling and burial	FMD model
	Existence of supporter during outbreaks	FMD model
	Participation or attendance in culling	FMD model
	Farmer's satisfaction on the provision of information by the government during the outbreak[a)]	FMD model
Socio-economic status	Farmer's satisfaction on the financial support for restoration from the government[a)]	FMD model
	Farmer's difficulties in economic conditions and human relationships	Personal attributes model
Physical health	Physical health problems	Personal attributes model
	Emerged health problems after FMD outbreaks	Personal attributes model
Mental health	Psychological health problems	Personal attributes model
	Emerged health problems after FMD outbreaks	Personal attributes model
	K6[b)]	Personal attributes model

a) This score ranges from 1 to 5 (dissatisfied very much=1 to satisfied very much=5). b) K6 is assessment scale of mental health status. The total score can range from 0 to 24, and higher score indicates severe mental stress.

because of inconsistencies in the answers from some farmers. Contradictions were observed between answers associated with physical or mental health and the farmers' own descriptions of their stresses. To keep the dataset consistent, answers that were responded later in the interview were regarded to be correct, and those that were responded early in the interview were carefully amended, because it was generally assumed that respondents became comfortable enough to disclose problems later in the interview. The free comment, which was the final question, was considered to be the most reliable source for data cleaning. Interviews were sometimes conducted with several individuals in a household, because the primary purpose of the interviews was to monitor the mental health status of individuals in affected farming households. In such cases, digitized individual-level data were integrated into representative responses at the farm level. During this process, two sections in particular were carefully dealt with. For the integration of responses about satisfaction with the information and support provided by the government, farm owners' answers were used, because the owner's intention should be the most influential factor in restarting a business. When an owner was not interviewed, an answer with lower satisfaction was selected. The integration of individual K6 scores into a farm-representative score was carried out by using the highest score (poorest mental health status) among the respondents as the farm K6 score; this was done, because poor mental health status of any individual in a household might affect the decision at the farm level to restart farming.

Statistical analysis: Statistical analyses were performed to reveal the associations between the restart of farming and factors associated with disease control during the epidemic, farm characteristics and personal attributes. In the univariate analysis, the Wilcoxon rank sum test was performed to compare counts and score data between farms that did and did not restart operation. The chi-squared test, Fisher's exact test and generalized linear models (GLMs) were used for the categorical data to compare proportions of farms that did and did not restart. Significant farm characteristics factors were further examined for the association with administrative units using GLMs.

In multivariable analysis, a logistic regression model was used; status of restarting or not restarting farming was used as a response variable (restarting: 1 and non-restarting: 0), and variables with P values less than 0.2 in the univariate analyses were used as explanatory variables. Collinearity was checked for all the combinations of these explanatory variables with the cut off correlation coefficient 0.9; no collinearity was found among these variables. As there was a significant difference in the proportion of restarted farming between city-township administrative units (see Results), intra-class correlation should have been dealt with statistics assigning hierarchical structure, such as a mixed effects model. However, as the numbers of both administrative units and explanatory variables were many, and mixed effect models do not converge, GLMs were used with administrative units included as one of explanatory variables adjusting intra-class correlations.

Explanatory variables were classified as factors associated with disease control during the epidemic, farm characteristics and personal attributes, and three multivariable models were developed for these factors: FMD model, farm characteristics model and personal attributes model. Moreover, the farm characteristics and personal attributes models were subdivided into three models using data from all farms, cattle farms and pig farms, because farmers' feelings and stress responses to the epidemic were thought to differ depending on these circumstances. For farm types, beef cattle fattening (feedlot) and integrated (integration of cow-calf and feedlot operations) farms were combined as feedlots for analysis, because published sociological studies reported that farmers in cow-calf operations had higher stress levels than did those in fattening and integrated-management farms [11]. Although the variable of poor physical condition did not have a P value less than 0.2 in the univariate analysis, this item was included in a personal attributes model, because it best represented farm owners' or family members' physical conditions.

Backward stepwise simplification was performed using likelihood ratio test to test whether the new simpler model was significantly worse regarding the description of data. Looking down the list of parameter coefficient and P value, the variable which had highest P value was removed and was tested whether removing variable significantly changes the deviance. This simplification was conducted for each multivariable model until P values of the remaining factors became less than 0.05. Finally, a generalized mixed-effects model with binomial errors was performed to estimate more precise coefficients in final models, selecting the restarting status of a business as a response variable, the significant variables estimated in the each multivariable model as explanatory variables and the administrative units as a random effect.

To better understand the associations remaining in the final multivariable model, associations between owner's age and physical condition and between owner's age and farm size were additionally tested using both the Wilcoxon rank sum test and Spearman's correlation test. All analyses were conducted using the computer software R, version 2.15.2 (R Foundation for Statistical Computing, Vienna, Austria), and package lme4 was used for mixed effect model.

RESULTS

Summary statistics: Of 1,358 affected farms, 782 (57.6%) participated in our study; of these, 212 were infected, and 566 were vaccinated farms. Four farms did not provide information on the status of infection (Table 2). Most participating farms (698; 152 infected, 542 vaccinated and 4 unknown) were cattle farms; only 80 were identified as pig farms.

Of 782 farmers, 55.4% (428/773) restarted or were planning to restart business. Nine farms didn't provide information regarding the status of resumption. The proportions of farmers who restarted or were planning to restart according to animal species raised were 54.8% (379/692) in cattle, 60.3% (47/78) in pigs, 50.0% (1/2) in farms raising both cattle and pigs, and 100% (1/1) in a boar farm. According to K6 score, only one cattle farmer (1/782, 0.1%) had SMI at

Table 2. The number of farms participated according to the characteristics of farms

	Infected farms (%)	Vaccinated farms (%)	Unknown (%)[a)]
Cattle farms			
Dairy	13 (1.7%)	22 (2.8%)	0 (0.0%)
Beef reproduction	102 (13.0%)	460 (58.8%)	4 (0.5%)
Fattening	18 (2.3%)	16 (2.0%)	0 (0.0%)
Integrated	10 (1.3%)	13 (1.7%)	0 (0.0%)
Unknown[b)]	9 (1.2%)	31 (4.0%)	0 (0.0%)
Total	152 (19.4%)	542 (69.3%)	4 (0.5%)
Pig farms			
Reproduction	15 (1.9%)	6 (0.8%)	0 (0.0%)
Fattening	5 (0.6%)	4 (0.5%)	0 (0.0%)
Integrated	30 (3.8%)	11 (1.4%)	0 (0.0%)
Unknown[b)]	8 (1.0%)	1 (0.1%)	0 (0.0%)
Total	58 (7.4%)	22 (2.8%)	0 (0.0%)
Cattle and pigs	2 (0.3%)	1 (0.1%)	0 (0.0%)
Boar	0 (0.0%)	1 (0.1%)	0 (0.0%)
Grand total	212 (27.1%)	566 (72.4%)	4 (0.5%)

a) Status of farms as to infected or vaccinated was not provided. b) Category of farms was not provided.

Table 3. Univariate analysis results for administrative units

Township	Restarted	Not-restarted	Proportion of restart (%)	Coefficient	*P*-value
Kawaminami	164	104	61.2	Reference	-
Kijo	43	20	68.3	0.31	0.30
Miyazaki	30	6	83.3	1.15	0.01
Saito	4	62	6.1	−3.20	<0.01
Shintomi	117	40	74.5	0.62	<0.01
Takanabe	45	22	67.2	0.26	0.37
Tsuno	25	91	21.6	−1.75	<0.01

the time of the survey; the other farmers (781/782) did not.

Results of statistical analysis: Table 3 shows the resumption of farming according to administrative units. The proportions of restarted farms in Saito ($P<0.01$) and Tsuno ($P<0.01$) were significantly lower than in Kawaminami, which was the center of the epidemic. On the other hand, the proportions of restarted farms in Miyazaki and Shintomi were significantly higher than in Kawaminami ($P<0.01$).

1. Results of the FMD model −univariate analysis: Table 4 shows the results of univariate analyses of categorical data for factors associated with disease control during

Table 4. Univariate analysis for categorical data on disease control during the epidemic

Contents of question	Restarted	Not-restarted	Proportion of restart (%)	*P*-value
Farm status in the outbreak				
Infected farm	145	63	69.7	<0.01
Vaccinated farm	282	281	50.1	
Help slaughtering at other farms				
Helped	76	22	77.6	<0.01
Not helped	321	308	51.0	
Observation of slaughtering				
Observed	110	76	59.1	0.19
Not observed	287	252	53.2	
Place for slaughter				
In farm	191	102	65.2	<0.01
Outside farm	24	15	61.5	
Communal burial place	190	218	46.6	
Both in farm and communal burial place	5	2	71.4	
Place for burying				
In farm	60	32	65.2	<0.01
Outside farm	65	33	66.3	
Both in and outside farm	3	0	100	
Communal burial place	279	272	50.6	
Both in farm and communal burial place	2	0	100	
Someone to talk to about FMD				
Existed	173	71	70.9	<0.01
Not existed	229	242	48.6	
Supporter in the epidemic				
Existed	268	170	61.2	<0.01
Not existed	117	128	47.8	
Trouble with their business and finance				
Troubled	187	106	63.8	<0.01
Not troubled	218	222	49.5	

Table 5. Univariate analysis for categorical data on farm characteristics

Contents of question	Restarted	Not-restarted	Proportion of restart (%)	*P*-value
Species of livestock				
Cattle	379	313	54.8	0.74
Pig	47	31	60.3	
Cattle and pig	1	1	50	
Boar	1	0	100	
Type of operation (cattle farm)				
Beef reproduction	285	276	50.8	<0.01
Fattening and integrated	43	14	75.4	
Type of operation (pig farm)				
Reproduction	12	9	57.1	0.96
Fattening and integrated	30	19	61.2	
Business style of farming				
Source of income from only farming	207	91	69.5	<0.01
Multiple sources of income	200	225	47.1	
Farm management types				
Family-owned farm	383	318	54.6	0.03
Corporate farm	29	10	74.4	

Table 6. Univariate analysis for count data on characteristics of family and farms

Contents of question	Restarted (95 percentile)	Not-restarted (95 percentile)	*P*-value
Family size	3.8 (1–8)	3.2 (1–5)	<0.01
Number of generation in a family	2.1 (1–3)	1.9 (1–3)	<0.01
Age of owner	58.8 (31–79)	64.9 (39–84)	<0.01
Number of cattle in a farm	50.2 (1–410)	49.0 (2–291)	<0.01
Number of pigs in a farm	2,249.9 (7–6,406)	777.4 (333–4,700)	<0.01
Number of non-family employee	0.3 (0–4)	0.04 (0–0)	<0.01

the epidemic. Factors significantly associated with hesitation to restart farming were vaccinated farm ($P<0.01$), not having helped slaughtering at other farms during the FMD epidemic ($P<0.01$), slaughtering and burying animals in a communal burial place ($P<0.01$), having no one with whom to talk about stress from FMD or no supporter during the epidemic ($P<0.01$), and not being troubled by business matters and finances after the epidemic ($P<0.01$). On the question regarding satisfaction with information provided by the government during the outbreak, farmers who resumed farming scored lower than those who did not (1.1 vs. 1.5, $P<0.01$, not shown in Table 4).

2. Results of the farm characteristic model −univariate analysis: Table 5 shows the results of univariate analyses of categorical data for factors associated with farm characteristics. The factors significantly associated with hesitation to restart farming were beef reproduction farms ($P<0.01$), multiple sources of income ($P<0.01$) and family-owned farms ($P=0.03$). In order to understand why restarting rate was low in Saito City (6.1%) and Tsuno Town (21.6%, see Table 1), additional analyses were conducted for these three factors. In the GLM choosing Saito City as the reference, the proportion of farmers with multiple source of income in Saito City (81.4%) was not significantly different from Miyazaki City (62.9%, $P=0.051$) and Tsuno Town (78.7%, $P=0.7$), but was higher than all the other towns and cities (mean 51.8%, $P>0.05$). There was no significant difference between Saito City and Tsuno Town, and the other towns and cities in the proportions of beef reproduction farms and family-owned farms ($P>0.05$).

3. Results of the personal attribute model −univariate analysis: Table 6 shows the results of univariate analyses of count data for family and farm characteristics. Factors significantly associated with hesitation to restart farming were smaller family size ($P<0.01$), smaller number of generations in a family ($P<0.01$), increased age of owner ($P<0.01$), smaller number of cattle ($P<0.01$), smaller number of pigs ($P<0.01$) and smaller number of non-family employees ($P<0.01$).

Table 7 shows the results of univariate analyses of categorical data for factors associated with personal attributes. Personal attributes significantly associated with hesitation to resume farming were feeling no distress ($P<0.01$), having no trouble with personal relationships during and after the epidemic ($P=0.01$), better psychological condition ($P<0.01$) and having an illness at the time of the interview ($P=0.01$). The K6 scores of farmers who did not resume farming (mean=0.73) were not significantly higher than those of farmers who did resume farming (mean=0.58, $P=0.9$; not shown in the table).

Table 7. Univariate analysis for categorical data on personal attributes related factors

Contents of question	Restarted	Not-restarted	Proportion of restart (%)	*P*-value
Sex of owner				
Male	401	312	56.2	0.16
Female	27	32	45.8	
Dissatisfaction on current job				
Dissatisfied	10	7	58.8	0.87
Not dissatisfied	355	305	53.8	
Distress				
Distressed	120	69	63.5	<0.01
Not distressed	247	243	50.4	
Trouble with family member				
Troubled	102	88	53.7	0.74
Not troubled	306	246	55.4	
Illness of family member				
Illed	66	52	55.9	0.87
Not illed	332	276	54.6	
Trouble between family members				
Troubled	8	6	57.1	1
Not troubled	384	320	54.5	
Trouble with child rearing				
Troubled	4	7	36.4	0.24
Not troubled	389	320	54.9	
Trouble in caring old and disabled family member				
Troubled	24	22	52.2	0.85
Not troubled	370	305	54.8	
Trouble with personal relationships				
Troubled	90	48	65.2	0.01
Not troubled	315	286	52.4	
Trouble with neighborhood				
Troubled	52	32	61.9	0.12
Not troubled	326	297	52.3	
Physical condition				
Bad	320	255	55.7	0.77
Better	100	85	54.1	
Psychological condition				
Bad	257	156	62.2	<0.01
Better	158	181	46.6	
Death of family member within a year after outbreak				
Died	11	16	40.7	0.17
Not died	417	329	55.9	
Previous illness				
Had	199	166	54.5	0.27
Did not have	209	146	58.9	
Present illness				
Had	216	201	51.8	0.01
Did not have	196	122	61.6	

4. Results of multivariable analysis: In the FMD model, the factors associated with hesitation to restart farming were higher level of satisfaction with the information from the government (slope=−0.20, SE=0.09, P=0.02), not having helped animal slaughter at other farms during the FMD epidemic (difference of logit=−1.00, SE=0.31, P<0.01) and being vaccinated farms (difference of logit=−0.73, SE=0.24, P<0.01) (Table 8).

For all farms in the farm characteristics model, the factors associated with hesitation to restart farming were small scale (slope=0.0004, SE=0.0002, P=0.06) and having multiple sources of income (difference of logit=−0.59, SE=0.18, P<0.01). For cattle farms, the factor associated with hesitation to restart farming was a smaller number of cattle in the farm (slope=0.02, SE=0.004, P<0.01). Similarly, for pig farms, a smaller number of pigs were associated with hesitation to restart farming (slope=0.0006, SE=0.0003, P=0.02) (Table 8).

For all farms in the personal attributes model, the factors associated with hesitation to restart farming were smaller family size (slope=0.16, SE=0.06, P<0.01), higher age of the owner (slope=−0.04, SE=0.008, P<0.01), better psychological status (difference of logit=−0.46, SE=0.2, P=0.02) and poor physical condition (difference of logit=−0.54, SE=0.26, P=0.04). For cattle farms, the factors associated with hesitation to restart farming were smaller family size (slope=0.14 SE=0.06, P=0.01) and higher age of the owner (slope=−0.04, SE=0.009, P<0.01). For pig farms, the factors associated with hesitation to restart farming were smaller family size (slope=0.34, SE=0.14, P=0.02), better psychological status (difference of logit=−1.36, SE=0.64, P=0.03) and poor physical condition (difference of logit=−3.60, SE=1.19, P<0.01) (Table 8).

Additional statistics revealed a significant correlation between small farm size and higher age of the owner for both cattle (rho=−0.34, P<0.01) and pig farms (rho=−0.32, P<0.01). Moreover, the age of owners with poor physical condition (mean=63.0 years) was significantly higher than that of owners with good physical condition (mean=57.2 years), suggesting that poor physical condition and higher age are statistically related.

DISCUSSION

Locally and internationally published reports of the impact of FMD outbreaks are mostly related to economic losses. However, affected farmers also experience mental distress due to loss of their animals [18], and studies of this problem are still scarce. Our questionnaire survey revealed three factors associated with hesitation to restart farming: (1) mental distress caused by the disease epidemic, inadequate support, and conflicts with other farmers and associated organizations during FMD control, (2) limited capacity in small farms of elderly owners with physical health problems and (3) farmers' degree of intensity toward livestock farming.

Several causes of distress as well as relief for the farmers were identified by the survey. A locally published paper also described substantial daily stress caused by anxiety and fear of their farms becoming infected with FMD virus, and sadness and fear caused by culling animals on infected farms [9]. However, according to the multivariable model, vaccinated farms hesitated to resume farming rather than infected farms. Vaccinated farmers suffered from sadness,

Table 8. Results of multivariable analysis for three models

Model	Variable	Coefficient	SE	*P*-value
FMD model	All farm			
	Level of satisfaction on the information from the government	−0.20	0.09	0.02
	Not helping slaughtering at other farms	−1.00	0.31	<0.01
	Being vaccinated farms as compared to infected farms	−0.73	0.24	<0.01
Farm characteristics model	All farm			
	Number of livestock in a farm	0.0004	0.0002	0.06[a)]
	Multiple source of income	−0.59	0.18	<0.01
	Cattle farm			
	Number of cattle in a farm	0.02	0.004	<0.01
	Pig farm			
	Number of pigs in a farm	0.0006	0.0003	0.02
Personal attributes model	All farm			
	Family size	0.16	0.06	<0.01
	Age of owner	−0.04	0.008	<0.01
	Having better psychological condition	−0.46	0.2	0.02
	Having bad physical condition	−0.54	0.26	0.04
	Cattle farm			
	Family size	0.14	0.06	0.01
	Age of owner	−0.04	0.009	<0.01
	Pig farm			
	Family size	0.34	0.14	0.02
	Having better psychological condition	−1.36	0.64	0.03
	Having bad physical condition	−3.60	1.19	<0.01

a) This factor couldn't be removed from final model, because deviance was significantly different. Positive value of coefficient shows association with restart, while negative value hesitation.

because healthy and non-infected animals had to be culled due to the disease control [9]. Some older farmers misunderstood that animals would not be culled after vaccination [9]. Vaccination was conducted on 1,066 farms in only four days, and informed consent might be insufficient for farmers because of the limited time. Moreover, farmers who had vaccinated their animals felt a sense of unfairness compared to those who had not vaccinated. In principal, both infected and vaccinated farms were fully compensated for the lost animals based on the market value of animals by the government. However, vaccinated farms and infected farmers not participating in the Agricultural Insurance Scheme received 100% of the market value of animals, while infected farms participating in the insurance scheme did 120% [16]. For the infected farms, 80% of the value was compensated from the national government by the Act on Domestic Animal Infectious Diseases Control, and if participated in the insurance scheme, 20% of the value was paid as insurance money. However, as non-insured farms could not receive the insurance money, special allocation tax equivalent to 20% of the value was paid from the prefectural government to both insured and non-insured infected farms; eventually insured infected farms received 120% of the value of lost animals. For vaccinated farms, 100% of the value of lost animals was compensated from the national government by the Act on Special Measures Concerning FMD, which was issued just after the start of vaccination. These vaccinated farms did not receive insurance money.

As for other causes of distress, conflicts with rice- and crop-producing farmers were also concerned. A previous report suggested that rice- and crop-producing farmers complained that livestock farmers were compensated for losses incurred by the restriction of movement, but they were not [11]. Moreover, the magnitude of epidemic seemed to affect the restarting their business. The first case of FMD was detected in Tsuno Town, and Kawaminami Town was the epicenter of the epidemic [15]. The devastating damage in these areas might lead to the low restarting rate.

On the other hand, two factors associated with relief from the distress of the FMD epidemic were found to have encouraged resumption of farming. Farmers who had someone to talk to about their stress during the FMD epidemic resumed farming significantly more often than those who did not. The therapeutic effect of discussing one's own emotions has been reported among veterinarians who participated in FMD control [5], as well as among the evacuees after the Great East Japan Earthquake [10]. Another relieving factor was participation in animal depopulation on other farms after one's own animals were culled. During the epidemic, the Miyazaki Prefectural Government employed farmers whose animals had been slaughtered to assist with depopulation activities on other farms [9]. Farmers were likely able to share their experiences and feelings, alleviating their distress.

Multivariable analyses showed that advanced owner age, small farm size and poor physical condition were factors associated with hesitation to restart farming. Additional analyses suggested that older owners with small farms and poor physical condition gave up farming. Farmers do not have a

labor force to help run the farm when the owner and family members are physically ill. In Miyazaki Prefecture, 70% of the agricultural work force was over 60 years old [12], and a lack of successors was also associated with elderly farmers not restarting farming. Larger family size was associated with resumption of farming; this can be explained by the similar hypothesis that higher capacity (sufficient labor force and financial resilience) was a prerequisite for resumption of farming.

Psychological illness among farm owners and/or family members was associated with resumption of farming. It is possible that those who resumed farming recalled their experiences from FMD epidemic in the course of everyday farming activities, while those who did not resume farming were not exposed to activities associated with past tragedy. It implies that farmers still remain psychological distress even after one year past the epidemic. Meanwhile, K6 scores higher than the cut-off point, which is the measure of SMI, were not associated with resumption of farming. Because K6 score is a screening tool for SMI and is more suitable for the acute phase of a tragic event [10], in the present survey conducted one year after the epidemic, K6 might fail to pick up less severe but persisting psychological illness which the respondents had. Thus, the Impact of Event Scale-Revised instrument, which is used to detect post-traumatic stress disorder [1], might have been better for this study.

Farmers' dedication to their businesses seemed to positively influence resumption of farming. Our results showed that the level of satisfaction with the information provided by the government during the epidemic had a significant negative association with resumption of farming. According to our previous investigation to farmers and the locally published paper [9], two main frustrations among farmers against the government during epidemic were lack of information on exact geographical locations of infected farms and effective disinfectants against FMD virus. Highly motivated farmers who resumed farming might particularly have had such frustration, although there are no supporting scientific data available to test the hypothesis. Farmers who relied only on livestock farming had a higher restarting rate than those with multiple sources of income; this fact also supports the hypothetical association between attitude towards farming and resumption of farming. According to farmers and field veterinarians, many livestock farmers with multiple farming activities, including rice and crop cultivation, shifted to less risky crop production after the epidemic (personal communication). Our results also showed that the restarting rate was the lowest in Saito City, where the proportion of farmers with multiple source of income was high.

The present study shows that hesitation to restart farming after animal depopulation due to an FMD epidemic is caused largely by mental distress, but also by a lack of capacity and resources (even with economic support from the government) and by degree of intensity toward livestock farming. Our results indicate that three kinds of support may effectively encourage farmers to restart: relief of mental distress at the time of the epidemic, maintenance of economic security, and improved and regular provision of information on disease prevention for greater biosecurity. This paper highlights farmers affected by the FMD epidemic; however, another study reported that local restaurateurs who lost customers wishing to avoid fueling the spread of disease were economically and psychologically most affected during and after the epidemic [20]. Public services should consider coordinating different sectors to improve preparedness for future disasters caused by highly contagious animal diseases.

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