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Long-Term Prevalence of Disaster-Related Deep Vein Thrombosis in Minamiaso Village After the 2016 Kumamoto Earthquakes: A Prospective Cross-Sectional Analysis

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Abstract

Objective: This study aimed to examine the prevalence of deep vein thrombosis (DVT) among evacuees in Minamiaso, a village which was temporarily isolated after the earthquakes, from the acute to recovery phase after the 2016 Kumamoto Earthquakes (GLIDE no: EQ-2016-000033-JPN).
Methods: This prospective study, which was approved by Fukui University Medical Research Ethics Committee (approval no. 20160024 and 20160089), enrolled 181 evacuees (73.9 ± 11.6 y) who participated in a series of 3 DVT screenings using portable ultrasound machines conducted over 19 mo. All participants completed a questionnaire before the screenings, and none of the participants attended all 3 screenings. Data analysis was performed using EZR version 1.41.
Results: The DVT prevalence was 14.3% (79.4 ± 8.2 y) at first screening of evacuees staying in shelters and 18.5% (71.5 ± 13.1 y) and 12.2% (72.8 ± 10.9 y) in second and third screenings of evacuees staying in temporary housing, respectively. Multivariate analysis revealed age ≥75 y and alcohol consumption as independent risk factors in the entire cohort and in patients aged ≤74 y, respectively.
Conclusions: A high DVT prevalence over a long time period of 19 mo was observed where survivors were temporarily isolated after the disaster.

Minamiaso, a village located approximately 34 km northeast of Kumamoto City (Figure 1), has a population of approximately 10,000, with 36.6% of the population aged ≥65 y, and agriculture and forestry are 2 main industries. The 2016 Kumamoto Earthquakes (GLIDE no: EQ-2016-000033-JPN) with a maximum seismic intensity of 7.0 occurred on April 14 and 16, 2016, and caused significant damage to the Kumamoto region.[1,2] In Minamiaso, the earthquakes caused 23 deaths, including 7 disaster-related deaths, and 23 serious or minor injuries; 1650 houses were partially damaged or destroyed.[1,2] A total of 2688 evacuees were forced out of their homes and into disaster shelters.[2] The situation in Minamiaso was critically different from that in other disaster affected areas as the village was temporally isolated. A landslide and the collapse of Great Aso Bridge led to the blocking of traffic and railway access.[1,2] Furthermore, the village experienced a greater lack of information compared to other districts due to delays in the restoration of communication networks.[1,2] The situation was worsened by the suspension of services at Aso Tateno Hospital, the only hospital in Minamiaso.[1,2] Three months after the disaster, the evacuees started to move from the shelters into temporary housing, and the number of households in temporary housing reached as high as 397.[3]

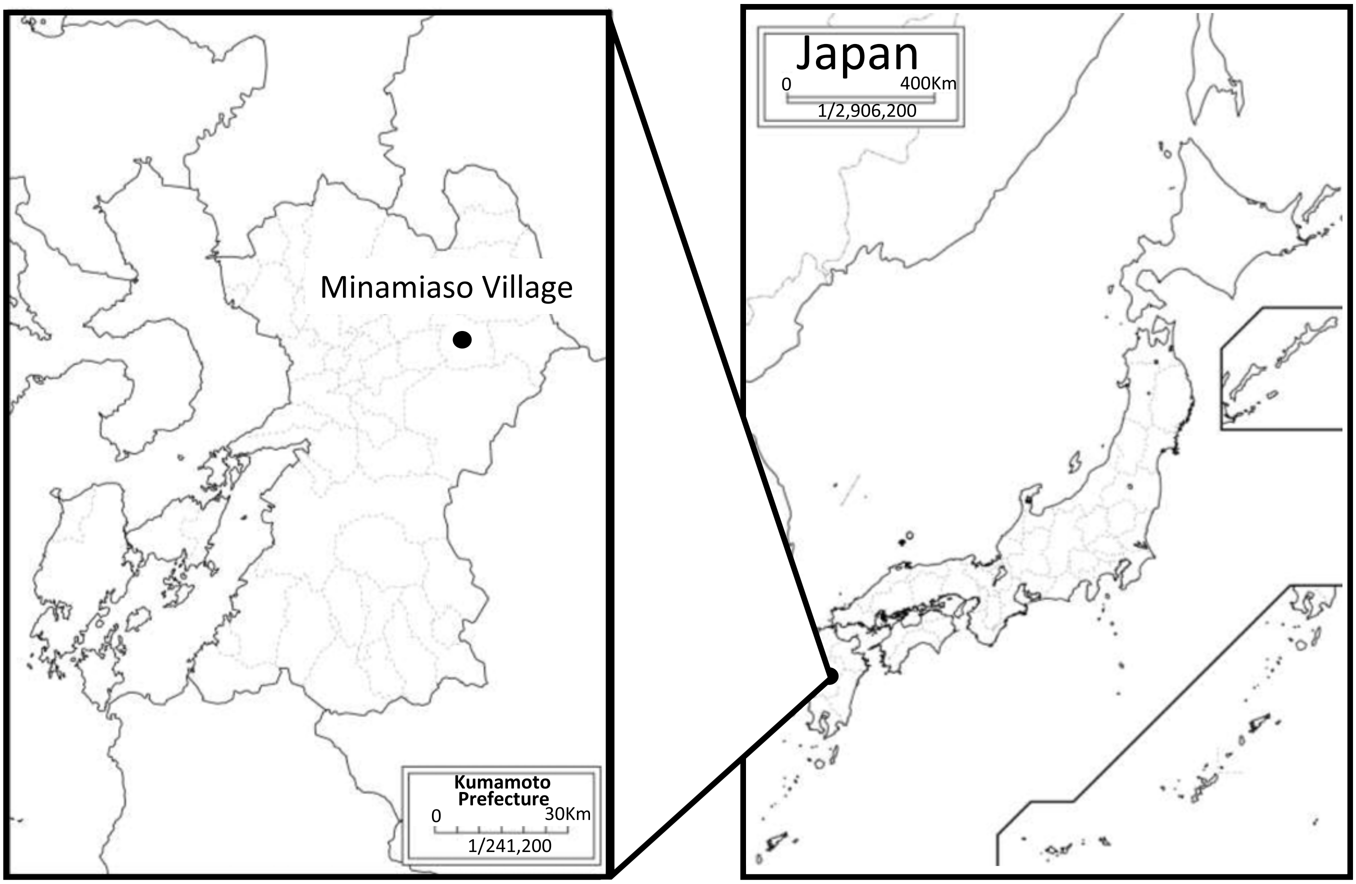

Figure 1. Research area: Minamiaso Village (•), Kumamoto Prefecture, is located approximately 34 km northeast of Kumamoto city.

Cardiovascular disorders occur more frequently after a disaster of this scale.[4,5] Hypertension-related acute cardiovascular events may occur on the day of the disaster, whereas pulmonary embolism and deep vein thrombosis (DVT) may take days to develop.[4,5] Previously, DVT screenings had been performed immediately after the 2016 Kumamoto Earthquakes to determine the prevalence of DVT in the Aso district, which includes Minamiaso and Aso City.[6] The DVT rate as 11.1% was observed (mean age, 68.1 y) among evacuees in the Aso district who were screened immediately after the 2016 Kumamoto Earthquakes; this rate was approximately 5 times higher than that under normal circumstances in the general Japanese population (2.2%; mean age, 63.3 y).[6,7] Postdisaster DVT is assumed to occur at high rates because of the living conditions in shelters and temporary housing, with evacuees becoming dehydrated because they drink less water to reduce their frequency of urination, are less active physically, sleep in vehicles, and take sleeping pills.[6–8]

As part of the Kumamoto Earthquakes Thrombosis and Embolism Protection Project (KEEP Project), which was established after the 2016 Kumamoto Earthquakes,[9] DVT screenings were conducted in the acute and subacute phases after the disaster as a large-scale preventive intervention against the economy class syndrome. The DVT prevalence among all project participants was 10.6% (mean age, 70.4 y).[9] In a DVT screening activity conducted in a coastal area of Iwate Prefecture after the 2011 Great East Japan Earthquake (GEJE, GLIDE no: Q-2011-000028-JPN), 382 (mean age, 74 y) subjects among a cohort of 3316 individuals (mean age, 71.6 y) were diagnosed with DVT (11.5%).[8]

The DVT prevalence immediately after the 2016 Kumamoto Earthquakes (Kumamoto City and Mashiki Town) among evacuees in shelters located near the epicenter was 33% in April 19, 2016, but declined to 2.7% in May 14, 2016, as a result of improvements in living conditions.[9] In our previous study, the DVT rate was also significantly higher than that in the general population immediately after the disaster but gradually declined with residents returning to relatively normal living conditions.[6,7] However, among residents in temporary housing, the prevalence of DVT annually increased after the GEJE from 9.9% in 2013 to 12.7% in 2014 and 13.5% in 2015 because of poor temporary housing conditions such as small living spaces and reduced activities of daily living (ADL).[8] Hence, a high prevalence of DVT was suspected among the evacuees in temporarily isolated affected areas because of poor environmental conditions in shelters.

In the present study, we examined DVT prevalence in areas affected by the 2016 Kumamoto Earthquakes using a prospective cross-sectional analysis of evacuees who underwent a series of 3 DVT screenings. Specifically, we determined the DVT prevalence in a temporarily isolated area during the first 19 mo after the 2016 Kumamoto Earthquakes.

Methods

Participants

At the request of physicians in the Aso district, preventive interventions for disaster-related diseases, including DVT, were

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conducted immediately after the disaster with collaborative disaster support from public health nurses in Minamiaso. The first DVT screening was performed in shelters. Participation in the first screening was on a voluntary basis. A written document, which explained that the study was aimed to determine DVT prevalence and risk factors in the disaster affected area, was provided to those who wished to participate in the study, and all study participants provided written informed consent. The second and third screenings were performed in temporary housing after obtaining acknowledgment from the local government. Posters to raise awareness about DVT prevention were displayed 1 mo before the screenings. Public health nurses from Minamiaso provided additional support for the screenings. Participation in the second and third screenings was also voluntary, and screenings were conducted only after written informed consent was obtained. The timeline for screenings was designed to compare DVT prevalence rates between the acute phase (shelters) and the early and late recovery phases (temporary housing) after the disaster, with consultation with the local government. Preventive interventions, such as promotion of simple exercises, introduction of cardboard box beds, and nutritional guidance especially to increase protein intake, were implemented in the shelters. Participants with positive DVT findings received a patient referral document and were encouraged to visit their local medical institutions.

The first screening conducted in the 3rd wk after the disaster (May 3-4, 2016) included 42 evacuees (83.3% females; mean age, 79.4 ± 8.2 y) living in shelters. The second screening conducted 8 mo after the disaster (December 24-25, 2016) included 65 residents living in temporary housing (81.5% females; mean age, 71.5 ± 13.1 y). The third screening conducted 19 mo after the disaster (November 3-4, 2017) included 74 residents living in temporary housing (78.3% females; mean age, 72.8 ± 10.9 y).

Although the local information was shared with the staff of the KEEP Project, the present study was conducted independently of other studies performed under the KEEP Project. Thus, a separate ethical approval was obtained for the present study, and the data were analyzed independently of the other studies, revealing novel findings.

The present study, which was registered with the UMIN Clinical Trial Registry (UMIN-CTR ID 000039410) and approved by the Fukui University Medical Research Ethics Committee (approval no: 20160024 and 20160089), was conducted in compliance with the Declaration of Helsinki. Informed consent was obtained from all participants included in the study.

Medical Examination Items

Following written consent, all participants underwent medical evaluation in the following order: a questionnaire to gather information on demographics such as age, sex, and lifestyle; blood pressure measurement; lower extremity venous ultrasonography; and explanation of the results.[6,8] Ultrasonography was performed by several medical technologists, each with more than 5 y of experience. To improve uniformity, all medical technologists discussed the evaluation criteria in advance of the examinations.[6]

Examination for venous thrombosis in left and right popliteal veins to the periphery was examined using 1 of the following portable devices with the participant in sitting position: LOGIQe (3.3-10.0 MHz linear probe; GE Healthcare, Tokyo, Japan), Noblus (5-18 MHz linear probe; Hitachi Medical, Tokyo, Japan,), CX50 (3-12 MHz linear probe; Philips Japan, Tokyo, Japan), Viamo (6.2-11.0 MHz linear probe Canon Medical Supply, Tokyo, Japan), and NanoMaxx (6-13 MHz linear probe; SonoSite, Tokyo, Japan).[6,8] The presence of thrombi was confirmed using both color Doppler and the venous compression method, in which the vein was compressed by the probe to evaluate compressibility.[6,8,10,11]

Thrombus age was classified as organized or fresh.[6,12–14] Additionally, organized thrombi were defined as those with regression, ie, isoechoic to hypoechoic mural thrombi, whereas fresh thrombi were defined as hypoechoic lesions that were floating and filling the vein. Soleal vein dilatation, defined a diameter of ≥8 mm, is a risk factor for DVT.[6,15] In the present study, only popliteal veins were evaluated due to the large number of participants and the limitations in screening setting and time. With improvements in ultrasonography technologies, the sensitivity and specificity to detect distal DVT have improved to above 90%, comparable to those of proximal DVT.[16]

Most of the members in the screening team have been involved in disaster support activities, including DVT screenings, since the Noto Hanto Earthquake in 2007 (GLIDE no: EQ-2007-000039-JPN)[17] and, therefore, had a high level of coordination and technical skills. After the GEJE, the diagnostic performance of ultrasonography for detecting DVT was frequently evaluated in postdisaster environments and the efficiency of ultrasonography in screening populations at high risk for venous thromboembolism was demonstrated.[8]

Medical Services

The outpatient care in Aso Tateno Hospital, which is the only hospital with an emergency department in Minamiaso,[18] returned to normal operations on August 28, 2016, while inpatient hospital care with 32 beds was restarted on September 11, 2016.[18] The number of outpatients declined to nearly one-third of that before the disaster (38,497 in 2015), with 1445, 8460, and 13,388 patients treated in 2016, 2017, and 2018, respectively. There were 8 private clinics and 5 dental clinics in 2016, but 1 dental clinic ceased operations in 2017.[19] However, the extent of the disaster's impact on services provided by these clinics could not be grasped and was initially unclear. Several temporary clinics were set up by Médecins Sans Frontières and private organizations after the disaster. We confirmed that 1 of the temporary clinics maintained operations until August 2017.[18]

Total Medical Expenses

The total medical expenditure in Minamiaso has decreased significantly from 1,231.27 million yen in 2013 to 1,173.78 million yen in 2016 after the disaster.[20]

Statistical Analysis

All statistical data were analyzed using the EZR version 1.41 (Saitama Medical Center, Jichi Medical University, Saitama, Japan), which is a graphical user interface for R (The R Foundation for Statistical Computing, Vienna, Austria). EZR is a modified version of R commander designed to add statistical functions frequently used in biostatistics.[21] The 2 groups were compared using the Mann-Whitney U-test for continuous variables and χ^2 test (including Yates continuity correction) for nominal variables. The 3 groups were compared using the Kruskal-Wallis test for continuous variables and Fisher exact test for nominal variables (both post-hoc pairwise comparisons). The risk factors for DVT were identified using multiple logistic regression analysis (stepwise method). A *P*-value of <0.05 was defined as statistically significant.

Table 1. Changes in DVT and characteristics of subjects in Minami Aso Village

	Total $n = 181$	First screening (shelters) 3rd week after the disaster $n = 42$	Second screening (temporary housing) 8th month after the disaster n = 65	Third screening (temporary housing) 19th month after the disaster n = 74	*P* value
Age (y)	73.9±11.6	79.4±8.2	71.5±13.1	72.8±10.9	0.000333[ab]
≥75 years old, *n* (%)	99(54.7)	33(78.6)	28(43.1)	38(51.4)	0.00094[ab]
Gender (male/female)	40/141	7/35	12/53	21/53	0.276
Smoker, *n* (%)	10(5.52)	1(2.4)	2(3.1)	7(9.5)	0.233
Drinking, *n* (%)	39(21.5)	6(14.3)	11(16.9)	22(29.7)	0.093
Sleeping pill use, *n* (%)	56(30.9)	11(26.2)	19(29.2)	26(35.1)	0.59
Heart disease, *n* (%)	47(25.9)	13(31.0)	10(15.4)	24(32.4)	0.0464[f]
Hypertension, *n* (%)	102(56.3)	28(66.7)	33(50.8)	41(55.4)	0.271
Diabetes, *n* (%)	28(15.4)	12(28.6)	6(9.2)	10(13.5)	0.0293[a]
Dyslipidemia, *n* (%)	46(25.4)	5(11.9)	14(21.5)	27(36.5)	0.0093[b]
Difficulty getting up, *n* (%)	48(26.5)	16(35.7)	16(24.6)	16(21.6)	0.247
Anti-coagulant or anti-platlet agent, n (%)	37(20.4)	12(28.6)	9(13.8)	16(21.6)	0.168
Lower limb pain, *n* (%)	7(3.8)	3(7.1)	3(4.6)	1(1.4)	0.223
Lower varicose veins, *n* (%)	50(27.6)	10(21.8)	16(24.6)	24(32.4)	0.517
Lower leg edema, *n* (%)	46(25.4)	19(45.2)	11(16.9)	16(21.6)	0.0041[ab]
Walking time shortened, *n* (%)	84(46.4)	30(71.4)	22(33.8)	32(43.2)	0.00053[ab]
Sleeping in a vehicle, *n* (%)	111(61.3)	17(40.5)	37(56.9)	57(77.0)	0.00029[bf]
Soleal vein dilatation (≥ 8mm), *n* (%)	70(38.6)	17(40.5)	23(35.4)	30(40.5)	0.804
DVT, *n* (%)	27(14.9)	6(14.3)	12(18.5)	9(12.2)	0.577
Fresh DVT, *n* (%)	13(7.1)	5(11.9)	3(4.6)	5(6.8)	0.356
organized DVT, *n* (%)	14(7.7)	1(2.4)	9(13.8)	4(5.4)	0.091

Mean ± SD, number of cases (%).
a, 1st vs 2nd; b, 1st vs 3rd; c, 2nd vs 3rd = Statistical significance.
d, 1st vs 2nd; e, 1st vs 3rd; f, 2nd vs 3rd = Statistical tendency.
Fisher exact test (post-hoc pairwise comparisons),
Kruskal-Wallis test (post-hoc pairwise comparisons).

Results

A total of 181 (40 men, 141 women; mean age = 73.9 ± 11.6 y) evacuees staying in shelters and temporary housing attended a series of 3 DVT screenings. None of the participants attended all 3 screenings, and there were only 22 participants who were included in both the second and third screenings.

The overall DVT prevalence was 14.9%, whereas 3 DVT prevalence rates in the first, second, and third screenings were 14.3%, 18.5%, and 12.2%, respectively (Table 1). There were no significant changes in DVT prevalence among the screenings ($P = 0.597$, Fisher exact) (Table 1). The Kruskal-Wallis test to determine DVT risk factors based on questionnaire responses revealed a change in age ($P = 0.00033$) with study duration, and the Fisher exact test revealed that there were changes in the rates of heart disease ($P = 0.0464$), diabetes ($P = 0.0293$), dyslipidemia ($P = 0.0093$), and sleeping in a vehicle ($P = 0.00029$) (Table 1) over time. The comparison of the participants with and without DVT at each screening using the Mann-Whitney U and χ^2 tests did not reveal significant differences between the groups. However, the comparison of participants with and without DVT in the entire cohort of 181 participants revealed that mean age ($P = 0.041$; Mann-Whitney U) and the rate of participants with advanced age of ≥75 y ($P = 0.0047$; χ^2) were significantly higher in the DVT-positive group than in the DVT-negative group.

By multiple logistic regression analysis, advanced age (≥75 y) was an independent risk factor for DVT (odds ratio, 2.71; 95% confidence interval, 1.080-6.790; $P = 0.032$) (Table 2). The comparison of participants with and without DVT among the 82 individuals aged ≤74 y revealed that the rate of alcohol consumption was significantly higher among those with DVT compared with those without DVT (χ^2). By multiple logistic regression analysis, alcohol consumption was an independent risk factor for DVT in participants aged ≤74 y (odds ratio, 58.9; 95% confidence interval, 3.660-948.000; $P = 0.032$) (Table 3).

Among the 22 repeat participants who were included in both the second and third screenings, DVT resolved without medical treatment in 2 participants (Table 4). Of the 3 repeat participants with persistent DVT, progression from organized to fresh thrombus was found in 2 participants, including 1 participant who was treated with medication, and regression from fresh to organized thrombus was found in 1 participant who was treated without medication. As shown in Table 3, participants 3 and 7 had recurrent DVTs, which were fresh thrombi originating from organized thrombi. In the third screening, 57 of the 74 subjects (77%) reported to have slept in vehicles for a period of time after the disaster.

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Table 2. DVT risk factor and comparison of DVT and Characteristics of Subjects in Minami Aso Village

Analysis type	DVT Positive *n* = 27	DVT negative *n* = 154	*P* value	Odds ratio	95% CI Lower - Upper	*P* value
	Univariate analysis			Multivariate analysis		
Age (y)	76.8±12.5	73.3±11.4	0.041	–	–	–
≥75 years old, *n* (%)	20(74.1)	79(51.3)	0.047	2.71	1.080 – 6.790	0.0329
Gender (male/female)	3/24	37/117	0.215	0.38	0.109 – 1.370	0.141
Smoker, *n* (%)	0(0)	10(6.5)	0.365	–	–	–
Drinking, *n* (%)	6(22.2)	33(21.4)	1	–	–	–
Sleeping pill use, *n* (%)	11(40.7)	45(29.2)	0.33	–	–	–
Heart disease, *n* (%)	7(25.9)	40(26.0)	1	0.911	0.350 – 2.370	0.848
Hypertension, *n* (%)	17(63)	85(55.2)	0.589	–	–	–
Diabetes, *n* (%)	1(3.7)	27(17.5)	0.122	–	–	–
Dyslipidemia, *n* (%)	7(25.9)	39(25.3)	1	–	–	–
Difficulty getting up, *n* (%)	7(25.9)	40(26.0)	1	–	–	–
Anti-coagulant or anti-platlet agent, n (%)	5(18.5)	32(20.8)	0.992	–	–	–
Lower limb pain, *n* (%)	0(0)	7(4.5)	0.556	–	–	–
Lower varicose veins, *n* (%)	8(29.6)	42(27.3)	0.985	–	–	–
Lower leg edema, *n* (%)	5(18.5)	41(26.6)	0.992	–	–	–
Walking time shortened, *n* (%)	15(55.6)	69(44.8)	0.41	1.57	0.676 – 3.640	0.294
Sleeping in a vehicle, *n* (%)	16(59.3)	95(61.7)	0.98	1.15	0.482 – 2.760	0.748
Soleal vein dilatation (≥ 8mm), *n* (%)	11(40.7)	59(38.3)	0.98	–	–	–

Mean ± SD, number of cases (%).
Univariate analysis: Mann-Whitney U test and χ2 test. Multivariate analysis: Multiple logistic regression analysis.

Table 3. DVT risk factor and comparison of DVT and characteristics of subjects in Minami Aso Village (≦74 y old)

Analysis type	DVT Positive *n* = 7	DVT negative *n* = 75	*P* value	Odds ratio	95% CI Lower - Upper	*P* value
	Univariate analysis			Multivariate analysis		
Age (y)	60.8±13.7	65.1±10.2	0.311	–	–	–
Gender (male/female)	1/6	17/58	0.972	0.172	0.012– 2.470	0.195
Smoker, *n* (%)	0(0)	9(12.0)	0.734	–	–	–
Drinking, *n* (%)	5(71.4)	14(18.7)	0.007	58.9	3.660-948.000	0.00403
Sleeping pill use, *n* (%)	2(28.6)	19(25.3)	1	–	–	–
Heart disease, *n* (%)	0(0)	19(25.3)	0.293	–	–	–
Hypertension, *n* (%)	4(57.1)	31(41.3)	0.682	9.4	0.720– 125.000	0.087
Diabetes, *n* (%)	0(0)	12(16.0)	0.558	–	–	–
Dyslipidemia, *n* (%)	3(42.9)	22(29.3)	0.753	–	–	–
Difficulty getting up, *n* (%)	3(42.9)	16(21.3)	0.411	–	–	–
Anti-coagulant or anti-platlet agent, n (%)	0(0)	7(9.3)	0.89	–	–	–
Lower limb pain, *n* (%)	0(0)	7(4.5)	0.556	–	–	–
Lower varicose veins, *n* (%)	0(0)	2(2.7)	1	–	–	–
Lower leg edema, *n* (%)	2(28.6)	14(18.7)	0.894	–	–	–
Walking time shortened, *n* (%)	4(57.1)	32(42.7)	0.734	2.1	0.302 – 15.100	0.447
Sleeping in a vehicle, *n* (%)	6(85.7)	52(69.3)	0.634	2.51	0.237 – 26.500	0.445
Soleal vein dilatation (≥ 8mm), *n* (%)	4(57.1)	30(40.0)	0.98	–	–	–

Mean ± SD, number of cases (%).
Univariate analysis: Mann-Whitney U test and χ2 test. Multivariate analysis: Multiple logistic regression analysis.

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Table 4. DVT status of repeat patients

Evacuees	Second screening $n = 22$ DVT = 5(22.7) Thrombotic state Fresh DVT	Organized DVT	Recurrent DVT	Anti-coagulant or anti-platlet agent
No. 1	None	Yes	None	None
No. 2	None	Yes	None	None
No. 3	None	Yes	None	None
No. 4	None	Yes	None	None
No. 5	Yes	None	None	None
No. 6	None	None	None	None
No. 7	None	None	None	None
	Third screening $n = 22$			
	DVT $n = 5$(22.7)			
	Thrombotic state			
Evacuees	Fresh DVT	Organized DVT	Recurrent DVT	Anti-coagulant or anti-platlet agent
No. 1	None	None	None	None
No. 2	None	None	None	None
No. 3	Yes	Yes	Yes	Yes
No. 4	Yes	Yes	None	None
No. 5	None	Yes	None	None
No. 6	Yes	Yes	None	None
No. 7	Yes	Yes	Yes	None

Discussion

This study revealed a high prevalence of DVT over a long period of time (up to 19 mo) after the 2016 Kumamoto Earthquakes. The DVT detection rate in the general population in ordinal times in Japan was 2.2% (mean age = 63.3 y).[7] The prevalence of DVT in the early stage after the earthquakes was 14.3% (mean age = 79.4 y), which was higher than that of the general population. Furthermore, it remained high even after the evacuees moved from shelters to temporary housing (18.5% mean age = 71.5 y, 12.2% mean age = 72.8 y). A previous study indicated that being older than the mean age of the subjects contributed to the high prevalence of DVT in the coastal area of Iwate Prefecture after the GEJE.[8] The mean age of our subjects was 73.9 y, and the risk factor was found to be advanced age (≥75 y/o).

Similar to the study conducted in the coastal area of Iwate Prefecture, this study also indicated the contribution of advanced age. The relationship between DVT and lower extremity symptoms (varicose veins, lower extremity edema, and lower extremity pain) could not be clarified because of the limited number of subjects. Particular features of the local environment after the disaster, such as infrastructure damage (including traffic networks) and the temporary suspension of Aso Tateno Hospital, presumably had a significant impact on survivor health.[1,2,18] This study did not assess the treatment status at the private clinics; moreover, several temporary clinics were set up after the earthquakes. However, the total medical expenditure in the year of the earthquakes greatly decreased, suggesting a decrease in the patients' health-care seeking behavior compared with that before the disaster. Many patients in this area are assumed to have stopped treatment or otherwise gone untreated for chronic diseases.

Aging is a risk factor for DVT even under normal circumstances, but its impact might have increased in the post-disaster situation wherein evacuees' activity levels declined.[22,23] This tendency was particularly notable in persons of advanced age and persisted over a long period. We could not clarify the relationship between physical activity level and DVT. However, walking ability is associated with a decline in the ADL and reduction in the quality of life of the elderly.[24] The results of this study showed that 70% and 30-40% of evacuees in the shelters and temporary housings, respectively, experienced a decrease in the amount of time spent walking each day compared with before the disaster. Decreased walking time can lead to a decline in ADL. Considering this, the decline in ADL after the disaster might have led to the development of disuse syndrome and subsequently contributed to the development of DVT.

Prevention of DVT is very important for disaster-affected people suffering from disuse syndrome.[25] Elderly residents in emergency shelters have been reported to suffer frequently from disuse syndrome.[26] The percentage of elderly people who lost motor functions was higher among those who relocated to temporary housing after the GEJE than those who remained living in the same house as before the earthquake.[27] Participating in group exercise sessions may reduce the risk of worsening depressive symptoms among elderly disaster survivors.[28] Two evacuees in the shelters were found to have DVT, despite taking anti-coagulants or anti-platelet agents. The long-term availability of exercise sessions in emergency shelters from the beginning may be effective to prevent a variety of disaster-related disease outcomes.

We found that alcohol consumption was a risk factor for DVT among evacuees aged 74 y and younger. A warning about the relationship between alcohol consumption and developing DVT has been reported for people traveling by air.[29] Alcohol can depress the central nervous system and can cause underperfusion by muscle areflexia.[29] After the Kumamoto Earthquakes, the number of alcohol-related consultations increased, and the increased

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alcohol consumption among disaster survivors due to stress has become an issue.[30] This indicates that the increased alcohol consumption and post-earthquake lifestyle may have contributed to the development of DVT.

Another notable finding of this study was the large proportion of subjects who had to sleep in a vehicle for some time after the disaster. At our third screening, more than 70% of the subjects reported having the experience of sleeping in a vehicle. A link between DVT prevalence and sleeping in a vehicle has been reported in a previous study of the 2004 Mid Niigata Prefecture Earthquake (GLIDE:EQ-2004-000114-JPN).[31,32] An increase in the number of days staying in private vehicles increased the risk of developing DVT.[33] However, this study did not reveal any relationship and sustained risks between the number of nights spent in a vehicle and development of DVT. The Kumamoto earthquake sequence began with a foreshock of 7.0 seismic intensity (on the Japan Meteorological Agency scale), which was followed by the main shock of similar seismic intensity and many aftershocks; thus, houses sustained a great deal of damage.[1,2] Because many people affected by disaster were worried about being evacuated from inside a building, they slept in their vehicles.

The prevalence of DVT among elderly people staying in emergency shelters may reflect the environmental factors and the experience of sleeping in a vehicle either at the time of the disaster or shortly after. The progression of DVT to proximal veins is not yet fully clarified, nor is the pathophysiology of embolization.[15,34] A venous thrombus is formed in a vein within a few days and regresses through thrombus organization.[22] Thrombus organization is often accompanied by venous valve destruction, although valve function is retained in some cases.[22] In this study, 2 cases of thrombus disappearance and 1 case of thrombus regression (from fresh to organized thrombus) were observed. Many cases of community pulmonary embolism are associated with recurrent DVT.[35] This study found 2 cases of recurrent DVT (from organized to fresh thrombus). Recurrent DVT cases have also been reported in the chronic phase after the earthquake in a different region.[36] The prognosis for lower extremity DVT can be improved by early and appropriate treatment.[37] However, the presence of a residual thrombus is a risk factor for recurrence, and people with recurrent DVT are at greater risk of postthrombotic syndrome.[38]

In Minamiaso village, the transportation system was blocked, and restoration of the communication system was delayed, which made information dissemination difficult.[1,2] In isolated areas, local government collaboration and interventions are crucial for publishing information in papers and for contacting people directly. The local government was also affected by the disaster, and the coping capacity to receive the disaster relief activities was lacking in the village. This might have contributed to the prevalence of disaster-related diseases (including DVT). Japan is a disaster-prone country, and some areas, such as Minamiaso village, are likely to be isolated. When a region becomes isolated and health-care providers are affected by the disaster, the patients' health-care seeking behavior may decline. Given this, medium- to long-term support through DVT screenings is necessary.

In the future, it is important for medical personnel to accurately investigate the situation of the evacuees immediately after a disaster. Furthermore, before disasters, support systems should be established and education on preventive interventions should be provided to local government officials, disaster relief teams, and volunteer organizations. These will contribute to reducing the prevalence of disaster-related diseases, including DVT, at an early stage as well as in the medium- to long-term stage. It is also important to raise peoples' awareness about DVT at an early stage. Implementation of medium- to long-term DVT screening should be integrated into regional disaster management plans and public healthcare support activity.

Limitations

This study has several limitations. First, because the screenings were performed by our examination team within a limited time frame, not all evacuees in shelters and temporary housing could be targeted. Therefore, only a limited number of participants who gave written informed consent were screened. Second, our sample could be biased toward a particular health-conscious section of the population; hence, individuals might have been more attracted to our offer of screening. Third, considering that medical history and lifestyle were determined according to a self-reporting questionnaire, making considerations based on actual influencing factors, including cancer, coagulopathy, and history of DVT, was impossible. Fourth, the number of evacuees housed at each shelter and temporary housing was unknown. Fifth, there were few to no data on the history of DVT before the earthquakes. Thus, the risk of DVT before and after the earthquakes was not accurately identified. Sixth, the screenings were performed only for below-knee DVT, with no screening of whole leg DVT being carried out. Seventh, differences between several medical technologists need to be taken into account. Eighth, regarding alcohol consumption, no information was obtained on the type and amount of alcohol. Future studies taking these limitations into consideration are necessary.

Elderly Japanese men are less likely to participate in community health and welfare services than elderly women,[39] which might explain the higher rate of women participation in the current study's screenings. Therefore, men should be encouraged to participate in preventive health activities through direct contact and communication. However, it is necessary to bear in mind that evacuees are particularly vulnerable to stress. Even if the study itself is not ethically problematic, the evacuees may be stressed about the participation. Research in the disaster area should be conducted in accordance with the guidelines of the Japanese Society of Psychiatry and Neurology and the WHO Guidance on Research Methods for Health and Disaster Risk Management. The rights and interests of the disaster survivors must be taken into consideration, and the research must not impose any physical or mental burden.[40,41] It is also important that disaster studies are promptly approved by the appropriate ethics committees and fully coordinated with the local government authorities to provide necessary medical and welfare services to the survivors. This study was conducted with sufficient consideration of the evacuees after consultation with local doctors in Minamiaso village. The public health nurses in the village were also present during the screenings.

Conclusions

In Minamiaso village, which was temporarily isolated after the disaster, a high prevalence of DVT was observed over a long period of time (19 mo). This study's screening activity conducted from the acute to recovery phase after the disaster contributed to early identification of DVT to reduce post-DVT diseases, such as pulmonary embolism.

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