Research Report

The Effect of Heavy Net Sulfur Air Pollution on Healthy Japanese Workers: The Relationship of Lung Function to Long-term Exposure to Sulfur Volcanic Emissions on Miyake Island.

Hideyuki UNO[1,2], Hyogo HORIGUCHI[3] and Fujio KAYAMA[3]

Miyake Island (Miyakejima), a small island located south of Tokyo, Japan, in the Pacific Ocean, has an active stratovolcano, Mt. Oyama. The volcano began erupting in June 2000, and volcanic gas, consisting primarily of sulfur dioxide (SO_2), is still being emitted. We measured the peak expiratory flow rate (PEFR), administered questionnaires (dealing with age, workplace, past medical history, present incidence of persistent coughing and smoking habits), and did clinical examinations (blood pressure, and height) of 100 Japanese male workers in January 2003 by simple random sampling and cross-sectional study. We obtained complete data for 96 healthy subjects. Although the measured PEFR/predicted PEFR values, taking age and physique into account, tended to be lower in the group exposed to high SO_2 levels than in the group exposed to low SO_2 levels, there was no significant difference (Mann-Whitney *U-test*, $p=0.886$). We also did a multiple logistic regression analysis on the measured PEFR/predicted PEFR values using SO_2 concentration, respiratory diseases, Brinkmann Index and systolic blood pressure (BPs). A statistically significant difference was on BPs (OR:1.032 ; 95% CI:1.001-1.064).

We were able to conclude that our results could be attributed to measured PEFR/predicted PEFR against BPs rather than SO_2 air pollution. This study will present useful information that can be used for the purposes of discussing risk with the residents of Miyake Island and other settlements located in close proximity to active volcanoes.

(Key words : Sulfur dioxide, Volcanic emissions, Miyake Island, Lung function, Peak expiratory flow rate)

Introduction

Miyake Island (Miyakejima) is a small island located south of Tokyo, Japan, in the Pacific Ocean (Figure 1). The administration of the island is the responsibility of the Tokyo Metropolitan Government. This isolated island has a circumference of 38 km and has an active stratovolcano, Mt. Oyama (775m). The volcano began erupting in June 2000 and had the largest recorded

1. Center for Community Medicine, Division of Community and Family Medicine, Jichi Medical University, 3311-1 Yakushiji, Shimotsuke-City, Tochigi 329-0498, Japan
2. Tokyo Metropolitan Government, Welfare and Health Office, Department of Medical Policy, Tokyo, Japan
3. Center for Community Medicine, Division of Environmental Medicine, Jichi Medical University, 3311-1 Yakushiji, Shimotsuke-City, Tochigi 329-0498, Japan

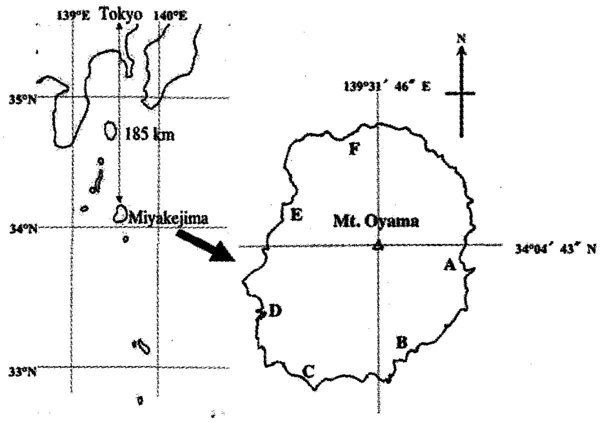

Figure 1 The location of Miyake Island (Miyakejima), one of the Izu islands south of Tokyo and the 6 sites at which ambient SO_2 concentrations were measured. Site names were as follows : A : Miike ; B : Tsubota ; C : Usuki ; D : Ako ; E : Izu Igaya ; F : Kamitsuki.

eruption in August 2000. The volcanic gas consisted primarily of sulfur dioxide (SO_2), with a flux in excess of 40,000 tons per day[1]. A large quantity of volcanic gas (SO_2 flux, approximately 3,000–10,000 tons per day), is still being emitted by Mt. Oyama, accounting for as much as 10%-30% of all SO_2 emitted from volcanoes around the world. By way of comparison, Mt. Kilauea in Hawaii is famous for emitting SO_2, but the daily quantity of gas effused into the atmosphere only amounts to 1,000–2,000 tons[2,3]. In this context, therefore, the volcanic activity on Miyake Island is one of the largest episodes of net SO_2 air pollution derived from a natural disaster.

It is well known that even brief exposure to SO_2 can trigger an asthma attack in asthmatics[4–6], as well as in healthy subjects[7]. In asthmatics, bronchoconstriction due to SO_2 exposure can occur at levels well below currently accepted standards[8]. Reports of SO_2 concentration on Miyake Island indicate that the concentrations still exceed various environmental air standards. From the time of peak volcanic activity until February 2005 when the evacuation order was lifted by the mayor of Miyake village[9], all inhabitants were evacuated from the island and prevented from returning home, despite cessation in seismic and volcanic activity. The only people permitted to reside on the island from July 2002 onwards were civil servants and contractors who were involved with the operation, reconstruction, and restoration of the damaged infrastructure in preparation for the full-scale return. During that time, SO_2 emission had not completely ceased.

In our previous studies, we investigated the medical histories of outpatients seen from July 2002 until June 2004 at the Miyake-mura National Health Insurance Center Clinic and the respiratory symptoms of the inhabitants participating in a 3-day rehabilitation project during October and December 2003. We did not identify any respiratory cases directly connected with higher ambient SO_2 air pollution[10,11]. Thus, in the current study, we investigated the potential adverse effects of SO_2 air pollution on healthy workers using a simple lung function test (peak expiratory flow rate : PEFR), which is more objective and precise than the approach used in our previous studies[10,11].

No reports have yet been published dealing with the relationship between SO_2 air pollution caused by a natural disaster and the lung function of on-site workers. Here we report the results based on monitoring ambient SO_2 air pollution on Miyake Island and the effect of these SO_2 levels on a simple lung function test (PEFR)[12] of the workers. As well, we also report what other factors combined with their simple lung function tests aggravated their conditions.

Materials and Methods

1. Prevention and precautions against SO_2 air pollution

Employees of the National, Tokyo Metropolitan, and Miyake-mura Governments, residing on Miyake Island from July 2002 to the present, were permitted to work between 8 a.m. and 6 p. m. every day except on rainy days. Recently-constructed accommodations equipped with air-scrubbing systems capable of removing sulfur using active carbon were prepared for the workers. The indoor pressure was maintained at levels that were higher than the outdoor pressure to prevent the invasion of ambient SO_2 air. The air-scrubbing systems were activated when outdoor SO_2 concentrations exceeded 0.1 ppm. As a precautionary measure, these contractors were required to stay indoors from 6 p.m. to 8a.m. and were only permitted to commute on the island by car. To prepare for any contingency, contractors were kept informed of the locations of the nearest emergency institute, clinic, doctor's office, or similar facility. In addition, the contractors were always required to wear their gas masks fitted with sulfur-removal cartridges (Chemical Cartridge Respirator, GM76, SHIGEMATSU, Tokyo, Japan) outdoors when the ambient SO_2 concentrations exceeded the recommended safety levels[13] (above 2 ppm for a 5-minute period). Information on the ambient SO_2 air situation on Miyake Island was made available in the form of daily handouts distributed by the Tokyo Metropolitan Government's rural administration offices.

2. Atmospheric SO_2 measurement on Miyake Island

The atmospheric SO_2 concentrations were measured continuously every minute, using automatic UV fluorescence ambient SO_2 monitors (APSA-360, HORIBA, Kyoto, Japan, in regions A-E;100-AH, RIKEN KEIKI, Tokyo, Japan in region F) at 6 locations (A-F) on Miyake Island by the 3 Government levels (Figure 1). The SO_2 average concentration measured over a 5-minute period was taken as being typical of short-term exposure. We then used this concentration to calculate the yearly average for assessing long-term exposure. We used the environmental air standards of 2 ppm, 5 ppm, and 0.04 ppm for the 5-minute period, as well as for the yearly standard based on the Threshold Limit Value-Time Weighted Average (TLV-TWA) as determined by the American Conference of Government Industrial Hygienists (ACGIH), a Short-Term Exposure Limit (STEL) as determined by the American National Institute of Occupational Safety and Health (NIOSH), and the Environmental Safety Level as determined by the Japanese National Government, which were originally advisory limits established for occupational health monitoring.

Given that the subjects wore gas masks, personal monitoring was not undertaken, as it would not accurately reflect actual SO_2 exposure in individuals.

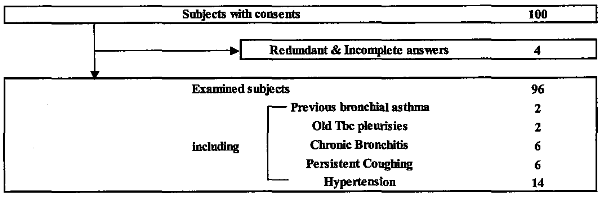

Figure 2 The selection process used to screen healthy consenting subjects

3. Study population

We explained the purpose of this study to the relevant labor union and obtained informed consent from 100 Japanese male workers by simple random sampling in January 2003, who had resided on Miyake Island since the beginning of the full-scale return preparation operation that had started in July 2002 (no females were sampled) (Figure 2). We finally obtained complete data for 96 healthy subjects, having included 14 cases of hypertension (systolic blood pressure; $BPs \geqq 160$ mmHg) and 10 cases of respiratory disease (2 cases of previous bronchial asthma, 2 cases of old tuberculous pleurisy, 6 cases of chronic bronchitis and 6 cases of persistent coughing). The subjects with previous bronchial asthma and chronic bronchitis had had these symptoms and had received treatment before July 2002 when they had come to Miyake Island.

4. Lung function tests and questionnaires administered to workers

To measure the effect of air pollution on health subjects, we used the PEFR because of its simplicity[12]. In January 2003, we also administered questionnaires (age, workplace (sites A-F)), past medical history, present incidence of persistent coughing and smoking habits) and undertook clinical examinations (blood pressure, height) with the support of the 3 levels of Government. Due to technical difficulties, we could not determine the proportion of time that the gas masks were worn. We used the Brinkman's Index (BI) as an index of smoking habit.

BI = a number of cigarettes per day × period of smoking (year)

We used PEFR as the $FEV_{1.0}$ (forced expiratory volume in1second), because the PEFR is well correlated with $FEV_{1.0}$[14,15] and is useful for diagnosing obstructive pulmonary diseases, such as bronchial asthma[16]. The PEFR was measured using the ATS (American Thoracic Society) scale (range: 60-880 liter/minute) using a mini-Wright peak flow meter (Clement Clarke, London, UK)[14,15]. In order to correct for the effects of age and physique[16,17], we adjusted the value of the measured PEFR using the predicted PEFR, which was calculated using the formula:

$$\text{Predicted PEFR (L/min)}^{[18]} = -389.9 + 16.6 \times \text{age (years old: y.o.)} - 0.338 \times \text{age (y.o.)}^2 + 0.00189 \times \text{age (y.o.)}^3 + 4.54 \times \text{height (cm)}$$

5. Statistical analysis

The each statistical analysis included the Mann-Whitney *U-test* and the multiple logistic regression analysis. In multiple logistic regression models, we used Brinkmann Index and BPs as continuous variables and judged a factor as significant when the standard partial regression coefficient (SPRC) was relative high with $p < 0.05$, evaluating Odd`s ratio (OR). Statistical significance was set at $p < 0.05$.

Table 1 Average ambient SO_2 concentrations at different locations between March 2002 and February 2003

	Yearly average (ppm)	Frequency of hourly average at above 2 ppm(%)	Frequency of monthly average at above 2 ppm (minute)	Frequency of monthly average at above 5 ppm (minute)
A	0.28	24.3	1325	206
B	0.02	3.2	59	2
C	0.12	14.6	372	21
D	0.04	6.8	148	2
E	0.04	5.5	135	10
F	0.02	2.1	60	1

Results

1. Ambient SO_2 air pollution on Miyake Island

The 6 locations where ambient SO_2 concentrations were measured between March 2002 and February 2003 (Table 1) are presented in Figure 1. We found that the yearly SO_2 air pollution averages in regions A and C exceeded Japanese environmental safety levels. It was also found that the frequency of concentrations exceeding 2 and 5 ppm for 5-minute periods was higher in regions A and C than in regions B, D, E, and F. Consequently, we designated subjects residing in regions A and C as constituting the "High concentration group" and the individuals residing in regions B, D, E, and F as constituting the "Low concentration group".

2. Characteristics of the examined healthy workers

We evaluated age, height, Brinkmann Index, measured PEFR and BPs in subgroups divided by these SO_2 levels, respiratory diseases, smoking habits, measured PEFR/predicted PEFR and BPs, using the Mann-Whitney U-test (Table 2). Brinkmann Index in respiratory disease group was significantly higher than in no disease group ($p=0.036$). Age in smoking habit group was significantly lower than in no smoking group ($p=0.027$), as well as in measured PEFR/predicted PEFR≧80% group ($p=0.017$). BPs in measured PEFR/predicted PEFR<80% group was significantly higher than in measured PEFR/predicted PEFR≧80% group ($p=0.014$). Measured PEFR in no hypertension group was significantly higher than in hypertension group. ($p=0.006$).

3. Measured PEFR/predicted PEFR of the examined healthy workers

We evaluated measured PEFR/predicted PEFR in subgroups divided by these SO_2 levels, respiratory diseases, smoking habits and BPs, using the Mann-Whitney U-test (Figure 3). Measured PEFR/predicted PEFR in smoking group was significantly lower than in no smoking group ($p=0.010$). Borderline significance was also observed in hypertension group ($p=0.059$). Results of the multiple logistic regression analyses are shown in Table.3. BPs (OR: 1.032 ; 95% CI: 1.001-1.064) was a significant factor.

Table 2

Age, Helght, Brinkmann Index, measuredPEFR, and Systolic Blood Pressure for the 2 groups according to SO_2 concentration levels.

Total (n=96)	L (n=86)	H (n=10)	*P* value
Age (y.o.) Mean±SD (range)	49.7±8.5 (25-63)	42.9±15.0 (20-67)	0.090
Heigho (cm) Mean±SD (range)	165.8±6.6 (146-184)	167.2±7.0 (155-177)	0.517
Brinkmann Index Mean±SD (range)	786.9±605.0 (0-2520)	431.5±333.0 (0-900)	0.066
measuredPEFR (ml) Mean±SD (range)	544.4±78.7 (300-680)	559.0±56.1 (460-650)	0.648
BPs (mmHg) Mean±SD (range)	136.0±20.2 (100-192)	133.8±19.4 (110-170)	0.714

Age, Height, measuredPEFR, and Syttolic Blood Pressure for the 2 groups according to smoking.

Total (n=96)	Smoking (+) (n=86)	Smoking (−) (n=10)	*P* value
Age (y.o.) Mean±SD (range)	48.3±9.6 (20-63)	55.2±6.1 (46-67)	0.027*
Height (cm) Mean±SD (range)	166.3±6.2 (154-184)	162.9±9.5 (146-174)	0.464
measuredPEFR (ml) Mean±SD (range)	542.9±78.5 (300-680)	572.0±53.3 (500-660)	0.322
BPs (mmHg) Mean±SD (range)	135.2-20.0 (100-190)	140.2±20.4 (122-192)	0.521

Age, Height, Bminkmann Index, and measuredPEFR for the 2 groups according to SystoliccBlood Pressure

Total (n=96)	No Hypertension (n=82)	Hypertension (n=14)	*P* value
Age (y.o.) Mean±SD (range)	48.7±9.9 (20-67)	50.9±6.3 (38-60)	0.636
Height (cm) Mean±SD (range)	166.4±6.3 (152-184)	163.0±8.0 (144-177)	0.148
Brinkmann Index Mean±SD (range)	726.1±576.6 (0-2520)	889.3±679.1 (0-2280)	0.496
measuredPEFR (ml) Mean±SD (range)	554.6±74.0 (300-680)	495.0±73.4 (390-640)	0.006*

Age, Height, Brinkmann Index, measuredPEFR, and Systolic Blood Pressure for the 2 groups according to respiratory diseases.

Total (n=96)	Resp (+) (n=18)	Resp (−) (n=78)	*P* value
Age (y.o.) Mean±SD (range)	51.6±9.7 (24-62)	48.4±9.4 (20-67)	0.078
Height (cm) Mean±SD (range)	165.9±6.6 (155-177)	166.0±6.7 (146-184)	0.933
Brinkmann Index Mean±SD (range)	1015.8±688.1 (0-2520)	688.5±554.0 (0-2280)	0.036*
measuredPEFR (ml) Mean±SD (range)	514.4±100.1 (300-650)	553.2±68.8 (360-680)	0.157
BPs (mmHg) Mean±SD (range)	135.1±22.2 (100-190)	135.9±19.6 (104-192)	0.914

Age, Height, Bminkmann Index, and Systolic Blood Pressure for the 2 groups according to measuredPEFR/predictedPEFR

Total (n=96)	cea/prePFEFR<80% (n=13)	mea/PEFR≧80% (n=83)	*P* value
Age (y.o.) Mean±SD (range)	54.0±7.1 (35-63)	48.2±9.6 (20-67)	0.017*
Height (cm) Mean±SD (range)	165.4±6.2 (158-177)	166.0±6.7 (146-184)	0.638
Brinkmann Index Mean±SD (range)	990.8±531.2 (150-2100)	712.2±594.5 (0-2520)	0.065
BPs (mmHg) Mean±SD (range)	147.4±16.7 (188-170)	133.9±19.9 (100-192)	0.014*

H : High concentration group, A+C
L : Low concentration group, B+D+E+F
Resp (+) : Previous bronchial asthma, Old Tbc pleurisie, Chronic bronchitis & Present persistent coughing
mea/prePEFR : measuredPEFR/predictedPEFR
* Significantly different by the Mann-Whitney U-test ($p<0.05$)

Discussion

In our previous studies[10,11], we investigated the medical histories of outpatients seen from July 2002 until June 2004 at the Miyake-mura National Insurance Center Clinic. Of the 10 bronchial asthma attacks requiring the attention of a doctor, none could be attributed directly to SO_2 air pollution. We also investigated the respiratory symptoms of the inhabitants participating in a3-day rehabilitation project during October and December 2003. SO_2 air pollution was not found to aggravate respiratory symptoms. Nonetheless, it has been demonstrated that SO_2 gas may affect the lung function of healthy subjects, even at1ppm of short-term exposure[18]. It is also known that long-term exposure to air pollution including SO_2 can lead to increased PEFR variability, even in healthy subjects[12]. We therefore wanted to ascertain whether the subjects had subclinical hypersensitivity to SO_2 gas under these conditions.

Thus, in this study, we investigated whether long-term exposure to SO_2 affected the lung

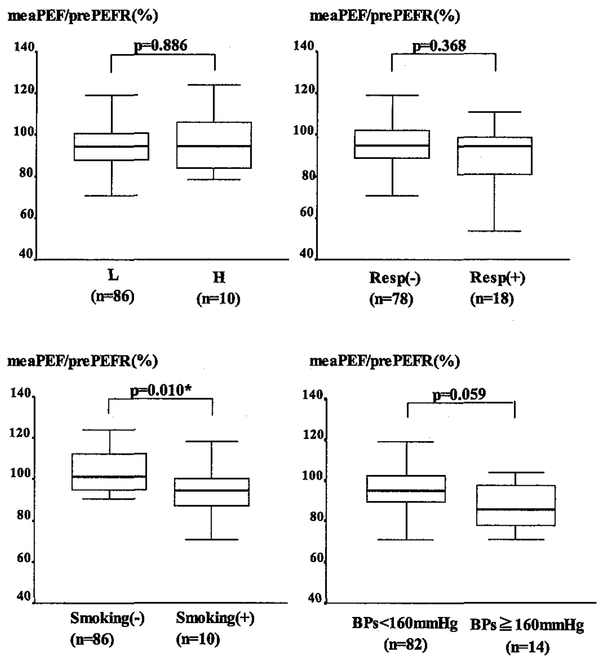

Figure 3 Measured PEFR/predicted PEFR of the workers on the island.

Table 3 Multiple logistic regression analysis on the workers with mea/prePEFR$<80\%$ ($n=96$)

Dependent variable	Independent variable	SPRC	p value	OR	(95% CI)
mea/pre PEFR$<80\%$	SO_2 concentration	0.000	0.995	1.007	(0.105-9.635)
	Respiratory disease	0.940	0.332	0.496	(0.120-2.047)
	Brinkmann Index	1.041	0.308	1.001	(1.000-1.001)
	BPs	4.161	0.041	1.032	(1.001-1.064)

SPRC : standard partial regression coefficient OR : Odd's ratio CI : confidence interval

functions of healthy workers that were exposed to SO_2 gas. The SO_2 concentrations in regions A and C were considerably higher than the concentrations that could trigger an asthma attack[4-7]. However, no statistically significant relationship could be found between SO_2 air pollution and measured PEFR/predicted PEFR in healthy workers. Statistically significant difference was observed in measured PEFR/predicted PEFR of smoking subgroups ($p=0.010$), using the Mann-Whitney U-test. In multiple logistic regression models, Brinkmann Index was not a significant factor. It is known that measured PEFR in smokers is significantly lower than that in no smokers[19-21]. It is also, however, known that measured PEFR in smokers is not significantly lower in Asian and Black[22]. Unfortunately, we could not obtain non-exposed subjects under the particular circumstances in this study. Therefore, we may not always conclude that smoking habits had no influence on their lung function, taking SO_2 exposure into account. We cannot also conclude whether our results could be attributed to the lung dysfunction against the risk of SO_2 air pollution. BPs was a significant factor in the multiple logistic regression analyses, although a borderline difference was observed in BPs group ($p=0.057$) using the Mann-Whitney U-test. It is known that PEFR was associate with cardiovascular diseases[23-25] and a atherosclerosis development[24]. It is also known that a remarkable elevation of blood pressure causes from lung function tests in hypertensive subjects[26].

Based on this study, we could conclude that our results could be attributed to measured PEFR/predicted PEFR against BPs rather than SO_2 air pollution. This study will present useful information that can be used for discussing risk with residents of Miyake Island and other settlements that are located in close proximity to active volcanoes.

Acknowledgements

The authors wish to thank Dr. K. Maruyama, Director of the Tokyo Islands Health Center, for his support in making this study possible. We would like to express our special gratitude for the cooperation of Tokyo Metropolitan Government's Field Provision headquarters, Miyake-mura officials, the staff of the Miyake-mura National Health Insurance Center clinic, and the relevant labor union on Miyake Island.

References

1) Fujii T, Hamaguchi K, Kagiyama T et al.: Reports on Volcanic Activities and Volcanological Studies in Japan for the Period from 1999 to 2002. National Committee for Volcanology and Chemistry of the Earth's Interior, Japan 2003 : 13-18, 2003.
2) Elias T, Sutton AJ, Stokes JB et al.: Sulfur dioxide emission rates of Kilauea Volcano, Hawaii, 1979-1997. US Geological Survey Open-File Report : 98-462, 1998.
3) Elias T and Sutton AJ : Sulfur Dioxide Emission Rates from Kilauea Volcano, Hawai'i, an Update : 1998-2001. US Geological Survey Open-File Report : 02-460, 2003.
4) Frank NR, Amdur MO, Worcester J et al.: Effects of acute controlled exposure to SO_2 on respiratory mechanics in healthy male adults. J Appl Physiol 17 : 252-258, 1962.
5) Linn WS, Shamoo DA, Spier CE et al.: Respiratory effects of 0.75 ppm sulfur dioxide in exercising asthmatics : Influence of upper respiratory defenses. Environ Res 30 : 340-348, 1983.
6) Schachter EN, Witek TJ, Beck GJ et al.: Airway effects of low concentrations of sulfur dioxide : Dose-response characteristics. Arch Environ Health 39 : 39-42, 1984.
7) Bethel RA, Sheppard D, Geffroy B et al.: Effect of 0.25 ppm sulfur dioxide on airway resistance in freely breathing, heavily exercising, asthmatic subjects. Am Rev Respir Dis 131 : 659-661, 1985.
8) Sheppard D, Wong WS, Uehara CF et al.: Lower threshold and greater bronchomotor responsiveness of asthmatic subjects to sulfur dioxide. Am Rev Respir Dis 122 : 873-878 ; 1980.
9) Miyake-mura : Outline of the Keynote Address for Former Inhabitants Returning to Miyake Island, 2004 (in Japanese). (URL ; http://www.miyakemura.com/pr/housin/housintop.htm)
10) Uno H, Horiguchi H, Omae K et al.: Effects of volcanic sulfur dioxide on reconstruction workers and residents returning to Miyake Island. San Ei Shi 47 : 142-148 ; 2005. (in Japanese with English abstract)
11) Uno H, Horiguchi H and Kayama F : Respiratory symptoms associated with transient exposure to sulfur dioxide (SO_2) from Mt. Oyama volcano on Miyake Island south of

Tokyo. Jichi Medical School J : 157-167, 2005.

12) Singh V, Khandelwal R and Gupta AB : Effect of air pollution on peak expiratory flow rate variability. J Asthma 40 : 81-86, 2003.

13) Japanese Cabinet Office and Tokyo Metropolitan Government General Affairs Department : Study Reports on Volcanic Gas Emissions in Miyake Island, 2003. (in Japanese) (URL : http://www.metro.tokyo.jp/SAIGAI/SAITAI/SHOUSAI/×0d49100.htm)

14) Wright BM and Mckerrow CB : Maximum forced expiratory flow rate as a measure of ventilatory capacity with a description of a new portable instrument for measuring it. BMJ 21 : 1041-1047, 1959.

15) Wright BM : A miniature Wright peak-flow meter. BMJ 2 : 1627-1628, 1978.

16) Qunajer PH, Lebowitz MD, Gregg I et al. : Peak expiratory flow : conclusions and recommendations of a Working Party of the European Respiratory Society. Eur Respir J Suppl 24 : 2s-8s, 1997.

17) Quanjer PH, Tammeling GJ, Cotes et al. : Lung volumes and ventilatory flows. Report Working Party Standardization of Lung Function Tests, European Community for Steel and Coal. Official Statement of the European Respiratory Society. Eur Respir J Suppl 16 : 5-40, 1993.

18) Tsukioka K, Akazawa K and Tanabe N : Peak expiratory flow rate standard for Japanese subjects. In: Peak Expiratory Flow in Normal, Healthy Japanese Subjects, Kyowa Kikaku, Tokyo, 2002, pp12-47 (in Japanese)

19) Read J and Selby T : Tabacco smoking and ventilatory function of the lungs. BMJ 5260 : 1104-8, 1961.

20) Zamel N, Youssef HH and Prime FJ : Airway resistance and peak expiratory flow-rate in smokers and non-smokers. Lancet 1 : 1237-8, 1963.

21) Gregg I and Nunn AJ : Peak expiratory flow in symptomless elderly smokers and ex-smokers. BMJ 298 : 1071-2, 1989.

22) Seltzer CC, Siegelaub AB, Friedman GD et al : Differences in pulmonary function related to smoking habits and race. Am Rev Respir Dis 110 : 598-608, 1974.

23) Klein BE, Moss SE, Klein R et al. : Peak expiratory flow rate : relationship to riskvariables and mortality : the Wisconsin Epidemiologic Study of diabetic retionopathy. Diabetic Care 24 : 1967-71, 2001.

24) Zureik M, Kauffmann F, Touboul PJ et al. : Association between peak expiratoey flow and the development of carotid atherosclerotic plaques. Arch Intern Med 161 : 1669-76, 2001

25) Simons LA, MaCullum J, Simons J et al. : elationship of peak expiratory flow rate with mortality and ischemic heart disease in elderly Australians. Med J Aust 166 : 526-9, 1997.

26) Kinqisepp PH, Jaqomaqi K and Raamat R. Changes of heart rate and blood pressure in registration of forced respiration flow-volume loop. Clin Physiol 21 : 208-13, 2001.

硫酸系火山ガスを長期曝露している日本人健常労働者の肺機能への影響

宇野　秀之[1]　　堀口　兵剛[2]　　香山不二雄[2]

要　約

三宅島は太平洋上，東京南部の小島である。雄山という活火山は2000年6月に噴火が始まり，主にSO_2である火山ガスは未だに排出が続いている。我々は三宅島での長期間滞在労働者100人にピークフロー，自己記述式質問票，血圧と身長測定を行い，最終的に63人の健常労働者個人データを得た。年齢と体格を考慮した予測PEFRで実測PEFRを補正し，作業場所を2群分けし実測PEFR/予測PEFR比を使用しMann-Whittney U検定を行ったが，有意差は認めなかった。また実測PEFR/予測PEFR比をSO_2濃度，呼吸器疾患，Brinkmann Index，収縮期血圧を独立変数として多変量解析を行った。収縮期血圧にて優位な関連性が認められた（OR：1032；95%CI：1.001-1.064）。この我々の結果では，measured PEFR/predicted PEFR比の低下はSO_2大気汚染よりむしろ収縮期血圧に因るところが大きいということが言えた。この研究は三宅島住民や活火山に近接する他居住地区でのリスクコミュニケーションの目的で使用される有益な情報となるであろう。

1．自治医科大学地域医療学センター地域医療学部門
2．自治医科大学地域医療学センター環境医学部門