

THE HIGH ALTITUDE MEDICAL STUDIES IN JAPAN

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RESUMEN: Los Estudios Médicos Sobre Altura en Japón

Los estudios médicos japoneses sobre altura empezaron con la expedición de Manaslu en 1953. desde entonces, entre muchas expediciones de Japón a los Himalayas, 34 de ellas han reportado trabajos médicos. Ocho reportes fueron destacados entre estas 34 expediciones, y especialmente dos de ellas se distinguieron: la *Japanese Alpine Club Mt. Everest Expedition*, 1970 (JMEE'70) y la *Kyoto University Medical Research Expedition to Xixabangma*, 1990 (KUMREX'90). Se presenta una introducción de algunos artículos de KUMREX'90. La *Sociedad Japonesa de Medicina de Montaña (JSMM)* se estableció en 1981 y se publica cada año los reportes de las Symposia Japoneses sobre Medicina de Montaña. El JJMM vol. 16, último número, se publicó en Diciembre de 1996. Entre los numerosos especialistas e investigadores de altitud, los Dres. Matsubayashi, Saito, Masuyama y Horii han realizado remarcables contribuciones y se presentan aquí algunos de sus trabajos. Desde 1966, se ha reportado muchos casos de AMS severo (HAPE/HACE) en Japón, si bien no hay muchas montañas por encima de 3,000 m. El Dr. Kobayashi y sus colaboradores han reportado investigaciones sobre muchos casos de HAPE y de alta susceptibilidad de los casos a la altura. Además de la medicina de montaña, se están realizando también trabajos sobre fisiología en altura. El Dr. Asano de la Universidad de Tsukuba es el líder en este campo en Japón.

Palabras claves : JJMM, Expedición Medicina

RÉSUMÉ: Les études médicales de haute altitude au Japon.

Historique et travaux récents sur la recherche médicale de haute altitude au Japon : Les études médicales japonaises dans ce domaine ont commencé avec l'expédition Manaslu en 1953. Depuis lors, 34 expéditions japonaises à l'Himalaya ont rendu compte de travaux de recherche médicale. Huit de ces reportages sont à signaler et deux se distinguent particulièrement : ceux de la *Japanese Alpine Club Mt. Everest Expedition*, 1970 (JMEE 70) et de la *Kyoto University Medical Research Expedition to Xixabangma*, 1990 (KUMREX 90). Une introduction à quelques articles sur la KUMREX est proposée. La *Japanese Society for Mountain Medicine (JSMM)* a été créée en 1981 et la revue *Japanese Journal of Mountain Medicine (JJMM)* - comptes rendus de la réunion annuelle du symposium japonais de médecine de montagne - est publiée chaque année. Le dernier numéro du JJMM, vol 16 a paru en décembre 1996.

Parmi les nombreux spécialistes de haute montagne et chercheurs d'altitude, les Drs. Matsubayashi, Saito, Masuyama et Horii ont réalisé des travaux remarquables dont quelques-uns sont présentés ici.

Bien qu'au Japon il y ait peu de montagnes dépassant 3 000 m, de nombreux cas graves de AMS (HAPE/HACE) ont été signalés depuis 1966. Le Dr. Kobayashi et ses collègues ont rendu compte de leurs recherches sur de nombreux cas de HAPE et de la très grande susceptibilité des sujets affectés à la haute altitude. En plus de la médecine d'expédition, l'investigation physiologique comprend l'altitude simulée que l'on réalise dans de nombreuses universités. Le Dr. Asano de l'Université Tsukuba est à la tête des recherches dans ce domaine au Japon.

Mots-clés : JJMM, Oedème pulmonaire d'altitude, Médecine d'expédition.

SUMMARY: Japanese high altitude medical study began at Manaslu Expedition in 1953. Since then, among many expeditions to Himalaya from Japan, 34 of them have reported medical research works. Eight reports were remarkable among these 34 expeditions, and especially two of them were distinguished. These two reports were *Japanese Alpine Club Mt. Everest Expedition*, 1970 (JMEE'70) and *Kyoto University Medical Research Expedition to Xixabangma*, 1990 (KUMREX'90). Abstract of some papers on KUMREX'90 are introduced here. The Japanese Society of Mountain Medicine(JSMM) was established in 1981, and the *Japanese Journal of Mountain Medicine(JJMM)*, proceedings of the annual meeting of the Japanese Symposium on Mountain Medicine is being published every year. JJMM vol.16, the latest issue, was published in Dec. 1996. Among many Japanese medical researcher-mountain climbers, Dr. Matsubayashi, Dr. Saito, Dr. Masuyama and Dr. Horii did remarkable works and some of their main works are introduced here. Since 1966, many cases of severe AMS(HAPE/HACE) have been reported in Japan though there are not many mountains higher than 3,000m. Dr. Kobayashi and his colleagues have reported researches on many HAPE cases and high susceptibility to high altitude of the cases. Besides expedition medicine, physiological research works on simulated altitude are also carrying out at several universities. Dr. Asano of Tsukuba University is the leader of this field in Japan.

Key Words: JJMM, High Altitude pulmonary edema, Expedition Medicine.

1. INTRODUCTION

In Japan, there are many mountaineers, hikers, climbers and trekkers going up not only low mountains within Japan but high mountains all over the world, so consequently, the number of

victims of acute mountain sickness(AMS) or even high altitude pulmonary edema(HAPE) and/ or high altitude cerebral edema(HACE) is not a few even on the mountains in Japan, though there are few mountains over 3,000m height. Accordingly, we have many works on

mountain medicine. However, the most of them are not well known in the world, because the rate of numbers of these papers published in foreign medical journals has been low.

In 1983, Dr.Houston kindly offered me the opportunity to introduce our works to people outside of Japan at the Third International Hypoxia Symposium held at Banff, CANADA1). And Dr.Monge and Dr.León-Velarde gave me the second chance to introduce our recent works on high altitude medical researches in Japan at the Second World Congress on High Altitude Medicine and Physiology, 1996 held in Cusco, PERU.

2. JAPANESE SOCIETY OF MOUNTAIN MEDICINE

The Japanese Society of Mountain Medicine(JSMM) was established in 1981. The Japanese Symposium on Mountain Medicine has been held annually and its proceedings,"The Japanese Journal of Mountain Medicine(JJMM)_ is being published every year. This journal, written in Japanese with English abstracts, contains most of our works on mountain medicine. As for example, the contents of the latest issue of JJMM,vol.16 published in Dec.1996 are introduced here,

S.ISOMURA: Special Lecture; International Travel and Health

M.HORII: Memory of the Late Dr.John Sutton

J.R.SUTTON: Lessons from Operation Everest II

F.OKUDA: Prediction of Acute Mountain Sickness by Uric pH Measurement

S.ONODERA: Relationship Between Rating of Perceived Expedition and Heart Rate on Hiking or Climbing of Middle and High Age

M.NAKASHIMA: Recurrent Symptoms of Pneumothorax with Up and Down at Moderate Altitude (A Case Report)

Y.MATSUZAWA: Ventilatory Response to Sustained Hypoxia in Subjects with Previous Histories of High-Altitude Pulmonary Edema

T.KIZAKI: Swimming Training Improves Immune Response

K.MATSUBA: Trial of Disinfection of Drinking Water by Sodium Hypochlorite Solution during Nyainqentanglha(7,046m)

Expedition

M.TAGAWA: A Report on a HRA Pheriche Clinic during Autumn in 1995

T.KOBAYASHI: Effect of O₂ Breathing on Changes of Arterial Oxygen Saturation and Breath-Holding Time (BHT) during High Altitude Trekking

H.OKAMOTO: Enzymatic Adaptation of Skeletal Muscles after Hypobaric Training in Rats.

M.YAMAMOTO: Exercise Physiology of Climbing 8,000m Peak without Bottled Oxygen: Fitness, Acclimatization, and Work Capacity

M.CHIDA: The Effects of Nitric Oxide Donor on the Change of Oxygen Saturation at High Altitude

R.OGIWARA: Risk Management for High Altitude Disease in Travel Agencies Which are in Charge of High Altitude Trip and Tours in Japan

M.NAKASHIMA: Report of The Second World Congress on High Altitude Medicine and Physiology 1996

For more informations, contact with the secretariate of JSMM.

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3. JAPANESE HAPE, THE WORKS OF SHINSHU UNIVERSITY GROUP

The highest peak in Japan is Mt.Fuji(3,776m). More than 100,000 people go up this mountain every summer season, but the incidence of severe AMS is very few.

Supposedly, Mt.Fuji is a single peak and easy to approach so the most of the climbers can get to top and to down before AMS symptoms appear. On the contrary, in case of traverse of Japan Alps, mountaineers should stay at altitudes higher than 2,400m for several days, and some people hypersensitive to altitude often suffer from AMS or even HAPE. The first case of Japanese HAPE was reported by Arai et al in 1966²⁾. Since then, more than 80 cases have been reported. The altitude of onset of Japanese HAPE is as low as 2,680m-3,190m. Among those reports on Japanese HAPE, the clinical works of Kobayashi and his colleagues of

Shinshu University are excellent. The summary of deal works on their own 46 cases are as follows(3, 4);

1. Features of physical examinations on admission:
 - a) Hematological and biochemical analysis; increased; Ht, WBC, Creatine kinase decreased; Plt, Serum protein and Serum Fe.
 - b) Arterial gas analysis: Ph; 7.48 ± 0.04 , P_aCO_2 ; 31 ± 12.7 torr, P_aO_2 ; 44.6 ± 4.0 torr
 - c) Broncho-alveolar lavage: increased; IL-1- β , IL-6, IL-8, TNF- α and ICAM-1
 - d) Chest X-ray and brain CT films: Characteristic findings of pulmonary edema.
2. Common physical characteristics of Japanese HAPE patients:
 - a) Greater increase in pulmonary vascular resistance index
 - b) Higher pulmonary arterial pressure level during hypoxia
 - c) Blunted hypoxic ventilatory drive
 - d) High frequency of increase of human leukocyte antigen DR-6

They concluded that these patients might have genetic predisposition to hypoxic hypersensitivity(5, 6, 7). They also have published several other HAPE-related reports (3, 9)

Furthermore, Ueda and others of Shinshu University group organized Matsumoto Inter-national Symposium on High-altitude Medical Science with splendid proceedin~ses (10, 11) twice in 1987 and 1991.

4. THE HISTORY OF JAPANESE MEDICAL RESEARCHES RELATED TO EXPEDITONS

The Japanese high altitude medical study began at Manaslu Expedition by Japanese Alpine Club in 1953. Since then, among many expeditions to Himalaya from Japan, 34 of them (Table 1 and Table 2) have reported medical research works. The following 8 reports out of these 34 expeditons were remarkable and especially two of them were distinguished. These two reports were Japanese Alpine Club Mt.Everest

Expedition, 1970(JMEE'70) and Kyoto University Medical Research Expedition to Xixabangma, 1990(KUMREX'90).

- 1953-56; Manaslu(8,125) (Nepal) (12) Tatsunuma, Sumiyoshi, Tokunaga.
- 1970; Mt.Everest(8,848) (Nepal) (13) Sumiyosi, Nakashima, Hirotsu, Ohmori. This was the first Japanese expedition equipped with large scale medical research team. Some results of this physiological, hematological and biochemical research works were presented at The 7th International Congress of Biometeorology at Noordwijk, Netherland in 1971.
- 1976; Pik Kommnizma(7,595) (Pamir) (14) Asano. Asano observed very high incidence of high altitude retinal haemorage (HARH) among climbers of this expedition. He took retinophotograms of climbers at the base-camp before and after the ascent. He found 15 HARH cases out of 16(94%) climbers after the ascent.
- 1980; Ganesh Himal V(6,750) (Nepal) (15) Nagao, Shinohara, Sasaki, Imaizumi, et al.
- 1984; Kangchenjunga(8,595) (Nepal) (16) Masuyama. 1988; Mt.Everest(8,848) (Nepal-Tibet) (17) Saito, Masuyama, Suzuki, Horii, Hirata, Nukariya, Mizukoshi.
- 1990; Xixabangma(8,012) (Tibet) Saito, Matsubayashi, Nakashima, et al. This was the genuine large scale medical research expedition of Kyoto Univeraity. The medical reports of this expedition was distingushed. Abstracts of some papers are introduced separately later in 6.
- 1991 Cho Oyu(8,201) (Tibet) (19) Horii.

5 THE FOUR DISTINGUISHED JAPANESE MEDICAL RESEARCHER - CLIMBERS

The names of the most distinguished 4 medical doctors in Japan and their main mountaineering records and research works are as follows;

(♣ :Summit-climb, *The first ascent, ★ :Party leader)

SAITO, Atsuo M.D. (Kyoto University)

1962:Saltoro Kangri ♣♣ (7,742) (Karakorum);Electrocardiogram (20)

He recorded electrocardiograms of climbers at the base camp.

This was the first EKG record took at 5,200m above sea level.

1973:Yalung Kang ♣♣ (8,420) (Nepal); Electrocardiogram (21)

1980:Everest ★ (8,8423) (Tibet); Electrocardiogram (22)

1984:Naimonanyi ★ 7,695) (Tibet); HAPE,Respiratory Function (23)

1988:Everest ★ (Tibet-Nepal); EKG, EEG, HARH, Respiratory, etc. (17, 18)

1990:Xixabangma ★ ♣ (8,012) (Tibet); EKG, EEG, HARH, Hormons,etc.

1992:Namcha Barwa ★ (7,762) (Tibet);

MATSUBAYASHI, Kozo M.D. (Kyoto University)

1982:Gang Ben Cheng t ♣♣ (7,281) (Tibet); Urine Catecholamines (24)

1984:Naimonanyi ♣♣ (7,695) (Tibet); HAPE, Respiratory Function (23)

1985:Masakong ★ ♣ * (7,200) (Bhutan); Cerebral Blood Flow.etc. (25, 26)

1990:Xixabangma ♣ (8,012) (Tibet); EKG, EEG, HARH, Hormons, etc.

MASUYAMA,Shigeru M.D. (Chiba University)

1984:Kangchenjunga(8,595);Ventilation control (16)

1986:Kunlun, Peak7, 167 ♣ ; Ventilatory Chemosensitivity (27)

1988:Everest; EKG, EEG, HARH, Respiratory, Hormons (28) 29)

He observed hypoxic ventilatory response of highlanders (Sherpa) and concluded that,

1. It is not always blunted.
2. They keep good ventilation both at rest and at exercise or acute hypoxic exposure.
3. Even highlanders, hypoxic ventilatory response curve decreases by age, but good ventilation and oxygenation are still kept.

HORII, Masako M.D. (Kanagawa Cancer Center Hospital)

1980:Kedarnath Dome (8,31); Circulatory Physiology of Women (30)

1988:Everest (Tibet-Nepal); EKG, EEG, HARH, Respiratory, Hormons (31)

1991:Cho Oyu (8,201) (Tibet); High Altitude Physiology of Aged (19)

She found that VO_{2max} of 4 Japanese middle-aged(52-55 years old) Mt.Cho Oyu(8,201m) summit-climbers was between 52.6and 63.9 ml/kg/min, almost same level of excellent marathon runners. She also found that mean SO_2 of summit-climbers was always higher than that of non-summit climbers significantly at any altitude.

6. MEDICAL STUDIES OF HIMALAYAN EXPEDITIONS OF KYOTO UNIVERSITY

Kyoto University is a really outstanding university in Japan, which dispatched total 28 scientific expeditions to Himalaya and other high mountains.Among them, 6 expeditions shown in Table 3 have performed distinguished medical works, and the last one, Kyoto University Medical Research Expedition to Xixabangma, 1990 (KUMREX'90) was the first and the best genuine large scale medical research expedition in Japanese history of mountaineering. Some of their works were presented on the 7th International Hypoxia Symposium, Lake Louise, in 1991. (Hypoxia and Mountain Medicine, J.R.Sutton,G.Coates and C.S.Houston ed. Queen City Printers Inc. Burlington. Vt. 1992)

**Table 1. CHRONICLE OF JAPANESE EXPEDITIONS TO HIGH MOUNTAINS
WITH MEDICAL RESEARCH(1953-1981)**
(BEFORE ESTABLISHMENT OF JAPANESE SOCIETY OF MOUNTAIN MEDICINE)

YEAR	MOUNTAIN(m)	AREA	RESEARCH MEMBER
1953-56	Manaslu(8,125)*	Nepal	Tatsunuma,et al.
1962	Saltoro Kangli*(7,654)	Karakorum	Saito,Hayashi.
1966	Aconcagua(6,969)	Peru	Takasi,Hara,et al.
1970	Everest(8,842)*	Nepal	Nakashima,Ohmori,et al.
1973	Yalung Kang(8,420)	Nepal	Saito.
1976	Pik Kommnizma*(7,595)	Pamir	Asano,Hara.
1977	Tharkott(6,099)	India	Hara,et al.
1979	Huascaran(6,767)	Peru	Hara,et al.
1980	Ganesh Himal V*(6,750)	Nepal	Nagao,et al.
1980	Kedarnath(6,940)	India	Horii.
1980	Everest*(8,842)	Nepal	Saito,et al.
1981	Bogoda(5,445)	China	Nose,et al.
1981	Everest(8,842)	Nepal	Hayashida.et al.
1981	Japanese Society of Mountain Medicine(JSMM) Established		

*Remarkable Research

ADACHI,Minami (32)measured hematocrit(Ht) and erythropoietin. The mean Ht at 6,920m was $65.5 \pm 3.0\%$ (47-70%). Erythropoietin increased with ascent prior to increase of Ht, then decreased acutely with progress of acclimatization, and increased again with further gain of altitude.

DEMIZU,Akira (33) observed high altitude

insomnia of climbers through the incidence of day-time sleepiness. It was observed 2.7% at 5,-6,000m, 12% at 6,-7,000 m then 28% at 7,-8,000m(summit:8,008m). Oxygen saturation measured by pulsoximeter(SpO_2) was also observed. Mean SpO_2 in night was 98% at sea level, 77% at 3,650m, 73% at 5,640m then 59% at 7,430m respectively. Arterial gas analysis at base camp(5,020m) was as follows:

On arrival(Apr/22):	PaO ₂ :27-43torr,	PaCO ₂ :18-32torr,	pH:7.48-7.61
On leaving(May/28):	41-46	17-31	7.40-7.58

ENDO,Katsuaki (34)recorded EEG of climbers. He stored it on magnetic tape and brought back to Kyoto. The event related potentials and auditory evoked potentials in human brain were analysed by means of a computer. Both potentials decreased at high altitude. It is very interesting finding that, the event related potentials of climbers with high altitude retinal hemorrhage(HARH) was obviously lower than that of climbers without HARH.

HIRATA,Kazuo (35) observed left ventricular function and cardiac wall motion potentials using centerline method by means of 2-Dimension Echocardiography, which was brought up to the base camp(5,020m). He observed depression of septal movement which reflected increased right ventricular load, induced by pulmonary hypertention came from

environmental hypoxia. On the other hand, the movement of left ventricular posterior wall increased for the compensation of depressed septum movement.

JIN-NOUCHI,Yosuke (36) observed lower left ventricular function among Himalayan highlanders comparing with Japanese by means of echocardiography.

MATSUBAYASHI, Kozo (37) reported the discrepancy between brain oxygen and glucose metabolism after coming back from high altitude climbing by means of positron emission computed tomography(PET). It was observed that brain blood flow was decreased and brain oxygen uptake was increased but glucose metabolism was unchanged. He supposed this phenomenon might suggest that human blood

flow, oxygen uptake and glucose metabolism increased at altitude.

MATSUBAYASHI, Kiyoaki (38) brought two young Japanese monkeys up to camp 5,640m and measured several physiological indicators, such as, body weight, respiratory rate, puls rate, expiratory gas analysis, EEG, RBC, Ht, Erythropoietin, T3, T4 and Cortisol. The results from monkeys were almost same as human samples.

NAKASHIMA, Michiro (39, 40), the author, observed the incidence of HARH at the base camp(5,020m) by means of retinocamera. He found very high HARH incidence among Himalayan newcomers. On arrival to base camp, 7 out of 9 newcomers(78%), and on leaving from base camp, 8 of 9 newcomers who had climbed above 6,000m(89%) were suffered from severe HARH. On the contrary, in case of Himalayan experiences, not only the incidence was low(1 out of 8(13%) on arrival, and 7 out of 19 summit climbers(37%) on leaving), but all HARH findings of them were mild. It is interesting enough that, inspite of such high incidence of HARH, none of all cases complained any symptoms.

SETO, Siro (41) measured platelet factor 4(PF4), β -thromboglobulin (β -TG), thromboxan B2(TXB2) and 6-keto prostaglandin F1Q (6-PGF1a), and found all but 6-PGF1Q increased. These results suggested increased blood coagulation tendency, but comparing with high rate of this tendency the real incidence of intravascular blood coagulation at high altitude was relatively not so high, especially among Japanese climbers, so, he supposed that there might be some unknown counter factors to protect blood coagulation at high altitude.

SUGIE, Tomoharu (42) brought gastrofiberscope up to the base camp and found high incidence of acute gastric mucosal lesion among expedition members. He concluded that hypoxia might be one of the major factors of gastric hemorrhage, which is not uncommon among high altitude climbers.

7. RESEARCH WORKS ON SIMULATED HIGH ALTITUDE

Besides these great deal of medical researches on expeditions, several experimental training to get acclimatization by means of hypobaric chamber prior to the expedition have also been investigated at some universities. According to

Asano and his colleagues of Tsukuba University (43), it was mentioned that the Himalayan candidate examinees could get good acclimatization and easier and faster Himalayan climb after this sort of simulated altitude training.

8. DISCUSSION

There is an anecdote. About 200 years ago, an American natural scientist was invited to Japan as the teacher of natural science. He taught his students mathematics, chemistry, physics, botany and so on from the beginning. One day he suddenly realized that his students knew all about natural sciences but English language. They had already learned natural sciences through Dutch. The lesson of this anecdote is "It is unavoidable for someone to be considered as ignorant, if he has no means to express his knowledge."

The volume of medical documents written in English and published in foreign journals by Japanese researchers is not so few, but most of the documents have been written only in Japanese and published in Japanese journals within Japan. How huge is the accumulation of researches on mountain medicine, expedition medicine and high altitude physiology, as long as written in Japanese only, it is no use for the progress of medical sciences of the world. All of Japanese medical investigators should take this lesson to heart.

9. OVERVIEW

Japanese Society of Mountain Medicine was established in 1981, which is publishing Japanese Journal on Mountain Medicine with English abstracts every year. The latest issue, vol.16 was published in Dec.1996.

We have many cases of AMS or even HAPE and/or HACE in Japan at altitude above 2,700m. Why at relatively not so high altitude Kobayashi and his colleagues of Shinshu University have been investigating the genetic hypersensitivity predisposition to altitude of Japanese HAPE patients. Shinshu University group also has organized splendid international symposiums on high altitude medicine twice.

Until now, 34 Japanese expeditions reported medical researches, and 8 of them were remarkable.

**Table 2. CHRONICLE OF JAPANESE EXPEDITIONS TO HIGH MOUNTAINS
WITH MEDICAL RESEARCH(1982-1994)**
(AFTER ESTABLISHMENT OF JAPANESE SOCIETY OF MOUNTAIN MEDICINE)

YEAR	MOUNTAIN(m)	AREA	RESEARCH MEMBER
1982	Gang Ben Cheng*(7,281)	Tibet	Matsubayashi,et al.
1983	Jichudrake(7,012)	Bhutan	Hashimoto,et al.
1983-84	Everest-Lhotse(8,511)	Nepal	Asaji,Song,Kobayashi.
1984	Kanschenjunga*(8,595)	Nepal	Masuyama,et al.
1984	Naimonanyi(7,694)	Tibet	Saito,Matsubayashi,et al
1984	Bhagirathill	India	Kawai,et al.
1985	Masakong(7,200)	Bhutan	Matsubayashi.
1986	Nianquingtanggula	Tibet	Katayama,Sakai,Kasai.
1986	Kuniun,P.7,167	China	Masuyama.
1988	Everest*	Nepal- Tibet	Saito,Suzuki,Nukariya, Masuyama.
1988	Yan(6,230)	India	Honjo,et al.
1989	K.P.6,666	Karakorum	Nito,et al.
1990	Xixabansma*(8,012)	Tibet	Nakashima,et al.
1990	Cho Oyu(8,201)	Tibet	Doi,et al.
1991	Cho Oyu*(8,201)	Tibet	Horii.
1992	Gasherbrum I (8,068)	Karakorum	Kamio.
1992	Crown(7,265)	China	Shimada.
1993	Damavand(5,611)	Iran	Noguchi.
1993-94	Everest	Nepal	Sumiyosi.
1994	Bhagirathi(6,856)	India	Nakashima.
1994	Lobche Peak(6,145)	Nepal	Kashimura.

*Remarkable Research

The names and main works of following 4 medical doctores, Saito and Matsubayashi (Kyoto University), Masuyama (Chiba Univ.) and Horii (Yokohama) are introduced as the distinguished mountain climber-medical researchers.

The best and the largest medical research expedition from Japan was Kyoto Univeraity Medical Research Expedition to Xixabangma, 1990(KUiZREX'90). Some of the papers, mainly presented on the 7th International Hypoxia Symposium, Lake Louise, in 1991, were introduced.

Besides medical studies on expedition, some succesful trials to get acclimatization using hypobaric chamber have been reported by Asano et al.

REFERENCES

1. Nakashima,M,:High Altitude Medical Research in Japan. Hipoxia, Exercise and Altitude, Alan R.Liss, Inc.New York,NY:173-182,1983.
2. Arai,T, et al,: A Case Report of High Altitude Pulmonary Edema(in Japanese). Naika 18:357-362,1966.
3. Kobayashi,T,: High-Altitude Pulmonary Edema in Japan(in Japanese). Japn J Thoracic Dis 33: Supplement 1-6,1995.
4. Kobayashi,T, Koyama,S, Kubo,K, et al: Clinical Features of Patients with High - Altitude Pulmonary Edema in Japan. Chest 92:814-821,1987.
5. Levine,BD, Kubo,K, Kobayashi,T, et al: Role of Barometric Pressure in Pulmonary Fluid Balance and Oxygen Transport. J Appl Physiol 64:419-428,1988.
6. Matsuzawa Y, Fujimoto K, Kobayashi T,et al: Blunted Hypoxic Drive in Subjects Susceptible to High-Altitude Pulmonary Edema. J Appl Physiol 66:1152-1157, 1989.
7. Kawashima A, Kubo K, Kobayashi T, et al: Hemodynamic Responses to Acute Hypoxia,

- Hypobaria, and Exercise in Subjects Susceptible to High-Altitude Pulmonary Edema. *J Appl Physiol* 67:1982-1989, 1989.
8. Nakagawa S, Kubo K, Koizumi T, et al: High-Altitude Pulmonary Edema with Pulmonary Thromboembolism. *Chest* 103:948-950, 1993.
 9. Koizumi T, Kawashima A, Kubo K, et al: Radiographic and Hemodynamic Changes during Recovery from High-Altitude Pulmonary Edema. *Int Med* 33:525-528, 1994.
 10. Ueda G, Kusama S, Voelkel NF, ed.: High-Altitude Medical Science(HAMS). Shinshu University Press, Matsumoto, Japan, 1988.
 11. Ueda G, Reeves JT, Sekiguchi M, ed.: High-Altitude Medicine. Shinshu University Press, Matsumoto, Japan, 1992.
 12. Tatsunuma T, Yamazaki F, Tokunaga A.: Medical Observations at High Altitude. *Manaslu* 1954-: English Abstract 11, Mainich Newspapers, Tokyo, 1958.
 13. Nakashima M.: The Respiratory and Circulatory Function of Mountaineers on Mt. Everest. *Biometeorology* 5, Part H:88, 1972.
 14. Asano T.: High Altitude Retinal Hemorrhage(HARH) (in Japanese). *Iwa to Yuki* 53: 42-47, 1977.
 15. Nagao Y, ed.: Ganesh Himal V, Tokyo Jikeikai Medical College. Gendaisha, Tokyo, 1983. (in Japanese)
 16. Masuyama S, Kimura H, Kuriyama T, et al: Control of Ventilation in Extreme Altitude Climbers. *J Appl Physiol* 61:500-506, 1986.
 17. Masuyama S, Hirata K, Saito A.: "Ondine's Cures", Side Effect of Acetazolamide? *Am J Med* 86: 637, 1989.
 18. Hirata K, Masuyama S, Saito A.: Obesity as a Risk of Acute Mountain Sickness. *Lancet* 2/8670; 1040-1041, 1989.
 19. Horii M, et al: Physiological Characteristics of Middle-aged High Altitude Climbers of a Mountain over 8000m in Hight. *J Wilderness Med* 5: 447-450, 1994.
 20. Saito A.: Electrocardiographic Observations at Saltoro Kangri(in Japanese). Saltoro Kangri, Asahi Newspapers, Tokyo: 68, 1964.
 21. Saito A, Takagi S, Nakashima M.: Electrocardiographic Observation at Yalung Kang(in Japanese). Yalung Kang, Asahi Newspapers, Tokyo 154-155, 1975.
 22. Saito A, Nishiyama S, Gashu S.: Electrocardiographic Chages on Climbers Studies of the Japanese Alpine Club Members on Mt.Chomolangma(Tibet) (Engl. Abst.). *Japn J Mountain Med* 1: 68, 1981.
 23. Saito A, Matsubayashi K, Nakashima M.: A Case of High Altitude Pulmonary Edema(HAPE) (Suspected) on Mt.Naimon'anyi(Gurla Mandata)7694m in 1985(Engl.Abst). *Japn J Mountain Med* 6: 30-31, 1986.
 24. Matsubayashi K, Saito A, Nakashima M.: The Changes of Urine Catecholamines and Their Metabolites at High Altitude in Tibet Himalaya(Engl.Abst). *Japn J Mountain Med* 3: 182-183, 1983.
 25. Matsubayashi K, Nakashima M, Saito A, et al.: Platelet Aggregability at High Altitude(Engl.Abst). *Japn J Mountain Med* 6: 84, 1986.
 26. Matsubayashi K, Ozawa T, Nakashima M, Saito A.: Cerebral Blood Flow and Metabolism Before and After Staying at High Altitude. (Engl.Abst). *Japn J Mountain Med* 6: 57, 1986.
 27. Masuyama S, Hasako K, Kouchiyama S. et al.: Periodic Breathing during Sleep at High Altitude and Ventilatory Chomosensitivities to Hypoxia and Hypercapnea. High-Altitude Medical Scienses, Ueda G. et al ed. Matsumoto, Japan, 229233, 1988.
 28. Masuyama S, Kouchiyama S. Shonozaki T, et al.: Periodic Breathing at High Altitude and Ventilatory Responsiveness. *Japn J Physiol* 39: 523-535, 1989.
 29. Masuyama S, Hasako K, Kojima A. et al.: Do Nepalese Sherpas Maintain High Hypoxic Ventilatory Drive? (Engl.Abst). *Japn J Mountain Med* 10: 81, 1990.
 30. Horii M, Ishizuka H.: ECG Changes of Women Climbers during Himalayan High Altitude Mountaineering(in Japanese). *Kokyu to Junkan* 32: 481, 1984.
 31. Horii M, Nukariya K, Suzuki H, Mizukoshi H.: Analysis of Five Days Continuous Ambulatory Electrocardiogram at Hgh Altitude(Engl.Abst). *Japn J Mountain Med* 10: 75, 1990.
 32. Adachi M, Seto S, Sugie T, et al.: Sequential

- Analysis of an Erythropoietic Drive at High Altitudes. JR.Sutton,G.Coates,C.Houston ed, Hypoxia and Mountain Medicine, Queen City Printers Inc.Burlington, Vt, 296, 1992.
33. Demizu A, Matsubayashi,K, Nakashima M, et al,: High Altitude Insomnia and Continuous Pulsoxymetry at High Altitude. JR.Sutton, G.Coates,C.Houston ed, Hypoxia and Mountain Medicine, Queen City Printers Inc.Burlington, Vt, 301, 1992.
 34. Endo K, Adachi M, Demizu A, et al,: The Event Related Potentials and Auditory Evoked Potentials in the Human Brain at High Altitude. JR.Sutton, G.Coates, C.Houston ed, Hypoxia and Mountain Medicine, Queen City Printers Inc. Burlington, Vt, 302, 1992.
 35. Hirata K, Ban T, Jinnouchi Y, Kubo K,: Echocardiographic Assesment of Left Ventricular Function and Wall Motion at High Altitude in Normal Subjects. Am J Cardiol 68: 1692-1697, 1991.
 36. Jin-nouchi Y, Matsubayashi K, Ozawa T, et al,: Characteristics of Cardiovascular Physiology in Himalayan Highlanders. JR.Sutton, G.Coates, C.Houston ed, Hypoxia and Mountain Medicine, Queen City Printers Inc. Burlington, Vt, 307, 1992.
 37. Matsubayashi Kozo, Seto S, Demizu A, et al,: Discrepancy between Brain Oxygen and Glucose Metabolism after High Altitude Climbing. -The PET Study-. JR.Sutton, G.Coates, C.Houston ed, Hypoxia and Mountain Medicine, Queen City Printers Inc.Burlington, Vt, 313, 1992.
 38. MatsubaYashi KiYoaki: PhYsioloZical Phenomena of JaDanese MonkeYs in Himalaya (Engl. Abst.). Himalayann Study Monograghs 2:117-125, 1991.
 39. Nakashima M, Saito A, Endo K, et al: High Altitude Retinal Hemorrhage(HARH) Observed on Kyoto University Medical Research Expedition to Xixabangma(8027m) 1990(KUMREX'90). JR.Sutton, G.Coates, C.Houston ed, Hypoxia and Mountain Medicine, Queen City Printers Inc.Burlington, Vt, 315, 1992.
 40. Nakashima M, Saito A, Endo K, et al: The Incidence of High Altitude Retinal Hemorrhage(HARH). High Altitude Medicine, Ueda G,et al ed. Shinshu Univ. Press, Matsumoto, Japan: 275-278, 1992.
 41. Seto S, Adachi M, Kubo S, et al: Platelet Activation is Present or Not at High Altitudes. JR.Sutton, G.Coates, C.Houston ed, Hypoxia and Mountain Medicine, Queen City Printers Inc.Burlington, Vt, 320, 1992.
 42. Sugie T, Kan N, Saito A, et al: Acute Gastric Mucosal Lesion at the High Altitude. JR.Sutton, G.Coates, C.Houston ed, Hypoxia and Mountain Medicine, Queen City Printers Inc.Burlington, Vt, 320, 1992.
 43. Asano K,: Effect of Simulated Altitude Training and Climbing on Aerobic Work Capacity. High Altitude Medicine, Ueda G, et al ed. Shinshu Univ. Press, Matsumoto. JaDan: 428-434. 1992.

Table 3. HIMALAYAN EXPEDITIONS OF KYOTO UNIVERSITY WITH REMARKABLE MEDICAL RESEARCHES

1962 Salto Kangli(7,742), Karakorum	
Saito, Hayashi;	Cardiographic Observations at 5,200m above sea level
1973 Yalung Kang(8,420) Nepal	
Saito, Takasi;	EKG, Blood Pressure, Breath Holding Time.
1982 Gang Ben Cheng(7,281) Tibet	
Matsubayashi;	Urine Catecholamines and their Metabolites at Altitude
1984 Naimonanyi(7,694) Tibet	
Saito, Matsubayashi;	High Altitude Pulmonary Edema(HAPE)
	Respiratory Function During Long Term Sojourn Above 4,700m
1985 Masakong(7,200) Bhutan	
Matsubayashi;	Cerebral Blood Flow and Metabolism Before and After High Altitude Sojourn
1990 Xixabansma(8,012) Tibet	
Adachi;	Sequential Analysis of Erythropoietic Drive
Demizu;	High Altitude Insomnia and Continuous Pulseoxymetry
Endo;	Event Related Potentials and Auditory Evoked Potentials
Hirata;	Left Ventricular Function and Wall Motion Examined by 2-D Echocardiography
Jin-nouchi;	Characteristics of Cardiovascular Physiology
Matsubayashi, Ko.;	Discrepancy Between Brain Oxygen and Glucose Metabolism
	After High Altitude Climbing
Matsubayashi, Ki.;	Hematological and Physiological Study of Monkey
Nakashima;	High Altitude Retinal Haemorrhage(HARH)
Seto;	Platelet Activation Is Present or Not at High Altitude
Sugie;	Acute Gastric Mucosal Lesion at the High Altitude