Awareness and prevalence of acute mountain sickness and prevalence of obstructive airflow limitation among Nepalese porters: A cross-sectional study in Khumbu Valley, Nepal

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ABSTRACT

Background: Acute mountain sickness is a major public health problem in high altitudes. Similarly, anecdotal evidence suggests that there is high prevalence of tobacco smoking among this group though prevalence of obstructive airflow limitation is not known.

Objectives: The main aims of the study were to measure the awareness of AMS and report the prevalence of AMS and obstructive lung diseases in high altitude Nepalese porters.

Setting: This study was done with bases in Namche Bazaar (3460metres), Pheriche (4270m), Thokla pass (4830m), Gorakshep (5140m) and Everest Base Camp (5364m).

Method: A cross-sectional study was conducted using standardized multiple choice questionnaires among high altitude porters working at Namche and above during May-June 2008. Total 200 porters were interviewed. Lake Louis questionnaire was used for diagnosis of AMS. Spirometry was performed in 160 porters at Namche Bazaar.

Results: Awareness of AMS was medium among 50% of porters and 36% had low knowledge regarding AMS. The total prevalence of AMS was 4% among porters. The prevalence of AMS was 0.6% at 3460m, 13.3% at 4270m, 21.4% at 4830m and 28.5% at 5364m. Prevalence of tobacco smoking was 34%. Frequency of airflow limitation was 17.9% which was defined by FEV1/FVC <0.7. Vital signs (BP, PR and RR) and saturation pressure of oxygen (SpO_2) were significantly associated with AMS outcome (p-value <0.05). Age and smoking were not found to be associated with airflow limitation.

Conclusion: The level of awareness regarding AMS in porters was in the middle range in Khumbu region. Prevalence of AMS was low compare to climbers and foreign trekkers. Prevalence of smoking was high but it was not related to airflow limitation. Airflow limitation might be due to open indoor fires used for cooking which is very common in this region and other hyperactive lung diseases. Different organizations working for porters should focus on awareness programmes regarding AMS and adverse effects of smoking tobacco.

Keywords: acute mountain sickness, obstructive lung diseases, airflow limitation, tobacco smoking, high altitude, porters.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

ABG	Arterial Blood Gas
AMS	Acute Mountain Sickness
ATS	American Thoracic Society
BMI	Body Mass Index
BP	Blood Pressure
COPD:	Chronic Obstructive Pulmonary Disease
ERS	European Respiratory Society
FEV1	Forced Expiratory Volume at One Second
FEV6	Forced Expiratory Volume at six second.
FVC	Forced Vital Capacity
GOLD	The Global Initiative for Chronic Obstructive Lung Disease
HACE	High Altitude Cerebral Edema
HAI	High Altitude Illness
HAPE:	High Altitude Pulmonary Edema
MMSN	Mountain Medical Society of Nepal
O_2	Oxygen
OLD	Obstructive Lung Disease
OPD	Obstructive Pulmonary Disease
$PaCO_2$	Partial Pressure of Carbon dioxide
PaO_2	Partial Pressure of Oxygen
PPFEV1	Percent of Predicted Forced Expiratory Volume at one second
PPFVC	Percent of Predicted Forced Vital Capacity
PR	Pulse Rate
RR	Respiratory Rate
SpO_2	Saturation Pressure of Oxygen
WHO	World Health Organizations

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Ranjan Parajuli
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CHAPTER 1: INTRODUCTION

1.1 Country profile

Nepal is a landlocked country situated between China and India in South Asia. It has a population of about 27 million people. Nepal is divided in five regions, fourteen zones and seventy-five districts administratively. Katmandu is the capital city [1] .

For a long time, Nepal has been a favorite tourist destination due to its geographical variations from plains of Terai which is neighboring India to beautiful high Himalayas in north facing Tibet. Nepal is also famous in the world as “birthplace of Lord Buddha” and “Land of Himalayas”. It is the country of Mount Everest which is the highest peak in the world with a height of 8848 metres. Mount Everest, is also known by the name of “Sagarmatha” (hat of the world) in Nepali language and “Chomolungma” meaning Goddess mother of the Earth in Tibetan language [2].

Many tourists from different parts of world travel to Nepal each year, for trekking and mountaineering in the Himalayas. It is the dream of many climbers to reach to the summit of Mt. Everest but only few succeeds. Since, Nepal is one of the poorest countries in the world and due to its geographical diversities, traveling to Himalayas in Nepal is very difficult compared to western world.

Many of the tourists and the trekkers are accompanied by Nepalese porters carrying their luggage. Carrying heavy loads in the high altitudes is a real challenge as well as risky. These porters are predominantly from ethnic groups like Sherpa, Rai, Tamang and Magar. Among these, Sherpa are famous for mountain climbing and though many Sherpa work as porters in this region , not all porters are Sherpa [3] .

1.2 Altitude and human settlement

Approximately, around 140 million people around the world live permanently at altitudes higher than 2500 meters [4, 5]. Presently, the highest settlement in the world is in the village of La Rinconada at 5100m in Peru. This is a mining village with almost seven thousand residents [6].

For the ease of understanding, high altitude by consensus is categorized into three subdivisions such as “High altitude (1500m to 3500m), “Very High Altitude (3500m to 5500m) and “Extreme Altitude (above 5500m) [7] .

1.3 Normal physiologic changes in altitude

On ascent to higher altitude, barometric pressure of oxygen decreases while the percentage of available oxygen in atmospheric air stays at 21%. The partial pressure of oxygen determines the amount of oxygen available during each breath and with increasing altitude each breath will hold less oxygen [8].

Initially, the partial pressure of oxygen in the arterial blood (PaO2) falls parallel to the partial pressure in the atmosphere. When the falling PaO2 reaches critical level (approx.8kPa), chemo- receptors located in the carotid and aortic bodies start signaling for stimulating the increased ventilation, which in turn results in expelling of CO2 and lowering of PaCO2, ultimately raising the body pH. Both, low PaCO2 and high pH give a strong negative feedback on ventilation, limiting the ultimate effect of this immediate response to hypoxia [8]. Over days of this moderate hyperventilation, the kidneys respond by expelling buffer (bicarbonate) and thereby aiding the normalization of pH. In turn, this again allows the ventilation to increase further [9]. Over the long term say weeks to months, the chronic hypoxia also stimulates the production of hemoglobin and erythrocytes, increasing the blood capacity for O2 transport [8].

Thus, the physiological response to hypobaric hypoxia consists of immediate, intermediate, and long term effects which in turn work to improve O2 delivery to body tissue and thus supporting body acclimatization to high altitude. All of these mechanisms mentioned can also be related to pathophysiology of altitude sickness.

1.4 Hypoxia of high altitude and barometric pressure

Hypoxia is the main insult to the body in high altitude which finally develops AMS. The compensatory mechanisms help lot in acclimatization of body with low oxygen but do not totally prevent the effects of hypoxia. Hypoxia of high altitude impairs physical and mental performance and causes sleep disturbance and finally develops AMS [8]. Figure 1 shows the barometric pressure in different altitude [8].

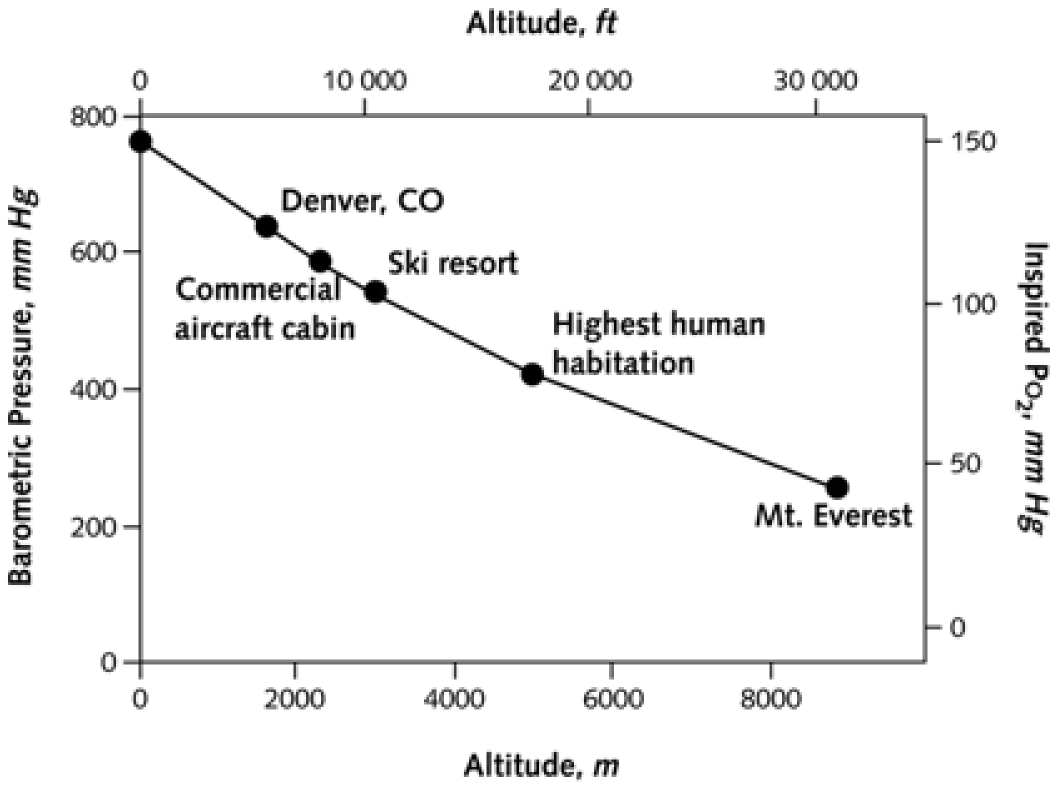

Figure 1: Altitude, barometric pressure and inspired PO2 [Source: The physiologic basis of High-Altitude Disease

1.5 Literature review

1.5.1 High altitude illness

High Altitude illness refers to a collective term for Acute Mountain Sickness (AMS), High Altitude Cerebral Edema (HACE), and High Altitude Pulmonary Edema (HAPE) which affects unacclimatized travellers shortly after ascent to high altitude. Acute Mountain sickness is more frequent where as HAPE and HACE are less frequent but potentially fatal [9].

1.5.2 Acute mountain sickness

Acute mountain sickness is a benign form of high altitude illness comprising mainly of non-specific symptoms such as headache, anorexia, nausea, vomiting, fatigue dizziness and sleep disturbance [10-13]. Symptoms occur within 6-12 hours of ascent, on individuals who rapidly ascend over 2500m without sufficient acclimatization and varies in severity from mild to incapacitating [12].

Headache is the most common and most prominent symptom of AMS, although its cause remains unclear [10-14]. Non specific signs and symptoms of AMS can result in diagnostic confusion with other disorders such as exhaustion, dehydration, hypothermia, alcohol hangover and migraine [10].

Anyone who goes to high altitude can get AMS. Certain individuals acclimatize quickly and can avoid AMS on further ascent while others cannot. The best way for prevention of mountain sickness is by ascending slowly and allowing enough time for body to acclimatize [8]. For prevention, Acetazolamide (Diamox) 125 mg twice daily can be prescribed otherwise the mainstay of treatment of AMS is rest, fluid and mild analgesics [7, 9].

1.5.3 High altitude cerebral edema (HACE)

If the symptoms of AMS are neglected, then it can progress to HACE which is considered to be life threatening [15, 16]. HACE is severe form of AMS which is characterized by ataxia and altered consciousness which may progress to coma and can cause death due to brain herniation [9-11, 17]. Persons with HACE are often found to be confused and may not recognize that they are ill. Usually, the illness progresses over a period of hours or days [18]. HACE usually appears during the night time and the individual with symptoms of HACE must be brought down to low altitude immediately. It is dangerous to wait further until the morning [7, 9]. The treatment for HACE is immediate descent in conjunction with oxygen, if available, and Dexamethasone [8, 10, 17]

1.5.4 High altitude pulmonary edema (HAPE)

Another form of severe altitude illness is HAPE which often occurs together with AMS but it can present itself independent of AMS. Similar to HACE, HAPE also often occurs in the nighttime and it is also an urgent medical condition. It is the most common cause of fatality due to high altitude and occurs in the initial 2-4 days of arriving at high altitudes over 2500m [11, 19]. In some cases, HAPE can develop to HACE due to an exacerbation of already critical hypoxia [10]. Hypoxia of high altitude causes constrictions of the some of the blood vessels in the lungs, shunting all the blood through limited vessels which are not constricted. Due to this, the pressure in these blood vessels which are not constricted increases which in turn results in high pressure leak of fluid from the blood vessels into the lungs leading to HAPE [10, 20]. Exertion and cold can also raise the pulmonary blood pressure and may contribute to either the onset or worsening of HAPE. Individuals suffering from HAPE experience extreme fatigue, tachypnea, productive cough, drowsiness, and peripheral cyanosis [20, 21]. Pneumonia, high altitude cough and bronchitis and asthma are possible differential diagnosis for HAPE [9].

The treatment of choice is immediate descent, rest and oxygen supply but in the case , immediate descent and oxygen supplement are not available, Nifedipinde is a potentially important life saving medication [20, 22]. All this can be summarized by saying that altitude illness is common problem in high altitude and it can lead to fatal outcomes if underestimated or mistreated.

1.5.5 Pathophysiology of AMS, HAPE and HACE

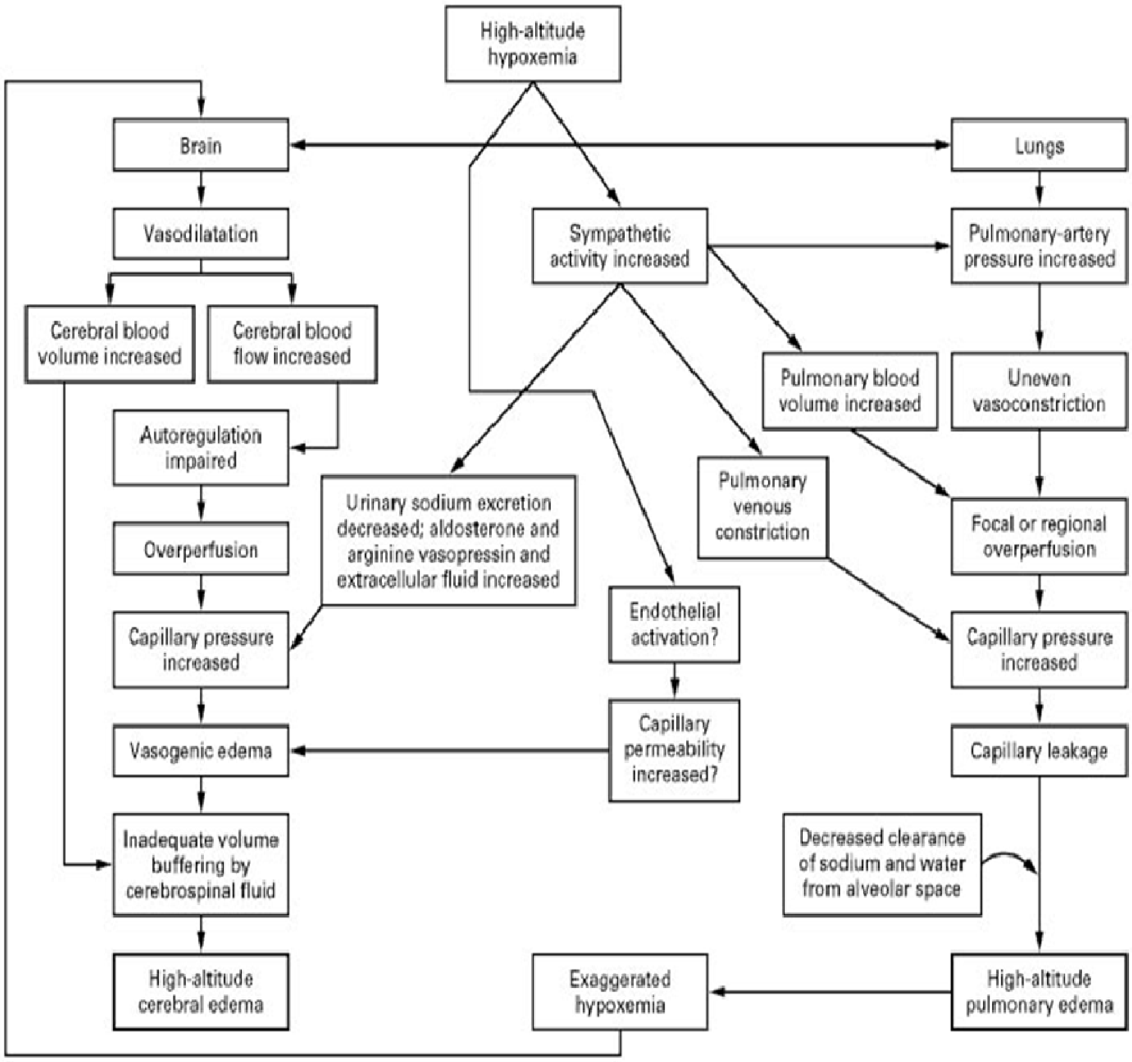

Figure 2: Proposed Pathophysiological Process of High-Altitude Illness. (Source: High-Altitude Illness: Peter H. Hackett, Robert C.Roach)

At high altitude, hypoxia can lead to vasodilatation, increased capillary blood flow, increased capillary pressure and leakage of fluid from the cerebral and pulmonary microcirculation. So, the ultimate effect in the brain is swelling with edema. The mild clinical scenario in this case is AMS with the severe form of HACE. Similarly, with edema in the lungs it leads to HAPE (Figure 2) [11, 18].

1.6 Risk factors

Rate of ascent and individual susceptibility are known to be associated to HAI [7, 9]. HAI is much more common at altitudes higher than 2500 meters but it has been recognized between 1500 -2500 meters [23]. Previous history of altitude illness and permanent low altitude(<900m) residency are also known risk factors for HAI [12]. Physical fitness has not been shown to be a risk factor but exertion at altitude has been documented to be associated with AMS [24].

Children and adults are more susceptible than those over 50 years[12, 25] In general, the risk of HAI does not seem to be different in men and women but few studies have shown that incidence of AMS is higher in women [26]. Although, an association between AMS and dehydration has been noted [27], it is unclear whether dehydration is an independent risk factor for AMS. Porters, pilgrims and other native populations are also vulnerable to altitude illness as studies have shown [28, 29]

1.7 Epidemiology of high altitude illness

It has been shown that 47% of trekkers flying to Lukla at altitude of 2840m from kathmandu suffered from altitude sickness during the first 24 hours [30]. In the Mount Everest region of Nepal, about 50% of trekkers who walk to altitudes higher than 4000 m over 5 or more days developed AMS [30, 31] and about 84% of people who fly directly to 3740 m were affected [26]. The incidence of AMS at moderate altitudes(1500m-3500m) in Northern America was 25% [12]. High-altitude illness is much more likely to occur at altitudes higher than 2500 m but presently it has been recognized at altitudes between 1500 m and 2500 m [23].

Some studies have shown that the prevalence of AMS in the Himalaya vary from 43% to 63% [30] and 9% to 69% in the alps [15]. The incidence of HACE and HAPE is much lower than AMS in Everest region from 0·1–4·0% [10].

1.8 Obstructive lung disease and airflow limitation

1.8.1 Background

Obstructive lung disease including chronic bronchitis, emphysema and asthma are the fourth leading cause of death in USA [32]. Environmental air pollution and cigarette smoking has been linked to increased prevalence of obstructive lung disease [33]. Asthma is most common in children but can occur in any age group [34]. Chronic bronchitis and emphysema can together be called as a single disease entity as COPD These lung diseases have a common feature of airflow limitation as measured by the Spirometry. Expiratory volume in the first second (FEV1) is low and there is low ratio of FEV1 to forced vital capacity (FVC) [35].

Chronic Obstructive Pulmonary Disease (COPD) is a major cause of morbidity and mortality around the world. Currently, 210 million people worldwide have COPD while 3 million people died of COPD in 2005. It has been predicted that COPD will be the fourth leading cause of death worldwide by 2030 [36].

The most common symptoms of COPD are chronic cough and difficulty of breathing, initially only on exertion but later also at rest. It is a progressive disease that may lead to death. It is most frequently diagnosed in people aged 40 or over. The most important causes of COPD are cigarette smoking, indoor air pollution (biomass fuel used for cooking and heating), air pollution, occupational dusts and chemicals vapors, irritants, and fumes [37]. Approximately, 15% of tobacco smokers suffer from COPD [38, 39].

The diagnosis of airflow limitation is based on spirometry showing a reduced FEV1/FVC ratio below 0.7. The seriousness of COPD is then graded based on post-bronchodilator FEV1 expressed as percent of predicted value for the individual [40, 41]. Other tests such as pulse oximeter, radiological procedures, arterial blood gas (ABG), alpha -1-antitrypsin level are also valuable though non-specific in diagnosis and determination of severity of OLD [40]. Table 1 shows the COPD classifications based on Gold criteria [42].

Prevalence and mortality of obstructive lung diseases in general is high and similarly the medical cost associated with them has been increasing in recent years. Therefore, it is important to identify the patients and treat them before they reach the symptomatic and costly stages of diseases [43]. Although, COPD and asthma account for most obstructive lung diseases, a broad spectrum of other disorders, including bronchiectasis, upper airway lesions, bronchiolar diseases, and some interstitial lung diseases, are associated with airflow limitation. These less common forms of obstructive lung diseases are often misdiagnosed because of their uncommon occurrence and poor recognition [44].

Table 1: Classification and diagnosis of COPD (GOLD)

SEVERITY	**SPIROMETRY**
COPD definition	Post-bronchodilator FEV1/FVC < 0.7
Mild (GOLD I)	FEV1 > 80%predicted
Moderate (GOLD II)	FEV1 50 - 80% predicted
Severe (GOLD III)	FEV1 30 - 50% predicted
Very Severe (GOLD IV)	FEV1 < 30% or <50% with respiratory failure

Source: ***http://www.goldcopd.com***

WHO estimates that about 1.1 billion people worldwide are smokers which is almost one third of the world population [45]. Prevalence of tobacco smoking in Nepal is also very high and one survey in rural areas in Kathmandu showed that the prevalence of daily tobacco smoking in men was 85% whereas in female was 62% respectively [46]. Tobacco smoking has been anecdotally reported to be similarly prevalent in high altitude porters though there are no data specifically in this group of workers.

The indoor use of biomass fuels increases the risk of airflow limitation and especially in the less developed countries and rural areas; it may be the most important contributor for the prevalence of COPD [47-50]. The prevalence of COPD in Nepal has been estimated at 18.3% [51] .

1.9 Rationale of the study

Working as a porter at high altitude can be a dangerous job. Porters often carry a load which is double their own body weight**.** Human-powered load carrying, in geographical areas has always been a challenge with risk of mountain sickness in altitude [52] but study regarding their awareness and incidence of AMS is almost non-existent. It would be challenging but very informative to explore this group in regards to their awareness and prevalence of AMS. Due to a possible high prevalence of tobacco smoking and the use of biomass fuels for indoor cooking among porters, we hypothesize that early airways disease may be present in porters working in this region and that they might suffer from different forms of obstructive lung disease. Obstructive airway disease may also be a risk factor for HAI. Early detection and followed by effective treatment will be important for effective control of these conditions. Spirometry is an important diagnostic tool for preliminary diagnosis of respiratory diseases. Spirometry data on the porters in Everest region is non-existent. Findings of our study will be useful for further planning of implementation for preventative initiatives and medical care. It is also of interest to ascertain whether working as a high altitude porter is possible for persons with airflow limitation and whether such airflow limitation may expose the porter to other high altitude health problems such as acute mountain sickness.

CHAPTER 2: OBJECTIVES

2.1 General objective

The general objective of the study was to measure awareness and prevalence of high altitude illness and obstructive lung disease among porters in Khumbu Valley.

2.1 Specific objectives

1. To determine the awareness of acute mountain sickness.
2. To determine the prevalence of acute mountain sickness at Namche Bazaar and after ascent from Namche Bazaar until Everest Base Camp.
3. To describe the prevalence and burden of tobacco smoking.
4. To estimate the prevalence of airflow limitation.

CHAPTER 3: METHODOLOGY

3.1 Research design

Study design was cross-sectional. This study was done between May-July 2008.

3.2 Study site

The study was conducted in the Khumbu Valley or Everest Region. It is one of the most popular trekking regions in Nepal. Khumbu is one of the three settlements of Sherpas. It is located at the Solukhumbu district in north-eastern area of Nepal. Khumbu elevation ranges from 3300m all the way to highest point in the earth, Mount Everest, 8848m.This region is famous due to its proximity to some of the worlds' highest mountains and home of Sherpas-the famed mountain people of Nepal.

Namche Bazaar is small village in this region situated at an altitude of 3460 metres. It is well- known among tourists trekking in the Khumbu region and especially with the mountaineers. The main income of people living in Namche is tourism and has population mainly of Sherpa. It takes two days from the nearest airport located at Lukla to reach Namche on foot. Travellers usually spent one night in Phakding (2610m) or Monjo (2835m) for acclimatization where in Namche travellers usually spend 24-48 hours for acclimatization. Moving up in the Khumbu valley, one will find several small villages including Deboche (3710m), Pangboche (3930m),Tengboche (3860m), Pheriche (4270m), Dingboche (4410m), Gorakshep (5140m) before reaching the Everest Base Camp which is situated at 5364m.

Photo 1: Namche Bazaar (Aerial view)

3.3 Study population

We included porters working in this region at or above Namche regardless of ethnic background during May to June 2008. The porters were classified in two groups. One group was working independently and next group was working with expeditions or foreign trekkers. They were enrolled by the primary investigator (author) en route directly on place of study i.e. Namche and above until Everest base camp at different altitudes. This study was done with bases in Namche Bazaar (3460m), Pheriche (4270m), Thokla Pass (4830m), Gorakshep (5140m) and Everest Base Camp (5364m).

A. Inclusion criteria

We included porters 18-65 yrs of age either male or female working independently or for expeditions.

B. Exclusion criteria

- Pregnant females (missing menstruation for more than 7 days).
- Porters who have spent in study site at least for 2 days or 48 hours as they will be acclimatized already.
- Porters who were descending.

3.4 Sampling

The prevalence rate of 50% was used as reference for sample size calculation on the basis that no study has been done on this topic previously including all ethnic groups of porters. This prevalence rate was used as reference to calculate sample size with 5% absolute precision and 95% confidence interval. The minimum required sample size (n) was 384 (using Open-Epi version 2.2, CDC, USA). Due to time constraints and financial limitations, we were only able to include 200 porters in the study. Every case was enrolled by the administrator (author) directly.

3.5 Study procedure

The study was performed in five different villages in Khumbu valley located at different altitudes. One-hundred sixty porters in Namche Bazaar (3460m), 15 in Pheriche

(4270m), 14 in Thokla Pass (4830m), 4 in Gorakshep (5140m) and 7 in Everest Base Camp (5364m) were interviewed and examined. AMS scoring system (Lake Louis score) was used to diagnose AMS. This scoring system is based on Lake Louis AMS questionnaire (see appendix 3). Spirometry was performed on 160 porters in Namche Bazaar (3460m).

3.5.1 Physical examination

This was performed by researcher and research assistants after enrolling the participants in the study**.** There were four research assistants who were all physicians and members of Mountain Medical Society of Nepal (MMSN). Vital signs (BP, HR, and RR) were taken and recorded after each porter has 15 to 20 minutes rest. The vital signs were taken in sitting position. Oxygen saturation was taken by using Pulse Oximeter. Finger oximeter from Smiths Medical Family Companies was used. The product described is covered U.S Patent No.6, 654,621. The 3rd or 4th digit finger was used to record the oxygen saturation because of thinner fingernail to have the better pulse signal.

3.5.2 Lake Louis score (LLS)

Lake Louis score was used to diagnose AMS [53].

Diagnosis of AMS was based on:

- Rise in altitude within the last 4 days
- Presence of a headache

Plus

- Presence of at least two other signs and symptoms such as nausea, fattigue and difficulty of sleeping.

Total score of 3 or more.

Total score of 3 to 5 was defined as “mild AMS” and a score of 6 or more as “severe AMS”. Lake Louis questionnaire was made available in native Nepali Language (see appendix 3). For each individual, an AMS sheet was filled out and diagnosis was made accordingly.

3.5.3 Interview schedule

A standardized close-ended questionnaire was administered for interviewing the porters for socio-demographic information, awareness of AMS and informations on smoking history and respiratory symptoms (see appendix 1). Questionnaires were first developed in English language and translated to native Nepali language by the researcher. The questionnaires for measuring awareness of AMS were modified from a previous study 'Awareness of altitude sickness among a sample of trekkers in Nepal' by Dr. James Glazer [13]. Questions were designed to attain their knowledge of acute mountain sickness. An altitude awareness score was established with a maximum score at 10 points. Questions included mainly signs and symptoms, cause, treatment and prevention related to acute mountain sickness. In an effort to know their previous altitude exposure and acclimatization history, subjects were asked about their place of residence, the number of times they have been to Namche and above until Everest Base Camp. The questionnaire used for interviewing about previous medical history and respiratory symptoms was a modified version of the British medical research council questionnaire. Porters were asked about history of cough, breathlessness, wheezing, past medical history, and smoking habits.

3.5.4 Spirometry

Spirometry was done in Namche. Procedure for spirometry was attempted according to ATS/ERS standards for pulmonary function testing. The primary investigator was trained to perform spirometry before leaving for the field. All porters were instructed by researcher for proper blowing as fast, hard and long as possible with at least three tests in the seated position. Those who completed at least one acceptable FEV1 and FVC measurement (lasting at least 6 seconds) were chosen for further analyses**.** Spirometry was not done in porters who denied to do it and who felt dizzy after doing the first trial. Denial was mainly due to use of spirometry for the first time in most of the individuals and being new to them. Individuals were afraid due to fear of adverse effect which might lead to acute mountain sickness. This belief was more frequent among porters after Namche as altitude increased. Individual decisions were respected and they were not coerced to perform the test. Above Namche, mostly due to denial and extreme weather conditions, spirometry was not performed. The test measures for various pulmonary function tests were recorded in the Easy One spirometry itself and it was brought back to

Norway for analysis. Reference values for spirometry for lung volumes were used as 10% less than caucasians [54, 55].

Airflow limitation in our study was defined as FEV1/FVC<0.7 [40].

3.6 Data processing and analyzing

All data obtained from interviews and physical examinations was checked for completeness and consistency and reviewed by the researcher. SPSS 15.0 was used for data entry and analysis. Double data entry was done. Two data sets obtained from data entry were validated by the researcher. Basic descriptive statistics including measure of central tendency, variance and frequency were computed for all important variables measured in the study samples. Chi-square test was used for analyzing association in categorical data, and t-test was used for analyzing comparisons of group mean. The level of significance was set at 5% and interpretation was done accordingly.

3.7 Ethical clearance

Ethical clearance was obtained from Nepal Health Research Council (NHRC) in Nepal. Informed consent was taken from each participant before enrolling them in the study. Mainly, the oral consent was taken. The nature of the study, possible harms and benefits, rights of participants and duties of the researchers were informed to each participant. Participants were ensured to maintain the confidentiality. Participation was voluntary and participants had right to withdraw from the study at any time without any adverse consequences. There were no any invasive methods used during the study.

CHAPTER 4: RESULTS

4.1 General characteristics of participants

Table 2: General characteristics of participants

Characteristics		**Frequency (n=200)**	**Percentage (%)**
Age group	18-29	105	52.5
	30-39 years	55	27.5
	>40 years	40	20.0
Sex	Male	199	99.5
	Female	1	0.5
Marital status	Single	59	29.5
	Married	141	70.5
Education	Illiterate	108	54.0
	Literate	92	46.0
Alcohol consumption	Daily	136	68.0
	Occasional	7	03.5
	Total abstainers	57	28.5
Smoke (Tobacco)	Smokers	65	32.5
	Ex-smokers	7	03.5
	Non-smokers	128	64.0
Chewing Tobacco	Yes	66	33.0
	No	134	67.0
Working	Independently	169	84.5
	Expeditions	31	15.5

Table 2 shows demographic and characteristics of participants of this study. A total of 200 porters were interviewed and examined. With regards to obstructive lung disease, 200 were interviewed and examined, 160 were asked to perform spirometry and of these, 4 refused. Among the 200 interviewed, 199(99.5%) were male and 1(0.5%) female. The majority of porters were married (70.5%). The mean age of participants was 29.8 years.

Most of the porters (54%) were illiterate. Illiterate group included those porters who have never been to school and literate group were those who had primary and above education. Almost 32.5% were current smokers, 3.5% were ex-smokers. Almost 68% consumed alcohol daily [2.25units (1 unit = 1 glass of homemade Rakshi or rice wine)] whereas 66% used chewing tobacco. In our study, 169(84.5%) of porters were working independently and 31(15.5%) were working in expeditions during the time we did our study. However, 24(12%) porters who were working independently during our study had experienced once or more working with expeditions previously and similarly, 5(2.5%) porters who were working in expeditions had worked independently.

4.2 Working as a porter: socio-economic aspects

Table 3: Working as a porter: socio-economic aspects

N=200	Yes	Percentage (%)
Paid-well	161	80.2
Good income	160	80.5
Risky job	119	59.8
Will continue working as porter	51	25.6
Knowledge of porters organizations	46	23.0
Organizations assistant in awareness	38	19.1
Satisfied with work	175	87.5

Table 3 shows porters' personal experiences with work and socio-economic aspects related to their job. About, 80% of total studied porters said they are paid well and income from working was enough to survive though 119(59.5%) of porters thought that the job was risky because of AMS and the other life threatening conditions. Only 26% will continue working as porters, making it as their profession. About 23% of porters had the knowledge of different porter organizations established in the region and 19.1%, said they were given different awareness programme regarding AMS. The majority of porters (87.5%) said they were happy with their profession.

4.3 Source of information regarding AMS

Figure 3 shows the source of information porters had regarding AMS. They came to know about AMS mostly from their friends working with them (94.3%) and self experienced of AMS (15.4%) was the major source of information and internet being the least source (1%). Almost 50% of the porters had the previous history self-reported AMS. The mean altitude where they had AMS was 4839m. We were not able to get the previous history of HAPE and HACE. Most porters [136 (68%)] said that there are enough health posts (number were not specified) on route from Namche to base camp but only about 23.5% believed there is easy access to AMS medications. A minority of porters (26 [13%]) were carrying medications during interview. Out of them, 12 were carrying Diamox, 15 were carrying Anti-inflammatory drugs and 1(3.84%) was carrying Antibiotic. Only 11(5.5%) porters, all working on different expedition teams had counseling regarding AMS.

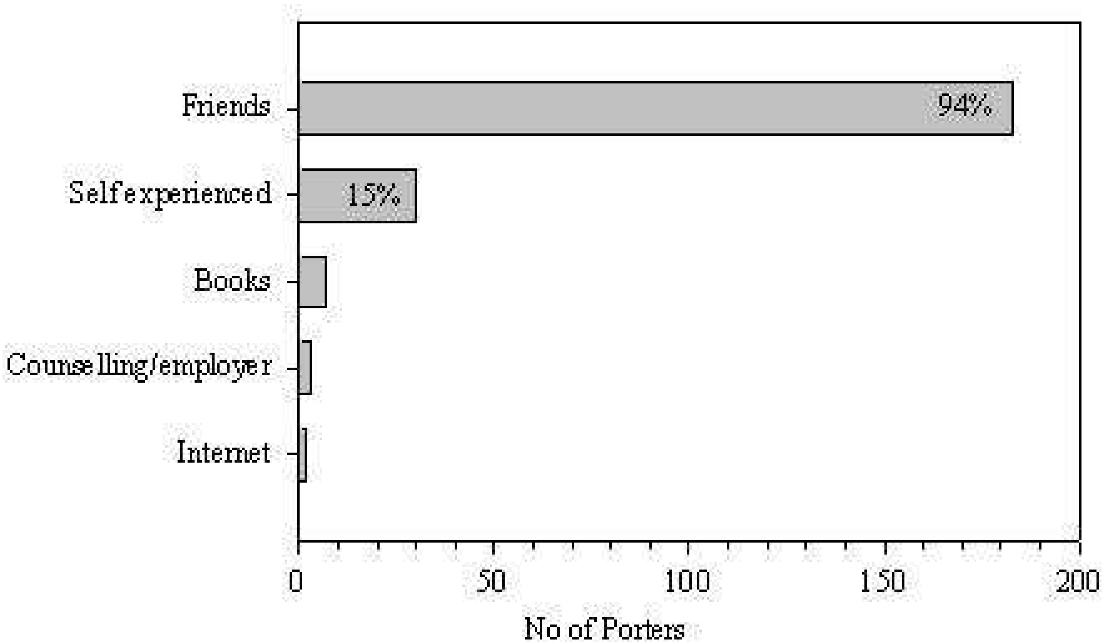

Fig 3: Source of Information regarding AMS

Multiple response questions sum not equal to 100%

Furthermore, 173(86.5%) of porters wanted to know more about AMS and its complications and believed different awareness programmes will be beneficial for the group. Almost, 75% of porters thought health professionals are the best source for getting more informative guidance and counseling regarding AMS whereas only 5% thought internet might be the good way for AMS awareness programme.

4.4 Acute mountain sickness awareness score

Table 4: Number of porters answering correctly for each individual component of the AMS awareness score

n=200	**Answered Correctly**	**%**
A. Symptoms of AMS		
1. Headache	163	81.5
2. Nausea	98	49.5
3. Dizziness	75	37.5
4. Fattigue	70	35.0
B. Causes of AMS		
5. Altitude	100	50.0
6. Ascent rate	129	64.5
C. Other factors		
7. Prevention	139	69.5
8. Treatment	178	89.0
9. Life-Threatening	164	82.0
10. Partner with AMS*	41	20.5

***Porters who answer correctly to take a break and stay at same place until AMS symptoms pass away in case their friends will have AMS**

Table 4 shows the scoring of the study population on the individual items in the AMS awareness score. Almost 82% of the porters believed that the headache was one of the main symptoms of AMS whereas only 49.5% of porters thought nausea was also caused by AMS. About, 37.5% of porters believed that dizziness was a symptom of AMS whereas only 35% answered fatigue as a symptom of AMS.

Regarding the cause of AMS, 50% believed altitude causes AMS and 64.5% answered ascent rate is the next cause.

About, 69.5% of porters answered correctly for the possible preventive measures in AMS and 89% believed there is treatment for AMS whereas 82% answered AMS as a life threatening condition. Only 20.5% of porters answered correctly for the measures to take for the treatment of partner with AMS.

4.5 AMS awareness categorization

Highest scoring was 10 and lowest being 0. The scores were normally distributed with mean score at 5.09 and standard deviation of 2.25 (Figure 4).

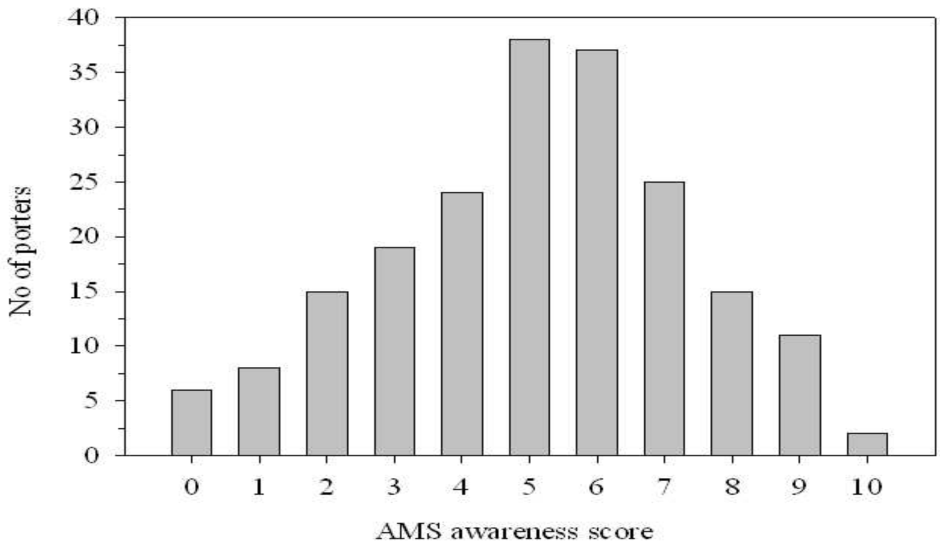

Fig 4: AMS Awareness score for individual porters (n=200)

Table 5: AMS awareness score categorization

Score	**Frequency (n =200)**	**Percentage (%)**
Low (0-4)	72	36
Middle (5-7)	100	50
High (8-10)	28	14

Table 5 shows the categorization of porters in three groups according to awareness score. Those porters who achieved awareness score eight and above were categorized in highly aware and 28(14%) were in this group. Porters who scored 5 - 7 were categorized in the middle range and most of the study population fell in this group 100(50%). Those who scored less than 5 were categorized in group having low knowledge. Number of porters who were categorized to have low knowledge was 72(36%).

4.6 Comparison of some porters characteristics with AMS awareness score

Table 6: Comparison of some porters' characteristics with AMS awareness score n=200

Characteristics	Low Awareness n (%)	Average Awareness n (%)	High Awareness n (%)	p-value*
Education				
Uneducated	46 (42.6)	54 (50.0)	8 (7.4)	<0.05
Educated	26 (28.3)	46 (50.0)	18 (21.7)	
Age				
18-39 years	58 (36.3)	76 (47.5)	26 (16.3)	0.14
40 and above	14 (35.0)	24 (60.0)	2 (5.0)	
Experience				
0-5 years	40 (41.2)	43 (44.3)	14 (14.3)	0.75
6-10 years	14 (35.0)	20 (50.0)	6 (21.4)	
11-20 years	14 (29.1)	28 (58.3)	6 (12.5)	
21 years and above	4 (26.6)	9 (60.0)	2 (13.3)	
History of AMS				
AMS (+)	22 (22.0)	56 (56.0)	22 (22.0)	<0.001
AMS (-)	50 (50.0)	44 (44.0)	6 (6.0)	
Working				
Independently	63 (37.5)	90 (53.3)	16 (9.5)	<0.001
Expeditions	9 (29.0)	10 (32.3)	12 (38.7)	

***p-value of chi square**

Table 6 shows that Self –reported previous history of AMS and working type were significantly associated with altitude awareness score (p<0.001). Education was also found to be statistically significant predictor of AMS awareness, with educated group having more altitude awareness score (p<0.05). The porter's age and years of experience did not have any significant association with awareness score.

4.7 Prevalence of acute mountain sickness

We interviewed and examined 160 porters in Namche Bazaar (3460m), 15 in Pheriche (4270m), 14 in Thokla Pass (4830m), 4 in Gorakshep (5140m) and 7 in Everest Base Camp (5364m).

Table 7: AMS case describing personal history(age in years, sex and smoking status), location/altitude in meters, ascent profile for previous 24 hours (place and height in meters) and vital signs with Lake Louis score (LLS)

Case	Personal History	Location/ Altitude in meters	Ascent profile(m)	SpO2 (%)	PR/min	RR/min	Blood Pressure		LLS
							Sys	Dia	
1*	19,Mns	Namche (3460)	Toktok-Namche (800)	84	101	28	130	70	7
2*	32,Ms	Pheriche (4270)	Deboche-Pheriche (500)	88	106	24	120	80	6
3*	27,Ms	Pheriche (4270)	Tengboche-Pheriche (400)	84	112	20	130	90	6
4	47,Ms	Thokla Pass (4830)	Pangboche-Thokla Pass (900)	88	113	24	120	90	7
5*	23,Ms	Thokla Pass (4830)	Pangboche-Thokla Pass (900)	82	116	23	110	80	6
6*	28,Ms	Thokla Pass (4830)	Pheriche-Thokla Pass (600)	84	102	22	130	90	8
7	19,Mns	EBC (5364)	Lobuche-EBC (500)	86	108	20	130	70	8
8*	38,Ms	EBC (5364)	Gorakshep-EBC (200)	83	114	22	130	80	10

*** With previous history of AMS**

3 to 5 = mild AMS

6 or more = severe AMS

Abbreviations (Ms-male smokers, Mns-Male non-smokers, EBC-Everest Base Camp)

Table 7 shows prevalence of AMS. The cases were found at different altitudes between Namche and base camp. Eight out of 200 porters were diagnosed to have AMS using Lake Louis questionnaire. The prevalence of AMS was 0.6% at 3460m, 13.3% at 4270m, 21.4% at 4830m and 28.5% at 5364m. All porters in our study who had AMS were classified as having severe AMS and the mean altitude where they suffered from AMS was 4769.7m. Six of the eight porters who had AMS were smokers. Prevalence among current smokers was 9.2%. Six of the porters had self reported history of AMS. Self reported previous history of AMS was at a mean altitude of 4375m. Seven of them were working individually and one was working for expeditions. Most of them were heading to Everest Base camp and they planned to reach the Base Camp within 2-3 days (48-72 hours) from Namche Bazaar. None of them were taking Diamox.

Table 8: Demographics and vital signs in porters with AMS compared to porters without AMS

AMS (n=200)	Yes (n=8) mean (SD)	No (n=192) mean (SD)	p-value*
Systolic BP	125.0 (7.5)	108.2 (12.2)	<0.001
Diastolic BP	81.2 (8.3)	74.2 (10.8)	0.50
Pulse rate	109.0 (5.6)	79.4 (12.1)	<0.001
Respiratory rate	22.8 (2.5)	18.0 (3.1)	<0.01
SpO2	84.8 (2.2)	92.4 (3.5)	<0.001
BMI	21.1 (0.9)	21.3 (1.6)	0.75
Age	30.0 (10.3)	29.1 (9.6)	0.70

***p-value: Significance of Age, BMI and vital signs tested with independent sample t-test**

Table 8 shows the difference of vital signs in the context of mean and standard deviation between AMS and non-AMS cases. Similarly, Age and BMI were also compared between two groups. Both systolic and diastolic blood pressure was higher in porters with AMS. There was also significant difference in mean of respiratory rate, pulse rate in porters with AMS which was higher than the group without AMS. Systolic BP, pulse rate, respiratory rate and SpO2 were found to be significantly different between two groups.

4.8 Presenting airways symptoms

Table 9: Comparison of presenting airways symptoms among smokers and non-smokers (n=200)

Respiratory symptoms	Current/ ex-smokers n =72 (%)	Non- smokers n =128 (%)	Total n (%)	p-value*
Cough in morning	46 (63.9)	73 (57.0)	119 (59.5)	0.34
Cough during the day	31 (55.4)	25 (44.6)	56 (28.0)	<0.001
Phlegm	40 (55.6)	40 (31.3)	80 (40.0)	<0.01
Cough for > 3 months during a year	23 (31.9)	11 (8.6)	34 (17.0)	<0.001
Cough >3 weeks in 2 years	22 (30.6)	20 (15.6)	42 (21.0)	<0.05
Breathlessness than own age	29 (40.3)	30 (23.4)	59 (29.5)	<0.05
Breathlessness climbing two stairs at ordinary pace	18 (25.0)	16 (12.5)	34 (17.0)	<0.05
Breathlessness at normal pace at level ground	4 (5.6)	4 (3.1)	8 (4.0)	0.40
Breathlessness while at rest	0 (0.0)	1 (0.8)	1 (0.5)	0.45
Attack of breathlessness	21 (29.2)	12 (9.4)	33 (16.5)	<0.001
Wheezing sound ever	21 (29.2)	15 (11.7)	36 (18.0)	<0.01

***p-value o of chi-square**

Table 9 compares the airways symptoms between smokers and never smokers. Coughing, coughing with phlegm, cough for 3 months or more during a year, cough with cold more than 3 weeks in 2 years, breathlessness than own age, breathlessness at normal pace, experiencing attack of breathlessness and wheezing sound were all significantly more frequent among smokers. Particularly, it should be noted that “attacks of breathlessness” were almost 3 times more frequent in porters who smoke. Morning cough (also called “Khumbu cough”) frequency did not vary significantly by smoking status and is in general very common among porters and trekkers in this region and altitude.

4.9 Spirometry

Table 10: Spirometry results between smokers and never-smokers [Mean (SD)]

Pulmonary function test	Current/ex-smokers n=41	Non-smokers n=82	p-value
FEV1	2.92 (0.8)	2.94 (0.5)	0.82
PPFEV1	93.59 (22.9)	93.32 (15.8)	0.94
FVC max	3.79 (1.0)	3.82 (0.6)	0.87
PPFVC	100.81 (23.0)	100.77 (16.0)	0.99
FEV1/FVC	0.77 (0.09)	0.77 (0.08)	0.87
Frequency of air flow limitation n [(%)]	8 (19.15%)	14 (17.07%)	0.73**

Frequency of airflow limitation defined as FEV1/FVC<0.7

p-value of independent sample t-test and chi-square**

Table 10 shows pulmonary function test results for the 123 smokers and non-smokers who were able to perform at least one acceptable FVC maneuver. FEV1/FVC ratio was similar in both groups with a mean at 0.77 (SD 0.08). Similarly, there was no significant difference in PPFEV1and PPFVC in two groups. Total of 8(19.15%) in current/ex-smokers and 14(17.07%) in never smokers group have FEV1/FVC < 0.7. Smoking does not seem to be associated with airflow limitation in this group of porters.

4.10 Physical examination

In the examination of chest, wheezing/rhonchi was present in 23(11.5%), and crepitations/rales was present in 3(1.5%).Three of the AMS cases had wheezing and one presented with rales. HAPE was ruled out in the porter who presented with rales. On examinations of abdomen, water brush and symptoms of acute peptic ulcer disease was present in 29(14.5%) of porters. Five (2.5%) porters had edema on bilateral leg and history of edema but no diagnosis was made before.

CHAPTER 5: DISCUSSION

The overall prevalence of AMS was 4%. Similarly, 50% of porters were categorized in the middle range regarding awareness of AMS. The prevalence of current/ex-smokers was 36% and the prevalence of airflow limitation was 17.8%.

5.1 Methodological issues

This study was designed as a cross-sectional survey. A cross-sectional study has the advantage of being economical, as well as easy to carry out. With limited resources and time periods, it was the most useful study design for our research questions. Similarly, it was best suited for prevalence study.

Our study sample was based on convenience and as such, selection bias can be one of the potential biases in our study. During the study period, we were able to include almost all porters passing through at the time. With the exception of 3 porters less than 18 years old, who were not included due to falling outside inclusion criteria for age, there were no porters who refused. Next, we included the porters who were heading towards Base camp, so porters who were descending, possibly due to AMS, were not included in the study.

Despite having a high response rate, there is unquestionably a selection bias due to healthy worker's effect. This bias may underestimate the frequency of porters with respiratory problems or weaker health because they tend to leave the work. A healthy worker effect is a nearly unavoidable source of bias in occupational health studies though a longitudinal study design attenuates the effect. Thus, in the case of our study, using a longitudinal design and recruiting porters just as they begin their career and following them during their first trips, would be close to an ideal method for our research question.

Recall bias could also have influenced the results because past medical history regarding AMS was recorded during the study. Some of the porters may have wished to hide their previous medical history and other daily habits like smoking and drinking alcohol. This bias hopefully was minimized by ensuring the porters full confidentiality.

We used interview-based questionnaires to test their level of awareness regarding AMS and to reveal their past medical history mainly regarding respiratory symptoms. It is very important to interpret the questions correctly. We performed pre-testing of the questionnaire in few porters and changes were made in the final version before collecting the data. Ideally, questionnaires should be filled out by the subject themselves to avoid interviewer-added bias. Because of high prevalence of illiteracy this was not possible in our study.

5.2 External validity

This was the first study targeted to porters in the Khumbu region regarding level of awareness of AMS and prevalence of tobacco smoking and respiratory symptoms. This study can be a reference for future epidemiological studies targeting this group for awareness of mountain sickness and obstructive airways diseases. The study was conducted in Khumbu valley. This is one of the most famous trekking destinations among tourist in Nepal. This is the gateway to Mount Everest, the highest peak in the world. The numbers of porters in this region may well be more than the other tourist destinations of Nepal like in Round Annapurna. Most of the porters were not ethnic Sherpa but different ethnic groups from lowland. This being the case, one could argue that the Khumbu is the ideal setting for investigating porter's health and working conditions in general.

5.3 Awareness of AMS

Knowledge among 50% of porters was in the middle range, 36% had low knowledge of AMS, and only 28% were in higher knowledge group. Questions related to AMS signs and symptoms, treatment, causes and prevention were included during interview. Previous study done on trekkers in the Annapurna region in Nepal showed that awareness among tourist population was also in the middle range [13]. This study among tourist also showed that there was an association between experience and knowledge (awareness increased with experience of being in high altitude in years) in contrast to our study.

A previous study reported that porters in Nepal carry luggage almost double their weight [56]. It is more strenuous to carry heavy loads in these altitudes with difficult paths and exertion has been identified as one of the major risk factor for developing AMS [10, 57]. So, porters who have less knowledge have more chances of getting AMS.

Most of the porters (86.5%) showed interest to know more about AMS where physicians was thought to be the most useful source (74.5%), and internet being the least (10%) which is in contrast to the study among foreign trekkers where internet was one of the major source of information [13] .Most porters had learnt about AMS through their friends (94.3%) or from self experienced (15.7%).

Belief in herbal medicine was prominent. We found that 37.5% of porters believe that herbal medicine can cure AMS, though still 73% will prefer to take western medicine in case they suffered from AMS. There are different herbal treatments which are traditionally used for prevention of AMS but Ginkgo biloba is the one studied most. In one study, Ginkgo biloba prevented AMS incidence for moderate altitude (5400m) with a gradual exposure. A total of 44 western climbers were recruited and randomized into two groups. Climbers who were given Ginkgo biloba did not develop mountain sickness whereas in the placebo group 40.9% developed AMS [58]. In a controlled trial it was found to be effective in reducing both the symptoms and the incidence by almost 50% during an abrupt ascent to 4100m [59] . But in contrast, the study done in 2004 by Gerstch et.al revealed no preventive action of Ginkgo biloba but instead suggested that acetazolamide 250mg twice daily had prevented symptoms of AMS [60]. There are no other documented studies on herbal preparations which can be used in prevention and treatment of AMS. Presently, it has been in practice for sojourners in Nepali Himalayas to be prescribed or advised 125 mg of acetazolamide twice daily [61].

Another interesting finding is that 36% of porters thought the cause of AMS was vegetation. It is the belief among them that some plants or grasses in high altitude cause AMS. High altitude plants like Sunpati (Rhododendron anthopogon D. Don) were thought to be one of the risk factors. These plants were more commonly found in altitude above 4000m. Porters had belief that smell of Sunpati can cause AMS. One of our research assistants complained of strong bad smell which was of Sunpati before presenting with symptoms of AMS between Dingboche (4410m) and Dugla Thokla (4620m). To our knowledge, there is no documented scientific basis for this belief.

Most porters seem to be unaware of what to do in case their partner or friends had AMS as 69% said that they would go to less altitude as soon as possible and 82% had a belief that AMS is life-threatening. The more appropriate action might include simply rest, fluid and drinks are the first way of treatment, as it is most often not necessary to move down altitude at once. AMS is in itself not life-threatening. These responses show that low awareness might lead to misinterpretation of the problem.

A 12-year follow up study in Annapurna region suggested that increased in awareness was one of the main reasons for decreased prevalence in AMS. The study found an increase in awareness in trekkers from 80% to 95% with decrease in AMS prevalence from 43% to 29% [62]. That study also found medication usage among those trekkers increased from 17% to 56%; mainly acetazolamide and analgesics [62]. In our study, only 13% of porters were carrying similar medications.

Another study done among trekkers climbing Thorang Pass (5400m) showed, 80% had elementary knowledge of the diagnosis and treatment of AMS. Elementary knowledge was defined to be having knowledge of at least 2 symptoms of AMS and a treatment where descent was thought to be the most important. The study reported that 3% of studied population had never heard of AMS before [63]. In our study, 6% of porters have never heard of AMS.

It was common for porters to work two or three times a week from Lukla to Namche round-trip. About 29% of porters in our study never have been to base camp. Apparently, we did not find any relation between numbers of times porters reaching Namche Bazaar and Base Camp to the level of awareness regarding AMS.

A minority of the porters (23%) have knowledge about different organizations working for their welfare. The majority of porters (80.5%) was satisfied with their work and payment and will continue to work as a porter although they think their job is risky.

5.4 Prevalence of AMS

We found 8 (4%) porters with AMS, diagnosed according to the Lake Louis questionnaire. All 8 porters developed AMS at different altitudes. We interviewed and examined 160 porters in Namche Bazaar (3460m), 15 in Pheriche (4270m), 14 in Thokla

Pass (4830m), 4 in Gorakshep (5140m) and 7 in Everest Base camp (5364m). In these places where we interviewed and examined the porters, we established small camps. One AMS case was found in Namche, 2 in Pheriche, 3 in Thokla Pass and 2 in Base Camp. The prevalence of AMS was 0.6% at 3460m, 13.3% at 4270m, 21.4% at 4830m and 28.5% at 5364m.

A study performed in the Swiss Alps on 466 climbers also found increasing prevalence of AMS with increase in altitude: 9% at 2850m, 13% at 3050m, 34% at 3650m and 53% at 4559m. This study also found the prevalence of HAPE and HACE to be 2.36% at an altitude of 4559m [15].

Hackette and Rennie found among 278 trekkers on way to Everest at altitude of 4200m an overall prevalence of 53%. Two years later they found decrease in prevalence to 43% in 200 trekkers which is still much higher than our study for similar altitudes [31]. In a study done in Nepal among pilgrims in Gosaikunda at 4154m, the incidence was 4.4 % [64] but the next study done on the same site but at altitude of 4300m after few years showed increased incidence of AMS to 68% [29] . These were grossly conflicting results probably due to different methods of diagnosis nevertheless they were some of the few studies done on native Nepali pilgrims.

AMS cases were diagnosed more frequently as we ascended. There are basic and fixed timetables recommended for trekkers heading for Base Camp, and these are also applied for most of the porters working in expeditions. However, for those working individually, recommendations are often ignored and they increase their altitude haphazardly with large elevation gains per day. It is usually up to them to decide how long they can walk in a day. During our study, 7 porters who had AMS were trying to reach the Base camp within two to three days (48-72hours) from Namche because of the high demand of porters to Base Camp. They were trying to ascend almost 2000m in 48-72 hours where it is preferably advised to take 4-5 days to reach base camp from Namche Bazaar. Advisable ascent rate to avoid AMS would be 300m per day above 2000m [65]. A study in Kilimanjaro in Tanzania among Finnish trekkers documented 75% incidence of AMS and was contributed to rapid ascent [14]. In our study, it would be reasonable to argue that rapid ascent encouraged by a high porter demand is an important factor in development of AMS among porters.

In our study, 50% of the study population had self reported previous history of AMS with a mean altitude of 4839m and lowest reported altitude of 3860m which is much higher than altitudes reported in studies of western population where AMS has been reported at altitudes as low as 1500m [66].

Among trekkers climbing in Thorang Pass (5400m), the overall prevalence of AMS was found to be 63 % and AMS was positively correlated with rate of ascent and negatively correlated with pre-trek acclimatization [63]. Since, trekkers and climbers are staying about two days in Namche Bazaar for acclimatization, the porters working with them also stay back and our findings of only one porter with AMS working in expeditions might be due to this fact that porters working in expeditions are more acclimatized.

Body mass index has previously shown correlation with AMS in men [63]. But contrast to this study, we did not find any correlation between BMI, age and alcohol consumption and AMS in our study. There was an association between smoking and AMS for unknown reason. Prevalence of AMS among current-smokers was 9.2%. Six of eight porters with AMS were smokers.

There was no relation between those who had self reported previous history of AMS and present outcome of AMS. Apparently, we did not find any relation between AMS outcome and the numbers of times porters previously had been to Namche Bazaar or Base Camp.

We found that there was no significance difference between the two groups regarding the diastolic blood pressure but systolic blood pressure was found to be higher in AMS group. This was in contrast to the study done in the Swiss Alps which concluded that the cardiovascular system is not primarily affected in acute mountain sickness, though they had similar findings regarding pulse rate and respiratory rate which was found to be higher on AMS group [15].

Oxygen saturation decreased according to increased in altitude. In AMS group, mean Sp02 was well below than that of non-AMS group. Decrease saturation pressure might be a specific indicator of inadequate acclimatization and impending AMS [67]. In our study, mean oxygen saturation among porters with AMS was 84.8% compared to non-AMS group with 92.4%.

During our study, we advised those with AMS not to ascent further and stay in the nearest village or, alternatively, to stay with us until the symptoms pass away. Some of them were even asked to descend to nearby village due to weather conditions. We furthermore provided them with acetazolamide 125mg and paracetamol 500 mg. acetazolamide has proven to be effective in prevention of AMS as well as it has some efficacy for the AMS cases [61]. One porter presented with rales but apparently he did not develop any complications related to HAPE. We were not able to follow up porters with AMS further in the next day though there were no reports about any casualties during the period.

The prevalence of AMS among porters in Khumbu is not as high as in tourist or trekkers or pilgrimage in other parts of Nepali Himalayas but it must not be underestimated. This population is not immune to AMS as other sojourners to Himalayas.

5.5 Prevalence of smoking and airflow limitation in high altitude porters

In our study, we found that prevalence of current tobacco smoking was 34% whereas 2% of the porters were ex-smokers. Among ever-smokers, the median number of pack years was 1.7 (mean 3.7). Low pack year of smoking can be due to young age of porters and usually they smoke few sticks per day. The average number of cigarettes smoked was 6 sticks per day and the average number of years they have smoked was 13 years. We were able to document the prevalence of airflow limitation to be 18% based on pre-bronchodilator spirometry. The airflow limitation with FEV1/FVC less than 0.7 was seen in 8(19%) of porters who were current/ex-smokers and 14(17%) of porters who were not smoking. Our findings are in agreement with previous research in Nepal where the prevalence of COPD has been estimated to be 18.3% based on a study in residents who were more than 20 years in two rural communities in a hilly region of Nepal [51] .

Airflow limitation in our study does not seem to be associated with tobacco smoking (OR 0.849, 95% CI 0.324-2.225). The airway obstruction may be related to smoke from open indoor fires or possibly to hyperactive airways and asthma which are very active in young population and shows similar obstructive patterns as in of COPD. During the study period, none of the porters reported that they had asthma. The obstruction pattern might well be due to open indoor fires as it is common in these places in Khumbu region as there is no electrical or gas oven [68]. A study performed in 60 villagers from two villages of the Khumbu, Dingboche and Thame, found evidence of early airway obstruction defined as reduced forced expiratory flow at 25 to 75% of vital capacity. Subjects in the study were young (8 – 45 years) and otherwise healthy though most had significant exposure to indoor biomass smoke [68] .

There is conflicting evidence regarding an association between altitude and COPD prevalence. A study done in Columbia showed the positive relationship between COPD prevalence and altitude where as the PLATINO study which was done in five Latin American cities which showed negative association with altitude [69, 70]. It has been reported in a study that lower air density at higher altitude might alter pulmonary function [71]. It was found that FVC was slightly lower and FEV1 was slightly higher which would have the net effect of increasing the FEV1/FVC ratio and apparently lowering the rate of airflow limitation [71, 72]

Also in regards to asthma prevalence results are conflicting. One study suggests that asthma rates are lower at higher altitude [73] and it is recognized that exposure to cold, high altitude air can provoke bronchial irritation leading to obstructive patterns in airways [74]. However, mountain environment provides reduced pollutant and vegetation (allergens) and thus may be less likely to provoke hyperactive airways or asthma [75].

Morning cough was prevalent in 60% of porters and cough during the day was prevalent in 56% of porters. Most of the porters were complaining of dry cough. At high altitude, a dry, irritating cough is very common and often called the “Khumbu cough” or “Khumbu Hack.” It has been attributed to the inspiration of the cold, dry air which characterizes the high altitude environment [76, 77]. There have not been many studies done regarding cough at high altitude. The pathophysiology of cough at high altitude is that increased minute ventilation of cold dry air at very high altitude is likely to cause airway irritation through airway drying, mucus production, post nasal drip from vasomotor rhinitis and bronchospasm. The cough is exacerbated further at extreme altitudes above 5500m, and may result in intercoastal muscles strain and sometimes even rib fractures [76]. The present investigator group experienced the “Khumbu cough” from Namche and upward which was exacerbated as we ascended further up the khumbu valley, and was self-relieved on decreasing our altitude.

We found that 21% of porters were giving the history of chronic bronchitis based on history of cough for more than 3 weeks in two years in a row. This could be correlated to chronic obstructive pulmonary disease as patient history of chronic cough and breathlessness is clinical mode of diagnosis of COPD [78]. It may also be simply an expression of the “Khumbu Cough.” Thus, the role of altitude in the development of OPD and subsequent outcomes is an area that could benefit from further investigations.

In our study, porters who smoked showed higher a prevalence of respiratory symptoms than never-smokers. Attack of breathlessness was almost three times more frequent in porters who smoked. It has been reported that breathlessness has been common to those who have been smoking for many years and in older age group [79]. Further, it has been documented in a study done on Norwegian population that respiratory symptoms increased by smoking burden. Almost 12% of the total study population reported episodes of wheezing or breathlessness during past 12 months. The mean number of pack years of smoking was 15.9 and 10.3 among men and women which was much higher than in our study [80]. Our study suggested that although most of porters who were young and light smokers, attack of breathlessness was still more common.

CHAPTER 6: STRENGTHS AND LIMITATIONS

This is the first study done in porters in Khumbu region. The results from our study can be used a as reference and starting point for future study.

We used a questionnaire for data collection, so there are chances for misinterpretation of the questions by the porters and also by interviewers. This fact means that it is usually better to use a self answered questionnaires. We could not able to do it because of high illiteracy rate.

We attempted to do the spirometry according to ATS/ERS criteria but we were not able to do acceptable FEV1 and FVC maneuver for all 160 porters. Only 123 porters were able to do at least one FEV1 and FVC maneuver. The quality of data was not optimal but we were able to get rough impression of airflow limitation. The reasons that we were not able to get good quality were due to time burden, location as well as embarrassments of porters to do spirometry infront of other participants. In future, more time should be given for doing spirometry.

Our sample was less than calculated sample size. Due to time constraints and financial limitation, we were only able to take 200 porters in the study. The actual numbers of porters working in that region was not exactly known although we were told by local residents the number of porters might be around 400-500 working all through the year

The political scenario of the country was also a limitation for our study although in the region we did our study, the presence of Maoists was not felt or seen. However, the psychological stress of unexpected problems that might be created by Maoists was always there.

CHAPTER 7: CONCLUSIONS AND REMARKS

In this study, 200 porters in the Khumbu region were interviewed and examined to assess the level of awareness and prevalence of acute mountain sickness and airflow limitation. Similarly, spirometry was done and airflow limitation was defined as having FEV1/FVC ratio <0.7.

The level of awareness was in the middle range among 50% of porters according to our 10 point awareness score and 36% fell in the low knowledge group. About 6% of porters had never heard of AMS. Porters were working two to three times a week from Lukla to Namche, up and down. They are the only means of goods transportation in this extreme corner of the world. Nevertheless, there is lack of awareness programmes. These porters have been struggling with this extreme environment plus poor socio-economic conditions. More awareness programmes regarding AMS will be beneficial for the porters and in the future, organizations working for porters' welfare should put forward various informative and awareness programmes in this region.

The prevalence of AMS was 4% across all of our encounters but increased with increasing altitude. Although, the prevalence was low compare to other studies among trekkers and climbers, AMS does occur among porters with frequency increasing with altitude.

The prevalence of tobacco smoking in this group was 34% though most were very light smokers. The prevalence of airflow limitation was 18% though it was not associated with smoking history. Open indoor fires for cooking, hyper-reactive airways disease and asthma might explain the high prevalence of airflow limitation. Awareness programmes against smoking might be an effective measure among this group as we found out that prevalence of respiratory symptoms were higher in the ex/current smokers. We recommend using modern stoves or cooking gases instead of open indoor fires for cooking if possible.

Establishing health posts or primary health centers between Lukla and Base Camp with enough health personnel could be of further help as most porters considered health personnel to be the best source of informations on AMS.

We would suggest a follow-up study using post-bronchodilator spirometry to determine the prevalence of obstructive lung disease.

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APPENDICES

Appendix 1: Questionnaire for Awareness of Acute Mountain Sickness

ID no#

Part I

1. Demographic Data

A. Name:

B. Age: C. Gender: 1) Male 2) Female D Birthdates:

E. marital status: F. Education: G. Permanent Residence: H. Weight (KG):

I. Height (cm):

2. How do you work?

A. Independently B. with expeditions

3. How many times have you been to Namche?

4. How many times how you been to Everest base camp?

5. Have you heard of Acute Mountain Sickness (AMS)?

A. Yes B. No

If yes then answer 6 - 14

6. If you have heard of AMS how did you?

A. Friends B. Books C. Internet D.Counselling

E. Employer F. Other _______

7. What are the Signs and symptoms?

A. Headache B. Nausea C. Fattigue D. Dizziness

8. What is the cause of AMS?

A. Vegetation B. Altitude C. Do not know

9. Do you ever have AMS?

A. Yes B. No C. I don’t know

10. If yes, how many times?

A. One time B. Two time C. Three time D.>Three time

11. Where do you have it?

Name of the place and will be later converted to height.

12. Can AMS be prevented?

A. Yes B. No

13. Can AMS be treated?

A. Yes B. No

14. Is AMS a life threatening disease?

A. Yes B. No C. I do not know

15. Does the rate of ascent influence the occurrence of AMS?

A. Yes B. No C. I do not know

16. Have you ever attended Travel clinic?

A. Yes B. No

17. If Yes, did you have counselling about AMS?

A. Yes B. No

18. What will you do if you have headache during trek?

A. Take medicine B. Take herbal medicine C. Nothing

19. Are you carrying any medications with you?

A. Yes B. No

20. If yes

A. Diamox B. Pain-killers C. Dexamethasone (or other steroid) D. Antibiotics

21. Did you take any medications before your trip for prevention of AMS?

A. Yes B. No

22. Do you think herbs can prevent AMS?

A. Yes B. No C. I do not know

23. How many years of trekking experience do you have as a porter?

Number or year or estimate number of year

24. What do you do if your partner/friend had AMS symptom during the trip?

A. Go down at once B. Continue going up C. Take a break and stay at same place until symptoms pass. D. Don't know or don't what AMS is.

25. Approximately, how many liters of water do you drink during a day?

A. One liter B. Two liters C. Three liters D. > Three liters

26. Is it easy to get a good meal on the way?

A. Yes B. No

27. How many times do you eat per day during the trip?

A. One time B. Two time C. Three time D.> Three time

28. Are there any health post/ medical clinics on the way in case you got sick?

A. Yes B. No

29. If yes, are there enough health personnel?

A. Yes B. No C. I have never been

30. Do you have easy access to medication in case you need for AMS?

A. Yes B. No

31. How often do you take rest when you start going up?

A. Less than hour B. Every 1 hour C. Every 2 hour D. Three or more hours

32. How many hours do you sleep at night?

A. < Four hour B. Four hour C. Six hour D.> Six hour

33. Do you drink alcohol?

A. Yes B. No

34. If yes, do you drink daily?

A. Yes B. No

35. Do you drink when you are working as a porter?

A. Yes B. No

36. If yes, what kind of alcoholics drink you drink?

A. Homemade/Local B. Commercial

37. How many glasses do you drink daily during your trip?

A. Just one glass B. Two glasses C .Three glasses D. > Three glasses

38. If you drink beer, how many bottles?

A. One bottle (660ml) B. Two bottles C. Three bottles D. >Three bottles

39. Have you ever smoked tobacco cigarettes?

A. Yes B. No

If yes,

40. Do you smoke now?

A Yes B no

41. What age were you when you started smoking? ______

42. If you have quit smoking, how old were you when you quit?

43. How many sticks per day, do you smoke?

Number of cigarettes per day (or best estimate)

44. Do you want to know more about AMS?

A. Yes B. It does not matter C. No

45. What do you think the best way to know about it?

A. Health personnel B. Internet C .Book D. Counseling at travel clinic

Part II

Experience of Working as Porter

1. Are you paid well?

A. Yes B. No

2. Is the income from work enough to survive?

A. Yes B. No

3. Is your job risky?

A. Yes B. No

4. Will you continue to work as porter, if you get another job in the same payment?

A. Yes B. No

5. If yes, why?

6. If no, why?

7. If you are working as a porter in expedition team, do people take care of your health which might arise due to AMS or other medical causes?

A. Yes B. No

8. Do you think it's easy to tell your problem to the person responsible in case you got sick?

A. Yes B. No

9. Do you have any language barrier with your guide/ with your expedition's team?

A. Yes B. No

10. Do you know of any organizations for your welfare?

A. Yes B. No

11. If yes. Do they help you in any kind of training or counseling for health problems that might arise during your trip as a porter?

A. Yes B. No

12. Are you happy with your work as a porter?

A. Yes B. No

Part III

Irritations from the airways

1. Do you usually cough or clear your throat in the morning?

A. Yes B. No

2. Do you usually cough during the day?

A. Yes B. No

3. Do you usually have phlegm when coughing?

A. Yes B. No

4. Do you have cough for three months or more altogether during a year?

A. Yes B. No

5. During the last two years, have you had cough and/or phlegm in connection with a cold for more than three weeks?

A. Yes B. One time C. Several times D. No

6. Are you breathless than people of your own age when walking uphill?

A. Yes B. No

7. Are you breathless when you climb two flights of stairs at an ordinary pace?

A. Yes B. No

8. Are you breathless walking at a normal pace on level ground?

A. Yes B. No

9. Are you breathless while at rest?

A. Yes B. No

10. Do you sometime experience attacks of breathlessness?

A. Yes B. No

11. Do you ever have wheezing (A wheezing sound) in your chest?

A. Yes B. No

12. Have you ever been treated by a physician or have you ever been hospitalized for one of the below mentioned diseases?

A. Asthma	a) Yes	b) No	c) Don’t know
B. Bronchitis	a) Yes	b) No	c) Don’t know
C. Emphysema	a) Yes	b) No	c) Don’t know
D. Pleuritis	a) Yes	b) No	c) Don’t know
E. Pulmonary tuberculosis	a) Yes	b) No	c) Don’t know
F. Heart infarction	a) Yes	b) No	c) Don’t know
G. Angina pectoris	a) Yes	b) No	c) Don’t know
I. Other heart diseases	a) Yes	b) No	c) Don’t know

Interviewed by: Signature: Date:

Thank you very much for your time.

Appendix 2: Questions used for AMS awareness score

What are the Signs and symptoms of AMS?	Yes	No
Headache	1	0
Nausea	1	0
Fattigue	1	0
Dizziness	1	0
What is the cause of AMS?	Yes	No
Vegetation	0	0
Altitude	1	0
Do not know	0	0
Can AMS be prevented?		
Yes	1	
No	0	
Can AMS be treated?		
Yes	1	
No	0	
Is AMS a life threatening disease?		
Yes	1	
No	0	
I don't know	0	
Does the rate of ascent influence the occurrence of AMS? Yes	1	
No	0	
I don't know	0	
What do you do if your partner/friend had AMS symptom during the trip?		
Go down at once	0	
Continue going up	0	
Take a break and stay at same place until symptoms pass.	1	
Don't know or don't what AMS is.	0	

Appendix 3: AMS worksheet in Nepali

Based on the Lake Louise AMS Questionnaire

Name______________________________ Age ____ Sex____ Date ____________

Prev Hx AMS/HAPE/HACE?

Meds:

Ascent Profile:

Treatment:

Time ____ ____ ____ ____

Altitude ____ ____ ____ ____

Symptoms:

1. Headache: (Kapal Dukcha)

No headache (**Dukdaina**) 0 ____ ____ ____ ____

Mild headache (**Ali Ali Dukcha**) 1 ____ ____ ____ ____

Moderate headache (**Thikai Dukcha**) 2 ____ ____ ____ ____

Severe, incapacitating (**Ekdam Dukcha**) 3 ____ ____ ____ ____

2. GI: (Pet Ko Bare Lachyanharu)

No GI symptoms (**Wak-Wak Chhaina, Bhok Lagcha**) 0 ____ ____ ____

Poor appetite or nausea (**Wak-Wak Lagcha, Bhok Chhaina**) 1 ____ ____ ____

Moderate nausea or vomiting (**Wak-Wak Ra Ali-Ali Banta**) 2 ____ ____ ____ _

Severe N&V incapacitating (**Dherai Banta**) 3 ____ ____ ____ ____

3. Fatigue/weakness: (Thakai Lagne)

Not tired or weak (**Thakai Chhaina**) 0 ____ ____ ____ ____

Mild fatigue/weakness (**Alikati Thakai**) 1 ____ ____ ____ ____

Moderate fatigue/weakness (**Thikai-Thikai Thakai**) 2 ____ ____ ____ ____

Severe F/W, incapacitating (**Dherai Thakai**) 3 ____ ____ ____ ____

4. Dizzy/lightheaded: (Ringata Lagne)

Not dizzy (**Ringata Chhaina**) 0 ____ ____ ____ ____

Mild dizziness (**Alikati Ringata**) 1 ____ ____ ____ ____

Moderate dizziness (**Thikai-Thikai Ringata**) 2 ____ ____ ____ ____

Severe, incapacitating (**Dherai Ringata**) 3 ____ ____ ____ ____

5. Difficulty sleeping: (Sutna Garo)

Slept as well as usual (**Ramrai Suteko**) 0 ____ ____ ____ ____

Did not sleep as well as usual (**Ramrai Nasuteko**) 1 ____ ____ ____ ____

Woke many times, poor night's sleep (**Dherai Choti Utheko**) 2 ____ ____ ____

Could not sleep at all (**Sutdai Nasuteko**) 3 ____ ____ ____ ____

Symptom Score: ____ ____ ____ ____

Clinical Assessment:

6. Change in mental status:

No change 0 ____ ____ ____ ____

Lethargy/lassitude 1 ____ ____ ____ ____

Disoriented/confused 2 ____ ____ ____ ____

Stupor/semi consciousness 3 ____ ____ ____ ____

7. Ataxia (heel to toe walking):

No ataxia 0 ____ ____ ____ ____

Maneuvers to maintain balance 1 ____ ____ ____ ____

Steps off line 2 ____ ____ ____ ____

Falls down 3 ____ ____ ____ ____

Can't stand 4 ____ ____ ____ ____

8. Peripheral edema:

No edema 0 ____ ____ ____ ____

One location 1 ____ ____ ____ ____

Two or more locations 2 ____ ____ ____ ____

Clinical Assessment Score: ____ ____ ____ ____

Total Score (Symptom + Clinical): ____ ____ ____ ____

Appendix 4: Questionnaire wording for respiratory symptoms

Cough

Chronic cough

Cough during day

Cough with phlegm

Cough more than three months during a year

Cough more than three weeks during last two years in connection with cold

Breathlessness

Having to stop for breath and must stop for sometime before starting any activity again.

Troubled by shortness of breath when hurrying or walking on normal pace on level ground.

Troubled by shortness of breath when climbing two stairs.

Troubled by shortness of breath even at rest.

Wheezing

Whistling sound during inspiration which might be associated with cough and cold and any other airways symptoms.

Past medical history

Ever been treated or admitted to the hospital for any illness related to lung and heart such as asthma, bronchitis, pulmonary tuberculosis, Myocardial infarction.

Smoking Habits

Never-smokers were defined as individuals who had never smoked cigarette during their lifetime.

Ex-smokers were defined as individual who smoked previously but had stopped smoking at the time of the study.

Current smokers were defined as individuals who were smoking during the time of study

Appendix 5: Oral consent form

Questionnaire number: Date:

Title: Awareness and prevalence of acute mountain sickness and prevalence of obstructive airflow limitation among Nepalese porters: A cross-sectional study in Khumbu Valley, Nepal

My name is Dr. Ranjan Parajuli. I am currently doing my Master of Philosophy in International Health at University of Bergen, Norway. As a part of programme, I am conducting a research designed to learn about "Awareness and prevalence of acute mountain sickness and prevalence of obstructive airflow limitation among Nepalese porters".

Purpose and background: A team of researcher from University of Bergen and Tribhuwan University Teaching Hospital, Kathmandu, Nepal affiliated to Mountain Medical Society of Nepal are studying awareness of acute mountain sickness and prevalence of acute mountain sickness and obstructive airflow limitation in this region among porters.

Confidentiality: Your participation in the study is completely voluntary and confidential. Your name will not be connected with information you provide or the findings of our study.

Benefits: The informations you provide during this interview may provide an overview of prevalence of acute mountain sickness and obstructive pulmonary disease and awareness of high altitude illness among porters in Khumbu valley or Everest region. This might be helpful for different organizations working for your benefits to improve their strategies and implicate new policies needed.

If you have any questions about our research, I will answer them at any time. Again, your participation is completely voluntary and your responses to our questions will be anonymous.

We will very much appreciate your participation.

Appendix 6: Map of study site