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Trekking with non-cardiovascular preexisting health conditions at altitude

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Original article

Abstract

Aim: An epidemiological assessment of the preexisting health conditions of trekkers in the Solu-Khumbu region / Mount Everest (Nepal) to inform preventative and future pre-travel advice.

Material and methods: Adult volunteers (n = 350, 122 female, mean age 42.7 y (SD = 13.5), 35% aged 50 y+) completed a comprehensive health survey followed by a basic medical examination while trekking at 2800–5160 m. Cardiological problems were excluded.

Results: Only 51% sought some kind of medical pre-travel advice, and 150 reported one or more preexisting health conditions (predominately orthopaedic and trauma surgery n = 91). Many did not receive some, or all, of the recommended vaccinations. AMS symptoms were reported by 213, 59/350 took acetazolamide, and 53 didn't factor in any acclimatisation days. None of the volunteers undertook specific muscular training before their trek (i.e. hiking with a rucksack the same weight as on trek), though 257/350 participated in some sport regularly back home. In those experiencing "a current pain" (n = 135), 64 had cephalgia, 28 had knee pain, 13 had shoulder pain, and more. Alcohol abuse or dependence was probable in 30/84 assessed; and 26/350 were occasional or

Keywords

- trekking
- prevention
- diseases
- Nepal
- altitude
- pre-existing diseases
- travel medicine

Contribution

A – Preparation of the research project
B – Assembly of data
C – Conducting of statistical analysis
D – Interpretation of results
E – Manuscript preparation
F – Literature review
G – Revising the manuscript

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regular users of recreational drugs. Existing or past nicotine abuse was reported by 104/350 with an average consumption of 14.8 cigarettes a day, and 25 continued to smoke during the trek with an average SpO_2 value of 90.9% (SD 3.8) vs. 90.5% (SD 4.4) in non-smokers. In 308 who provided their height and weight, 219 had a normal BMI, and 76 had pre-adiposity.

Conclusion: The preexisting health conditions of trekkers included a broad spectrum of diagnoses and fitness. Exacerbations of some of these conditions can be consequential when compounded by remote locations, AMS and limited or no access to comprehensive health care. Most would have benefited from comprehensive pre-travel medical advice.

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Introduction

The number of trekking tourists to popular global destinations continues to increase. For example, between the 1980s and 2012 the number of visitors to Nepal has risen by over 1000%,[1] and with the exception of a collapse in tourism during the COVID-19 pandemic, this tendency has continued.[2] The diversity of trekking trails in Nepal cannot be found in any other part of the world and this attracts a wide variety of visitors, including those with preexisting health conditions.

Of all the visitors to Nepal, 13.1% participated in climbing or trekking activities. However there is also a significant group of native Nepalese hikers, about 70%, who visit high altitude locations during pilgrimages who are less studied.[3-6] In parallel with this rise in trekking visitors, the number of medical emergencies has also increased. The spectrum of trekking emergencies differs from those of mountaineering due to the different risk profile of such tours, but also because the travellers are significantly older, and thus statistically more likely to be affected by chronic medical conditions.[7-9] Therefore factoring in these potential medical problems, in addition to altitude advice, should be an integral part of their trip preparation.

While there is extensive literature about altitude-related diseases for any age group, sex and activity, studies specifically on the preexisting diseases of trekkers at altitude are scarce. To shed more light on this, we collected comprehensive data from 350 trekkers in the Solo Khumbu area (Sagharmata National Park, Nepal) regarding their preexisting health conditions. The cardiovascular diseases of this same group have already been published.[9,10] The current paper is therefore focused on all the other preexisting diseases reported excluding cardiovascular ones. The goal was to establish an evidence base identifying the most relevant preexisting diseases of such trekkers that may help further inform the advice offered by doctors giving pre-travel advice to future trekkers.

Material and methods

Data acquisition was performed at Gorak Shep (5207 m), Dingboche (4340 m), Tengboche (3860 m), Namche Bazaar (3440 m) and in Lukla (2860 m), all of which are located in the Solo Khumbu valley (Sagarmatha / Mt. Everest National Park, Nepal). Gorak Shep and Dingboche are more or less siuated at the highest location of the trek (normally reached after 7 to 10 days) and the participants were interviewed there. The interviews at the other locations were performed when the trekkers returned from their trek (typically day 12 or 13 of their sojourn). Inclusion criteria were: 18+ years of age, tourist type (trekking or expedition climber), and no language barrier (English, German, or translation of the questionnaire by a competent translator). Exclusion criteria were: locals, age <18 years, and impaired mental status of any origin which would deny the volunteer's ability to give informed consent.

The questionnaire included the following data: demographics (age, sex, height, weight, ethnicity, profession, marital status), general lifestyle at home (diet, hydration, sporting activity, smoking status, medicinal drugs used, the use of performance-enhancing drugs – especially acetazolamide[11,12] or amphetamine), the actual tour profile – organized group or individual (self-guided) tour, the duration of the individual stages and acclimatisation days or detailed altitude profile where available, trip preparation (travel medicine advice received, vaccinations), and any current complaints that may be caused by the trekking tour or the altitude (e.g. headache, nausea, dizziness, diarrhoea, shortness of breath, muscular problems, joint problems or injuries).

The main part of the questionnaire focused on previous medical conditions (operations, their localisation and causes, and preexisting illnesses). The following important chronic diseases were included: diabetes mellitus, cancer (if yes, which, since when and which treatment), arterial hypertension, rheumatic and orthopaedic diseases, bronchial asthma, COPD, psychiatric

diseases, infectious diseases and allergies. There was also a category for "other" where participants could provide any information about health disorders. Further questions asked whether a deterioration in their health situation occurred due to a preexisting chronic illness during the trek, and whether the subject had previously received information about their chronic health impairment from their doctor. Topics of the autonomic system like micturition, defecation, appetite, thirst, and weight fluctuations were also included. Family history and previous illnesses of close relatives were documented.

A clinical check with the focus on orthopaedic topics was followed by taking measurements of: blood pressure, heart frequency, peak flow (Vitalograph asmaPLAN+, Vitalograph GmbH – Hamburg, Germany), and for those aged 40+ a fasting cholesterol level check (Accutrend Plus® Cholesterol – Roche, Berlin, Germany). A total cholesterol of <200 mg/dl was recorded as normal.[13,14] Peripheral oxygen saturation was measured using a CMS50E pulse oximeter (Contec Medical Systems – Qinhuangdao, China). Urine was tested using Combur 9 Test® strips (Roche, Berlin, Germany), which included semiquantitative tests for leucocytes, nitrate, pH, protein, glucose, ketones, urobilinogen, bilirubin, erythrocytes, and haemoglobin. The CAGE test was carried out to assess whether, and to what extent, the collective was at risk for alcohol misuse or dependence.[15] If two or more of the four questions were answered positively, a risk or even dependence must be assumed, which should then be verified by further measures.

Comparisons between the preexisting diseases and sex, or the localisation of actual pain, were performed using the Fisher's exact test. The t-test was used for the comparison of SpO_2 between smokers and non-smokers. For almost all comparisons the significance level was set at 5% due to the explorative nature of the investigation. Results were reported as frequencies and percentages or means, standard deviations (± SD), medians and ranges. The analysis was performed with SPSS V22 and Origin 8. The study was conducted according to the Declaration of Helsinki (1964) after approval by the Ethics Committee of RWTH Aachen University, Germany (reference EK 196/11).

Results

Collective and trip preparation

A total of 350 adult volunteers participated (n = 122, where female were 35%). The largest to smallest demographic groups by year bands were: ages 30–39 (n = 93, 28%), 18–29 (n = 70, 20%), 40–49 (n = 70, 20%), 50–59 (n = 61, 17%), 60–69 (n = 50, 14%) and finally ages 70–79 (n = 5, 1%) (Figure 1). Mean age was 42.7 years (SD = 13.5; median = 40; range 18–76), and 32% of the trekkers were aged 50+.

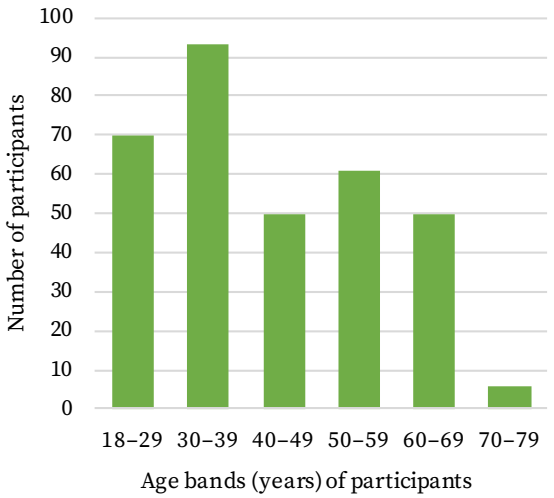

Figure 1. Age distribution of the collective

Regarding ethnicity, the majority came from Europe 67% [n = 236; France 14% (n = 50), United Kingdom 11% (n = 40), Germany 9% (n = 31), Switzerland 7% (n = 24), Spain 6% (n = 22)]. Canada and the USA were each represented by 6% (n = 22). Half of the collective (n = 178, 51%) had consulted a 'doctor' before travelling. The 'doctor' specified by 88 volunteers was a general practitioner, for 41 volunteers a physician with special training in travel medicine was consulted, and 6 had consulted an orthopaedic surgeon. 43 trekkers did not specify the doctor's speciality. The majority (n = 257, 73%) stated that they participated in sport regularly at

home, but most of this group (n = 247 rsp. 71% of the total collective) did no specific training to prepare for the trek. On average, 8.3 days (SD = 3.7; median = 8; range 5–37, Figure 2) were required for the ascent to Gorak Shep with an additional day to Mount Everest base camp.

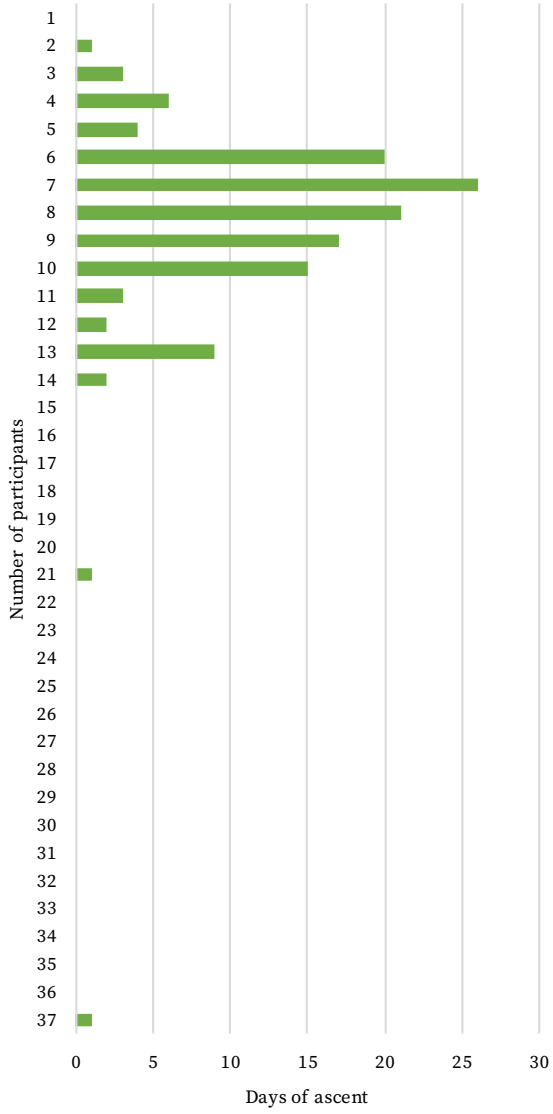

Figure 2. Days of ascent from Lukla (2860 m) to Gorak Shep (5207 m)

Most of collective (n = 308) provided information on their height and weight so that their Body Mass Index (BMI) could be calculated. Mean BMI was 23.4 (SD = 2.9; median = 23.2; range 17.2–38.5). The majority had a normal BMI (n = 219; 71%). However, the BMI for 25% (n = 76) of the volunteers was graded as pre-adiposity, 2% (n = 7) had an obesity grade, and another 2% (n = 5) were slightly underweight. One subject was in the obesity grade 2 range according to the WHO classification.[16] Severe underweight or obesity grade 3 were not found.

Regarding travel-specific vaccinations, 273 individuals (78%) stated that they had 'any kind of travel-related vaccination', and 64 (18%) did not provide any information. Only 13 individuals (4%) negated having any travel-related vaccinations. From the total collective (n = 350), 65% were vaccinated against hepatitis A, 63% against hepatitis B, 52% against typhoid fever, and 24% had received a rabies vaccination. Vaccination against Japanese encephalitis had been done in 9%.

Pre-existing diseases

Of the 350 volunteers surveyed, almost half (n = 150, 43%) had reported one or more preexisting (chronic) condition. More specifically, 32% had reported only one preexisting disease, but 8% reported two, 2% reported three, and 1% (n = 3) reported four different conditions. There was no difference between sexes and the presence of at least one preexisting (chronic) condition. Orthopaedic and trauma surgery accounted for the largest proportion (n = 91/150). Most orthopaedic diagnoses were related to the knees (Figure 3). The second most frequently occurring preexisting conditions were in the field of cardiology (44/150), and details about this group were published elsewhere.[10]

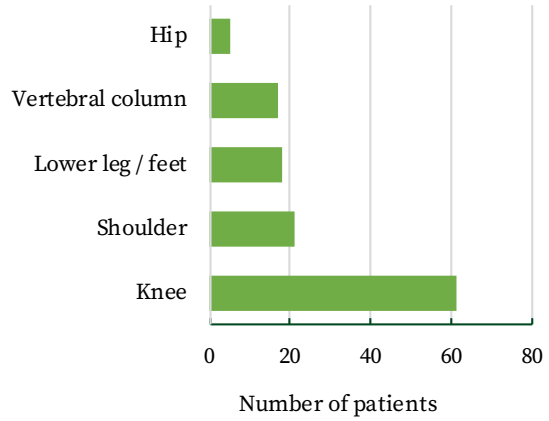

Figure 3. Distribution of orthopaedic diagnoses by body region

Endocrine disorders were experienced by a total of 14/150 travellers. Urological, gynaecological and pulmonological diseases were reported by 10 people in each category. Other preexisting conditions reported included gastroenterological disorders (n = 27/150),

psychiatric disorders (n = 7/150), and 6/150 had an oncological history.

Symptoms and findings during the trek

During their trek, 213 subjects (61% of the total collective) reported symptoms of acute mountain sickness (AMS): 155 (74%) complained of insomnia, 64 (30%) of cephalgia, 53 (25%) suffered from loss of appetite, 39 (19%) reported dizziness, and 29 (14%) suffered from nausea or acute vomiting. The Lake Louise Score[17] of 62 test subjects was 3 to 5, indicating a mild AMS (29% of the 213 affected with AMS symptoms). Four trekkers had a score of 6 or more (2% of 213 affected) indicating a severe AMS, and 147 subjects (69% of 213) showed a score of only 1 to 2 which does not comply with AMS but indicates an altitude-related deterioration. In summary, about one in three trekkers suffered from AMS at some point during their trek, although a fifth (n = 59/350; 17%) had taken acetazolamide (Diamox®) as a prevention. AMS symptoms corresponded to the extent of acclimatisation, and 53 subjects stated that they had not taken any acclimatisation days. The fastest ascent to Gorak Shep (5207 m) took five days, the longest 36 days.

A current pain was reported by just under half of the total collective (n = 135/350; 39%). From this group of 135 subjects experiencing a current pain, 64 (49%) reported cephalgia, 28 (21%) had knee pain, 13 (10%) had shoulder pain, 11 (8%) had abdominal pain, 7 (5%) had neck pain, 6 (4%) reported chest pain, and 4 subjects (3%) each complained of back and of hip pain. In 93% there was no association between presence of at least one pre-existing (chronic) condition and the localisation of actual pain. The remaining 7% consisted of persons with knee or back pain and a corresponding precondition.

A total of 16 subjects (5% of the total sample) reported a previous endocrine illness, of which 7 subjects were being treated for hypothyroidism. A quarter of the total collective (92/350; 26%) made themselves available for cholesterol testing. Eight of these subjects (9%) who didn't report any hypercholesterolaemia showed slightly, or pathologically elevated values, with a mean total cholesterol of 218 mg/dl and a maximum value of 288 mg/dl. Two others reported a preexisting hypercholesterinaemia, but the results showed total cholesterol concentrations lower than 150 mg/dl. Three subjects reported type 2 diabetes. Actual blood glucose levels were not possible to collect, but all diabetic persons were positive for glucose in the urine test (Table 1).

Fourteen individuals (4% of the total sample) reported a preexisting pulmonary illness. Of these, 13 had asthma and one had COPD. The peak flow measurement for the latter was 380 L/min (79% of the normal value). All asthmatics and the COPD subject had a short-acting beta sympathomimetic drugs with them as an on-demand medication. No one had a long-term medication, e.g. an inhalative corticoid.

Table 1. Results of urine tests

Parameter	Results	No. of subjects (n = 224)
Leucocytes	+	5
	++	3
	+++	–
	++++	1
Nitrite	+	64
Protein	+	176
	++	6
	+++	1
Glucose	+	–
	++	–
	+++	2
	++++	1
Ketone	+	5
	++	3
	+++	–
Urobilinogen	+	4
	++	–
	+++	3
	++++	1
Bilirubin	+	–
	++	–
	+++	–
Erythrocytes	+	8
	++	3
	+++	–
	++++	–
Hemoglobin	+	49
	++	13
	+++	–
	++++	1

The most important risk factor for cardiocirculatory and pulmonary diseases was smoking. Smoking also causes an increase in carboxyhaemoglobin (CO-Hb) that is relevant to performance physiology.[18,19] A third of the collective (104/350, 30%) confirmed

existing or past nicotine abuse, and 23/350 (7%) reported continued cigarette consumption. On average, the smokers consumed 14.8 cigarettes per day (SD = 11.0; median = 15; range 0.2–60.0), the mean number of pack-years smoked was 13.2 (SD = 13.0; median 8.75; range 0.5–60.0). The average SpO2 value of the smokers was 90.9% (SD = 3.8; median = 91; range 0–99) compared to lung-healthy non-smokers at 90.5% (SD = 4.4; median 91; range 0–99) The difference was not significant. It may come as a surprise that there was no significant difference in SpO_2 between smokers and non-smokers. In contrast to non-smokers, for whom a CO-Hb level of around 1% is typical, smokers have a level of 5–15%.[20] Conventional pulse oximeters do not recognise CO-Hb and show supposedly normal SpO_2 values. CO–Hb absorbs light at a similar wavelength to oxygenated haemoglobin, so CO–Hb is incorrectly interpreted as O–Hb. It can therefore be assumed that this is a methodological problem and that the smokers' values are falsely high.[21]

The peripheral oxygen saturation of the entire collective is shown in Table 2.

Table 2. Oxygen saturation of the collective, differentiated according to local altitude

Location	Altitude [m]	Number of participants	Mean SaO_2 [%]	Maximum SaO_2 [%]	Minimum SaO_2 [%]
Lukla	2860	31	95.1	98	90
Namche Bazaar	3440	23	92.6	98	83
Tengboche	3860	201	90.7	99	80
Dingboche	4340	79	88.9	99	68
Gorak Shep	5207	6	81.6	88	78

A very small number (12/350, 3%) of individuals reported a previous urological or gynaecological illness. Diagnoses included a broad spectrum of different diseases: benign prostatic hyperplasia (n = 2), prostate carcinoma with curative prostate resection (n = 2), ureteral stenosis (n = 2), pyeloplasty for recurrent pyelonephritis (n = 1), congenital unilateral renal aplasia (n = 1), and renal cell carcinoma (n = 1). Three women had previous gynaecological diseases (n = 2 breast cancer; n = 1 uterus myomatosus).

Two-thirds (n = 224/350, 64%) of the total collective provided a urine sample for examination. Three tests showed a significant glucosuria, all from diabetic patients. From those providing urine samples, 81.7% (183/224) had proteinuria and 33.0% (74/224) had detectable haemoglobin or erythrocytes in their urine. Details are given in Table 2.

A total of 27/350 (8%) subjects reported a previous gastroenterological illness. Most of these diagnoses occurred long ago, had healed without any consequences, and did not pose any risks when trekking. These diagnoses included appendectomy (n = 14), cholecystectomy (n = 3), and Gilbert's (Meulengracht's) syndrome (n = 1). However, some of the trekkers suffered from diseases which may deteriorate at any time including: inguinal hernia (n = 4), colon carcinoma (n = 1), lactose intolerance (n = 2), coeliac disease (n = 1), and primary sclerosing cholangitis (n = 1).

Fourteen percent of the total collective experienced diarrhoea during the trek (n = 50/350; 30 men/20 women). Their average age was 42 years (18–67), which corresponded well to that of the total collective.

Two trekkers reported a severe previous infectious disease. A 57-year-old male reported a history of tuberculosis, and a 30-year-old male suffered from an HIV infection. The latter was trekking with the long-term medication of Atripla® which is a fixed drug combination of efavirenz 600 mg, emtricitabine 200 mg and tenofovir 245 mg. His actual immune status was unknown and not checked before departure.

Six individuals (2% of the total sample) provided information on previous oncological diseases. Diagnoses included prostate carcinoma (n = 3), renal cell carcinoma (n = 1), colon carcinoma (n = 1), carcinoma in situ of the breast (n = 1). All tumours had been completely resected surgically; no metastases were known in any patient. None of the subjects had current symptoms suspicious of tumours or metastases.

Three trekkers reported pre-existing neurological diseases: essential tremor, fibromyalgia, and migraine. None of them had received any long-term therapy.

A total of 7 people provided information about an existing or previous psychiatric illness. Diagnoses included transient psychosis induced by cannabis (n = 1), panic attacks (n = 1), a depressive episode (n = 3), and anxiety disorder (n = 1). One person did not provide details. The drugs most often used as long-term medication were selective serotonin reuptake inhibitors (SSRIs) like fluvoxamine, escitalopram or sertraline and an antiepileptic substance (lamotrigin).

Occasional or regular recreational drug use was reported by a total of 26/350 individuals (7% of the total sample). Most of this group (n = 20) consumed cannabis or drugs containing cannabis, and in addition, 5 of these subjects also reported occasional cocaine and amphetamine use.

Occasional alcohol consumption was reported by the majority of the collective (n = 273/350; n = 78%). On average, these individuals drank alcoholic beverages 2.4 times/week, with an average of 1.1 litres of an alcoholic beverage being consumed per week. The consumption of beer or wine was predominantly reported. The maximum alcohol consumption was daily, the minimum was once a week. The CAGE Test was answered by 84 individuals. From this group of 84, the following answered up to four questions with a 'yes': 64% (n = 54) answered yes to one question, 17% (n = 14) to two questions, 18% (n = 15) to three questions, and one person (1%) answered yes all four questions. According to the CAGE test, alcohol abuse or alcohol dependence is probable if a person answers two or more questions positively.[15] From this group of 84, 36% of the trekkers must be considered at risk.

The majority of subjects who stated they were affected by a condition (n = 143) did not report any deterioration during the trek as a result. However, some reported pain in the affected region. While 9 trekkers stated that this did not impair their trip, two others (one with medial meniscus lesion, the other with coxarthrosis) were considerably impaired by pain. No other deterioration except pain was reported.

Discussion

The present study was an epidemiological survey of the prevalent preexisting conditions of trekkers in the Solu-Khumbu region / Mount Everest (Nepal). The aim of this study was to help inform and improve the pre-travel medical advice trekkers receive to include their preexisting health conditions. More comprehensive pre-trip recommendations should help reduce travel-associated problems through knowledge of the local situation and of the demands of the tour.

When comparing the data from the current study with the Nepalese tourism statistics, the age distribution matches, and there is also an association in terms of the geographic origin of the travellers. The age and sex distribution largely correspond to that of previous studies on travellers to Nepal.[22-24] It can therefore be assumed that the present results are a representative demographic of trekkers in the Himalayas.

Overall, the data from the current study confirmed that a relevant proportion of trekkers are travelling with preexisting conditions. On the one hand, there was enormously wide range of medical diagnoses affecting the trekkers, but on the other hand, these conditions were largely stable and only occasionally showed a significant deterioration while travelling in exceptional cases. Half of all the 350 participants (51%) sought qualified medical information before departure. This was provided by doctors trained in travel medicine and altitude medicine only in a minority of cases. However, their trip preparation and vaccination status were similar to those of previous studies, e.g. in the Annapurna circuit. Lechner et al. reported 67% of travellers being vaccinated against Hepatitis A, 65% against hepatitis B, 46% against rabies, and 57% against typhoid fever.[8,23] This is nearly identical to our actual results except for rabies: 65%, 63%, 24%, and 52%, respectively. However, neither our data, nor that of the referenced ones cited, corresponded in any way to the official immunisation recommendations for Nepal. Every visitor should have been vaccinated against typhoid fever, hepatitis A, tetanus, diphtheria, poliomyelitis, rabies and measles.[25] If they also visited the southern parts of the country (e.g. Terai), a Japanese Encephalitis vaccination and measures against malaria are additionally recommended.[25] Although some of the infections listed here (e.g. rabies, hepatitis A) may be treated by a post exposure prophylaxis, such vaccination must be given within a short time from the infection. The remote locations of most treks will make this timely post exposure vaccination impossible.

However, when one considers the large number of factors that even a healthy trekker should take into account to maintain health in such remote regions at high altitude, with limited hygiene and minimal infrastructure, the low level of specific training of the doctors providing advice seems alarming. Particularly in view of the large number of different preexisting conditions, (which can create very specific risk constellations, some will be discussed later), these doctors should have a sound expertise in internal medicine, sports medicine, and at least basic knowledge of orthopaedics in addition to classic knowledge of travel medicine when advising trekkers. In the case of orthopaedic diagnoses, specific knowledge about knee complaints and back problems are particularly important. This also emphasises that trip physicians should be experienced in primary care.[26]

Among the complaints that showed a deterioration during the tour, knee complaints dominated by far. This includes two trekkers with total knee replacements. To a lesser extent back and neck pain occurred. The high luggage weight, the long distances trekked, and the altitude profile collectively represented a major challenge for the musculoskeletal system. Data from sports medicine and physiotherapy suggest that these complaints may be at least partially reduced by adequate muscular training.[27-32] Therefore, candidates who plan on trekking should be advised to carefully consider their training status. Their training should include hikes with

a backpack which has a similar weight to the one they'll have when trekking. Surprisingly such a trip preparation wasn't performed by any of the participants. Another recommendation for persons with gonarthrosis should be the use of trekking sticks, especially when walking downhill.[33,34] However, hiking is still considered to be a low-risk activity for patients with knee problems.[35]

There is a controversial discussion in the literature about a possible connection between increased AMS prevalence and existing hypothyroidism due to inadequate substitution therapy or unrecognised hypothyroidism. Hypoxia leads to an increased enzyme activity of the inactivating 3-deiodinase, and consequently to reduced triiodothyronine (T3) levels.[36,37] A simultaneous temporary adrenal cortical insufficiency with reduced cortisol production was also observed.[38,39] This could result in increased temperature intolerance, faster fatigability and slower acclimatisation behaviour. Thyroid hormones also appear to have an influence on the 2,3-diphosphoglycerate concentration and thus on erythropoiesis.[40] However, even if it is still unclear whether hypothyroidism decreases altitude acclimatization or not, such disorders should be taken into account when advising trekkers.

The number of diabetic trekkers in our study was lower than expected. Diabetics can now routinely undertake such activities when using oral therapy if they follow some simple rules.[41] However, they must get some specific pre-travel advice, e.g. how to differentiate AMS and hyperglycaemia.[41] Insulin dependent persons face another problem because insulin should not freeze.[42] Some data indicate that carbohydrate absorption is delayed at altitude.[43] This may explain the reports by diabetic mountaineers who experience more difficult blood glucose management with increasing altitude.[44,45] In patients with type 1 diabetes, the increased risk of ketoacidosis should be emphasised because renal compensation of respiratory high-altitude alkalosis leads to considerable buffer loss.

One patient reported that she had undergone pituitary resection for acromegaly and that there was insufficient ACTH production by the pituitary gland with inadequate adrenal cortical stimulation. Occasional morning sickness, fatigue and headaches may be an expression of a relative cortisone deficiency and may be due to a lack of ACTH. Cortisone deficiency can be quickly remedied by taking the morning dose of hydrocortisone immediately after waking up. However, laypersons will have great difficulties in differentiating these symptoms from AMS. Reduced performance, fatigue, tiredness, loss of appetite and abdominal pain can be indications that the substitution dose is too low. Specific advice for such patients is mandatory before departure.

The finding of protein in the urine samples provided by 83 out of 224 volunteers was remarkably high. It cannot be assumed that these 83 volunteers had kidney disease. Even in healthy people, there appears to be a greatly increased permeability of the glomeruli at altitude. It is not known whether the increased permeability is caused by hypoxia or by hormonal changes.[46] On the other hand, the number of participants who showed erythrocyturia or haemoglobinuria was remarkably low. However there was constant exercise over several days, and this may have induced such findings.[47-49] Due to the lack of detailed diagnostic possibilities during the expedition, these findings must remain open for future investigations.

The incidence of traveller's diarrhoea was lower in our study (14%) compared to previous ones which reported 23% and up to 40% and more.[50-54] This cannot be explained by the actual data, and we also did not follow the collective to the end of their trek so there may be slightly more incidents of traveller's diarrhoea. However, it can be assumed that the findings from this well studied topic over many years have led to significantly improved hygiene and health awareness in the region, thus leading to a now lower incidence. For trekkers, traveller's diarrhoea is of special interest because even the loss of only 1–2% of body fluids leads to a significant performance decrease as each additional percentage of water loss can be equated with an ascent of an additional 500 m in altitude. This effect is due to the increase in blood viscosity, and thus the reduction in peripheral perfusion may lead to the occurrence of AMS symptoms without an actual ascent in altitude.[55]

Our study was performed while the discussion whether sleep disturbance is a symptom of AMS or not was still in progress. Therefore we used the 'old' definition with sleep quality included. This has also the advantage of a more direct comparison with other studies. However, the incidence of acute altitude sickness (AMS) is difficult to compare with other publications as it was extremely variable due to the five different altitude profiles. For example, Lechner reports an incidence of 17% in Manang (3500 m) from the Annapurna Circuit,[23] while Haunolder reports 72.6% from the Solo Khumbu,[9,10] Murdoch (1995) reported 75% Solo Khumbu,[56] and 74% of patients in the Mustang region (Nepal) were affected.[57] However, all authors were agreed that ascent rate was the most important risk factor, and that this condition can be avoided at least up to 5500 m in nearly all situations when appropriate acclimatization was performed. The altitude profile to include appropriate acclimatisation is easily

available in many publications (e.g.[59]) but nevertheless the incidence of AMS is still quite high. In our study a significant number of trekkers suffered from AMS as they obviously did not follow the recommendation but climbed too high too fast.

Data regarding the use and abuse of alcohol and drugs in the mountains is scarce. Decades ago the abuse of amphetamines in the Austrian Alps was investigated.[59] The authors found that 7.1% of alpinists above 3300 m of altitude, and 2.7% at 2500 m to 3300 m, were positive. There are no reports about the incidence of other drugs in mountaineering, also no detailed ones about alcohol although the increased risk in skiing has been documented.[60-62] Although alcohol does not increase the risk of AMS[63] our data showed that trekkers are abusing alcohol and substances to an alarming extent. From the 84 volunteers who answered The CAGE Test questions in our study, in 36% of this group alcohol abuse or dependance was probable. Even if no statement regarding the individual risk of this behaviour in the high mountains is possible from the available results, an urgent warning should be issued from a preventive medical point of view. After all, any change in awareness by alcohol or drugs has direct consequences for risk acceptance and risk management.

Special attention must be paid to the individual risk profile when trekking due to adverse effects of long-term medication. In the current study, this concerns fluvoxamine, lamotrigin or sertraline, for example, whose side effect profile includes symptoms that can easily be associated with travel-related illnesses, such as headaches, dizziness, tachycardia, diarrhoea, nausea or vomiting. These symptoms may be misinterpreted when travellers think about AMS or traveller's diarrhoea. On the other hand, diarrhoea or vomiting may reduce the uptake of necessary drugs which may have a significant effect on drugs which have a small therapeutic index. Theoretically sedative drugs should increase the risk of accidents (e.g. by stumbling because they decrease reaction time). Such topics should be addressed during pre-travel advice.

The trekker with HIV is an interesting case. First of all it demonstrated the advances in HIV therapy which enables the patients not only to live a normal daily life, but it also offered the opportunity for traveling in remote regions. However, if the side effect profile of the drugs is considered, then the following problems are among the most common symptoms that occur very frequently: cephalgia, dizziness, nausea, diarrhoea, and vomiting. All of them may have significant impact on the fitness to travel, especially in a remote area like Solo Khumbu. Obtaining detailed pre-travel information from this trekker's doctor on how to manage such problems abroad should be mandatory for every HIV patient before departure. An actual check of the immune status before departure should be also recommended. Of course, patients with reduced immune status should get detailed advice concerning any infectious risk during travel, especially water and food hygiene.

Conclusion

The preexisting health conditions of trekkers include a very broad spectrum of diagnoses that would have benefitted from comprehensive pre-travel medical advice. Only half of the 350 participants sought any type of pre-travel advice. Although the number of significant incidences when trekking was relatively small, we did not follow through to the conclusion of the trek. Physicians who provide travel advice to trekkers need a profound knowledge of the local infrastructure, the exposure to environmental factors, sound knowledge in different medical disciplines, especially internal medicine, orthopaedics and sports medicine, in addition to classic travel medicine topics. Apart from cardiovascular disease (see[9,10]), the most important medical problems in the population studied due to their potential risk or frequency were knee complaints, diabetes, and asthma/COPD. A significant number suffered from AMS and did not receive some, or all, of the recommended vaccinations.

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