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# Outdoor Adventure Practice in Kenya: Injuries, Illnesses, Non-Medical Concerns, and Evacuation Profiles on Mt. Kenya

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## Abstract

**Background:** Outdoor adventure is inevitably linked to risks that lead to injuries, psychological distress, illnesses, and even fatalities. Gathering detailed information on such occurrences and their contributing factors is a valuable component of risk management in outdoor programs. This study investigated the occurrence of injuries, illnesses, evacuation profiles, non-medical concerns, and near-miss events in outdoor adventure practice in Kenya.

**Methods:** A mixed-methods approach involving quantitative and qualitative methods was used to collect data from 136 outdoor adventure practitioners in Kenya. Questionnaires, key informant interviews, focus group discussions, and desk reviews were employed to collect data.

**Results:** The majority of injuries and illnesses occur during mountaineering (39%) and hiking and navigation (25.7%) events. The most reported incidents were mountain sickness (25%) and musculoskeletal injuries consisting of fractures (30%), cuts and wounds (14.7%), blisters (12.5%), sprains and dislocations (12.5%), and muscle strains and pulls (8.8%). Out of the 128 reported evacuation incidences on Mt. Kenya, 95 were due to mountain sickness and 10 due to falls. Combined age and sex of the climbers and the location/altitude on the mountain are predictors of the occurrence and the type of injury/illness on the mountain ( $\chi^2(10, n = 128) = 63.32, P < 0.001$ ). However, only altitude significantly contributes to the model ( $P < 0.001$ ). Reported near-miss incidences included flash floods, aggressive encounter with wildlife, getting lost for extended period, near falls and slips, and rolling-rock falls. Non-medical concerns reported included extreme anxiety, intoxication from drug and alcohol use, confrontation and fights, and disorientation.

**Conclusions:** There is evident incidence of injuries and illnesses of varying severity, with age, sex, and altitude reached being key predicting factors. Mitigating efforts and preventive measures should be employed as well as risk assessment and management to promote safety. The findings are vital to advise policy and practice and enhance awareness among practitioners and interested parties in Kenya and also in other destinations with similar conditions, terrains, and challenges.

**Keywords:** outdoor adventure, injuries, illnesses, near-miss, non-medical, risks

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## Introduction

Outdoor adventure activities are human-powered physical activities occurring in natural or nonurban environments for recreation and exercise and include elements of physical danger (Ewart, 1989). In Kenya, there are various natural settings that provide excellent facilities for outdoor adventure programs; however, the most prominent activities take place on Mt. Kenya, which is a world heritage site (UNESCO, 2016) that attracts foreign and domestic tourists for mountaineering expeditions. Other outdoor adventure destinations in Kenya are also home to various activities such as hiking, mountaineering, camping, team building, sports, games, physical fitness programs, camp craft, rock climbing, map reading and navigation, and solitude, among many others.

Adventure is inevitably linked to risk (Ewart, 1989; Walle, 1997). Due to the outdoor nature of the activities, risks of injuries, illnesses, or fatalities are present. For instance, mountaineering is characterized by the “deliberate seeking of risk and the uncertainty of outcome” (Ewert, 1989) while rock and ice climbing are widely considered to be “high-risk” sporting activities that are associated with a high incidence of severe injury and even death (Schöffl et al., 2010). Eliminating the physical challenge is impossible in wilderness and would fundamentally alter the activity, the outcome, and the mission. Despite the obvious dangers inherent in adventure programs, people continue to seek the remoteness and pleasures of outdoor adventure programs such as in mountaineering (Kale & Anholm, 2015). For instance, individuals may frequently experience acute altitude illness soon after ascent and although some only experience minor inconvenience, for others, the symptoms are incapacitating (Kale & Anholm, 2015). The wilderness setting poses a challenge of extreme weather conditions and limited availability/accessibility of specialized emergency equipment and services (Iserson, 2013). In an outdoor adventure scenario, a patient may not be able to access hospital care for one or more hours due to distance or

other challenges. Typically wilderness emergency care involves longer patient contact times, challenging environments, limited resources and equipment, and independent decision making (Iserson, 2013). Practitioners have a key role/responsibility in wilderness emergency care. While providers may not always know the complete medical treatment, they must be able to initially diagnose and care for patients while they transfer (evacuate) them to a health facility otherwise the patients may deteriorate or even die. Evacuations occur when injured or ill participants or instructors must leave the field before the end of the course/trip. Medical evacuations generally indicate that a person's condition was such that he or she needed medical care or was no longer able to participate on the course because of the medical condition (Leemon & Schimelpfenig, 2003). Understanding of expedition-related illnesses and injuries allows institutions and individuals to develop strategies to mitigate risk (Stanford et al., 2017). Illness is defined as an interruption, cessation, or disorder of body functions, systems, or organs and represents a "medical" problem. Injury is defined as damage, harm, or loss as a result of an external force and correlates to a "trauma" problem (Leemon & Schimelpfenig, 2003). Outdoor adventure-related illnesses and injuries include altitude-related illnesses and musculoskeletal injuries that include athletic injuries (sprains, strains, dislocations, fractures, and neck and spinal injuries) and soft-tissue injuries (such as cuts, wounds, blisters, and burns) (Leemon & Schimelpfenig, 2003). Other conditions include unconsciousness, gastrointestinal illnesses, hypoglycemia, hypothermia, seizures, heatstroke and heat exhaustion, lethargy and body weakness, asthmatic attacks, nose bleeding, and animal attacks and bites among others. The National Outdoor Leadership School (NOLS) predetermined criteria of what constitutes a reportable injury or illness focus on those that require more than simple first aid, those that require follow-up care or the use of prescription medications, and those that interfere with active participation for 12 hours and injury or illness that requires evacuation (McIntosh, et al., 2007). While the physical and health risks inherent in adventure activities are presumably managed by responsible well-trained practitioners guiding the teams, other risks such as psychological effects (e.g., emotional and behavioral concerns) may be mismanaged, or overlooked entirely (Musa & Thirumoorthi, 2015). There is need to also evaluate non-medical incidences, near-miss events, and evacuation profiles and procedures. These aspects also present risks and pose safety concerns that could either aggravate pre-existing conditions or cause the development of new injuries and illnesses.

Several studies have been conducted worldwide on injuries and illnesses encountered during expeditions. For example, Stanford et al. (2017) assessed the trends in skin and soft tissue-related injuries in NOLS wilderness expeditions from 1984 to 2012, McIntosh et al. (2012) analyzed mountaineering medical events and trauma on

Denali between 1992 and 2011, Neuhof et al. (2011) evaluated patterns, severity, and injury rates of acute sport climbing injuries in Europe, while Schöffl et al. (2010) evaluated injury and fatality risk in rock and ice climbing. A study by Platts-Mills and Hunold (2013) described an increase in older adults reporting mountaineering-related injury or illness in the United States between 1973 and 2010, and several other studies have analyzed high-altitude illnesses (American Alpine Club, 2006; Hearn et al., 2006; Largiader & Oelz, 1993; McIntosh et al., 2008; Paige et al., 1998; Smith, 2006). Larger studies such as a systematic review by Mort and Godden (2011) summarized evidence articles on injuries occurring in individuals participating in mountain and wilderness sports from 2034 articles. That particular study concluded that the majority of mountain and wilderness sports injuries are minor to moderate. However, some casualties have life-threatening medical problems, which may have long-term implications for return to sport and general well-being. All these studies agree that there is a high prevalence of injuries and illnesses in outdoor adventure pursuits which need to be periodically monitored and mitigated.

Gathering detailed information on injury and illness incidents and their contributing factors is a valuable component of risk management in outdoor programs. Actual data on incidents provide important information about the real, other than just perceived, risks involved in outdoor activities (Goode et al., 2014). Information on contributing factors provides an empirical basis to justify changes to policy, training, or program location or activity (Goode et al., 2014). Although there are no previous empirical studies reporting on injury rates or contributing factors for Mt. Kenya, the following are identified as possible leading causes of injuries and illnesses on Mt. Kenya based on unpublished sources. The mountain's highest peak is at 5,199 meters/17,057 feet. There is however quick ascension on some routes made possible by the option of driving from the base camp to 10,000 feet; hence climbers are usually not well acclimatized to high altitude due to the rapid ascent and are therefore highly susceptible to altitude sickness. Anecdotal reports from personal communications of long-service mountaineering instructors indicate that 7 out of 10 climbers on Mt. Kenya suffer from acute altitude sickness. In addition, the non-uniform and treacherous terrain of the mountain is characterized by very steep hills and deep valleys at the higher altitude levels of the mountain, which, unlike other much smoother and easier-to-climb mountains like Mt. Kilimanjaro, make it worse for climbers already suffering from altitude sickness. These climbers have to descend valleys in order to reach the next camp at the top of the hills for the night, thus making the maxim "climb high, sleep low" not applicable (Burtscher & Koch, 2016) on Mt. Kenya. The loose rocky surfaces closer to the peaks are further complicated by the episodes of snow, freezing events, and

dislodging rocks, which have led to more reports of soft tissue injuries and falls compared to other mountains like Mt. Kilimanjaro. The mountain also has unpredictable weather patterns with rapid changes from heavy rains and quick thick mist cover within a short time leading to increased wetness and incidences of getting lost. Most incidents of severe hypothermia are reported to take place between 10,000 and 14,000 feet due to the very windy and cold conditions at this point of the mountain. Other predisposing factors are linked to the wild, underdeveloped, and unmarked routes, poor climbing gear, wrong practices, and poorly trained personnel. An investigation of the risks for accident, injuries, and illnesses on Mt. Kenya provides important new information that is applicable to several other mountains with similar terrains, height, weather patterns, activities, and practices in Africa and beyond with equatorial Afro-alpine characteristics. Since many practitioners usually guide trips to various mountain destinations in East Africa, other parts of Africa, and beyond, this knowledge will sensitize them and guide decisions made on other mountains with similar challenges and conditions.

To the best of our knowledge, there is a paucity of data and very few of such studies relating to the East African region, thus limiting reviews and/or analyses of injury and illness status, trends, and predisposing factors in the East African region. Anecdotal sources, witnesses, and media reports suggest that there is a high occurrence of injuries and illnesses in outdoor adventure activities; however, there is dearth of research-based documented information on outdoor and adventure practice in Kenya. This motivated a study to investigate the occurrence of injuries, illnesses, evacuation profiles on Mt. Kenya, non-medical concerns, and near-miss events in outdoor adventure practice in Kenya. This information is vital to advise policy and practice and will enhance awareness among practitioners and interested parties in the East African region.

## Materials and Methods

### *Study Design*

The findings presented in this paper are based on data collected as part of a larger research study. The research study, entitled “Outdoor Adventure Practice in the Afro-Alpine Mountain Areas in East Africa: Training, Certification, Competence, and Standards in Injury Occurrence and Pre-Hospital Emergency Risk Management (PHERM)”, was a large cross-sectional survey. A mixed-methods approach involving descriptive, quantitative, and qualitative methods was used for this study to allow triangulation of data captured from different participants. The larger study aimed to establish the preparedness of outdoor adventure practitioners in PHERM in the Afro-alpine mountain regions—Mt. Kenya, Rwenzori Mountains, and Mt. Kilimanjaro—in East Africa. In the process, the

occurrence of injuries and illnesses and related concerns in the outdoor adventure practice was assessed.

The study protocol was reviewed and approved by the Kenyatta University Ethics Review Committee (KU/R/COMM/51/15-PKU005/104) and the National Council for Science and Technology in Kenya. Permission to conduct the study was sought from the park authorities of key institutions. Consent to get involved in the study was sought from each respondent after a detailed explanation of the nature and expectations of the study.

### *Study Location*

The Mt. Kenya region was chosen because it contains various popular venues and outdoor adventure destinations that attract tourists and locals for outdoor adventure activities as well as experiential training activities. Mt. Kenya, an Afro-alpine mountain, is the highest mountain in Kenya and the second-highest in Africa, after Mt. Kilimanjaro. The highest peaks of the mountain are Batian (5,199 m or 17,057 ft), Nelion (5,188 m or 17,021 ft), and Point Lenana (4,985 m or 16,355 ft). Its ragged series of peaks are crowned with snow, and its slopes are thick with forest. The highest peaks (Batian and Nelion) requires a difficult technical climb as the snow and ice peaks on the mountain have been retreating in recent years, making these climbs increasingly difficult and dangerous. It takes 3 to 7 days to trek to the peaks through thick forests, wildlife, and equatorial snow. The eight climbing routes, some of which are wild, underdeveloped, and unmarked, are characterized by an uneven terrain with several steep hills and deep valleys, loose rocky surfaces, several alpine lakes and rivers (see Image 1 (n.d.) and Image 2 (n.d.)), and rapidly changing weather conditions that present several risks to climbers. The mountain attracts about 16,000 climbers annually. The other natural outdoor adventure venues such as wilderness adventure and wildlife parks, forests, mountain ranges, camping venues, rivers, and lakes are natural facilities that are home to various activities like hiking, mountaineering, camping, team building, sports, games, physical fitness programs, camp craft, rock climbing, map reading and navigation, and solitude, among many others.

### *Target Population*

The study targeted outdoor adventure practitioners in the following designations: outdoor adventure facilitators and teachers, team-building instructors, porters, guides, and organizations’ decision makers such as program supervisor/department head, board of directors/trustees, and management. In addition, the study contacted other key informants such as emergency services doctors who handle patients at the mountains, and park rescue rangers. These practitioners were useful to provide eyewitness accounts and evidence of occurrences of injury and illness in the outdoor adventure

practice. They gave a picture of the circumstances surrounding such occurrences and important new information that is rarely recorded or documented.

The study excluded practitioners who had worked in outdoor and adventure programs for less than 6 months. It also excluded those who had been out of service and had not handled outdoor adventure activities for over 10 years. The study also excluded those that were involved in the pre-testing exercise.

### Sample Size and Sampling Procedures

The study used a snowballing approach to identify the respondents. This sampling procedure was suitable to select respondents from all groups and designations of respondents since there are no records or documentation indicating the population size or specific location of the outdoor adventure practitioners in the regions.

The primary sampling frame entailed identifying all groups, companies, and outfits that host or run outdoor adventure programs as well as freelancers. The secondary sampling frame entailed recruitment of the practitioners. To maximize variability, interest groups were first stratified into the various designations and the types of outdoor activities they handle. The target population list was generated over time using the snowballing approach and those who met the inclusion criteria were contacted. Informed consent forms were issued and only those who consented were recruited for the study. The study recruited a total of 136 participants, as presented in Table 1, to respond to the questionnaire. A subsample of 52 participants was also involved in the focus group discussions. The study identified and recruited five key informants consisting of three long-serving outdoor instructors/guides, a rescue ranger, and a long-serving porter.

### Data Collection

A self-administered questionnaire was used for data collection. The questionnaire was constructed and validated by the study team during the pilot testing exercise. After

Table 1  
Sample for focus group discussions ( $n = 52$ ).

Designation/responsibility	Total sample	Subsample
Teacher	5 (3.7)	5
Outdoor adventure facilitator	24 (17.6)	6
Team-building instructor	2 (1.5)	2
Guide and porter	33 (24.3)	11
Director/trustee	1 (0.7)	1
Institution management	2 (1.5)	2
Parks and forests authority	45 (33.1)	15
HOD/program supervisor	3 (2.2)	3
Any other (driver)	3 (2.2)	1
Manager	18 (13.2)	6
Total	136	52

consent was obtained, respondents were given instructions on how to complete and return the questionnaire. Questionnaires were then distributed and collected upon completion at the various outdoor adventure venues. Respondents were required to give a detailed account of the types and nature of injuries and illnesses that they had encountered during practice. They were to also indicate the causes and circumstances leading the occurrence of these and the type of activity in which the sufferer was engaged at the time of the incident.

Focus group discussions were conducted for park officials, porters, guides, and outdoor instructors and facilitators. These discussions were meant to collect additional information to complement the questionnaire data. Such information also included description of near-miss incidences, non-medical incidences, extreme weather and environmental factors such as flash floods and lightning strikes, animal attacks, and/or any other unforeseen incidences that pose danger to the participants. The study used specific guides for the various types of focus groups. The discussions were based on their experiences and encounters with outdoor adventure injuries, illnesses, emergency aid, and documentation. All conversations were recorded.

Interview guides were used to guide discussions with the key informants. The identified key informants were contacted and meetings scheduled at suitable locations convenient to the respondents. All conversations were recorded with the full knowledge and permission of the informants. All recorded data were later transcribed for data analysis. Records/documentation of these incidences were also available (where applicable) for further analysis where extrapolation of additional information such as sex, age, pre-existing medical conditions of the victims, and evacuation profile was sought.

A desk review was also conducted to review records and documents from key institutions in Kenya. The researchers collected documents such as incident report records as reported by the practitioners in the event of incidents involving injuries and illnesses and patient evacuation. Analysis of the data provided information on patient profiles, nature and types of injuries and illnesses, activity involved in, and the location at the point injury or illness.

### Statistical Analysis

Focus group discussions and interviews of key informants were recorded. The audio record files were compiled and deposited into the researchers' laptops. The data entry staff transcribed the qualitative data by listening to the conversations and handwriting the recordings word by word (text verbatim). The typed raw qualitative data were thereafter transferred to qualitative data analysis software and organized according to various themes. The data were then analyzed and results transferred to a Word document.

Both qualitative and quantitative data were cleaned in preparation for entry. A coding frame was developed following themes of the study to analyze the qualitative data, while an entry platform using the Statistical Package for Social Sciences (SPSS version 24) (Laerd Statistics, 2016) was prepared for the quantitative data. To analyze quantitative data, descriptive statistics were applied and results presented in frequencies and percentages in tables and figures.

A descriptive analysis was conducted on the data collected in the desk review of incident records and results on injuries and illnesses and evacuation profiles presented in frequencies and percentages. A multinomial logistic regression was performed to assess the influence of sex, age, and the location/altitude of the occurrence on the type of the injury/illness presented.

## Results

### Participant Characteristics

Table 2 presents the social demographic characteristics of the 136 participants who completed the questionnaires. Most (39.76%) of the participants were in the age category

of 30–39 years, with the majority (91.1%) being males. Of the sample, 44.1% had worked for six years and fewer and the majority (55.9%) had worked for seven years and more in the outdoor adventure practice. The respondents were of various work designations: 19.9% were outdoor adventure facilitators and team building instructors, 26.5% were porters and guides, while 36.8% were park and forest authorities. Half of the respondents (50.7%) had up to secondary school education while 49.2% had college/university education up to postgraduate degree level.

### Outdoor Adventure Activities and Injury Occurrence

Reported incidences encountered during outdoor and adventure activities indicate that the majority of injuries and illnesses occur during mountaineering (39%) and hiking and navigation (25.7%) events. A few incidences were reported in camping and team-building activities, rock climbing, and challenge courses. No injuries were reported in air-based activities such as bungee jumping and sky diving. Table 3 indicates that mountaineering is a high-risk activity with a high rate of injuries and illnesses compared to all other activities.

Table 2  
Characteristics of respondents.

Characteristics		Total = 136 (100) F (%)
Age of respondent (years)	Below 30	31 (22.8)
	30–39	54 (39.7)
	40–49	39 (28.7)
	50–59	12 (8.8)
Gender	Male	125 (91.9)
	Female	11 (8.1)
Years of working experience	Below 2	23 (16.9)
	2–6	37 (27.2)
	7–11	24 (17.6)
	12–16	25 (18.4)
	Above 16	27 (19.9)
Designation/responsibility	Teacher	5 (3.7)
	Outdoor adventure facilitator	24 (17.6)
	Team-building instructor	2 (1.5)
	Guide and porter	33 (24.3)
	Director/trustee	1 (0.7)
	Institution management	2 (1.5)
	Parks and forests authority	45 (33.1)
	HOD/program supervisor	3 (2.2)
	Any other (driver)	3 (2.2)
	Manager	18 (13.2)
Highest education level	No formal education	1 (0.7)
	Primary school	14 (10.3)
	Completed primary school	20 (14.7)
	Completed secondary school	34 (25.0)
	Completed college certificate/diploma	20 (14.7)
	Completed bachelor degree	35 (25.7)
	Completed postgraduate degree	12 (8.8)

Table 3  
Reported injuries according to outdoor adventure activities.

Activity	F	%
Camping and team building	7	5.1
Mountaineering	53	39
Hiking and navigation	35	25.7
Air-based such as bungee jumping	0	0
Water-based in rivers, pools, swamps, and ponds	3	2.2
Rock climbing	6	4.4
Challenge courses	4	2.9

Table 4  
Responses of injuries and illness occurrences.

Type of injury	F	%
Fractures	41	30
Mountain sicknesses	34	25
Blisters	17	12.5
Cuts and wounds	20	14.7
Head, neck, and spinal injuries	5	3.7
Sprains and dislocations	17	12.5
Chocking	0	0
Bites and stings	3	2.2
Allergies	2	1.5
Nose bleeding	2	1.5
Burns from fire, hot water	3	2.2
Headache	5	3.7
Snow and cold conditions	8	5.9
Sunburn to the skin	2	1.5
Drowning	2	1.5
Food poisoning	2	1.5
Muscle strains and pulls	12	8.8

### *Injury/Illness Type*

Table 4 presents the questionnaire-reported incidences of injuries and illnesses. The most frequently reported conditions were mountain sickness (25%) and musculoskeletal injuries consisting of fractures (30%), cuts and wounds (14.7%), blisters (12.5%), sprains and dislocations (12.5%), and muscle strains and pulls (8.8%). Least frequent conditions were allergies, nose bleeding, sunburn, drowning cases, and food poisoning. There was no reported incidence of choking.

In the focus group discussions, practitioners explained that apart from trauma-related injuries and altitude sickness, there were many incidences of hypothermia and frostbite in the mountain regions, blisters, snake bites during camping and hiking events, and lightning strikes. The discussion groups concluded that instructors should be ready to deal with these conditions.

### *Evacuation Profile of Incidences on Mt. Kenya According to Injury Type*

This study involved a retrospective analysis of the documented incidences in mountaineering reported on Mt. Kenya (1996–2018). The analysis only focused on

serious incidences that led to evacuation of a patient from the mountain and of which the patient survived. An account of those that did not survive is described elsewhere. These were incidences when participants or instructors had to leave the field before the end of the course/trip to seek medical care or were no longer able to participate on the course due to an injury or illness.

There were 128 reported incidences of patients (89 males and 39 females) who were evacuated and survived on Mt. Kenya from 1996 to 2018. Out of these, 95 were due to mountain sickness which was described using varying terms and symptoms. About 50 were simply reported as acute mountain sickness (AMS), 18 cases were reported as high-altitude pulmonary edema (HAPE), 2 as high-altitude cerebral edema (HACE), 6 as severe altitude sickness, and 4 as early/mild altitude sickness. The rest (15) were recorded simply by combinations of signs and symptoms of AMS, HAPE, or HACE. Reported symptoms of mountain sickness included headache and dizziness (17), breathing difficulty and chest pains (14), nausea, vomiting, and lack of appetite (11), and body weakness and fatigue (4). Overall, there were 24 incidences reported at the Shiptons camp (13,898 ft) all of which were due to mountain sickness. About 20 of 28 incidences at Old Mosses camp (11,155 ft), 19 of the 20 incidences at Mackinders camp (13,780 ft), 6 of the 7 incidences at Met station (10,007 ft), 4 of the 6 incidences at Austrian Hut (15,715 ft), and all incidences at Lunch Point and Teleki valley (13,800 ft) were also due to mountain sickness.

There were 10 reported incidences of falls at the peaks, 9 of which were cliff/glacier falls. Four of these 10 falls occurred at Lewis Glacier (17,021 ft), 3 at point Lenana (16,355 ft), 1 at point Nellion (17,021ft) and another at Harris Turn. These falls caused severe injuries that included head injuries, back, pelvic, and leg injuries, as well as unconsciousness. The other case of a fall was as a result of sliding on a gravel path leading to a dislocated ankle. Falls while climbing such as in rock climbing also represent one of the more common causes of serious injury, although acute and chronic musculoskeletal injuries of the hands and extremities are also frequent afflictions.

Other reported conditions included stomach problems and discomfort (5), neck and spinal injuries (4), hypothermia (4), blisters and foot injuries (4), lethargy and body weakness (4), ankle sprains (3), asthmatic attacks (3), knee injuries (3), unconsciousness (2), and a shoulder dislocation. There was an incident of rocks falling on climbers where one climber became injured and was evacuated. There was also an incidence of a motor vehicle rolling down on the mountain seriously injuring a guide who was on transit.

### *Predicting Factors to the Type of Injury/Illness*

To ascertain the influence of sex, age, and the location/altitude of the occurrence on the type of injury/illness

Table 5  
Predictors of injury and illness occurrences.

Predictor	$\chi^2$	df	<i>P</i>
Age	1.174	2	0.556
Gender	0.056	2	0.972
Location/altitude	37.421	6	0.000

presented, a multinomial logistic regression was performed. It was established that the full model had better statistically significant prediction of the dependent variable than an intercept-only model ( $P < 0.001$ ). Adding all the predictors to the model significantly predicted the dependent variable ( $\chi^2 (10, n = 128) = 63.32, P < 0.001$ ), the combined effect of which accounted for considerable variance among participants ( $R^2 = 0.39$ ). This means that all these factors of age and sex of the climbers together with the location on the mountain are predictors of the occurrence and the type of injury/illness on the mountain. Combined being older and female and with increase in altitude reached are notable risk factors for injury/illness on the mountain.

However, it was further established that when looking at these factors independently, unique statistically significant influence on the model only existed for altitude ( $P < 0.001$ ). Only altitude significantly contributes to the model (Table 5). This means that regardless of the climbers' age or sex, the type of injury/illness presented and severity to warrant evacuation is only dependent on the altitude reached (the higher one goes the higher the risks).

#### Near-Miss Incidences

The study also investigated near-miss, or close-call incidences in the outdoor adventure practice. These were any dangerous situation where the danger was missed by a small margin but did not result in injury at that particular time. Key informants and focus group discussion participants reported incidences of falls and near falls or slips and rock fall or rolling-rock events. There were also situations where people got lost for an extended period thus endangering their physical and psychological wellbeing. Incidences of flash floods or unplanned or unanticipated swim while river crossing with close-call water incidences were reported as well as numerous encounters with animals in the camp vicinity and aggressive encounters with wildlife.

#### Non-Medical Incidences

The study sought to investigate non-medical conditions and behavior during outdoor and adventure events that are likely to predispose clients to danger of injuries and illnesses. Key informants and focus group discussion participants reported that there were incidences of drug and alcohol use, verbal and physical confrontation and fights, and irresponsible sexual behavior. Symptoms of

anxiety, disorientation, emotional distress, and physiological limitations that alter or impair performance that may lead to injuries and illnesses were also noted. There were reports that guides and porters sometimes reported to duty intoxicated with alcohol and some participants sneaked in drugs and alcohol in programs. Cases of psychological and emotional distress were associated with high-altitude symptoms and inadequate acclimatization.

#### Discussion

The study found that occurrences of injuries and illnesses are not well recorded or documented in a structured database impairing necessary in-depth analysis of incident rates. Practitioners should keep records of all incidences and employ proper documentation practices important for further risk assessments and enhancement of risk management strategies.

Results indicate that the majority of injuries and illnesses occur during mountaineering and hiking and navigation events. A few incidences were reported in camping and team-building activities, rock climbing, and challenge courses. Mountaineering may include hiking, expeditions, and mixed and alpine climbing. All these activities present different physiological demands and involve different risks—from altitude-induced illnesses (beginning from around 2500 m) to diagnosing and managing all medical problems in the wilderness (American Alpine Club, 2006; Hearn et al., 2006; Largiader & Oelz, 1993; McIntosh et al., 2008; Paige et al., 1998; Smith, 2006). Rock and ice climbing are widely considered to be “high-risk” sporting activities that are associated with a high incidence of severe injury and even death (Schöffl et al., 2010). Depending on the specific type of climbing examined, a climber's experience and skills, grade of route difficulty, equipment, climbing surface (type of rock or ice, artificial indoor wall, scree), remoteness of location, altitude, and weather will implicate different levels of risk. In our study, no injuries were reported in air-based activities such as bungee jumping and sky diving. The possibility of serious injury or death associated with air activities has attracted very high standards of risk management in such programs. The strict pre-activity preparation, precautions employed, pre-activity briefing, and consent signing exercise indicate strict preventive measures compared to the practice in other outdoor adventure activities. This might be the reason for the low incidence of injuries in air-based activities.

Despite the obvious dangers inherent in climbing and the altitude-related illness experienced by nearly all who spend significant time in the mountains, people continue to seek the remoteness and pleasures of high places (Kale & Anholm, 2015). In our results, practitioners report that 7 out of 10 climbers on Mt. Kenya suffer from acute altitude sickness. More than one quarter of all reported cases in our study was due to acute mountain sickness.

Experiencing some discomfort is normal at altitude, but symptoms may worsen to become illness. Results indicate numerous cases of AMS followed by HAPE and HACE. Many other cases were recorded with symptoms that clearly point to HAPE or HACE but not specifically stated as so by the reporting authority. These symptoms include headache and dizziness, breathing difficulty and chest pains, nausea, vomiting and lack of appetite, and body weakness and fatigue. Although some experience only minor inconvenience, for others, the symptoms are incapacitating. Due to the often witnessed quick ascent and poor acclimatization, these individuals frequently experience acute illness soon after ascent. There is quick ascension on some routes made possible by the option of driving from the base camp to 10,000 ft; hence climbers are usually not well acclimatized to high altitude and are highly susceptible to altitude sickness. Literature shows that travel to elevations above 2,500 m is associated with risk of developing one or more forms of acute altitude illness (Luks et al., 2010). Contributing factors include living at lower altitudes, rapid ascent, altitude attained, duration of exposure to altitude, higher sleeping altitude, exertion, possible genetic predisposition, and previous history of altitude illness (Kale & Anholm, 2015). With the high prevalence of AMS, strategies to prevent its onset are vital. This may include adherence to the set ascent rates and regulations, climbers' education, continuous training of practitioners, as well as pre-hospital emergency care and risk management. More studies need to be conducted on Mt. Kenya to further investigate the incidence and predictors of AMS among trekkers on Mt. Kenya in order to adequately inform practice and mitigate health concerns.

Other studies have sought to investigate AMS at various mountain adventure destinations. On the neighboring Mt. Kilimanjaro, a study by Jackson et al. (2010) on incidence and predictors of AMS among trekkers on Mt. Kilimanjaro reported that incidences ranged between 47 and 75%. Findings by Davies et al. (2009) on determinants of summiting success and AMS on Mt. Kilimanjaro established that there was a high incidence of AMS on Mt. Kilimanjaro. The incidence of AMS for all trekkers was 77%, which is among the highest incidence rates of any trekking location in the world. In addition, only 61% of trekkers reached the summit (5,895 m). Various studies (Basnyat & Litch, 1997; Hackett et al., 1976; Hillenbrand et al., 2006; Kale & Anholm, 2015) have been conducted on other mountain destinations of various altitudes and generally confirm the conclusion that AMS is related to the rate of ascent and the altitude reached. Some studies have shown that individuals with a lower vital capacity and lower hypoxic ventilatory response are more likely to experience altitude illness (Kale & Anholm, 2015).

Musculoskeletal injuries that include athletic and soft-tissue injuries continue to be reported in outdoor and adventure practice. The study results indicate that the

majority of reported cases entailed musculoskeletal injuries such as fractures, cuts and wounds, sprains and dislocations, muscle strains and pulls, and blisters. The nature of outdoor adventure activities attracts a lot of acute trauma-related injuries, hence the numerous reported cases of musculoskeletal injuries. Some of the routes taken on Mt. Kenya have natural/wild mountain treacherous terrains where participants are constantly faced with challenges in maneuvering, crossing obstacles and water bodies, as well as engaging in technical climbs of rocks and alpine peaks. There are also cases of animal attacks. These factors predispose the participants to acute injuries especially among the less physically fit and inexperienced climbers. With the high prevalence of athletic injuries, strategies to prevent their occurrence are vital. Programs need to address this by employing safety procedures and guidelines, providing fitness information to participants as part of their enrollment information, striving to reduce pack weights, carefully planning course routes, emphasizing warming-up and stretching before hiking and strenuous activities, and deliberately teaching participants how to hike on rugged and uneven terrain. Eliminating the physical challenge is impossible in natural wilderness settings and would fundamentally alter the activity, the outcome, and the mission. On an active expedition, a sufficient amount of rest to heal an athletic injury is rarely possible. In addition, the discomfort of any medical problem is amplified in the wilderness. Patient tolerance for adversity is an important factor in the decision to remain in the field or evacuate. Even though athletic injuries themselves are not frequently serious, they continue to be a significant source of logistical challenges and lost course time. It was also reported that wounds are common on wilderness courses and can be challenging to care for on prolonged expeditions. Most wounds do not warrant evacuation and therefore must be protected and kept clean under potentially unhygienic conditions.

Our study also found a few reports of gastrointestinal infections and reactions. Similarly, a retrospective study (Kale & Anholm, 2015) of injuries and illnesses in NOLS programs also reported that most common illnesses recorded were gastrointestinal symptoms such as nausea, vomiting, and diarrhea (26.4%) and all flu-like illness, including flu symptoms and respiratory symptoms (16.6%). Gastrointestinal illnesses continue to be a health concern in wilderness settings. Focus group discussion respondents reported that climbers are fond of drinking water from the open ponds on Mt. Kenya which appear very clean and clear yet often contain animal wastes. Strict handwashing techniques, drinking water disinfection, proper disposal of human waste, and washing of common cooking utensils are the primary methods to decrease incidents of nonspecific gastrointestinal illnesses.

Other recorded injuries and illnesses on Mt. Kenya included cliff/glacier falls leading to severe head injuries, back, pelvic, and leg injuries, as well as unconsciousness

and falls as a result of sliding on a gravel path leading to dislocated ankles as well as falls while climbing such as in rock climbing. Stomach problems and discomfort, neck and spinal injuries, hypothermia, blisters and foot injuries, lethargy and body weakness, ankle sprains, asthmatic attacks, knee injuries, unconsciousness, and shoulder dislocations were also recorded as cases that were serious enough to warrant evacuation on Mt. Kenya. Harsh mountain weather, high altitude, environmental hazards, pollutants and hygiene, physical demands of climbing Mt. Kenya, psychological distress, and poor nutrition were reported as possible predictors of such illnesses and injuries in outdoor adventure practice on Mt. Kenya. Interviewed practitioners also expressed concerns over rising cases of hypothermia and frostbite in the mountain regions, blisters, and snake bites during camping and hiking events. The discussion groups concluded that instructors should be well trained and ready to deal with these conditions. Proper preparation for cold weather is imperative to prevent frostbite and hypothermia. It is also advised that wearing of appropriate protective clothing can provide some level of protection against snakebites in addition to not provoking snakes in the first place. Barker et al. (2010) have also noted that pre-hospital snakebite management should include removal of constrictive items, pressure immobilization, basic life support, pain control (paracetamol), and hydration (water only).

Outdoor practitioners in Kenya reported numerous lightning strikes during outdoor activities and that they did not have lightning safety education and procedures for their programs. This is a concern, considering that this is a high-risk zone and programs happen in the outdoor environment, thus lightning is a potential danger. In general, lightning strikes occur in the afternoon and so appropriate planning of trips in lightning-prone zones should consider this. It should also be noted that since death following a lightning strike is most often due to cardiopulmonary arrest, there is need for outdoor adventure practitioners to be able to initiate and perform effective cardiopulmonary resuscitation for a victim who is pulseless (Cooper et al., 2016).

Occurrences of injuries and illnesses are common worldwide with various accounts documented by institutions that offer outdoor adventure programs. For instance, a NOLS report (Leemon & Schimelpfenig, 2003) on incidences recorded from 1998 to 2002 indicated that athletic injuries accounted for 50% of all injuries, and soft-tissue injuries accounted for 30%. Athletic injuries were most often sprains and strains of knees (35%), ankles (30%), and backs (13%). Falls and slips around camp or while hiking were the leading contributing factors. Another NOLS course retrospective descriptive study (Kale & Anholm, 2015) examining incidences from 2002 to 2005 also found that athletic injuries (sprains, strains) and gastrointestinal illnesses were the most common medical incidents. Hypothermia, seizures, appendicitis, heatstroke, and pregnancy

complications occurred but with low frequency. Fractures, dental emergencies, tick fever, athletic injuries, and non-specific body pains were the conditions most frequently requiring evacuation. Many other studies conducted worldwide have provided information on injuries and illnesses encountered during expeditions (Mort & Godden, 2011) and summarized evidence on occurrence of injuries in mountaineering events and venues (McIntosh et al., 2012; Neuhofer et al., 2011; Platts-Mills & Hunold, 2013; Schöffl et al., 2010; Stanford et al. 2017) and analyzed high-altitude illnesses (American Alpine Club, 2006; Hearn et al., 2006; Largiader & Oelz, 1993; McIntosh et al., 2008; Paige et al., 1998; Smith, 2006). All these studies agree that there is high prevalence of injuries and illnesses in outdoor adventure pursuits which should be monitored periodically and mitigated.

Evacuations occur when participants or instructors must leave the field before the end of a course/trip. Most patients (evacuees) leave the field under their own power or are assisted. However, medical evacuations generally suggest that a person's condition warranted more sophisticated medical care or that the condition could not allow continued participation in the course. Cases warranting evacuation could be very serious and require urgent medical attention. Most evacuations due to illness or injury on Mt. Kenya were at Old Mosses camp (11,155 ft), followed by Shiptons camp (13,898 ft), Mackinders camp (13,780 ft), Met station (10,007 ft), Austrian Hut (15,715 ft), Lunch Point, and Teleki valley (13,800 ft) in that order. Several other evacuations due to falls occurred at Lewis Glacier (17,021 ft), point Lenana (16,355 ft), point Nellion (17,021 ft), and Harris Turn in that order. Understanding the evacuation profile of patients and the nature and severity of injuries and illnesses at specific locations on mountains or adventure venues provides practitioners with vital information. Some mountains in the world that have high volumes of visitors and climbers have identified "black spots" with high risk of illness and injuries. Climbers, guides, and instructors are advised to be more cautious, observant, and ready for any eventualities. This knowledge sensitizes them to incorporate caution, better risk management plans, and deliver the best care at such locations.

It was established that combined age, sex, and altitude reached were strong predictors of type of injury/illness presented and their severity to warrant evacuation. However, the altitude reached was the sole risk factor that significantly predisposed climbers to injury/illnesses that warrant evacuation. Caution and mitigating strategies should be employed with focus on the identified mountain "hot spots" from 13,000 ft and above (especially at Shiptons camp (13,898 ft), Mackinders camp (13,780 ft), and Austrian Hut (15,715 ft)). In addition, falls leading to serious injuries requiring evacuation of climbers are likely to take place mainly at the peaks especially in locations that require technical climbing maneuvers. Climbers and practitioners should bear this in mind and prepare accordingly.

The study also investigated near-miss, or “close-call” incidences in the outdoor adventure practice. These were any dangerous situation in which injury was missed by a small margin. Key informants and focus group discussion participants reported numerous incidences of falls and near falls or slips, rock falls, or rolling-rock events. They reported people getting lost for an extended period, hence endangering the physical and psychological well-being of the “lost” person. There were incidences of flash floods or unanticipated entry into the water representing close-call water incidences. There were also several encounters with animals in the camp vicinity and aggressive encounters with wildlife. All these are potential risks for injuries and illnesses. A near-miss or close-call incident is a dangerous situation where safety was compromised or was completely unforeseen. There are more close calls and near misses than there are actual accidents. If we only analyze accidents, we may be leaving out important safety issues unresolved. Near-miss incidents are important predictors of future incidents. It is important to report near-miss incidents to open discussion and analysis by instructors and managers. The discourse will enlighten others and lead to better risk management in the long term. The analysis of this information also helps in formulating risk management plans and prevents similar incidents from happening again (Mountain Safety Council, 2018).

The study also investigated non-medical conditions and behavior that are likely to predispose clients to danger of injuries and illnesses during outdoor and adventure events. Key informants and focus group discussion participants reported that there were incidences of drug and alcohol use, verbal and physical confrontation, and irresponsible sexual behavior. Also noted were symptoms of anxiety, emotional distress, and physiological limitations. The most worrying incidents reported concerned intoxicated guides and porters on duty and participants bringing drugs and alcohol during programs. The cases of psychological and emotional distress were associated with high-altitude symptoms and inadequate acclimatization. Risky verbal and physical behavior such as physical confrontation and fights, use of drugs and alcohol before or during the adventure program, or irresponsible sexual behaviors are significant factors that could present emotional or physical risks to other participants or instructors. These present psychological distress and physiological limitations that alter or impair performance and lead to injuries and illnesses are recognized negative impacts of behaviors. Measures should be taken to identify, prevent, intervene, and control such factors and behavior as and when they occur.

## Conclusions

This study concludes that the majority of injuries and illnesses occur during hiking, mountaineering, and navigation events. Acute mountain sickness has the highest

prevalence in Kenya, while musculoskeletal injuries have the highest prevalence among injuries. Institutions should be encouraged to establish proper documentation of information about incidences and injuries common to the various activities. This will allow providers to gauge potential dangers and to incorporate better risk-management plans for better delivery of medical care. During pre-participation screening, providers should include a dimension for educating the participants about the physical and environmental conditions that could increase the chances of or make them more vulnerable to injuries and illness. Ideally, this will decrease the incidence of morbidity during outdoor and adventure activities. In addition, it is imperative for organizations and interested parties to collect and share information about incidents or near-miss events that occur in their respective outdoor events. Such information will be a valuable learning experience for the outdoor community, and inform risk management policies and practices towards improving standards in service delivery in the spectrum of outdoor adventure.

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## References

- American Alpine Club. (2006). Accidents in North American mountaineering. *American Alpine Club*, 9(1), 59.
- Barker, S., Charlton, N. P., & Holstege, C. P. (2010). Accuracy of internet recommendations for prehospital care of venomous snake bites. *Wilderness & Environmental Medicine*, 21(4), 298–302.
- Basnyat, B., & Litch, J. (1997). Medical problems of porters and trekkers in the Nepal Himalaya. *Wilderness & Environmental Medicine*, 8, 78–81.
- Burtscher, M., & Koch, R. (2016). Effects of pre-acclimatization applying the “climb high and sleep low” maxim: An example of rapid but safe ascent to extreme altitude. *Journal of Human Performance in Extreme Environments*, 12(2), Article 2. DOI: 10.7771/12327-2937.1081
- Cooper, A. M., Andrews, C. J., Holle, R. L., Blumenthal, R., & Aldana, N. N. (2016). *Lightning related injuries and safety*. Retrieved from [https://www.researchgate.net/publication/309487275\\_Lightning\\_injuries](https://www.researchgate.net/publication/309487275_Lightning_injuries)
- Davies, A. J., Kalson, N. S., Stokes, S., Earl, M. D., Whitehead, A. G., Frost, H.,... Naylor, J. (2009). Determinants of summiting success and acute mountain sickness on Mt Kilimanjaro (5895 m). *Wilderness & Environmental Medicine*, 20(4), 311–317.
- Ewart, A. (1989). *Outdoor adventure pursuits: Foundations, models, and theories*. Columbus, OH: Publishing Horizons.
- Goode, N., Finch, C., Cassel, E., Lennie, M., & Salmon, P. (2014). What would you like? Identifying the required characteristics of an industry-wide incident reporting and learning system for the led outdoor activity sector. *Australian Journal of Outdoor Education*, 17(2), 2–15.
- Hackett, P., Rennie, D., & Levine, H. (1976). The incidence, importance, and prophylaxis of acute mountain sickness. *Lancet*, 27, 1149–1155.

- Hearn, S. T., Fraser, M. H., & Allan, D. B. (2006). Spinal injuries in Scottish mountaineers. *Wilderness & Environmental Medicine, 17*(3), 191–194.
- Hillenbrand, P., Pahari, A., & Soon, Y. (2006). Prevention of acute mountain sickness by acetazolamide in Nepali porters: A double-blind controlled trial. *Wilderness & Environmental Medicine, 17*, 87–93.
- Image 1. (n.d.). Mt. Kenya, <https://images.app.goo.gl/tFcxL84Aa1e3PhUT8>. Retrieved from <https://www.busiweek.com/kenya-government-urged-to-market-mt-kenya-region-for-tourism/>
- Image 2. (n.d.). jipe82, <https://i.pinimg.com/originals/bc/48/9f/bc489f32564babd28660be6f4c4fcfb5.jpg>. Retrieved from <https://visitheworld.tumblr.com/post/22603977176/small-waterfalls-on-the-way-to-the-top-of-mount>
- Iseron, K. V. (2013). Medical planning for extended remote expeditions. *Wilderness & Environmental Medicine, 24*(4), 366–377.
- Jackson, S., Varley, J., & Sellers, C. (2010). Incidence and predictors of acute mountain sickness among trekkers on Mount Kilimanjaro. *High Altitude Medicine & Biology, 11*, 217–222.
- Kale, R. M., & Anholm J. D. (2015). *Altitude-related disorders*. Retrieved from <https://emedicine.medscape.com/article/303571-overview#showall>
- Laerd Statistics. (2016). Somers' d using SPSS Statistics. *Statistical tutorials and software guides*. Retrieved from <https://statistics.laerd.com/>
- Largiadler, U., & Oelz, O. (1993). Analysis of overstrain injuries in rock climbing. *Schweizerische Zeitschrift für Sportmedizin, 41*(3), 107–114.
- Leemon, D., & Schimelpfenig, T. (2003). Wilderness injury, illness, and evacuation: National Outdoor Leadership School's incident profiles, 1999–2002. *Wilderness & Environmental Medicine, 14*, 174–182.
- Luks, A. M., McIntosh, S. E., & Grisson, C. K. (2010). Wilderness medical society consensus guidelines for the prevention and treatment of acute altitude illness. *Wilderness & Environmental Medicine, 2*(21), 146–155.
- McIntosh, S. E., Campbell, A. D., & Dow, J. (2008). Mountaineering fatalities on Denali. *High Altitude Medicine & Biology, 9*(1), 89–95.
- McIntosh, S. E., Campbell, A., Weber, D., Dow, J., Joy, E., & Grisson, C. K. (2012). Mountaineering medical events and trauma on Denali, 1992–2011. *High Altitude Medicine & Biology, 13*(4), 275–280.
- McIntosh, S. E., Leemon, D., Visitacion, J., Schimelpfenig, T., & Fosnocht, D. (2007). Medical incidents and evacuations on wilderness expeditions. *Wilderness & Environmental Medicine, 18*(4), 298–304.
- Mort, A., & Godden, D. (2011). Injuries to individuals participating in mountain and wilderness sports: A review. *Clinical Journal of Sport Medicine, 21*(6), 530–536.
- Mountain Safety Council. (2018). *New Zealand National Incident Database (NID)*. Retrieved from <https://www.incidentreport.org.nz/>
- Musa, G., & Thirumoorathi, T. (2015). Health and safety issues in mountaineering tourism. In *Mountaineering tourism* (pp., 320–338). Routledge.
- Neuhof, A., Hennig, F. F., Schöffl, I., & Schöffl, V. (2011). Injury risk evaluation in sport climbing. *International Journal of Sports Medicine, 32*(10), 794–800.
- Paige, T., Fiore, D., & Houston, D. (1998). Injury in traditional and sport rock climbing. *Wilderness & Environmental Medicine, 9*(1), 2–7.
- Platts-Mills, T. F., & Hunold, K. M. (2013). Increase in older adults reporting mountaineering-related injury or illness in the United States, 1973–2010. *Wilderness & Environmental Medicine, 24*(1), 86–88.
- Schöffl, V., Morrison, A., Schwarz, U., Schöffl, I., & Küpper, T. (2010). Evaluation of injury and fatality risk in rock and ice climbing. *Sports Medicine, 40*(8), 657–679.
- Smith, L. (2006). Alpine climbing: Injuries and illness. *Physical Medicine and Rehabilitation Clinics of North America, 17*(3), 633–644.
- Stanford, K. A., Phillips, L., Chang, Y., Leemon, D., Schimelpfenig, T., & Harris, N. S. (2017). Trends in skin and soft tissue-related injuries in NOLS wilderness expeditions from 1984 to 2012. *Wilderness & Environmental Medicine, 28*(4), 307–312.
- UNESCO. (2016). *World Heritage List*. Retrieved from [whc.unesco.org/en/list](http://whc.unesco.org/en/list)
- Walle, A. (1997). Pursuing risk or insight marketing adventures. *Annals of Tourism Research, 24*(2), 265–282. doi:10.1016/s0160-7383(97)80001-1