Risk management in suburban forest recreation areas: A retrospective analysis of illness cases

Jittakon Ramanpong[a], Chia-Pin Yu[a,b,*], Po-Neng Chiang[c], Ming-Jer Tsai[a,c]

[a] School of Forestry and Resource Conservation, National Taiwan University, Taipei, Taiwan
[b] T.H. Chan School of Public Health, Harvard University, Boston, MA, USA
[c] The Experimental Forest, College of Bioresources and Agriculture, National Taiwan University, Nantou, Taiwan,

ARTICLE INFO

ABSTRACT

Participating in forest recreation activities sometimes involves risks that result in illnesses and/or injuries. One important risk factor is participants' preexisting medical conditions, which may lead to illness incidents. Little has been studied about the relationship between participants' illnesses and their preexisting medical conditions, and, from a risk management perspective, that is crucial information with which to identify vulnerable groups for preventing incidents. Finding answers can help the site managers of Xitou Nature Education Area (XNEA) in Taiwan (R.O.C.) in risk management planning. Therefore, we retrospectively analyzed emergency medical service records between July 2012 and June 2018 that included each patient's age, sex, date, time, preexisting health conditions, and illness contracted. Of the 276 patients assessed, 56.2% were female. More than half (55.4%) had preexisting medical conditions. The most common symptom was dizziness (47.8%). Most health-related events occurred in the morning and during summer months. Elderly visitors (≥ 60 years) were the most vulnerable to illness. More men than women encountered syncope. Participants with high blood pressure had a higher risk of dizziness, respiratory problems, and syncope. Individuals with diabetes were vulnerable to weakness. Visitors with cardiac-related problems were likely to have chest pain or tightness in their chest. Preexisting medical conditions constitute an inherent risk in visitors, and this association with the occurrence of illness during forest recreation confirmed higher risks in specific patient groups. This epidemiological study describes the characteristics of illnesses and identifies the at-risk groups to facilitate future risk management planning for forest recreation in XNEA.

1. Introduction

Forest recreation is continuously gaining attention with a growing number of tourists (Gstaettner et al., 2019). Literature highlights engaging in outdoor recreation has a variety of benefits on health and wellbeing, such as improvement in self-esteem, as well as mental, physical and social functioning (Hartig et al., 2014; Kaplan, 1995; Korpela et al., 2017; Plummer, 2005; Swarbrick et al., 2004). Nevertheless, exploring nature and wilderness areas inevitably entails risks that may threaten health and safety (Kuenzi and McNeely, 2008). Managing risk to ensure visitor health and safety is considered an obligation of all outdoor recreation and tourism sites (Keirle, 2002; Spengler and Hronek, 2011). This is a complicated process because risk involves the complex interrelationships between humans and between humans and nature (Brown, 1998; Rayner, 1987). Researchers have proposed many risk management models in order to maintain the safety

of visitors (Brown, 1998; Spengler and Hronek, 2011). One of the simplest models containing the basic components of all risk management models is composed of four cyclical steps: risk identification (list of risks), risk evaluation (likelihood of risks), risk treatment (control measures), and risk implementation (risk monitoring and review) (Eagles et al., 2002; Spengler and Hronek, 2011). From a risk management perspective, risk identification and evaluation are fundamental steps that rely on past experience and include recognizing potential groups as well as determining a tolerable level of risk for participants (Barton, 2007; Ewert, 1984; Spengler and Hronek, 2011). Therefore, it is imperative to learn from the past by obtaining essential data and analyzing prior events (Dickson and Gray, 2012; Goode et al., 2016; Spengler and Hronek, 2011).

Incident analysis involving past experience not only enables managers to understand the effects of the context of an incident but also provides clues regarding risk sources (Dickson and Gray, 2012). These

risk sources are the interactions of participant characteristics (e.g. sex, age, health, and fitness), physical environments (e.g. terrain, infrastructure, and weather), and equipment (e.g. clothing, camping equipment, and shoes) (Brown, 1998; Haddock, 2013; Haddock et al., 1993). Visitors with preexisting medical conditions can be classified as unstable, and their health is at risk of worsening during an excursion (Greuters et al., 2009; Schutz et al., 2014). Hence, wilderness medical physicians strongly recommend maintaining good health (Auerbach, 2015). This does not imply that people with chronic illnesses should avoid natural areas; however, they should recognize their limitations, including their medical histories, before engaging and should wisely select their own level of engagement (Auerbach, 2015; Grant et al., 1996; Haddock, 2013). Forest recreation practitioners should thus first consider participants' health in terms of their preexisting medical conditions for risk management. Furthermore, eliminating all risk from outdoor recreation is impossible, therefore, sharing responsibility with visitors is a strategy for risk management (Dickson and Gray, 2012; Eagles et al., 2002; Sadler, 2004). In conclusion, site managers should understand visitors' characteristics that may lead to incidents and communicate risk information to travelers, who then must assume responsibility for recognizing the inherent risk and their personal well-being (Department of Conservation and Land Management, 1998; Dickson and Gray, 2012; Eagles et al., 2002; Grant et al., 1996; Rickard, 2014). Tourists should be self-reliant and know their own limitations for a safe and satisfying outdoor recreation experience (Brandenburg and Locke, 2017; Gstaettner et al., 2018; Haddock, 2013; Skaros, 1998).

Studies have reported numerous instances of illnesses in wilderness areas (e.g., Forrester and Holstege, 2009; Heggie and Heggie, 2004; Spano et al., 2018; Stella-Watts et al., 2012). However, few have traced whether visitors' medical conditions are related to the medical problems encountered. In order to develop useful risk management strategies and plans, further research is required to determine vulnerable conditions and the contributing factors that result in illness incidents among participants (Haegeli and Pröbstl-Haider, 2016). To this end, shifting from descriptive analysis to medical history analysis is necessary for understanding to whom, in what circumstances, and how a medical problem occurs (Drupsteen and Guldenmund, 2014; Shanmugam and Maffulli, 2008). Furthermore, as a popular forest recreation destination Xitou Nature Education Area's (XNEA) management team expected to have a better understanding of patients' profiles for planning risk management planning and reducing incidents in the future. Located in the middle of Taiwan, XNEA is one of the most popular forest recreation destinations and visitors can easily visit XNEA from Taiwan's second largest city, Taichung, via a 90-minute shuttle (The Experimental Forest et al., 2018). The suburban forest recreation destination, XNEA, provides visitors a pleasant natural environment with well-organized recreation facilities; as a result, the tourist arrivals are nearly 2 million per year (Wang et al., 2011). A rising need for ensuring visitors' health and safety was proposed to XNEA's management team. The analysis of patients' rescue reports was considered an approach to identify vulnerable groups. Additionally, understanding the relationship between visitors' encountered illnesses and their preexisting medical conditions can help destination managers improve their risk management plan. Therefore, the three objectives of this study were: (1) to report encountered illness characteristics in the Xitou Nature Education Area (XNEA), (2) to examine the association between visitors' preexisting medical conditions and illnesses encountered in XNEA by using a retrospective review approach, and (3) to identify high-risk groups to determine which visitors to target to increase health awareness and to aid destination managers in improving risk management planning.

2. Material and methods

2.1. Study site and the data protocol

XNEA is an experimental forest located in central Taiwan that is controlled by the College of Bio-Resources and Agriculture of National Taiwan University. XNEA was Taiwan's first forest recreation area has been serving academic research, education, conservation, and demonstration of forest management practices since 1970. XNEA is a concave valley surrounded by mountains at altitudes ranging from 800–2000 m. As a result of an intense humidity ranging from 88–93% as a daily high and a cool climate that is 16.6 °C on average (the temperature ranges from 11–28 °C), this forest often exhibits foggy conditions. The important recreation resources are composed of a well-organized trail network connecting visitors to many scenic spots throughout the area in three vegetation zones (coniferous, broad-leaved, and bamboo forests) which they can enjoy with indoor exhibitions, open air activities, outdoor sightseeing, forest therapy programs and social interaction. (Chiou et al., 2013; The Experimental Forest et al., 2018; Yu et al., 2019, 2017)

The retrospective review applied in this study was based on patient rescue reports from XNEAs' Emergency Medical Service for 6 years, spanning from July 1, 2012 to June 30, 2018. Incident reports were well documented by the rescue teams, each of which was composed of a nurse and rescue specialists. They summarized the details of the incidents from patient or witness narratives, and the details included symptoms, age, sex, date, time, and preexisting health conditions of patients. The research was approved by the Research Ethics Office of National Taiwan University (NTU-REC No. 201906HM013).

2.2. Data analysis

The total number of encountered illnesses was calculated using the incident rate as a ratio of the number of illness cases to illness exposure level (Dickson and Gray, 2012). The numerator was the number of patients over the year, and the denominator was the total number of visitors in that year. Regarding medical history and its relation with illnesses encountered by forest visitors, we hypothesized that a visitor's chronic disease or disorder is related to the illness experienced. Moreover, the relationship between sex and encountered illness was tested. Descriptive data were presented and a chi-square analysis was used for significance testing using SPSS Statistics 22 (IBM Corporation, NY, USA). A p value less than 0.05 was considered significant.

3. Results

Between July 2012 and June 2018, 276 individuals became ill at XNEA, and the number of rescued people decreased in each of the first 5 years and increased significantly in the final year. This is comparable to the illness rate, which continually decreased in successive years and also increased in the final year (Table 1).

The percentage of rescued female patients was 56.2 and male patients was 43.5%. The age range was 2–93 years, but some patients did not report their age. Age was classified into five groups, namely: unknown, ≤17, 18–39, 40–59, and ≥60 years, comprising 8%, 17.8%, 6.2%, 22.5%, and 45.7% of all patients, respectively. Regarding incident time and season, the data did not exhibit a clear difference in the number of patients. The number of patients rescued was slightly higher in summer (76; 27.5%) than in autumn (70; 25.4%), winter (66; 23.9%), and spring (64; 23.2%), and slightly more patients were rescued in the morning (123 people) than in the afternoon (113 people). Notably, a majority of patients (55.4%) had at least one chronic disease or disorder. Most rescued visitors had one chronic disease (124; 44.9%), followed by no chronic diseases (123; 44.6%), two (17; 6.2%), three (9; 3.3%), and four chronic diseases (3, 1.1%) (Table 2).

Illnesses were broadly classified into 14 groups based on symptoms. The most prevalent symptom among the 276 patients studied was

Table 1
Encountered illness frequencies and rates from July 2012 to June 2018.

Years	Total number of person-days	Illness number	Illness rate (per 1000 person-days)
July 1, 2012–June 30, 2013 (1st year)	1,711,003	83	0.049
July 1, 2013–June 30, 2014 (2nd year)	1,685,697	47	0.028
July 1, 2014–June 30, 2015 (3rd year)	1,996,232	39	0.020
July 1, 2015–June 30, 2016 (4th year)	1,999,008	35	0.018
July 1, 2016–June 30, 2017 (5th year)	1,950,662	21	0.011
July 1, 2017–June 30, 2018 (6th year)	2,202,713	51	0.023

Table 2
Epidemiological characteristics.

Demographics	Number	(%)
Sex		
Male	120	(43.5)
Female	155	(56.2)
Unknown	1	(0.4)
Age		
≤17	49	(17.8)
18−39	17	(6.2)
40−59	62	(22.5)
≥60	126	(45.7)
Unknown	22	(8.0)
Season		
Spring	64	(23.2)
Summer	76	(27.5)
Autumn	70	(25.4)
Winter	66	(23.9)

Table 3
Frequency of illnesses encountered by tourists from July 2012 to June 2018.

Illnesses	Number	(%)
Dizziness	132	47.8
Respiratory problems	54	19.6
Nausea or vomiting	53	19.2
Chest pain or chest tightness	46	16.7
Weakness	44	15.9
Syncope	32	11.6
Abdominal pain	29	10.5
Headache	26	9.4
Hyperhidrosis	13	4.7
Seizure	7	2.5
Diarrhea	6	2.2
Fever	5	1.8
Nose bleed	3	1.1
Rash	2	0.7

dizziness, accounting for 47.8% (Table 3).

Among the 153 patients diagnosed with preexisting conditions, hypertension was the most common in their medical histories (Table 4).

The number of illness encountered by cases in these five groups was also broken down in each year (see Table 5). Most of the illness cases occurred in the age group ≥60 years, followed by 40−59 years, ≤17

Table 4
Frequency of chronic diseases and disorders.

Chronic diseases and disorder	Number	(%)
Hypertension	72	26.1
Diabetes mellitus or hypoglycemia	35	12.7
Other non-orthopedic problems	26	9.4
Cardiac related	26	9.4
Asthmatic and other respiratory related problems	15	5.4
Cancer	10	3.6
Neurological disorders and stroke	9	3.3
Orthopedic or musculoskeletal problems	2	0.7
Hypotension	3	1.1

Table 5
Number of visitors encountering illness by age group.

Years	Illness number (people)					
	Total	≤17 years	18−39 years	40−59 years	≥60 years	Unknown
1st year	83	25	8	12	28	10
2nd year	47	16	0	18	12	1
3rd year	39	1	7	11	17	3
4th year	35	3	1	5	24	2
5th year	21	3	0	3	13	2
6th year	51	1	1	13	32	4
Total	276	49	17	62	126	22

years and 18−39 years.

When considering age distribution of the five groups (unknown, ≤17, 18–39, 40–59, and ≥60 years) across the six types of symptoms, the senior group (≥60 years) encountered illnesses more frequently compared to others (Fig. 1). The percentage of elderly groups was relatively high for most of the symptoms, typically more than 45%, except for respiratory problems, for which the percentage of elderly groups was only 33.3%.

Chi-square analysis indicated statistical significance in five encountered illness and chronic disease pairs: (1) dizziness and hypertension, (2) respiratory problems and hypertension, (3) chest pain or chest tightness and cardiac-related problems, (4) weakness and diabetes mellitus, and (5) syncope and hypertension (Table 6).

The chi-square test revealed a significant association between sex and illness only for syncope, X^2 (1, N = 275) = 8.25, p < .01 Although female participants outnumbered male participants in most cases, the difference between the two groups was nonsignificant (Fig. 2).

4. Discussion and conclusion

There are 276 cases in the current study. By analyzing these cases, we found the illness rate was highest during the period from July 2012 to June 2013, with 0.049 incidents per 1000 person-days, and the lowest rate was during the period from Jul, 2016 to June 2017, with 0.011 per 1000 person-days (Table 1). A decreasing trend of illness rate was observed at XNEA during the years covered by this study. The decreasing rate may be due to the risk management process. The tactics of risk management such as arousing risk awareness (e.g., using signage to inform visitors of risks), reducing interpersonal risk (e.g., limiting the number of tourists), or eliminating risks to participants (e.g., closing dangerous routes and remodeling facilities) were implemented by XNEA. Moreover, an electric golf cart provides a paid transportation service to people with mobility impairments, including some elderly, pregnant, and adolescent visitors, which could reduce illnesses experienced. These potentially vulnerable groups can enjoy nature in a comfortable manner through technology advancement without producing high levels of pollution. The development of new technology has been blended into outdoor recreation, yielding increased levels of comfort and safety that has played a part in making outdoor recreation safer than ever (Dickson and Gray, 2012). The percentage of female patients (56.2%) was greater than males, the most prevalent age group
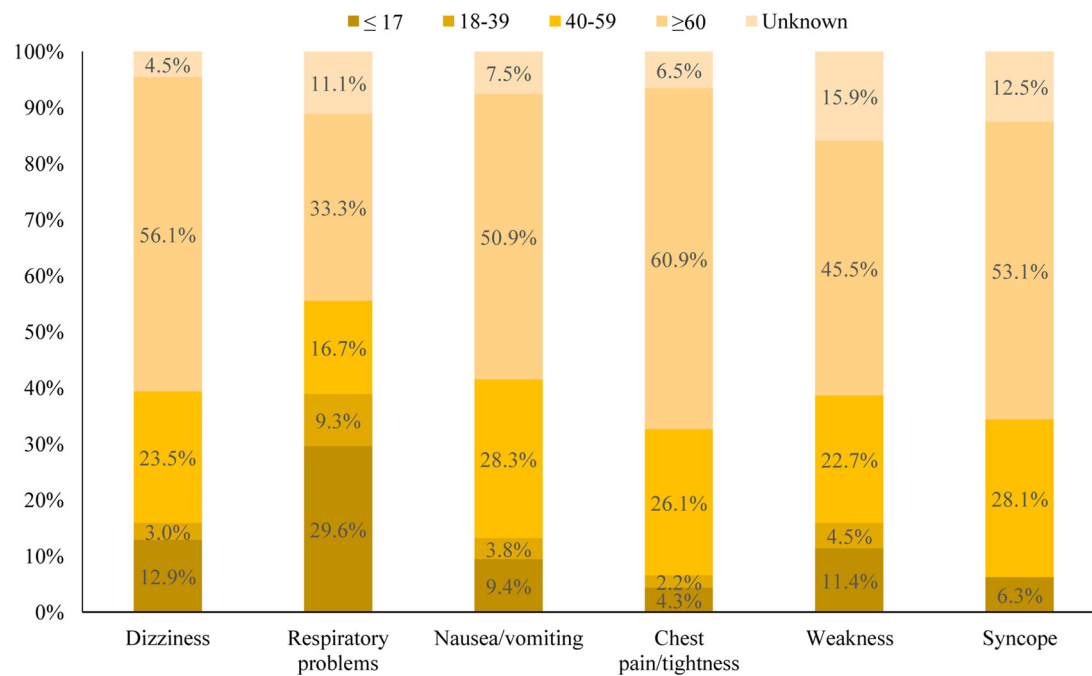
Fig. 1. Percentage distribution of illnesses by age group.

was ≥60 (45.7%), and most of the patients had a chronic disease or disorder. By reviewing these cases, we classified the illnesses occurred in XNEA into 14 groups based on symptoms, and dizziness was the most common symptom among the patients. We further analyzed patients' health conditions by reviewing their chronic diseases and disorders and found hypertension was the most common comorbidity in cases. Table 5 indicates older adults (≥60 years) visiting XNEA were the most vulnerable group to illness, whereas young adults (18–39 years) exhibited a smaller number of patients, which is consistent with other studies that have identified older adults as more vulnerable to illness (George Washington University & Adventure Travel Trade Association., 2013; Greuters et al., 2009; Keyes et al., 2016; Martínez-Caballero and Sierra Quintana, 2019). It should also be noted the illness numbers increased considerably (from 13 to 32 cases) in the ≥60 years age group. The XNEA management team indicated the increasing number of senior visitors (from 553,240–695,494 in the 6th year) may be the reason the illness frequency increased in the ≥60 years group. Further analysis (Fig. 1) illustrated the ≥60 group remains the highest for the six most common symptoms. The causes of vulnerability in this age group may be their physical and neurological impairment, particularly their preexisting medical conditions (Ramos-Sesma et al., 2018).

The discussion to this point has collectively indicated the association between pre-existing medical conditions and illness encountered in this study's sample, therefore we hypothesize that people who experienced an illness during outdoor activities was as a result of their pre-existing medical conditions. Our results showed that visitors with hypertension may develop dizziness, respiratory problems, or syncope, as was suggested in other studies (Khan, 2006; Marks, 2017; Moon and Schaffer, 2011). Visitors with diabetes mellitus may develop weakness and those with cardiac-related problems may develop chest pain or chest tightness, and these findings are similar to findings in Auerbach's (2015) study. In other words, visitors with high blood pressure had a higher risk of dizziness, respiratory problems, and syncope than visitors without high blood pressure did; those who had diabetes were vulnerable to weakness; and visitors with a cardiac-related problem were more likely to have chest pain or chest tightness. But, some of the significant relationships between preexisting medical conditions and encountered illness were lacking in our study but some connections

Table 6

Chi-square analysis of visitor chronic diseases according to illnesses encountered ($df = 1$, $n = 276$).

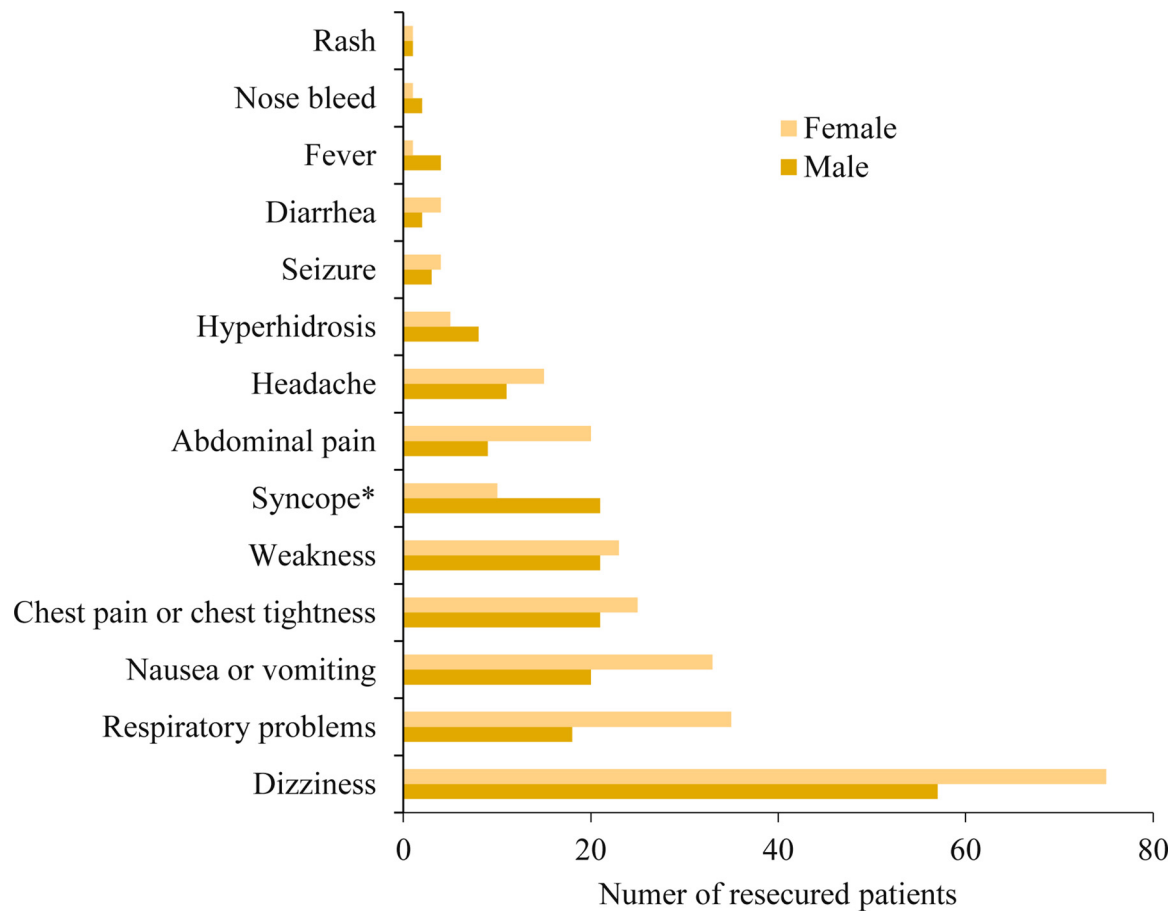| Preexisting medical conditions	Encountered illnesses									
	Dizziness		Respiratory problems		Chest pain/Chest tightness		Weakness		Syncope	
	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Hypertension	$\chi^2 = 11.890$ $p = 0.001^*$		$\chi^2 = 4.424$ $p = 0.035^*$		$\chi^2 = 0.000$ $p = 1.000$		$\chi^2 = 2.867$ $p = 0.090$		$\chi^2 = 8.112$ $p = 0.004^*$	
No	119	85	158	46	170	34	176	28	187	17
Yes	25	47	64	8	60	12	56	16	57	15
Diabetes mellitus	$\chi^2 = 0.670$ $p = 0.413$		$\chi^2 = 0.710$ $p = 0.399$		$\chi^2 = 1.106$ $p = 0.293$		$\chi^2 = 7.174$ $p = 0.007^*$		$\chi^2 = 1.204$ $p = 0.273$	
No	128	113	192	49	203	38	208	33	215	26
Yes	16	19	30	5	27	8	24	11	29	6
Cardiac related	$\chi^2 = 0.350$ $p = 0.554$		$\chi^2 = 0.225$ $p = 0.635$		$\chi^2 = 13.588$ $p < 0.001^*$		Expected frequency < 5		Expected frequency < 5	
No	129	121	202	48	215	35				
Yes	15	11	20	6	15	11				

Note: * statistically significant.

Fig. 2. Distribution of illnesses encountered by male and female patients rescued.

have been noted in medical education texts. Marks (2017), for example, stated that high blood pressure symptoms may include nausea or vomiting but we did not observe a significant relationship between people with hypertension and nausea or vomiting in our cohort. This variation may be caused by characteristics of visitors themselves, such as their physical fitness, or it may come from external factors, such as ambient temperature. Haddock (2013) also highlighted that alterations in mood, anxiety, fear, experience, confidence, or knowledge of the situation can lead to an unfavorable outcome for outdoor participants. Consistent with prior studies by Heggie and Heggie (2004) that explained illness in nature-based tourism emanated from misperceptions of tourists in regards to the potential of risk they were assuming. Certainly, effective risk management is necessary to understand and deal with a user's health and fitness, physical environment, and their psychological state (Angert and Schaff, 2010).

In the context of recreation in nature, effective risk management is crucial (Saunders et al., 2019; McIntosh et al., 2007). Identifying the high-risk groups is really helping destination managers to precisely and powerfully plan. Managers must make data-driven decisions, such as focusing more attention on preventing illness and injury for seniors, who are the highest-illness group based on descriptive analysis. Another vulnerable group is people with preexisting conditions. People in this group are more likely to develop an illness, and this includes people who have hypertension, diabetes mellitus, and cardiac-related problem. Our finding is consistent with those of other studies that demonstrated many elderly tourists traveling to natural areas had these common diseases (Keyes et al., 2016; Martínez-Caballero and Sierra Quintana, 2019). Based on all available research we can broadly say elderly visitors are a high-risk group in the study context. Apart from this, we hypothesized and tested the relationship between sex and illness

encountered. The only major association we found was the association between men and syncope. Consistent with Forrester and Holstege (2009) and Martínez-Caballero and Sierra Quintana (2019), syncope is more common in males than females during outdoor activities. Our study, also, provided empirical evidence of the significant relationship between sex and syncope development.

From a risk management perspective, both outdoor practitioners and participants should share responsibility by using an effective communication approach. This approach, suggested by Skaros (1998) in relation to emergency medical management in an outdoor-setting, could be implemented especially for high-risk groups. This study provides the XNEA management team scientific evidence which should be presented with precaution regarding the symptoms that visitors may experience that are related to preexisting medical diseases or disorders. Various methods can be used to communicate this message to potential visitors such as websites, videos, photographs, booklets, safety signs, or educational activities. In this way, visitors will be able to assess their level of fitness and prepare themselves before embarking on an excursion (Heggie, 2006).

This research may be the first study of outdoor safety reporting in Taiwan using retrospective analysis on illness cases in the forest recreation context. This provides an approach to outdoor recreation site managers for risk management. There are a few limitations in this study. This report does not include data from any environment except for the one we explicitly studied, so the results may not be applied to other forest recreation sites. Our results and research implementation are based on general outdoor activities most tourists can complete, such as walking, hiking, and picnicking, in suburban forest environments. Studying other activities or environments may offer different conclusions and further studying the relationship between environmental

conditions and preexisting medical conditions of visitors which may increase odds of experiencing illness is necessary for an effective risk prevention program.

Funding

CRediT authorship contribution statement

Jittakon Ramanpong: Conceptualization, Methodology, Data curation, Formal analysis, Writing - original draft. **Chia-Pin Yu:** Funding acquisition, Conceptualization, Methodology, Supervision, Writing - review & editing. **Po-Neng Chiang:** Conceptualization, Data curation, Writing - review & editing. **Ming-Jer Tsai:** Supervision, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgment

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.ufug.2020.126710.

References

Angert, D., Schaff, E.A., 2010. Preventing injuries and illnesses in the wilderness. Pediatr. Clin. North Am. 57 (3), 683–695. https://doi.org/10.1016/J.PCL.2010.02.001.

Auerbach, P.S., 2015. Medicine for the Outdoors: the Essential Guide to First Aid and Medical Emergencies, sixth ed. Elsevier, Inc, PA, USA.

Barton, B., 2007. Safety, Risk and Adventure in Outdoor Activities. Paul Chapman., London, UK.

Brandenburg, W.E., Locke, B.W., 2017. Mountain medical kits: epidemiology-based recommendations and analysis of medical supplies carried by mountain climbers in Colorado. J. Travel Med. 24 (2). https://doi.org/10.1093/jtm/taw088.

Brown, T.J., 1998. Risk management: research needs and status report. J. Exp. Educ. 21 (2), 71–85. https://doi.org/10.1177/105382599802100203.

Chiou, C.-R., Huang, M.-Y., Tsai, W.-L., Lin, L.-C., Yu, C.-P., Simon, 2013. Assessing impact of natural disasters on tourist arrivals: the case of xitou nature education area (XNEA), Taiwan. Int. J. Tour. Sci. 13 (1), 47–64. https://doi.org/10.1080/15980634.2013.11434668.

Department of Conservation and Land Management, 1998. Visitor Risk Management and Public Liability. Western Australia, Australia.

Dickson, T.J., Gray, T.L., 2012. In: Dickson, T.J., Gray, T.L. (Eds.), Risk Management in the Outdoors: A Whole-of-Organisation Approach for Education, Sport and Recreation. Cambridge University Press, Port Melbourne, Australia.

Drupsteen, L., Guldenmund, F.W., 2014. What is learning? A review of the safety literature to define learning from incidents, accidents and disasters. J. Contingencies Crisis Manag. 22 (2), 81–96. https://doi.org/10.1111/1468-5973.12039.

Eagles, P.F.J., McCool, S.F., Haynes, C.D., 2002. In: Phillips, A. (Ed.), Sustainable Tourism in Protected Areas: Guidelines for Planning and Management, Vol. 8. IUCN Gland, Switzerland and Cambridge, UK.

Ewert, A., 1984. The risk management plan: promises and pitfalls. J. Exp. Educ. 7 (3), 27–32. https://doi.org/10.1177/105382598400700308.

Forrester, J.D., Holstege, C.P., 2009. Injury and illness encountered in Shenandoah National Park. Wilderness Environ. Med. 20 (4), 318–326. https://doi.org/10.1580/1080-6032-020.004.0318.

George Washington University & Adventure Travel Trade Association, 2013. Adventure Tourism Market Study 2013. George Washington University, Washington DC, USA.

Goode, N., Read, G.J.M., van Mulken, M.R.H., Clacy, A., Salmon, P.M., 2016. Designing system reforms: using a systems approach to translate incident analyses into prevention strategies. Front. Psychol. Vol. 7, 1974. Retrieved from. https://www.frontiersin.org/article/10.3389/fpsyg.2016.01974.

Grant, B.C., Thompson, S.M., Boyes, M., 1996. Risk and responsibility: in outdoor recreation. J. Phys. Educ. Recreat. Dance 67 (7), 34–35. https://doi.org/10.1080/07303084.1996.10604817.

Greuters, S., Christiaans, H.M.T., Veenings, B., Loer, S.A., Boer, C., 2009. Evaluation of repatriation parameters: does medical history matter? J. Travel Med. 16 (1), 1–6. https://doi.org/10.1111/j.1708-8305.2008.00253.x.

Gstaettner, A.M., Lee, D., Rodger, K., 2018. The concept of risk in nature-based tourism and recreation – a systematic literature review. Curr. Issues Tour. 21 (15), 1784–1809. https://doi.org/10.1080/13683500.2016.1244174.

Gstaettner, A.M., Kobryn, H.T., Rodger, K., Phillips, M., Lee, D., 2019. Monitoring visitor injury in protected areas - analysis of incident reporting in two Western Australian parks. J. Outdoor Recreat. Tour. 25 (November 2017), 143–157. https://doi.org/10.1016/j.jort.2018.04.002.

Haddock, C., 2013. In: Corcoran, K., Corrigan, A. (Eds.), Outdoor Safety: Risk Management for Outdoor Leaders, third ed. New Zealand Mountain Safety Council, Wellington, New Zealand.

Haddock, C., Wisheart, P., New Zealand Mountain Safety Council, 1993. Managing Risks in Outdoor Activities, 1st ed. New Zealand Mountain Safety Council, Wellington, New Zealand.

Haegeli, P., Pröbstl-Haider, U., 2016. Research on personal risk in outdoor recreation and nature-based tourism. J. Outdoor Recreat. Tour. 13, 1–9. https://doi.org/10.1016/j.jort.2016.02.001.

Hartig, T., Mitchell, R., De Vries, S., Frumkin, H., 2014. Nature and Health. Annu. Rev. Public Health 35 (1), 207–228. https://doi.org/10.1146/annurev-publhealth-032013-182443.

Heggie, T.W., 2006. Chapter 13 – tourist trauma in national parks. In: Wilks, J., Pendergast, D., Leggat, T.T. (Eds.), Advances in Tourism Research, pp. 185–197. https://doi.org/10.1016/B978-0-08-044666-0.50021-X.

Heggie, T.W., Heggie, T.M., 2004. Viewing lava safely: an epidemiology of hiker injury and illness in Hawaii Volcanoes National Park. Wilderness Environ. Med. 15 (2), 77–81. https://doi.org/10.1580/1080-6032(2004)015[0077:VLSAEO]2.0.CO;2.

Kaplan, S., 1995. The restorative benefits of nature: toward an integrative framework. J. Environ. Psychol. 15 (3), 169–182. https://doi.org/10.1016/0272-4944(95)90001-2.

Keirle, I., 2002. Countryside Recreation Site Management: a Marketing Approach. Routledge, London.

Keyes, L.E., Mather, L., Duke, C., Regmi, N., Phelan, B., Pant, S., Basnyat, B., 2016. Older age, chronic medical conditions and polypharmacy in Himalayan trekkers in Nepal: an epidemiologic survey and case series. J. Travel Med. 23 (6), 52. https://doi.org/10.1093/jtm/taw052.

Khan, M.G., 2006. Hypertension. In Encyclopedia of Heart Diseases. Retrieved from. Elsevier, Amsterdam, The Netherlands, pp. 469–491. https://link.gale.com/apps/doc/CX3032000078/GVRL?u=866ntu&sid=GVRL&xid=47c86c49.

Korpela, K., Savonen, E.-M., Anttila, S., Pasanen, T., Ratcliffe, E., 2017. Enhancing wellbeing with psychological tasks along forest trails. Urban For. Urban Green. 26, 25–30. https://doi.org/10.1016/J.UFUG.2017.06.004.

Kuenzi, C., McNeely, J., 2008. Nature-based tourism. Global Risk Governance. pp. 155–178. https://doi.org/10.1007/978-1-4020-6799-0_8.

Marks, R., 2017. Hypertension (High blood pressure). In: Teichrow, J.K. (Ed.), Chronic Diseases: An Encyclopedia of Causes, Effects, and Treatments, Vol. 1. Greenwood, Santa Barbara, CA, pp. 418–421. Retrieved from. http://link.galegroup.com/apps/doc/CX7210000164/GVRL?u=866ntu&sid=GVRL&xid=c41c020d.

Martínez-Caballero, C.M., Sierra Quintana, E., 2019. Epidemiology of cardiac events during prehospital care in mountain rescues conducted in Aragon. Wilderness Environ. Med. 30 (1), 22–27. https://doi.org/10.1016/j.wem.2018.10.009.

McIntosh, S.E., Leemon, D., Visitacion, J., Schimelpfenig, T., Fosnocht, D., 2007. Medical incidents and evacuations on wilderness expeditions. Wilderness Environ. Med. https://doi.org/10.1580/07-WEME-OR-093R1.1.

Moon, T.J., Schaffer, M.S., 2011. Syncope. Berman's Pediatric Decision Making. pp. 36–40. https://doi.org/10.1016/B978-0-323-05405-8.00018-8.

Plummer, R., 2005. Outdoor Recreation: an Interdisciplinary Perspective. Kendall/Hunt, Dubuque, Iowa, USA.

Ramos-Sesma, V., Górgolas-Hernández Mora, M., Ramos-Rincón, J.M., 2018. The elderly traveler. Revista Clínica Española (English Edition) 218 (8), 426–434. https://doi.org/10.1016/J.RCENG.2018.03.011.

Rayner, S., 1987. Learning From the Blind Men and the Elephant, or Seeing Things Whole in Risk Management. Uncertainty in Risk Assessment, Risk Management, and Decision Making, pp. 207–212. https://doi.org/10.1007/978-1-4684-5317-1_17.

Rickard, L.N., 2014. Mountains and handrails: risk, meaning, and responsibility in three national parks. Environ. Commun. 8 (3), 286–304. https://doi.org/10.1080/17524032.2013.850109.

Sadler, P., 2004. Do we need a sign on every rock in the water? Standard of care in negligence and the tourism industry in Western Australia. Legal Issues in Business 6.

Saunders, R., Weiler, B., Scherrer, P., Zeppel, H., 2019. Best practice principles for communicating safety messages in national parks. J. Outdoor Recreat. Tour. 25, 132–142. https://doi.org/10.1016/J.JORT.2018.01.006.

Schutz, L., Zak, D., Holmes, J.F., 2014. Pattern of passenger injury and illness on expedition cruise ships to Antarctica. J. Travel Med. 21 (4), 228–234. https://doi.org/10.1111/jtm.12126.

Shanmugam, C., Maffulli, N., 2008. Sports injuries in children. Br. Med. Bull. 86 (1), 33–57. https://doi.org/10.1093/bmb/ldn001.

Skaros, S., 1998. Managing medical emergencies in the outdoors. In: Dougherty, N.J. (Ed.), Outdoor Recreation Safety. Human Kinetics, Champaign, IL, USA.

Spano, S.J., Hile, A., Jain, R., Stalcup, P.R., 2018. The epidemiology and medical morbidity of long-distance backpackers on the John Muir Trail in the Sierra Nevada. Wilderness Environ. Med. 29 (2), 203–210. https://doi.org/10.1016/j.wem.2018.02.006.

Spengler, J.O., Hronek, B.B., 2011. Legal Liability in Recreation, Sports, and Tourism, 4th ed. Sagamore Pub., Urbana IL, USA.

Stella-Watts, A.C., Holstege, C.P., Lee, J.K., Charlton, N.P., 2012. The epidemiology of caving injuries in the United States. Wilderness Environ. Med. 23 (3), 215–222. https://doi.org/10.1016/j.wem.2012.03.004.

Swarbrick, N., Eastwood, G., Tutton, K., 2004. Self-esteem and successful interaction as part of the forest school project. Support. Learn. 19 (3), 142–146. https://doi.org/10.1111/j.0268-2141.2004.00337.x.

The Experimental Forest, College of Bio-Resources and Agriculture, N. T. U, 2018. The Experimental Forest, College of Bio-Resources and Agriculture, National Taiwan University. The Experimental Forest, College of Bio-Resources and Agriculture, National Taiwan University, Nantou County, Taiwan.

Wang, Y.-N., Lin, L.-C., Chang, P.-C., Huang, Y.-R., Wang, C.-T., 2011. Preliminary investigation of visitor arrivals and management implication in Xitou Nature Education Area. J. Exp. Forest Natl. Taiwan Univ. 25 (3), 181–191.

Yu, C.-P., Lin, C.-M., Tsai, M.-J., Tsai, Y.-C., Chen, C.-Y., 2017. Effects of short forest bathing program on autonomic nervous system activity and mood states in middle-aged and elderly individuals. Int. J. Environ. Res. Public Health 14 (8), 897. https://doi.org/10.3390/ijerph14080897.

Yu, C.-P., Chang, W.-C., Ramanpong, J., 2019. Assessing visitors' memorable tourism experiences (MTES) in forest recreation destination: a case study in Xitou nature education area. Forests 10 (8), 636. https://doi.org/10.3390/f10080636.