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Looking beyond people, equipment and environment: Is a systems theory model of accident causation required to understand injuries and near misses during outdoor activities?

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Abstract

The National Incident Database (NID) provides a standardised, industry-wide, approach to incident reporting for the outdoor sector in New Zealand (NZ). The aim of this study was to determine whether the NID contributing factor categories (i.e. people, equipment and environment) are sufficient for classifying the data that has been collected on accident causation by the NID, or whether a systems theory framework is required. A sample of injury and near miss reports (n = 228) were extracted from the NID and analysed. All contributing factors identified were classified according to Rasmussen's (1997) Risk Management Framework (RRMF), which was adapted to describe the "led outdoor activity system". In total, 58 different contributing factor categories were identified across the 228 incidents. Factors were classified across all levels of the framework, which indicates that the NID categories are inadequate. The findings also demonstrate that RRMF is appropriate for classifying the contributing factors involved in less severe injuries and near misses that do not have in-depth investigations associated with them.

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1. Introduction

The National Incident Database (NID) has provided a standardized approach to incident reporting for organizations that provide led outdoor activities in New Zealand (NZ) since 2005. Organizations currently using the NID include commercial, school-based, not-for-profit and informal outdoor education and recreation groups [1]. Within the context of the NID, an incident is defined as "an undesired event that could or does result in a harm or loss" [2]. Each report includes an assessment of incident characteristics, free response text describing the incident, free response text describing the contributing factors involved in the incident and a set of categories to classify the contributing factors identified (people, equipment and environment).

These categories are based on a well-known model of accident causation developed specifically for the outdoor activity domain, Hale's Dynamics of Accidents Model (Hale, 1984 as cited in [3], also known as the Accident Potential Model [4-7]. This model proposes that "Environmental" and "Human Factors" hazards combine to create an accident potential. Curtis [3, 8] specified a number sub-categories for these hazards. Environmental hazards were broken down into the environment, equipment and driving/transportation. Human Factors hazards were broken down into participants and instructors. These categories focus analysts on the immediate context of the activity.

However, recent analyses of fatal outdoor incident investigation reports have found that many factors outside the immediate context of the activity influence accident causation [9, 10]. For example, an analysis of the Mangatepopo Gorge walking tragedy in New Zealand, in which six students and their teacher drowned, found that actions and decisions of government departments, regulatory bodies and activity centre management played a role in the outcome [10]. This demonstrates that a systems theory model of accident causation, which represents the broader "system of work", is required to understand accidents during led outdoor activities.

It is unclear whether systemic accident analysis methods are also required to understand the contributing factors identified in reports of less severe injuries and near misses, such as those that are primarily captured by the NID. The NID reports contain only a limited descriptions of events, and are typically completed by instructors whose primary experience pertains to the immediate context of the activity. Without training, they are probably unlikely to reflect on issues pertaining to the broader system of work. While the Mountain Safety Council (MSC) prepares yearly summary reports of the NID data [1, 11, 12], the contributing factors captured in the qualitative data from the reports has not been analysed. Thus, it is unknown whether the NID contributing factor categories comprehensively capture the contributing factors described in the reports. A comprehensive contributing factor taxonomy is a critical component of any incident reporting system as it increases the reliability of analyses, and assists with the rapid identification of recurring issues across multiple incidents.

The aim of this study was to determine whether the NID contributing factor categories (i.e. people, equipment and environment) are sufficient for classifying the data that has been collected on accident causation, or whether a systems theory framework is required. To address this question, Rasmussen's [13] Risk Management Framework (RRMF) will be used to classify the contributing factors identified from the qualitative descriptions of contributing factors in a sample of NID reports. RRMF describes six system levels (e.g. government, regulators, company, company management, staff, and work) that contribute to accident causation. The NID contributing factor categories (people, equipment and environment) would be classified at the last two levels of this framework. If the NID is comprehensive, then factors only at these levels should be identified in the reports. On the contrary, identification of other contributing would suggest that further contributing factor categories are required in led outdoor activity incident reporting systems. This study was conducted in 2011 to inform the development of an incident reporting system for the outdoor sector in Australia (The UPLOADS project; Understanding and Preventing Led Outdoor Accidents Data System, www.uploadsproject.org).

2. Method

Ethics approval was granted by the Monash University Human Ethics Committee.

2.1. Data source

Outdoor education/recreation incident reports (N = 1017) collected from 2007 to 2011 were provided to the researchers by the MSC in de-identified form. The qualitative data on contributing factors was contained in two fields, the "incident description" and the "causal narrative". The incident description asks the reporter to "describe what happened e.g. sequence of events, injuries and other harm, people, distances, times, sizes, etc. to present a clear picture of the incident", while the causal narrative asks the reporter to "explain in detail what you think caused the incident."

Each incident report includes a rating for "actual" severity, representing what actually happened in the specific incident, and "potential" severity, representing what could have happened in the worse-case scenario. The scale is numbered 1-10, where "1" reflects "a minor or short term impact on individual(s) that doesn't have a large effect on their participation" and "10" reflects "life changing effect on individual(s) or death" [14].

This study focusses on injury and near miss reports involving hiking activities. Injuries and near misses were coded in the original dataset and so could be readily identified. Hiking was defined by the authors as any activity involving walking or running in natural environments. Therefore, any report involving "hiking", "tramping", "field trips", "walking", "orienteering", "jungle trips" and "mud runs" were included in the analysis. Aggregation across these activities was necessary to identify a sufficient sample of incidents to support the analysis; these activities were considered to have enough common elements to justify aggregation across incidents. The researchers coded the activity type and 228 hiking cases were identified.

2.2. Data coding

Coding was conducted over four stages. Three researchers independently identified contributing factors from the *incident description* and *causal narrative* fields, and assigned descriptive codes to the text. Contributing factors were defined as those that contributed to the occurrence of the near miss or incident. Each factor had to be explicitly stated in the text and researchers were not permitted to draw any inferences from the reports. For example, from the causal narrative "A large group of kids moving along a road....maybe distracted by talking to each other and running around etc." the factors "large number of participants" and "distracted participants" were identified. One researcher collated all the factors identified from the data and ordered them into categories based on key themes. The categories were then reviewed by the other researchers, and disagreements resolved through discussion.

For the purposes of the present study, the RRMF was adapted to reflect the outdoor activity domain. The following six levels were included: (1) Government department decisions and actions; (2) Regulatory bodies and associations, schools and parents; (3) Activity centre management planning and budgeting; (4) Supervisory and management decisions and actions; (5) Instructors, participants and other actors at the scene of the incident; and (6) Equipment, environment and meteorological conditions. The contributing factors identified from the NID data were then classified according to these levels.

3. Results

3.1. Incident characteristics

There were 166 injury (72.8%) and 62 near miss (27.2%) cases. Injuries had a mean rating of 3.2 (SD = 1.5) for actual severity, and 4.6 (SD = 1.9) for potential severity. According to the rating scale, this means that on average the injuries reported had "medium impact on individual(s) that may prevent participation in the activity/programme for a day or two", and their potential for harm was rated similarly. In comparison, near misses had a mean rating of 2.6 (SD = 1) for actual severity, and 5.3 (SD = 2.2) for potential severity. This means that on average near misses were rated as having only "a minor or short term impact on individual(s) that doesn't have a large effect on their participation". However, they had the potential to have a medium impact on participation.

3.2. Contributing factors across the outdoor activity system

In total, 58 contributing factor categories were identified across the incidents. On average, 4.3 contributing factors (SD = 2.2; range 1 to 16) were identified per incident. A summary of the factors identified across the outdoor activity system levels is presented in Figure 1. In the following sections the factors classified at each level are summarized.

3.3. Government department decisions and actions

Few (5.3%, n = 12) incidents involved factors at this level. However, all factors identified were associated with the Department of Conservation and involved either required actions being undertaken incorrectly or not at all (e.g. failure to spray for wasps or repair tracks).

3.4. Regulatory bodies and associations, schools and parents

Few (1.3%, 3) incidents involved factors at this level. All factors identified involved schools or parents failing to communicate information to the activity provider (e.g. concerning pre-existing injuries).

3.5. Activity center management planning and budgeting

Again, few (4.8%, 11) incidents involved factors at this level. All factors identified reflected problems with activity center policies and systems. For example, failure to learn from previous similar incidents and poor staff training evaluation systems.

3.6. Supervisory and management decisions and actions

Only 10.1% (n= 23) of incidents involved factors at this level. All factors identified reflected problems with planning for activities. For example, a lack of planning for participants with special needs and high staff to participant ratios.

3.7. Instructors, participants and other actors at the scene of the incident

The majority (87.7%, 200) of incidents involved factors at this level. Factors at this level reflected issues with participants (77.2% of incidents, n=176), instructors or supervisors (51.3% of incidents, n=117), and other actors (6.1% of incidents, n=14). The most common factors involving participants were unsafe acts and failure to follow instructions. The most common factors involving instructors were judgment errors and lack of supervision of participants.

3.8. Equipment, environment and meteorological conditions

The vast majority (90.4%, 206) of incidents involved factors at this level. Factors at this level reflected issues with equipment (41.7% of incidents, n=95) and the physical environment (86.4% of incidents, n=197). The most common equipment-related factor was a lack of equipment; while adverse weather conditions were the most common environmental factor.

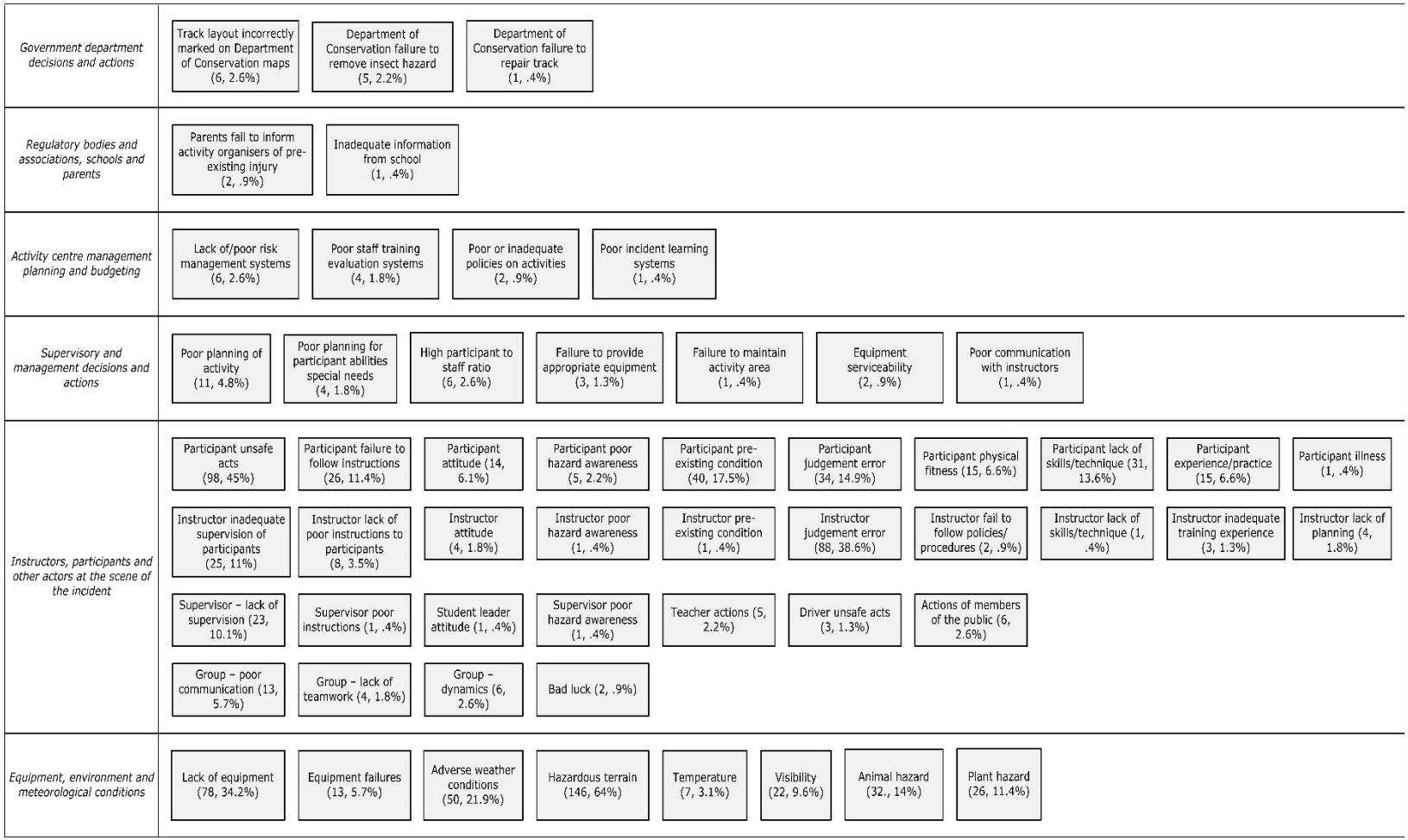

Fig. 1. Summary of contributing factors involved in hiking incidents. Numbers in brackets represent frequencies and percentage within the total incidents (n = 228).

4. Discussion

The aim of this study was to determine whether incidents reported to the NID include information about contributing factors outside of the current people, equipment and environment categories that are well defined within the NID. The analysis demonstrates that, for the incidents examined, there were various contributing factors outside of these categories. On the basis of this, it would seem that the current NID data coding framework is inadequate, since it does not support classification of contributing factors outside of people, equipment and environment, even though additional information exists in its records. This is an important and significant limitation because, whilst the NID provides useful information regarding people, equipment and environment contributing factors, it does not support analyses of the wider contributing factors involved in outdoor activity incidents. In order to identify these additional contributing factors, it was necessary for us to manually code the incident description and causal narrative sections of the report. This was a time consuming process: preliminary coding alone required approximately 10 minutes per report (i.e. one week full time for 228 reports), with another week devoted to the thematic analysis. Ongoing manual coding of incidents in this way would be too prohibitive for most organizations to adopt as standard reporting practice. It also makes it difficult for organizations to rapidly analyses their own data, and disseminate the lessons learnt in a timely fashion.

The findings also suggest that the RRMF is appropriate for classifying the contributing factors involved in incidents involving injuries and near misses that do not have in-depth investigations associated with them. Contributing factors were classified at all levels of the RRMF. Analysis of the classified factors indicates that safety during hiking activities is impacted by the decisions and actions of everyone in the system (e.g. public servants, activity center managers, and schools), not just instructors and participants. Moreover, in line with the RRMF, the analysis demonstrates that hiking incidents are caused by multiple factors across the system rather than one factor in isolation. Importantly, RRMF is capable of classifying the contributing factors both when there are multiple contributing factors across the levels and when there are only few contributing factors at only one or two levels.

It should be noted, however, that the RRMF only provides a starting point for the classification of contributing factors. Currently, only six broad levels are described within the framework. For the purposes of the current analysis, specific factors had to be identified from the reports and then classified according to key themes relating to those levels. Without taxonomies of specific contributing factors, it is difficult to reliably code incident reports and aggregate analyses in order to derive a useful summary of multiple accident cases. Incident analysis frameworks that use taxonomies of contributing factors to identify trends in multiple incident case data sets are commonly applied in other safety critical domains such as aviation [15] and rail [16].

Finally, it was not possible for this paper to address the implications of the current analysis for injury prevention strategies for several reasons. First, the identification of a comprehensive set of contributing factors was potentially limited by (1) biases in reporting caused by the contributing factor categories (e.g. reporters may have been more likely to report “activity leader judgement error” than as a contributing factor than “not addressed in activity standard” because the incident reporting form prompts them to consider the role of the former); (2) the lack of instructions regarding the detail to include in the incident descriptions and causal narratives on the NID report; and (3) a lack of detail within many of the NID reports. Secondly, it was not possible to identify the relationships between the contributing factors from the reports due to the lack of detail; this is a key aspect of developing effective, system-orientated risk controls.

In conclusion, the findings from this study support the argument put forward by Salmon et al. [10] that in order to support data coding regarding the contributing factors involved in outdoor incidents, a comprehensive domain-specific contributing factor taxonomy needs to be developed. This should be based on a systemic model of accident causation, such as RRMF. This is a critical step towards developing a holistic understanding of the factors influencing accident causation in this domain, to support the identification of more effective injury prevention strategies.

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