# INPLASY

## Death of winter backcountry sports practitioners in avalanches—a systematic review and meta-analysis of distribution in pathological causes

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## ADMINISTRATIVE INFORMATION

**Support -** GUESSED project.

**Review Stage at time of this submission -** Formal screening of search results.

**Conflicts of interest -** None declared.

**INPLASY registration number:** INPLASY202430011

**Amendments -** This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 03 March 2024 and was last updated on 03 March 2024.

## INTRODUCTION

**Review question / Objective** a. What are the proportions of avalanche death due to trauma, asphyxia and hypothermia, respectively? b. Could study sample size, source of data, time of accidents, regions and other potential features be possible confounders to the proportions? c. What factors to avalanche-related deaths can a narrative review of the current literature provide us about?

**Rationale** In the Alpine countries, avalanche disasters have been mentioned in literature as long ago as 218 BC . Our long cultural familiarity belies the fact that these destructive phenomena and their consequences are not yet fully understood. Specifically, there is a lack of a robust, up-to-date meta-analysis of the causes of death in avalanche accidents, which is critical information for emergency responders.

**Condition being studied** Deaths with avalanche as the primary cause.

## METHODS

**Search strategy** Literature searches involves the following electronic databases: MEDLINE (1950 to December 2023), Academic Search Complete (1948 to December 2023), SPORTDiscus (1982 to December 2023), Embase (1980 to DecemberJune 2023), ERIC (Education Resources Information Center; 1965 to December 2023), Scopus (1970 to December 2023), the Cochrane database (1993 to December 2023) and SafetyLit (1870 to December 2023).

We used a broad set of keywords. The keywords (with truncation) include "avalanche*", "snow burial*", "snow immers*", "casualty", "mortality", "fatal*", "death?", "trauma", "injur*", "survival", "snow*", "ski*", "mountain*", "sled*", "climb*", "winter", "sport*", "activit*", "pastime", and "recreation".

Specific search terms will also be confined to MeSH terms or Emtree in databases providing such functions. The search results will be then refined by Boolean logic combinations of the terms. No language constraints will be used.

**Participant or population** Non-survivors died of avalanche accidents.

**Intervention** No active intervention. But an avalanche is inevitably involved in the accidents to be researched.

**Comparator** This is not an intervention study. No comparator will be involved.

**Study designs to be included** Observational studies, retrospective studies, prospective studies (prospectively collect avalanche accident cases), autopsy series, and case report. Due to the nature of the researched topic (avalanche accident), controlled trials are ethically impossible to be found. Observational studies, retrospective studies, prospective studies, autopsy series, and case report. Due to the nature of the researched topic (avalanche accident), controlled trials are ethically impossible to be found.

**Eligibility criteria** We will have looser criteria for including studies for systematic review than for meta-analysis. This indicates we will use a number of studies for both meta-analysis and systematic review, and a number of studies for systematic review alone. The meta-analysis will include descriptive and analytical studies involving the distribution of death causes(pathologies) due to fatal avalanche accidents. Studies reporting participants with clearly confirmed pathology of death will be included. The Inclusion Criteria will be: descriptive and analytical studies that report the proportion of causes (pathologies/autopsy-diagnoses/pathophysiologies) of death (Trials are ethnically impossible in the issue). The Exclusion Criteria for meta-analysis will be (a) Studies based on a selected group of victims biasing the proportion or making the proportion impossible to obtain(e.g., studies focusing on the death of skiers with other winter activities such as hiking intentionally removed; studies focusing on traumatic death with other causes excluded); (b) Studies with causes of avalanche death were classified in a way none of trauma, asphyxia or hypothermia were used or can be inferred; (c) Studies with no relevant statistics obtainable (d) All relevant statistics were cited elsewhere (we would search the cited article to include it if it were not already in the study pool); (d) Studies with a single accident or with sample size <3 ; (e) Source and duration of data were already fully covered by another included studyFor the systematic review, we used all studies included in meta-analysis plus those excluded by criteria (a) and/or (d). The considerations are studies excluded by (a) can be controlling groups, to which we can compare the meta-synthesized results.For English articles, two of the authors will screen the titles, and abstracts when available, of potentially relevant studies. The same reviewers independently assessed the full text base on the following inclusion and exclusion criteria. Disagreements were resolved by consensus and arbitrated by consultation with a third reviewer. For non-English articles, we decided by consulting back-country sports researchers whose mother tongue is German, French, and Norwegian, respectively. For articles written in languages other than those mentioned above, we sought for external input from researchers who have good reading skills of the language.

**Information sources** Electronic databases, accident registries, contact with authors, consultation with avalanche experts and grey literature.

**Main outcome(s)** The proportions of deaths due to trauma, asphyxia and hypothermia (separately) in avalanche deaths.

**Additional outcome(s)** No additional outcomes. But for systematic review descriptive statistics will be presented for relevant topics such as type of sports involved. Additionally, if we find biased sample studies as defined in the section of search strategy, we will perform one-sample chi-square test (or Fisher's exact test when the data is sparse) or two-sample test for equality of proportions where appropriate to test the differences between the proportion of biased samples and the summary proportions pooled from the current meta-analysis. Alpha of 0.05 will be used, as is the common practice.No additional outcomes. But for systematic review descriptive statistics will be presented for relevant topics such as type of sports involved. Additionally, if we find biased sample studies as defined in the section of search strategy, we will perform one-sample chi-square test (or Fisher's exact test when the data is sparse) or two-sample test for equality of proportions where appropriate to test the differences between the proportion of biased samples and the summary proportions pooled from the current meta-analysis.

**Data management** Two authors will extract the planned parameters from the studies. A victim will be assigned with more than one cause of death if the authors have reported them as concomitant causes of deaths. If a study uses data from different sources and reported the proportions of death causes separately (e.g. to compare across these cohorts), we will extract each cohorts (series) as a single entry. If a study merges these sources to reach an overall proportion for legitimate reason,

we will extract this overall proportion as a single entry for the study.

If two or more studies have source and duration of data partially (not fully) covered by each other, we will try to extracted the non-overlapped subsets of statistics from the studies. When such subsets were not available, we will record them as separate entries but marked the overlap condition (for sensitivity analysis). We will prioritize the peer-reviewed over none peer-reviewed studies in the process.

Reports will be archived in Zotero. Data will be extracted into Excel. Quantitative analysis will be done in R. Manuscript will be done and reserved in overleaf.

**Quality assessment / Risk of bias analysis** Two authors will independently assess the risk of bias using JBI Critical Appraisal Checklist for Studies Reporting Prevalence Data to assess risk of bias. Disagreements will be resolved by consensus and arbitrated by consultation with a third reviewer. We do not exclude the possibility of adapting the instrument according to common specificity of included studies.

**Strategy of data synthesis** Generalized linear mixed model (GLMM) will be used to estimate the pooled proportions for each cause of avalanche death, separately. All meta-analysis series with available data for a cause in question will be used. Random-effects model will be employed to generate pooled estimates of effect. Logit transformation will be used to treat the raw proportion for entering the model. The pooled proportion will be expressed as proportion with accompanying 95% confidence intervals (CIs). Clopper-Pearson method will be used to compute confidence interval for individual studies.

Studies with extremely small sample size or biased sample would be misleading and consequently meta-analysis will be performed without these studies.

**Subgroup analysis** Subgroup analysis will be performed if there is unexplained high heterogeneity for the initial meta-syntheses and if sufficient data was available. The primary focus will be on on data time span, regions, sample sizes, and data representativeness. Other subgroups will be introduced post-hoc if we observe any interesting pattern while reading the full texts of included studies.

We will categorize the time span as "before the year of 2000", "after the year of 2000" and "across the year of 2000".

Regions will be the nations where the accidents happened.

Sample size is the number of victims included in a study or a cohort for analysis. Categories include both 30.

Data representativeness is size of population the non-survivors represent. They can be either Hospital/institution-based, local, nationwide and multi-nationwide.

**Sensitivity analysis** Leave-one-out sensitivity analyses will be performed for each cause. Studies with high risk of bias will be excluded in another sensitivity analysis.

On the other hand, a group of sensitivity analyses will be conducted by keeping one single study with largest sample size for each overlapped group of studies.

**Language restriction** No language limits will be imposed.

**Country(ies) involved** China, Finland, Ireland, Germany, Norway.

**Keywords** avalanche, cause of death, trauma, asphyxia, hypothermia, meta-analysis.

**Contributions of each author**
Author 1 - Guang Rong - Designing study; developing search strategy; searching reports; screening reports; assessing risk of bias; analyzing data; writing the manuscript.
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Author 3 - Benjamin Cowley - Consulting librarian; networking collaborators from multiple European countries; screening reports (settling dispute); assessing risk of bias (settling dispute); quality control of data analysis; improving the manuscript; inspecting the quality and progress of the full study; funding the study.
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