

ORIGINAL ARTICLE

Mountain Rescue Activity and Limitations of Accidental Hypothermia Surveillance in Spain: A Descriptive Analysis of Guardia Civil Data, 2018-2021

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ABSTRACT

BACKGROUND:

Accidental hypothermia is a potentially life-threatening complication of cold exposure in mountain and wilderness environments. Reliable surveillance requires clinically specific field data, but administrative rescue datasets may group hypothermia with other medical problems.

OBJECTIVE:

To describe mountain-rescue activity recorded by the Spanish Guardia Civil Mountain Service from 2018 through 2021 and assess whether publicly available administrative data can support estimation of accidental-hypothermia prevalence, severity, or clinical impact.

METHODS:

We performed a retrospective descriptive secondary analysis of aggregate data from the Statistical Yearbooks of the Spanish Ministry of the Interior. Annual intervention totals were extracted for 2018-2021. Detailed 2021 data were summarized using separate denominators for rescue interventions and rescued persons, including activity, accident type, mountain massif, age, sex, and rescue status. Because the public data contain no hypothermia-specific count, core-temperature field, clinical stage, treatment data, or patient-level linkage, no hypothermia prevalence estimate or causal analysis was attempted.

RESULTS:

Across 2018-2021, 3,780 mountain-rescue interventions were recorded: 974 in 2018, 981 in 2019, 790 in 2020, and 1,035 in 2021. Interventions decreased by 19.5% from 2019 to 2020 and increased by 31.0% from 2020 to 2021. In 2021, 1,489 rescued persons were reported across 1,035 interventions; 102 were recorded as deceased, 654 as injured, and 733 as uninjured at rescue reporting. Men represented 62.9% of rescued persons, and the largest age group was 19-30 years (22.4%). Hiking accounted for 552/1,035 interventions (53.3%), the Aragonese Pyrenees for 402/1,035 (38.8%), and same-level trips/falls for 302/1,035 (29.2%). A broad "physical problems" category accounted for 127/1,035 interventions (12.3%) and included severe hypothermia together with other medical conditions; hypothermia-specific frequency could not be isolated.

CONCLUSION:

Guardia Civil data provide a useful description of mountain-rescue workload but do not support estimation of accidental-hypothermia prevalence, severity, or outcome. Future surveillance should separately record suspected or confirmed hypothermia, core temperature and measurement method, clinical severity, exposure context, treatment, and outcome using harmonized definitions across rescue services.

KEYWORDS

accidental hypothermia; mountain rescue; wilderness medicine; prehospital care; surveillance; Spain

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

Guillermo Munoz, Guillem Serra, and Jesus Ceballos contributed equally to the conceptualization, methodology, investigation, data curation, formal analysis, visualization, writing of the original draft, and review and editing of the manuscript. All authors approved the final version of the manuscript.

DATA AVAILABILITY

Available from the corresponding author upon reasonable request.

ETHICS

Exempt

CONSENT

Not Applicable

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ABSTRACT

BACKGROUND: Accidental hypothermia is a potentially life-threatening complication of cold exposure in mountain and wilderness environments. Reliable surveillance requires clinically specific field data, but administrative rescue datasets may group hypothermia with other medical problems.

OBJECTIVE: To describe mountain-rescue activity recorded by the Spanish Guardia Civil Mountain Service from 2018 through 2021 and assess whether publicly available administrative data can support estimation of accidental-hypothermia prevalence, severity, or clinical impact.

METHODS: We performed a retrospective descriptive secondary analysis of aggregate data from the Statistical Yearbooks of the Spanish Ministry of the Interior. Annual intervention totals were extracted for 2018-2021. Detailed 2021 data were summarized using separate denominators for rescue interventions and rescued persons, including activity, accident type, mountain massif, age, sex, and rescue status. Because the public data contain no hypothermia-specific count, core-temperature field, clinical stage, treatment data, or patient-level linkage, no hypothermia prevalence estimate or causal analysis was attempted.

RESULTS: Across 2018-2021, 3,780 mountain-rescue interventions were recorded: 974 in 2018, 981 in 2019, 790 in 2020, and 1,035 in 2021. Interventions decreased by 19.5% from 2019 to 2020 and increased by 31.0% from 2020 to 2021. In 2021, 1,489 rescued persons were reported across 1,035 interventions; 102 were recorded as deceased, 654 as injured, and 733 as uninjured at rescue reporting. Men represented 62.9% of rescued persons, and the largest age group was 19-30 years (22.4%). Hiking accounted for 552/1,035 interventions (53.3%), the Aragonese Pyrenees for 402/1,035 (38.8%), and same-level trips/falls for 302/1,035 (29.2%). A broad "physical problems" category accounted for 127/1,035 interventions (12.3%) and included severe hypothermia together with other medical conditions; hypothermia-specific frequency could not be isolated.

CONCLUSION: Guardia Civil data provide a useful description of mountain-rescue workload but do not support estimation of accidental-hypothermia prevalence, severity, or outcome. Future surveillance should separately record suspected or confirmed hypothermia, core temperature and measurement method, clinical severity, exposure context, treatment, and outcome using harmonized definitions across rescue services.

KEYWORDS: accidental hypothermia; mountain rescue; wilderness medicine; prehospital care; surveillance; Spain; Guardia Civil

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Running title: Mountain rescue and hypothermia surveillance in Spain

INTRODUCTION

Accidental hypothermia is generally defined as an unintentional decrease in core body temperature below 35°C. Outdoor exposure, wet and windy conditions, trauma, exhaustion, immersion, and prolonged rescue times can all contribute to cooling, and hypothermia may be primary or secondary to another illness or injury [1-3]. In mountain rescue, hypothermia is clinically important because progressive cooling can impair cognition, ventilation, cardiovascular stability, and ultimately circulation. Contemporary prehospital guidance therefore emphasizes prevention of further heat loss, assessment of clinical stability, reliable core-temperature measurement when feasible, appropriate rewarming, and rapid transfer of unstable patients to suitable receiving centers [1-4].

Clinical severity cannot be inferred reliably from environmental exposure alone. The Revised Swiss System and current wilderness and resuscitation guidance use clinical responsiveness, hemodynamic stability, cardiac rhythm, and core temperature when available to inform risk assessment and transport decisions [2-4]. Severe accidental hypothermia and hypothermic cardiac arrest can have meaningful survival with appropriate resuscitation and extracorporeal rewarming, further emphasizing the value of accurate field documentation [5,6].

Spain has a complex mountain-rescue structure. The Guardia Civil Mountain Service records rescue activity in national statistical yearbooks, while some autonomous communities are served by other specialized public rescue organizations. These administrative data are valuable for describing workload, geography, activity, accident mechanisms, and rescued-person characteristics, but their suitability for disease-specific surveillance depends on whether clinical variables are recorded in a sufficiently granular way [7-10].

The source academic project originally proposed estimating the prevalence and impact of hypothermia in mountain accidents. However, the completed public dataset available for analysis does not contain a distinct hypothermia variable or patient-level clinical measurements. The scientifically supportable question is therefore narrower: what mountain-rescue patterns are observable in the official data, and what information is missing to quantify accidental hypothermia? Accordingly, this study aimed to describe Guardia Civil mountain-rescue activity from 2018 through 2021 and evaluate the ability of those aggregate records to support hypothermia surveillance.

MATERIALS AND METHODS

Study design and data source

This was a retrospective descriptive secondary analysis of publicly available aggregate administrative data. Data were obtained from the Statistical Yearbooks of the Spanish Ministry of the Interior for 2018, 2019, 2020, and 2021, specifically the sections reporting activity of the Guardia Civil Mountain Service [7-10]. The source academic thesis also summarized these yearbooks and proposed additional prospective clinical data collection; the present journal report analyzes only data that were already collected and verifiable in the public administrative sources.

Study population and units of analysis

The annual time series used the number of recorded mountain-rescue interventions in 2018-2021. For 2021, the official yearbook reported both intervention-level and rescued-person-level data. Intervention-level tables used 1,035 rescue interventions as the denominator for activity, accident type, and mountain massif. Person-level tables used 1,489 rescued persons as the denominator for age, sex, and rescue-status categories. These denominators were kept separate throughout the analysis. The 2021 yearbook also reported 275 false alarms in which the incident was resolved before a rescue intervention began; these were not included in the intervention denominator [10].

The 2021 dataset included 115 interventions that were not performed during conventional mountain-sport activities but required specialized mountain-rescue capability because of difficult access or terrain [10]. These events remained part of the official 1,035-intervention total and were retained in this descriptive analysis.

Variables and hypothermia ascertainment

Extracted variables were calendar year, number of rescue interventions, mountain massif, activity, accident/incident type, age group, sex, and rescue status (deceased, injured, or uninjured). Annual percentage change was calculated from the intervention totals. Detailed category proportions for 2021 were calculated using the denominator specified by the corresponding official table.

The public administrative dataset did not provide a distinct count for accidental hypothermia, measured core temperature, temperature-measurement site or device, Revised Swiss System stage, level of consciousness, blood pressure, cardiac rhythm, exposure duration, rewarming treatment, or patient-level outcome linkage. In the 2021 narrative, severe hypothermia appeared only as one example within the broad "physical problems" category, together with conditions such as exhaustion, dehydration, and myocardial infarction [10]. Consequently, neither a hypothermia-specific case count nor its prevalence, severity distribution, treatment pattern, or independent clinical impact could be estimated from these data.

Statistical analysis

Analyses were descriptive. Annual intervention counts are presented as n and year-over-year percentage change. Categorical 2021 data are presented as n (%), using the denominator specified by the source table. No hypothesis tests, confidence intervals, regression models, or causal estimates were performed because the data represent aggregate administrative counts rather than a sampled patient-level analytic cohort. All percentages and temporal changes were recalculated from the reported integer counts and checked for denominator consistency.

Ethics and reporting

This secondary analysis used publicly available aggregate administrative data and did not involve identifiable individual-level information, direct patient contact, or access to private medical records. Research ethics committee approval and individual informed consent were therefore not applicable to the present analysis. Reporting was prepared with reference to the STROBE principles for transparent reporting of observational studies [11].

RESULTS

Annual mountain-rescue activity, 2018-2021

A total of 3,780 Guardia Civil mountain-rescue interventions were recorded across the four-year period: 974 in 2018, 981 in 2019, 790 in 2020, and 1,035 in 2021 [7-10]. Activity was essentially stable from 2018 to 2019 (+0.7%), decreased by 19.5% in 2020, and then increased by 31.0% in 2021. The 2021 total was 5.5% higher than in 2018. The 2020 reduction occurred during the COVID-19 pandemic period; because the dataset contains no exposure denominator or counterfactual comparison, the change should not be attributed to mobility restrictions or behavioral changes on the basis of these data alone.

Table 1. Guardia Civil mountain-rescue interventions, 2018-2021

Year	Interventions	Share of 4-year total, %	Year-over-year change, %
2018	974	25.8	—
2019	981	26.0	+0.7
2020	790	20.9	-19.5
2021	1,035	27.4	+31.0
Total	3,780	100.0	—

Source: Spanish Ministry of the Interior Statistical Yearbooks, Guardia Civil Mountain Service sections [7-10].

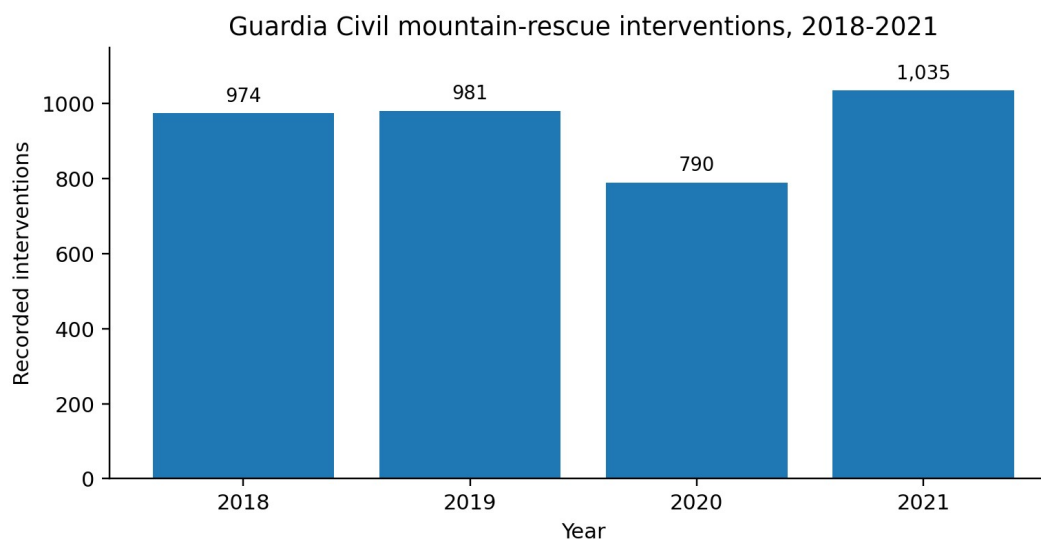


Figure 1. Annual Guardia Civil mountain-rescue interventions, 2018-2021. Values are official aggregate intervention counts [7-10].

Rescued-person profile in 2021

The 1,035 interventions in 2021 involved 1,489 rescued persons [10]. At the time of rescue reporting, 102 (6.9%) were recorded as deceased, 654 (43.9%) as injured, and 733 (49.2%) as uninjured. Men accounted for 936/1,489 (62.9%) and women for 553/1,489 (37.1%). The largest age group was 19-30 years (334/1,489, 22.4%), followed by 31-40 years (288/1,489, 19.3%), 41-50 years (282/1,489, 18.9%), and 51-60 years (272/1,489, 18.3%). These are person-level data and therefore should not be interpreted using the 1,035-intervention denominator. The deceased category is a rescue-status classification and should not be interpreted as cause-specific hypothermia mortality.

Table 2. Rescued-person characteristics and status, 2021

Characteristic	n	% of 1,489 rescued persons
Male sex	936	62.9
Female sex	553	37.1
Age 19-30 years	334	22.4
Age 31-40 years	288	19.3
Age 41-50 years	282	18.9
Age 51-60 years	272	18.3
Deceased	102	6.9
Injured	654	43.9
Uninjured	733	49.2

Age and sex categories sum to 1,489 rescued persons. Rescue-status categories also sum to 1,489. Source: 2021 Statistical Yearbook [10].

Intervention profile in 2021

Hiking was the dominant activity, accounting for 552/1,035 interventions (53.3%), followed by progression over rough terrain (128, 12.4%), canyoning (77, 7.4%), climbing (52, 5.0%), and mountain biking (34, 3.3%). The Aragonese Pyrenees accounted for 402/1,035 interventions (38.8%); the next largest massif categories were the Penibaetic System (105, 10.1%), Sierra de Tramontana (90, 8.7%), Central System (87, 8.4%), and Sierra Nevada (65, 6.3%).

Same-level trips/falls were the most frequently recorded accident type (302/1,035, 29.2%), followed by lost persons (207, 20.0%) and physical problems (127, 12.3%). Vertical falls accounted for 86 interventions (8.3%) and stranding/technical immobilization for 80 (7.7%). These categories describe rescue triggers or circumstances, not medical diagnoses.

Table 3. Leading 2021 intervention categories

Domain	Category	n	% of 1,035 interventions
Activity	Hiking	552	53.3
Activity	Progression over rough terrain	128	12.4
Activity	Canyoning	77	7.4
Activity	Climbing	52	5.0
Activity	Mountain biking	34	3.3
Geography	Aragonese Pyrenees	402	38.8
Geography	Penibaetic System	105	10.1
Geography	Sierra de Tramontana	90	8.7
Geography	Central System	87	8.4
Geography	Sierra Nevada	65	6.3
Accident/incident	Same-level trip/fall	302	29.2
Accident/incident	Lost person	207	20.0
Accident/incident	Physical problems	127	12.3
Accident/incident	Vertical fall	86	8.3
Accident/incident	Stranding/technical immobilization	80	7.7

Only the five largest categories in each domain are shown. All categories in the source tables sum to 1,035 interventions. "Physical problems" is a broad administrative category and is not a hypothermia case definition [10].

Hypothermia surveillance gap

The official 2021 narrative indicates that the “physical problems” category includes severe hypothermia among several other medical conditions [10]. Because the 127 physical-problem interventions are not disaggregated by diagnosis, a hypothermia-specific case count cannot be recovered from the public data. The available records also do not provide core temperature or the clinical variables required to stage hypothermia, assess risk of cardiac arrest, describe rewarming, or link prehospital severity to outcome. Therefore, the study’s original aim of estimating hypothermia prevalence is not achievable with the completed public dataset.

DISCUSSION

This secondary analysis yields two complementary findings. First, Guardia Civil mountain-rescue activity was substantial, with 3,780 interventions across 2018-2021 and a marked reduction in recorded interventions in 2020 followed by a rebound in 2021. Second, the public administrative data are not sufficiently granular for accidental-hypothermia surveillance: severe hypothermia is embedded within a broad medical-problem category, while temperature, clinical stage, treatment, and linked outcome data are absent.

The 2021 rescue profile provides useful operational context. More than half of interventions occurred during hiking, and nearly two fifths were recorded in the Aragonese Pyrenees. Same-level falls and lost-person incidents together accounted for almost half of interventions. These high-volume settings may be practical priorities for standardized cold-exposure and hypothermia documentation. However, the observed proportions are workload distributions rather than risk estimates because the number of people exposed to each activity, massif, season, or weather condition is unknown.

The distinction between intervention-level and person-level data is methodologically important. The 1,035 intervention records involved 1,489 rescued persons. Age, sex, and rescue-status proportions therefore describe people, whereas activity, geography, and accident-type proportions describe rescue events. Preserving those denominators prevents invalid cross-domain percentages and should be maintained in future multicenter surveillance.

Current accidental-hypothermia guidance makes clear why the missing clinical variables matter. A core temperature below 35°C defines accidental hypothermia, but field assessment must also account for responsiveness, hemodynamic stability, rhythm, mechanism, and the reliability of the temperature-measurement method [1-4]. The Revised Swiss System was specifically developed to improve field staging when temperature estimation is imprecise [4]. Patients with severe instability or cardiac arrest may require specialized transport and extracorporeal rewarming, for which prognostic and triage variables are clinically consequential [3,5,6]. A surveillance system that records only “physical problems” cannot support these clinical or epidemiologic questions.

Proposed minimum dataset for future surveillance

A practical next step is harmonized prospective data collection across mountain-rescue services. Table 4 proposes a minimum dataset derived from the variables anticipated in the source academic project and updated to align with contemporary hypothermia assessment principles [1-4]. The intent is not to create a new clinical guideline, but to define the minimum information required to distinguish exposure from disease, classify severity, and link prehospital care to outcome. A shared structured template should also preserve separate incident and patient identifiers so that multi-person rescues, repeat contacts, and cross-agency transfers can be distinguished without exposing identifiable patient information.

Table 4. Proposed minimum dataset for accidental-hypothermia surveillance in mountain rescue

Domain	Minimum recommended fields	Purpose
Case identification	Suspected/confirmed accidental hypothermia; primary vs secondary hypothermia	Separates hypothermia from broad medical-problem coding.
Temperature	Core temperature (°C); measurement site/device; time of measurement; unavailable/estimated flag	Supports reproducible case definition and assessment of measurement reliability.
Clinical severity	AVPU or GCS; systolic blood pressure; pulse; respiratory status; ventricular arrhythmia/cardiac arrest	Supports field severity assessment and risk stratification.
Exposure context	Ambient conditions; wet/immersion exposure; altitude/location; estimated exposure duration; season	Characterizes environmental and temporal determinants without inferring causality.
Coexisting condition	Trauma; avalanche burial; drowning/immersion; intoxication; acute medical illness	Distinguishes primary from secondary hypothermia and major confounders.
Treatment	Insulation; active external warming; warmed fluids; airway/ventilation; CPR; destination/ECLS-capable center	Links field severity to management and resource use.

Outcome	Rescue disposition; hospital transfer; return of spontaneous circulation when applicable; hospital survival/neurologic outcome when linkable	Supports clinically meaningful linkage between prehospital severity, management, and outcome.
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Proposed surveillance fields are informed by contemporary WMS, ERC, and ICAR MedCom recommendations [1-4]. They are not a substitute for clinical protocols.

Strengths

The principal strengths of this study are its use of official administrative data, explicit separation of rescue-event and rescued-person denominators, and conservative interpretation of what the dataset can and cannot support. The reframed objective avoids an unsupported prevalence estimate and treats the absence of hypothermia-specific fields as a reproducible surveillance finding rather than filling that gap by assumption. Standardized official categories also permit independent recalculation of the reported proportions.

Limitations

Several limitations are fundamental. First, the Guardia Civil Mountain Service does not represent all mountain-rescue activity in Spain; specialized rescue responsibilities are distributed across agencies, including regional services, so the data should not be interpreted as a complete national census. Second, the study uses aggregate administrative data and cannot link multiple variables at the individual level. Third, no exposure denominator is available for activity participation, time spent outdoors, altitude, weather, or seasonal visitation; consequently, category frequencies are workload distributions rather than incidence or risk estimates. Fourth, the 2020-2021 temporal changes occurred during the COVID-19 pandemic period, but this descriptive design cannot establish why rescue activity changed. Fifth, detailed age, sex, activity, geography, and incident distributions were available for 2021 and may not represent the entire 2018-2021 period. Sixth, rescue-status deaths are not cause-specific mortality data. Seventh, the records do not separately identify accidental hypothermia, and the broad “physical problems” category prevents estimation of its prevalence, severity, treatment, or outcome. Finally, administrative definitions, coding practices, and geographic coverage may change over time, and their accuracy could not be independently validated from the aggregate reports.

CONCLUSION

Guardia Civil mountain-rescue records document 3,780 interventions during 2018-2021 and 1,035 interventions involving 1,489 rescued persons in 2021. The central finding, however, is methodological: the available public data cannot quantify accidental-hypothermia prevalence, severity, treatment, or outcome because hypothermia is not captured as a distinct clinical condition. Harmonized multicenter surveillance using a minimum hypothermia dataset - including temperature, measurement method, clinical severity, exposure, treatment, and outcome - would allow future studies to move from rescue-workload description to clinically meaningful epidemiology.

DECLARATIONS

ETHICS APPROVAL AND CONSENT TO PARTICIPATE: Not applicable to the present secondary analysis, which used publicly available aggregate administrative data and no identifiable individual-level information.

FUNDING: No external funding.

CONFLICTS OF INTEREST: The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS: Guillermo Muñoz, Guillem Serra, and Jesús Ceballos contributed equally to the conceptualization, methodology, investigation, data curation, formal analysis, visualization, writing of the original draft, and review and editing of the manuscript. All authors approved the final version of the manuscript.

DATA AVAILABILITY: The aggregate data analyzed in this report are publicly available in the Statistical Yearbooks of the Spanish Ministry of the Interior cited in References 7-10.

PREVIOUS ACADEMIC VERSION: This manuscript is derived from the authors' master's thesis. The present journal version is restricted to completed, verifiable administrative data and does not present the thesis's proposed but uncollected hypothermia-specific clinical variables as study results.

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