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Assessing climate change's impact on cardiopulmonary health in the canton of Valais: a pilot study protocol

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Table of Contents

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Abstract

Background: Climate change is a challenge for health and humanity. In Switzerland, the canton of Valais is considered one of the driest regions in the Alps. Its air pollution can reach high levels; temperatures reach extremes of cold and heat. These climatic changes are harming the population's health and well-being. According to the Swiss Health Observatory, the emergency departments of Switzerland's 100 largest hospitals treated 1.722million cases in 2016, equivalent to 4,718 admissions daily. In Valais, 75,000 patients consulted at Sion's emergency department in 2022.

Objective: This pilot study aims to estimate climate change's impact on the cardiopulmonary comorbidities of Valais' population and explore adult patients' knowledge of climate change's consequences for their health. The study's findings will inform planning and facilitate estimations of how the care for adult patients presenting at Sion's emergency department needs to adapt and improve, and what changes must be made in the domains of health promotion and disease prevention. The feasibility and acceptability of the patient selection and data collection processes will also be explored.

Methods: The pilot study will use a convergent parallel mixed-methods design. Data collection will occur over a year, from 21 September 2024 to 20 September 2025. Descriptive statistics of the quantitive phase will be calculated, and the qualitative phase will undergo a thematic analysis.

Results: The 12-month recruitment period is expected to provide a sample of at least 60 patients. We will explore the process of recruiting patients to the study, the reasons for their consultation at Sion's emergency department, their triage level, their sociodemographic profile, and their knowledge about climate change and its potential links to their emergency department visit.

Conclusions: The pilot study's results will enable us to test the feasibility of the methods and procedures needed for a larger study and to search for the effects of potential associations between specific changes to the characteristics of Valais' microclimate and its population's health. Associations will enable us to establish typical profiles of the adult patients who consult at Sion's emergency department. The qualitative phase's results will help to reveal and explore those patients' personally and socially determined perceptions, experiences, knowledge and feelings about climate change. Clinical Trial: 2024-00900

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Pilot study protocol

Assessing climate change's impact on cardiopulmonary health in the canton of Valais: a pilot study protocol

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Climate change is a challenge for health and humanity. In Switzerland, the canton of Valais is considered one of the driest regions in the Alps. Its air pollution can reach high levels; temperatures reach extremes of cold and heat. These climatic changes are harming the population's health and well-being. According to the Swiss Health Observatory, the emergency departments of Switzerland's 100 largest hospitals treated 1.722million cases in 2016, equivalent to 4,718 admissions daily. In Valais, 75,000 patients consulted at Sion's emergency department in 2022**.**

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Keywords: Climate change; Global warming; Emergency department; Emergency nursing; Health; Sustainable care; Ecological medicine

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Introduction

The planet's climate crisis is directly damaging human health. Worldwide, 3.6 billion people live in areas highly sensitive to climate change. Rising temperatures, extreme weather events, air pollution and the spread of infectious diseases are just some of the major health threats exacerbated by climate change (1). Climate change has many other direct and indirect effects on human health, including physical and mental disorders. Projections for 2025 estimate that climate change will be responsible for 250,000 additional deaths per year between 2030 and 2050 (2,3). Worldwide, 9 out of 10 people breathe poor-quality air, and more than 7 million people die every year because of this pollution. Greenhouse gas emissions, particulate matter (PM), nitrogen dioxide (NO_2), tropospheric ozone (O_3) and sulfur dioxide (SO_2) are the pollutants with the most significant impact on human health. There has been a concurrent 57% increase in heatwave episodes since 2010. Heat-related deaths among people over 65 have risen by 70% in two decades (4).

In recent years, several studies have been conducted on the various components of the relationship between health and climate change in Switzerland, particularly via the SAPALDIA cohort (5). A review of 22 studies by Cicci *et al.* (6) highlighted positive associations between high temperatures and ischaemic heart disease, acute myocardial infarction, the risk of congestive heart failure and the number of emergency department (ED) consultations. Indeed, increasing numbers of ED admissions (6,7) and hospitalisations for respiratory and cardiovascular diseases have been linked to non-optimal temperatures and exposure to pollutants and unconventional natural gas development, while more cases of decreased lung function or chronic obstructive pulmonary disease have been linked to exposure to SO_2, NO_2 and PM_{10} (8–10). Finally, climate change generally leads to warmer temperatures and less frequent periods of frost, prolonging plant growth and pollination seasons and often increasing the overall amount of pollen produced. This phenomenon can lead to increased respiratory allergies, rhinitis and asthma in sensitive patients with IgE-mediated allergic reactions (11,12).

In addition to its impacts on health, climate change can compromise many social determinants of good health, exacerbating the inequalities in morbidity and mortality that particularly threaten vulnerable populations. Indeed, environmental risk factors, such as demographics, geography, biology, health, sociopolitical and socioeconomic status, health system capacity and overall equity, are responsible for 80% of common illnesses and 25–33% of the total disease burden (13). Vulnerability has four primary features: integrity (a person's sense of soundness), challenge (vulnerability is experienced when there is a perceived challenge to one's integrity and uncertainty about how to respond to it), capacity for action (the perceived ability to withstand, integrate or cope with the challenge), and multidimensionality (how vulnerability varies from one person to another and from one experience to another) (14,15). Older adults, infants from 0–1 year old, people with chronic diseases, those living in urban environments with a low socioeconomic status or experiencing social isolation (4,16), and people living at higher altitudes (6) are all considered to be population groups vulnerable to climate change. Finally, regarding biologically sex, Bayentin *et al.* (17) and Gebhard *et al.* (18) found that hospitalisations for ischaemic heart diseases and myocardial infarction were higher among younger women than among younger men. Women have a higher core temperature, skin temperature, heart rate and blood pressure than men, which can lead to decreased heat tolerance. However, men have a 33% higher incidence of stroke and a 41% higher prevalence of stroke than women (6).

EDs are gateways to the healthcare system. Their mission is to provide immediate specialist care to patients with urgent or life-threatening needs. Despite their heterogeneous profiles, EDs must provide patients with efficient, high-quality care, which the Institute of Medicine defines as the ability of a health service to increase the likelihood of achieving desired health outcomes in line with current professional knowledge (19). Quality of care is a multidimensional concept that implies safe, responsive, effective, efficient, equitable and

patient-centred care (19). In Switzerland, the national Ordinance on Quality of Care and Patient Safety sets out how healthcare facilities and institutions and healthcare professionals must be actively committed to ensuring the quality of care and promoting patient safety (paragraph 1). Moreover, through their collaboration, patients contribute to achieving the defined objectives of high-quality care and safety (paragraph. 2).
Ever more attention is being paid to the relationship between the environment and health. Climate change is causing health problems that did not exist before, leading to new healthcare needs. It is, therefore, essential to analyse climate change's impact on the healthcare system. Steered by the UK Medical Research Council's Guidance Framework, this pilot study aims to evaluate the feasibility of the patient selection process (estimation of recruitment and retention, sample size estimation, assessment of the relevance of inclusion and exclusion criteria) and the data collection process (for the qualitative and quantitative phases) projected for use in a future larger study. Specifically, the primary outcomes of the quantitative phase will be an exploration of patient recruitment, the reasons for their consultation, their triage level, and the follow-up of adult patients admitted to the ED. The three secondary outcomes will be an exploration of the sociodemographic profiles of the adult patients consulting at Sion's ED, the level of acceptability of a tool to explore patients' knowledge about climate change and its potential links with their ED visits, and an estimation of climate change's impact on the Valais population with diagnosed cardiopulmonary comorbidities.

Methods

Design

Achieving this pilot study's objectives requires a convergent parallel mixed-methods design. Pilot studies are commonly used in health-related research in disciplines such as nursing and medicine (20), frequently to generate data for sample size calculations. This seems especially relevant when there are no data from previous studies to inform the process (21,22).

Framework

The UK Medical Research Council's Guidance Framework provides a structured approach for the development, evaluation and implementation of complex healthcare interventions. Analysing different procedures within a healthcare system is a complex process. Many different elements should be considered, including the intervention's interactions with the context, stakeholders' perspectives and adherence to the protocol, uncertainties, the potential need to redefine the intervention's process, the efficacy and effectiveness of that process, the evaluation of the different resources used, and the consequences of the intervention's outcomes. The Guidance Framework offers a rigorous, evidence-based approach to developing and testing healthcare interventions. It helps ensure that complex interventions are effective and feasible to implement in real-world settings. The framework also emphasises the importance of understanding not just whether an intervention works, but how it works and in what contexts it can be most effective. (23).

Quantitative phase

Data collection will occur over the year from 21 September 2024 to 20 September 2025 (Figure 1).

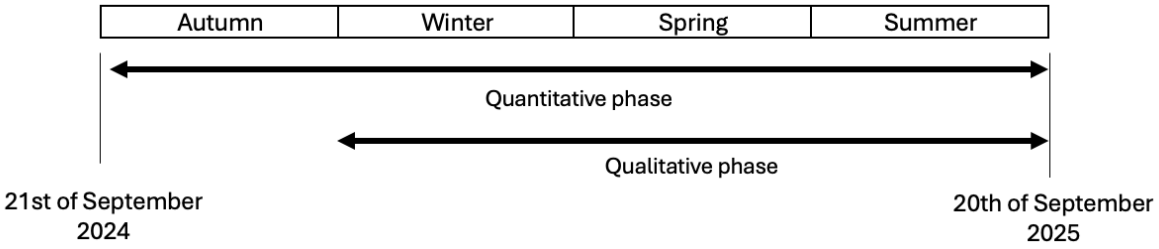

Figure 1: Pilot project's quantitative and qualitative phases.

The quantitative phase's objectives are to explore recruitment, the reasons for adult patients' consultations at Sion's ED, their triage level, their sociodemographic profile and their follow-up.
A sample size of 40 to 60 adult patients is planned, i.e. 15 per season. This represents just over 10% of the accessible sample, considering the estimated time of data collection and the pre-established inclusion criteria. According to Becker (1994), 10–20% of the potential full sample size is reasonable for conducting a pilot study (24). Patient recruitment for the quantitative phase will take place during the triage process.

Inclusion criteria and data collection

We will include all adult patients aged ≥ 18 who consult at Sion's ED and have cardiopulmonary comorbidities sorted into levels 3, 4 or 5 according to the Valais triage scale. The patient must be able to speak, understand and read French and sign the informed consent form with full knowledge of the facts. Eligible participants who sign this form but die during or after their ED consultation will be included in the study. The exclusion criteria are patients classified at levels 1 or 2 on the triage scale or who do not possess the capacity for discernment (as diagnosed by an ED physician). A level 1 classification on the Valais triage and severity scale implies a life-threatening condition. The patient's pathological situation could lead to death or the loss of an organ or a limb if care is not provided immediately. The patient must be transferred to an emergency care unit immediately. A level 2 triage classification requires urgent treatment since the pathological situation is not life-threatening but is susceptible to rapid deterioration. The patient must be transferred to an emergency care unit and assessed by a doctor as quickly as possible. We believe it is, therefore, inadvisable to involve patients triaged at levels 1 and 2 in the pilot study as their rapid care is vital. Finally, Sion's ED does not accept patients under 18, as they are referred directly to the paediatric ED.
The variables to be analysed can be divided into two categories: (1) sociodemographic data such as sex, age, place of residence (commune and/or postal code) and marital status (single, married, divorced, widowed, separated or in a couple) (2). Medical and clinical data collected during ED visits, such as triage level, reason for the consultation, diagnosis based on the ICD-10 classification, medical or surgical history, smoking status and ED readmissions in the last six months. All these questions, except for ED readmissions in the last six months, will be collected by the charge nurse during history taking and other exchanges with the patient. In this way, the data collection process for the study's variables of interest will not prolong emergency care or diminish its quality.
Sociodemographic, medical and clinical data will be analysed in conjunction with climate data, e.g. O_3 concentrations and air pollution data (Table 1).

	Variables of interest								
Databases	T_{max}	T_{min}	T_{mean}	NO_2	$PM_{2.5}$	PM_{10}	SO_2	O_3	Pollen
eteosuisse ttps:// ww.meteosuisse.admin.ch/ eteo/systemes-de-mesure/	X	X	X						X

estion-des-donnees.html									
ESIVAL tps://222.vs.ch/web/sen/qualite-de-air			X	X	X	X		X	

Table 1: Databases and variables of interest for meteorological data.

Recruitment procedure in triage

The procedures for participant recruitment will be carried out by triage nurses—the first nursing staff patients meet when they arrive at the ED—and the charge nurse. The principal investigator will explain the participant selection process to all the ED nurses at two team meetings (each 45 minutes long at the ED) and through an e-mail containing a PowerPoint presentation with a voice-over that will be sent out before those meetings. This will enable nurses to ask pertinent questions about their understanding of the recruitment algorithm. The patient selection process takes place within the framework of the study. The triage nurses' role is to prioritise the patient's health status for the duration of their ED stay. They will be responsible for identifying whether patients meet all the inclusion criteria and, thus, for initiating the selection process. The charge nurse and the triage nurse will then ask the patient whether they consent to participate in the study. If they agree, the nurses will collect the signed consent form. Charge nurses work closely with emergency physicians to optimise patient flows, organise nursing care or ensure the flow of information between healthcare professionals and care units. They are the first to receive information about the patient's discharge. As a reminder of the process and to ensure that it is carried out homogeneously, the participant selection algorithm (Figure 2) will be posted in every triage station and at the door of each cubicle. Indeed, nursing care in emergency contexts is often represented using an algorithm, so it is a visual tool that professionals in this field are familiar with. This will promote adhesion to and understanding of the algorithm.

The triage nurse will explain the study's purpose and the patient's contribution. They will then provide the patient with the study information document and the consent form. These additional explanations will not lengthen triage time nor compromise the quality of care. The patient will have time to read the various documents before entering the cubicle. When patients are given their discharge papers home (e.g. a prescription, a follow-up appointment, a potential sick note for their employer, other recommendations), the charge nurse will verify whether they have decided to participate in the study and will collect their signed consent form if this is the case. They will answer any questions the patient may have and remind them that their data will be coded and that they may receive a telephone call from the principal investigator. Consent to participate in the study is valid only if the patient's ED physician establishes that they are fully capable of discernment.

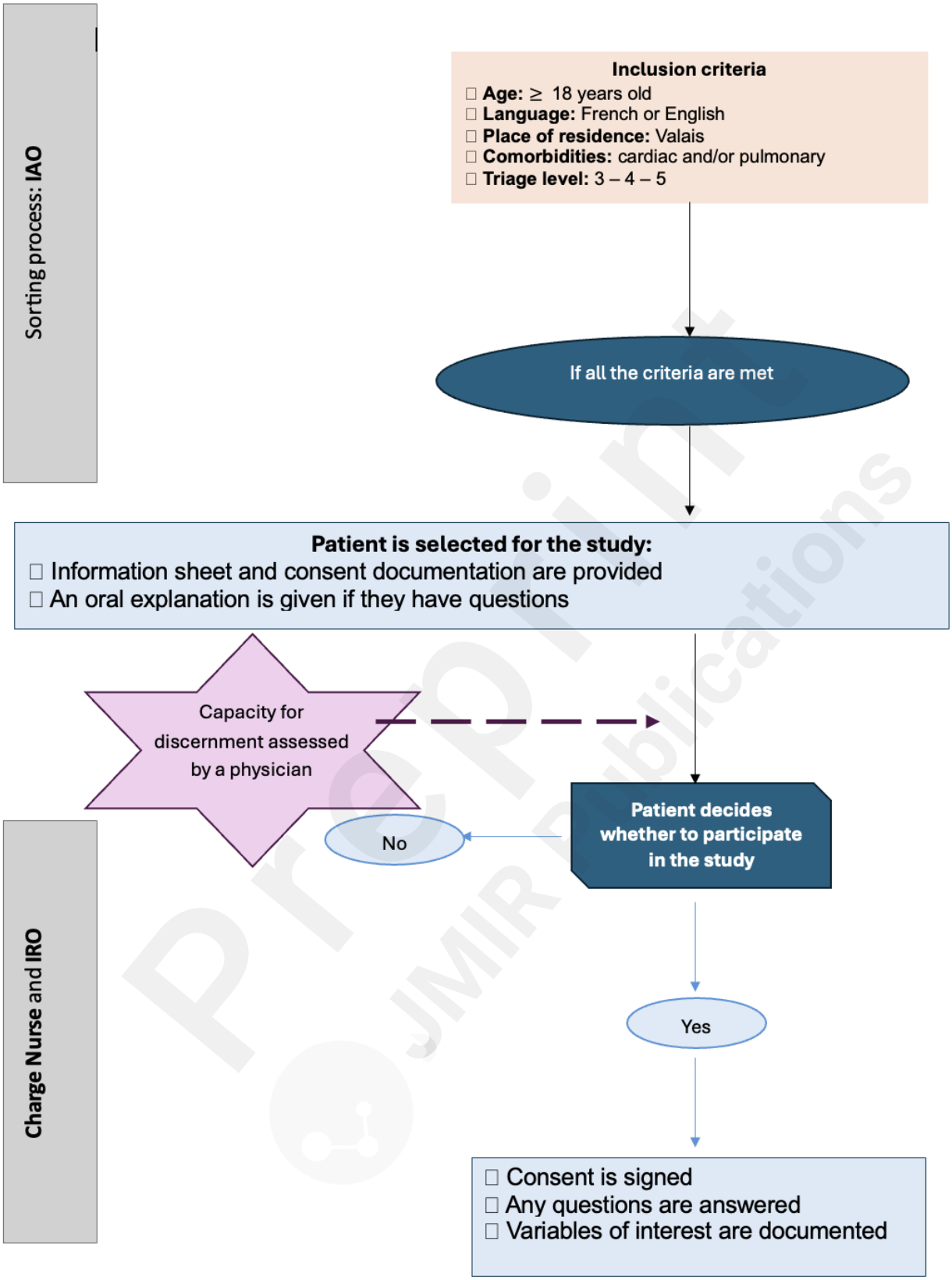

Figure 2. Patient selection algorithm.

Measuring temperatures and pollution

In Valais, the RESIVAL measurement station network monitors and analyses air pollution levels and calculates mean daily air quality parameters (24 h from 0 Coordinated Universal Time to 0 Coordinated Universal Time) all across the canton. Daily temperature variables (Tmin, Tmax,

Tmean) and pollen variables will be taken from MeteoSuisse, Switzerland's official federal national weather and climate service that operates under the Swiss Federal Department of Home Affairs. It is responsible for weather forecasting, climate monitoring, meteorological research, data collection and public weather-related services (www.meteosuisse.admin.ch).

Qualitative phase

The qualitative phase's objective is to explore patients' knowledge of climate change and its potential links to their ED consultations. Indeed, factors outside of medical care, such as health beliefs, knowledge and attitudes, and behaviours such as smoking, are categorised as social determinants of health (25).

Criteria and data collection

A non-probability sample of patients participating in the study's quantitative phase will be selected for inclusion in the qualitative phase. The qualitative phase will be documented through individual interviews of 30–45 minutes until data saturation is reached. The theoretical number of interviews required is approximately 10–15. At least six weeks after the ED consultation, the principal investigator will contact participants on an aleatory basis by telephone to ask them to participate in a 30–45-minute interview. Six weeks was chosen so as to be far enough removed from any potential hospitalisation that followed the index ED consultation. More information will also be collected and explored regarding the social determinants of health, categorised into five domains: (i) neighbourhood and environment (where patients live, work and play), (ii) health and quality of access to healthcare (patients' use of health services to achieve the best health outcomes), (iii) the social and community context (people with whom patients communicate and connect), (iv) patients' access to education, and (v) economic stability (patients' financial resources). These domains can affect wellness, illness and disease conditions (26). By recognising how social determinants impact health outcomes, nurses can play a key role in addressing health disparities and promoting health equity. Indeed, health disparities—variations in health linked to social, economic and environmental disadvantages within a society (27)—are a pressing issue that demands immediate attention.

Withdrawal and discontinuation

In the event of the patient's withdrawal from the study's qualitative phase, their data will still be analysed as part of the quantitative phase. Participants withdrawing from the qualitative phase will be replaced in order to maintain the estimated number of interviews required. Participants can withdraw from the qualitative phase at any time, which could be due to a change of mind or to any complication resulting in a loss in their capacity for discernment or ability to understand and speak French (e.g. an altered state of consciousness, intubation, tracheostomy, tracheotomy).

Results

Statistical analysis plan

Statistics calculated in a pilot study are not used to test the definitive effectiveness of its interventions but rather to assess the feasibility of the full-size study and refine its methodology. A variety of methods can be used to address the objectives established for a pilot study, and these need not be statistical (23). Indeed, statistical uncertainty must be taken into consideration before any of the pilot study's findings are generalised. The goal of publishing results from pilot studies is not to focus on their statistically significant findings but rather to provide their estimated effects on all the measures of interest and to describe the lessons that have been learned and will be informative in planning subsequent studies (24).

Factors such as the population's sociodemographic characteristics, economic conditions and access to outpatient and hospital care facilities may confound the relationship between ambient air pollution

and hospital admissions. More specifically, numerical and qualitative data will be analysed according to good clinical research practices. Statistics will be generated from the raw data collected from the ED's patient records and the appropriate meteorological and air pollution websites (MeteoSuisse and RESIVAL). A database gathering sociodemographic, health, meteorological and air pollution data will be prepared on an Excel spreadsheet. They will be imported into and analyzed using IBM-SPSS® software (IBM-Statistical Package for Social Sciences), version 29.0. Descriptive statistics such as mean and standard deviation (for quantitative variables) and frequency and percentages (for qualitative variables) will be calculated. Parametric statistical tests will be applied to normally distributed variables. Non-parametric statistical tests will be used for variables with non-Gaussian distributions. This data analysis will enable us to better describe the study participants' profiles. To estimate the effects of meteorological, sociodemographic and health data, we will calculate a conditional quasi-Poisson regression and distributed lag non-linear models. One advantage of the Poisson pseudo-maximum likelihood estimator is that the scale of the dependent variable does not affect the parameter estimates (9). In this type of regression model, a pseudo-likelihood is applied to properly scale the standard deviation of the coefficients proportionally to the potential overdispersion (7,31,44,45). We will use overdispersed generalised additive models with random-effect meta-analysis to investigate the associations between variables (46,47). ANCOVA models will also be developed to compare the means of a continuous dependent variable across multiple factor variables and to determine covariates' effects and interactions with other factors. Finally, the participant inclusion rate and study retention or drop-out rates will also be estimated, as will the total sample size required for the full-scale study.

The statistical significance threshold will be set according to the number of variables and the size of the database developed (two-sided p-values < 0.01 will be considered statistically significant, with 95% confidence intervals and Bonferroni adjustments for multiple comparisons).

Ethical considerations

The research protocol for this pilot project was presented to its different partners. A request for authorisation to proceed will be presented to Swiss Ethics. The support of the University of Applied Sciences and Arts Western Switzerland is assured. Participation in the study will be voluntary and pose no risk to the patients. In the context of this study, it is highly unlikely that participants will be exposed to any inconvenience or risk. Whether they participate in the study will in no way alter their care pathway or the quality of the care and follow-up they receive. Should the participant request them, the principal investigator will send them the pilot study's results by e-mail or post. Participation in this study will be of no direct benefit to the patient. However, the results may help improve the overall delivery of care by providing emergency medicine that is better adapted to patients' health status and needs. Finally, the pilot study's preliminary results will enable the research team to propose a larger-scale study.

Given the nature of the variables to be collected, personal data will be coded to protect the life, health, dignity, integrity, right to self-determination, privacy and confidentiality of the people participating in the research. The coding process will be based on the best-practice recommendations found in Article 29 of the Working Group on Data Protection (the independent European advisory body on data protection and privacy). A collaboration agreement has been drawn up with Hôpital du Valais in the canton's French-speaking area. The principal investigator will be granted access to data obtained with patient consent for the duration of the study. The data collection process will be carried out in compliance with the appropriate data protection, human research and ethical principles, thus ensuring respect for patients' rights and the confidentiality of their medical information. The coding key will be kept separate from the study data.
For the purposes of this pilot study, data will be stored on the Haute École de Santé Valais-Wallis'

Onedrive server. The coding key between personal data and the numerical code, as well as the transcripts of each individual interview, will be kept by the principal investigator.

Discussion

Principal results

The results of this pilot study will enable us to assess the feasibility of its methods and procedures in view of carrying out a larger study. They will also enable us to search for the possible effects of climate change or its associations with specific characteristics of Valais' microclimate and the health of its population. If this is the case, we will be able to establish profiles of the patients who consult in Sion's ED. This process would be similar to the concept of ecological medicine since it allows for the optimal use of environmental factors to provide patients with high-quality care and preserve ecological sustainability (28).
The results of the present pilot study could constitute a first step towards developing sustainable, ecological care. Indeed, today's duality of a healthcare system that provides benefits to patients and the population but has deleterious environmental consequences is becoming less and less acceptable. Finally, this pilot study will establish guidelines for a future larger-sized study.

Limitations

Data will be collected over one year so that all four seasons and their particularities—especially regarding climatic variables—can be studied. This pilot study is a single-centre study and will only represent results from the Hôpital du Valais' ED in Sion. Finally, its objective is to explore the potential for adult patient recruitment, the reasons for patients' consultations, their level of triage, and their follow-up after ED admission. It will also test the acceptability of a tool to explore patients' knowledge of climate change and its links with their ED visits. These preliminary results will constitute the first milestone in the assessment of the practicality of recruiting and retaining participants and in the determination of the most appropriate participant selection process to ensure stakeholder adherence for a full-scale study.

Conclusions

Nurses must be given the tools to come to grips with the global health ermergency that is climate change. Taking stock of the current situation, particularly in the alpine canton of Valais, in Switzerland, will require a thorough assessment. This pilot study's preliminary results will be used to inform a future large-scale study whose findings we may be able to generalise and to identify the climate change's impact on the environment and the health of Valais' population.

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Conflicts of Interest

None declared.

Abbreviations

ED: emergency department
~~GHG: greenhouse gas emissions~~

NO_2: nitrogen dioxide
O_3: ozone
PM: particulate matter
SO_2: sulfur dioxide

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