Methods

Study type and study design

Design, execution, analysis, and publication of this study was conducted in compliance with the international quality criteria "STrengthening the Reporting of OBservational studies in Epidemiology (STROBE)" [29] and "Standards for Reporting Qualitative Research (SRQR)" [66].

This was a monocentric, qualitative, mixed-methods, non-interventional, non-randomized research project.

Module 1 is designed retrospectively, modules 2 and 3 are cross-sectional.

Data sources

Data sources for module 1 were administrative data related to the COVID-19 crisis (notes, diaries, protocols, correspondence, like [90]) as well as personal mission experiences of the principal investigator of this study. Module 1 did not need any study subject recruitment. The first CIMIC mission of the Heidelberg CIMC liaison team started on 16 March 2020 with a crisis team meeting at the mayor's office in Heidelberg. Close of database for the mission analysis was 11 May 2022. At this date, CIMIC support had already ended.

Data sources for modules 2 and 3 were semi-structured interviews with key actors in disaster management as specified further below. Interview partners recruited for Modules 2 and 3 were subject to convenience sampling and were contacted personally and directly by the principal investigator. Subjects were recruited from adult non-vulnerable disaster response actors related to the management of the COVID-19 crisis. The rationale, purpose, goals, benefits, and risks of the study were explained in detail to the interview partners, and any questions were answered by the principal investigator. A study information sheet, an explanation on data protection, and an informed consent form was provided. If the subjects wished to take part in the study, the principal investigator and interview partners both signed the informed consent form. The semi-structured individual interview then started; all interviews were conducted by the principal investigator. The time needed was approximately 2 hours. The answers were recorded by the principal investigator. The subjects had the right to

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terminate the interview at any time without any disadvantages. The study started after receipt of the positive ethical vote and prospective study registration on ClinicalTrials.gov (study start with first subject enrolled 23 September 2022). The last subject was enrolled 17 November 2022.

Ethics

This study was submitted to the ethics committee of the Medical Faculty of the University of Heidelberg, Germany, and approved on 31 August 2022 (reference S-534/2022) before the recruitment of study subjects.

Study Registration

This study was prospectively registered on ClinicalTrials.gov on 21 September 2022 before study start and before enrollment (23 September 2022) of the first study subject (registration number NCT05552989 [80]). ClinicalTrials.gov is "a database of privately and publicly funded clinical studies conducted around the world" hosted by the U.S. National Library of Medicine [105].

Module 1: CIMIC mission in Heidelberg and Rhine-Neckar

The analysis of the local CIMIC mission in Heidelberg and Rhine-Neckar district was conducted through a qualitative, narrative, auto-ethnographic empiric approach according to the principles outlined by Creswell [22]. Here, the goal was to focus on three key issues:

(1) Understanding the thinking

The overarching guiding principle for CIMIC general and medical information exchange was a COVID-19 patient's journey through settings and institutions, this was described and analyzed in detail, because it illustrated the interconnected flow of information, their significance, and derived consequences for action.

(2) Understanding the players

Key players, stakeholders, and their relationships with each other were described and analyzed by two actors' diagrams. The first actors' diagram focused on the civilian administrative crisis management team and civilian disaster relief which represented the overall disaster relief perspective. The second actor's diagram focused on the medical aspects of COVID-19 disaster management and depicted the regional interclinical medical task force.

(3) Understanding the mission

Understanding rationale, motifs, goals, and forces deployed allows the reader to judge the impact of the present CIMIC actions for disaster relief. Therefore, the CIMIC support provided to the local population of Heidelberg and Rhine-Neckar was described and analyzed as described in detail below.

Medical information exchange analysis

Medical information exchange was qualitative and quantitatively ascertained by the principal investigator's networking, researching, and participating in crisis team meetings orthodromically guided by the SARS-CoV-2 patient's journey in a systems based-approach. Patients' journeys visualize the pathway of a patient across the healthcare system throughout the disease [6].

Mission analysis

Variables analyzed were goal of support mission, times of deployment (in month and year), and numbers and type of forces deployed. Results were graphically summarized by a bubble chart.

Modules 2 and 3: Impact of the Heidelberg/Rhine-Neckar CIMIC mission and lessons learned to be better prepared for future catastrophes

Modules 2 and 3 were based on semi-structured interviews with key players of the COVID-19 disaster response in Heidelberg/Rhine-Neckar, Germany.

Inclusion and exclusion criteria are presented in the following section.

Inclusion criteria

1. Age over 18 years
2. Direct or indirect involvement in civil-military collaboration during the COVID-19 crisis
3. Ability to provide consent
4. Providing written informed consent to participate in the study

Exclusion criteria

1. Failure to provide written informed consent to participate in the study

Interviewees

Interviewees were recruited upon invitation by the principal investigator [80]. A priori, a sample size of N = 10 was considered sufficient as a compromise of project feasibility, diversity of perspectives, and depth of insights. Seventeen potential study participants were contacted by the principal investigator, four invitees were not able to participate due to competing priorities, one invitee did not respond. Twelve participants were included after giving written informed consent, no interviewee discontinued the interview of withdrew consent.

Table 3 provides an overview of key stakeholders from the Heidelberg/Rhine-Neckar district disaster management community who were interviewed for this study.

Table 3. Interviewees by local disaster management function

Number	Interviewee disaster management function	Interview date [month/year]
Public health service		
1	Public health service physician	September 2022
2	Public health service physician	October 2022
3	Public health service physician, vaccination program	October 2022
Public service disaster managers and NGO's		
4	Public health and disaster management coordinator	November 2022
5	Director fire and disaster management agency	October 2022
6	Director fire and disaster management agency	October 2022
7	Red Cross operational manager	October 2022
Hospital and health care leadership		
8	Head, interclinical crisis management team and hospital alliance coordinator	November 2022
9	ICU cluster manager	November 2022
10	Nursing home director	October 2022
11	Nursing home care manager	November 2022
Civil-military cooperation		
12	Military CIMIC coordinator	September 2022

Semi-structured interview guide

Interviews were conducted in German language with the semi-structured guideline that is shown in Table 4. Interviews started after explanation of the study by the principal investigator and provision of written informed consent by the interviewee. The interviews started with an introductory sentence saying, "I have questions to you relating to 10 topics." At each step, the purpose of the questions was explained and then questions in the sections were asked iteratively (Table 4). Pauses were offered to participants during the interview.

Table 4. Semi-structured interview guideline

Number	Purpose of the question	Questions
1	Understanding of general perspectives and the context of the response	• Demographics (age, gender, marital status, citizenship, migration background, highest education, occupation, length of work experience, length of service in COVID-relevant field?)
2	Understanding of the specific professional context and perspectives of COVID disaster management	• What was your usual official professional role prior to COVID-19? • What was your official role in the pandemic (in terms of job title)? • What was your actual task in the pandemic (in terms of goals)?
3	Analysis of the perception of longitudinal pandemic development	• What phases would you divide your experiences or perceptions from the pandemic into?
4	Identification of the most important players	• Who were the five most important people (job title) to you in the pandemic response and why?
5	Analysis of task-specific challenges, results and lessons learned	• Which area exactly were you responsible for? • What were the three biggest challenges in your area? • What were the three biggest difficulties? • Which three things went best? • Which three things went worst? • What did you learn from this, what would you do the same, what would you do differently (how) and why?
6	Analysis of specific civil-military experiences, topics, outcomes, and lessons learned	• Did you have an insight into the work of the Bundeswehr? — if yes, where, and how? • In which areas were you supported by the Bundeswehr?

▶▶

Table 4. (continued)

Number	Purpose of the question	Questions
6 (continued)		• How would you rate the support of the Bundeswehr? — Which three things went best? — Which three things went the worst? — Which three things should you do differently next time (how) and why?
7	Comparison of civilian and military capabilities	• In which area of pandemic response was the **civilian side better** positioned and in which area was the **Bundeswehr better** positioned? • In which area of pandemic response was the **civilian side worse** positioned and in which area was the **Bundeswehr worse** positioned?
8	Analysis of the impact of civil-military support on local resilience	• Has the support of the Bundeswehr helped to strengthen resilience (resistance to crises)? — If yes, why? — If no, why not?
9	Analysis of mutual learning and synergies	• What can the civilian side learn from the Bundeswehr and what can the Bundeswehr learn from the civilian side?
10	**Outlook for the future:** Gap analysis and necessary preparations to strengthen resilience	• From the lessons learned perspective of the corona era: how well are we (the Heidelberg/Rhine-Neckar disaster management community) positioned for future disasters? — Where do you see strengths? — Where do you see weaknesses? — What do we need to do to be better prepared for future disasters? • In one sentence: what is your summary of the corona crisis? • Wish question: You have one wish that would come true—what would it be?

Qualitative data analysis: Coding of significant statements, horizontalization, grouping into clusters of meaning

The interviews were analyzed through a qualitative, mixed narrative-phenomenological approach as proposed by Creswell which was used in previous projects of similar scope published in the peer-reviewed literature [22, 23, 78, 79]. The interviews were audio-recorded and then transcribed anonymously in text format. The text was translated into English by the principal investigator and then examined for significant statements as a narrow unit of analysis. These significant statements were then horizontalized and grouped into clusters of meaning [22, 23]. The instruments did not change over time.

Techniques to enhance trustworthiness

Credibility was enhanced through prolonged engagement of the investigator with the subject matter (i.e., since the beginning of the pandemic). This included the ability of triangulation of the interview data analysis with independent observations of the investigator. The research context and the methods are being described in comprehensive detail in order to allow transferabilty into comparable settings and populations. Reflexivity as another factor of credibility is addressed in the section “Researcher characteristics and reflexivity”

Analytic framework: Appraisal of findings through a harmonized community resilience lens

Resilience is defined as “the capacity of a dynamic system to adapt successfully through multisystem processes to challenges that threaten the function, survival, or development of the system.” [59]. Concepts of resilience can vary substantially between publications and sometimes appear diffuse across the literature [79]. Therefore, Patel at al. conducted a systematic literature review of 80 published papers to define common concepts and identified nine core elements of community resilience (Figure 10), [71]. To systematically appraise and contextualize preparedness in a wider sense through a community resilience lens in this work, the clusters of meaning elaborated from the interviews in this study were then aligned post hoc into a nine-level framework of resilience elements as defined by the systematic literature review of Patel et al. [71].

The coding was conducted using the open-source qualitative data analysis software QualCoder 2.9-Ubuntu [24] run with Linux Mint 20 (LTS) Ulyana [56].

Results were presented in an aggregated form out of privacy considerations. Individual most significant statements that highlighted core ideas in a didactically valuable and highly illustrative manner were cited with potentially identifying information removed, again, for privacy reasons. Likewise, if considered necessary, contextual information was carefully added to the statement with a brief explanation to allow the reader better comprehensibility.

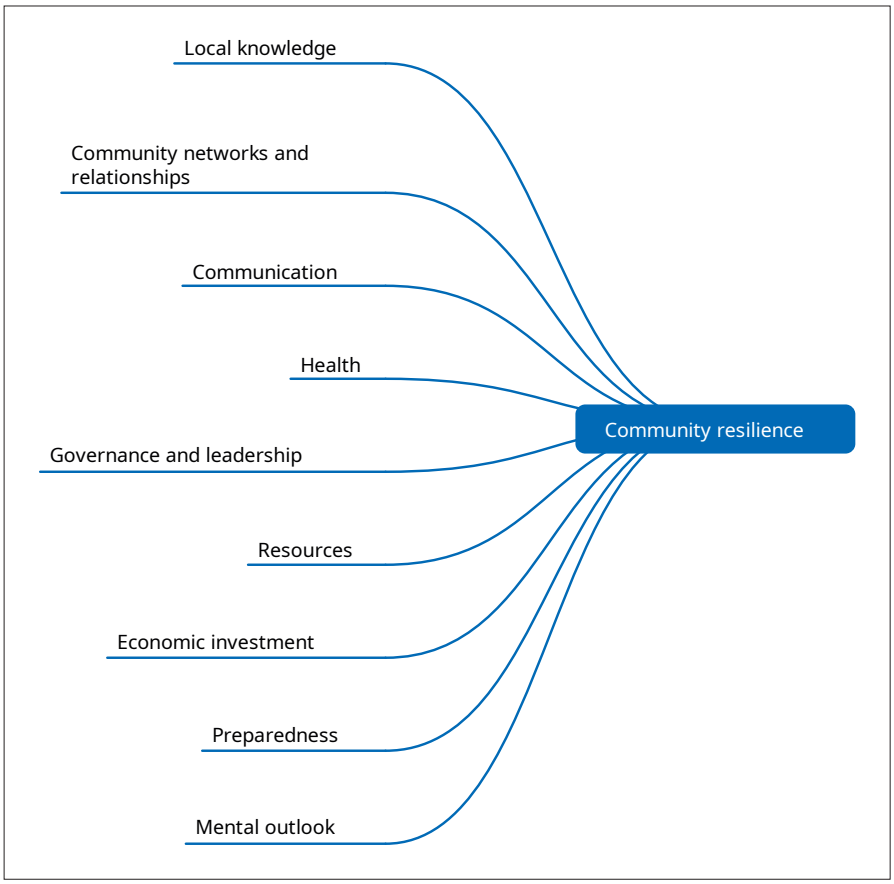

Figure 10. Nine core community resilience elements as defined by Patel et al., 2017 [71]

Variables and codes

Variables and codes analyzed are shown in Figure 11.

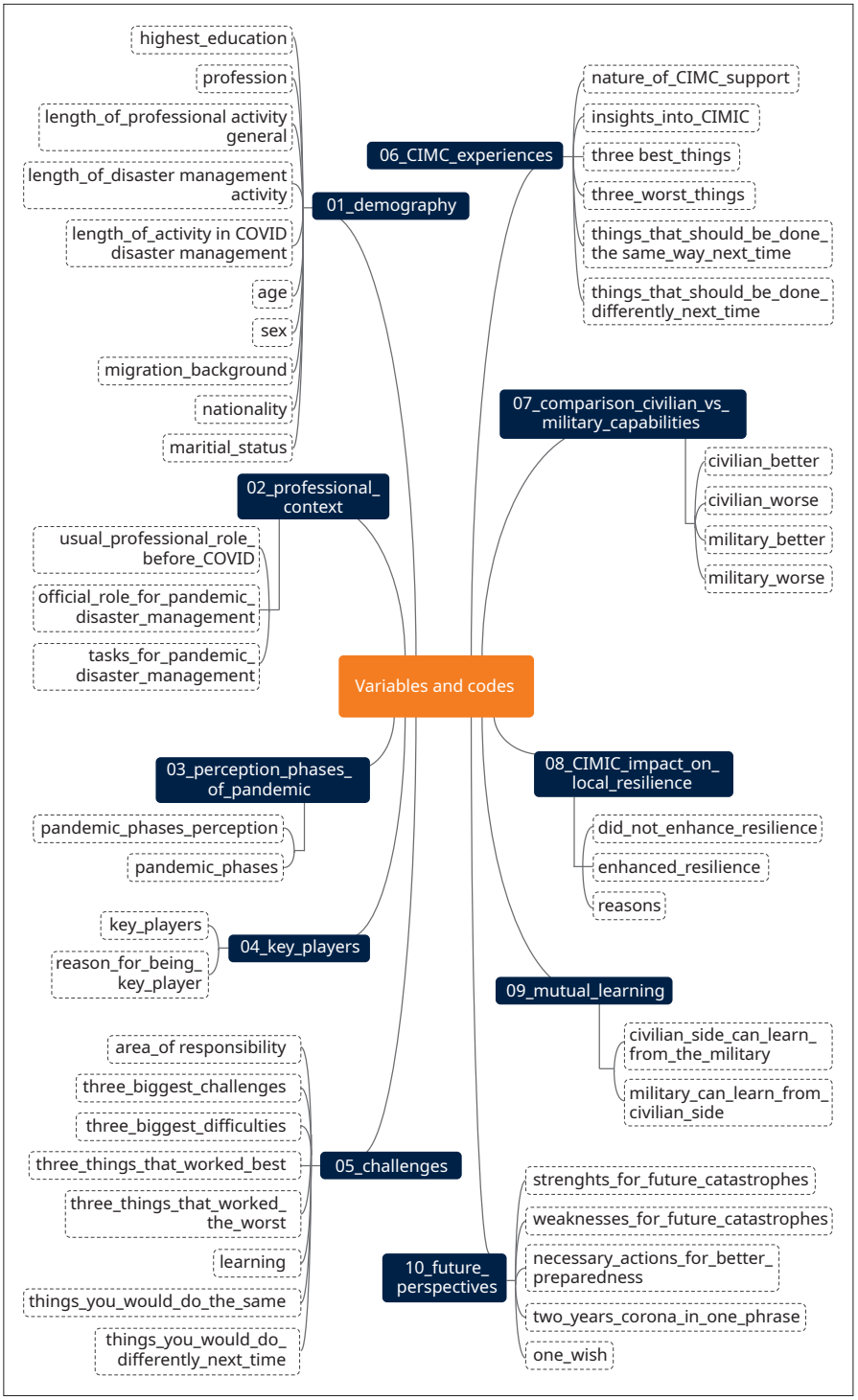

Figure 11. Variables and codes

Statistical analysis of quantitative variables

Continuous variables were analyzed through standard methods of descriptive statistics which included N, mean (if parametric), standard deviation (if parametric), median (if non-parametric) IQR (if non-parametric), minimum, maximum, missing values. Categorical variables were analyzed for frequency counts and percentages. Missing values were not imputed.

All calculations were conducted in RStudio "Tiger Daylily" (2389bc24, 2021-02-11) for Ubuntu Bionic using the packages "The R Base Package" ('base') version 4.1.3 and "Procedures for Psychological, Psychometric, and Personality Research" ('psych') version 2.2.3 [73, 77].

Epidemiological data: COVID-19 seven-day incidences and cumulative deaths for Heidelberg and Rhine-Neckar district

Data on the local COVID-19 seven-day incidences and deaths were obtained from the public health service Heidelberg/Rhine-Neckar district dashboard [75]. Data were reported for Heidelberg and the surrounding district separately because they are two distinctive administrative entities. The 7-day incidences give an indication about the spread of the infection in the population while numbers of deaths indicate the COVID-19 mortality.

Researcher characteristics and reflexivity

It is possible that qualitative data analysis and language translation can be influenced by the characteristics and the reflexivity of the individual conducting the research. The principal investigator of this work coordinated military-medical COVID-19 disaster management support for the city and healthcare system of Heidelberg, Germany, as well as for hospitals in the surrounding region since March 2020. He is a pediatric clinician-scientist practicing, researching, and teaching at the University Hospital Heidelberg, Germany, and the University of Heidelberg, Germany [79]. He has training or work experiences in Germany, the United States, France, Spain, the UK, Chile, and at the NATO (North Atlantic Treaty Organization) [79]. He currently serves as a reserve medical staff officer in the rank of a Lt.-Colonel (OF-4) of the German Armed Forces in the CIMIC liaison command Heidelberg, Germany [79].