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A qualitative assessment of disease and non-battle injuries in Ukraine since the Russian invasion

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Abstract

Background Disease and non-battle injuries (DNBI) often account for more military casualties than those from combat wounds. The February 2022 Russian invasion of Ukraine has severely limited access to care in areas with increasing patient care needs beyond combat injuries. The expansion of the draft resulted in an older military population susceptible to musculoskeletal injuries, while trench warfare and harsh winters create conditions conducive to cold weather injuries and infectious diseases. This study aims to assess the prevalence and scope of DNBI in Ukraine.

Methods We conducted qualitative key informant interviews with Ukrainian military and civilian health care workers from June 2023-February 2024 using an expanded version of the Global Trauma System Evaluation Tool which had components focusing on DNBI. Thematic content analysis was used to derive key themes related to DNBI from interviews.

Results We conducted 36 key informant interviews. Respondents described the wide range of DNBI that Ukrainian soldiers are experiencing. Infectious disease, cold weather injuries, musculoskeletal injuries, sexual assault, and mental health emerged as prevalent concerns. Respondents described the critical shortage of resources and the high burden on military hospitals as barriers to the delivery of adequate care for DNBI.

Conclusions DNBI in Ukraine are directly related to the physical environment and the age and fitness of the military population. The troop shortage has resulted in soldiers with chronic illnesses returning to duty, while the physical environment limits prevention measures for weather-related injuries and infectious diseases. The complex healthcare challenges created by these factors highlight the importance of a military health system with the capacity to provide service members with the full spectrum of care beyond combat injuries.

Keywords Ukraine, Disease and Non-battle Injury, Conflict, Military Health

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Background

The February 2022 Russian Federation invasion of Ukraine has severely damaged Ukraine's healthcare system [1]. Relentless attacks on medical facilities have crippled healthcare infrastructure and taken the lives of healthcare providers, leaving the war-torn region with severely limited access to care [2, 3]. Areas experiencing a surge in patient needs now face a critical shortage of healthcare personnel and limited access to essential medicines [4]. Historical data shows that disease and non-battle injuries (DNBI), defined as any illness or injury not caused by armed conflict, account for a significant proportion of military casualties, often exceeding those from combat wounds [5–7]. DNBI encompass a range of conditions including musculoskeletal injuries, infectious diseases, and the consequences of exposure to harsh environments [8, 9]. The high prevalence of DNBI in conflict settings highlights the crucial role of a robust and functioning health system capable of providing service members with the full spectrum of care.

Two years of war have taken a toll on Ukraine's manpower, forcing the government to expand the draft by lowering the enlistment age and reducing medical exemptions [10]. The average age of a Ukrainian soldier has increased from 35 at the start of the war to 43 in November 2023, raising concerns about susceptibility to musculoskeletal injuries and chronic illnesses such as hernias, pinched nerves, and cardiovascular complications [10, 11]. Prior to the start of the war, Ukraine's healthcare system faced significant challenges, including high prevalence rates of infectious diseases such as tuberculosis and measles, and low vaccination rates for COVID-19 and other vaccine-preventable illnesses [12, 13]. Trench warfare and harsh Ukrainian winters exacerbate these health issues, creating conditions conducive to cold-weather injuries and the spread of infectious diseases.

The war has resulted in large numbers of casualties with traumatic wounds, leaving soldiers highly susceptible to life-threatening infections [14]. Limited access to antibiotics on the front lines, delayed evacuations, and the conditions in which initial wound care is provided at point of injury have fostered an environment ripe for the development of complex and antimicrobial resistant infections. By the time service members reach medical facilities, they are often already infected with multidrug-resistant (MDR) organisms, making treatment significantly more challenging and raising the risk of further transmission [15–17]. Wounds infected with MDR bacteria and fungi not only increase morbidity and mortality, but also require more complex and resource-intensive treatment, further burdening an already strained healthcare system [14].

This research aims to assess the prevalence and scope of DNBI in Ukraine following the February 2022 Russian invasion. By gaining a deeper understanding of the current healthcare situation, we aim to inform medical operations and support for Ukraine, the United States, and the North Atlantic Treaty Organization (NATO). DNBI encompass a broad spectrum of health concerns, and analyzing the needs for DNBI care in Ukraine can guide future multinational medical support and offer valuable insights for mitigating similar challenges in future conflicts.

Methods

Study design and participants

We conducted semi-structured, in-depth key informant interviews (KIIs) of Ukrainians working in the health and trauma system of Ukraine during the current conflict. These KIIs focused on their experiences and needs related to the trauma care system. Participants were included if they were healthcare or healthcare-adjacent personnel currently working in some capacity supporting health and trauma care in Ukraine across applicable NATO Roles of care [18]. These include small unit/prehospital/Role 1, Role 2/small aid clinic (no surgical care), Role 2+ (limited surgical care), Role 3 (district hospital, some specialty care), and Role 4 (academic hospital, specialty care, rehabilitation). Participants were recruited from trauma and combat casualty care-themed symposia and Advanced Surgical Skills for Exposure in Trauma (ASSET) training events held from June 2023-February 2024 in Warsaw, Poland. At these events, participants were recruited for participation via purposive and snowball sampling methods and attended either an in-person or virtual interview.

Instrument

We adapted the Global Trauma System Evaluation Tool (G-TSET) developed by military and civilian trauma specialists as an assessment tool for use in low- and middle-income countries [19]. The adapted Ukraine Trauma System Assessment Tool (TSAT) evaluates trauma systems by assessing the functional capacity of domains including leadership and organization, prevention of injuries, access to injury care, initial injury care, acute injury care, rehabilitation, and education, research, and quality improvement. The first component of the TSAT collects quantitative demographic information. The remainder of the tool collects qualitative data from participants on different domains of the trauma system. (Table 1) The semi-structured directed qualitative instruments were developed in cooperation with the consortium involved in this study and its stakeholders. Two sections (Definitive Care Facilities: Disease and non-Battle Injuries & Definitive Care Facilities: Other) in the interview tool were dedicated to learning about diseases and injuries that are being observed and how they are being managed.

Table 1 Domains of the Ukraine trauma system assessment tool (TSAT)

Leadership/Command and Control	Critical Care in Definitive Care Facilities
Planning and Coordination	Telemedicine in Definitive Care Facilities
Resource Assessment	Injury Patterns in Definitive Care Facilities
Logistics and Supply	Blood Product Use in Definitive Care Facilities
Communications	Disease and Non-Battle Injuries (DNBI) in Definitive Care Facilities
Mass Casualty Plan	Mental Health
	Rehabilitation
System Triage and Patient Transfer	Injury Registry, Epidemiology, and Process Improvement
Prehospital Care/ Emergency Medical Services	Technology/ Products/ Devices
Prehospital Chemical, Biological, Radiological, Nuclear, and Explosives	Injury Prevention
Prehospital Training	Environmental Factors and Dental Trauma
Prehospital Training Definitive Care Facilities	Summation Questions

Table 2 Interview guide section headings and questions pertaining to DNBI

Definitive Care Facilities: Disease and non-Battle Injuries (DNBI)
What injuries among military member are you treating that are not a direct result of the war?
What impacts are these injuries having on your facilities' ability to provide care?
Are you seeing any patterns in the injuries that are not a direct result of the war?
Are you seeing any associations between the environment, equipment, or battle conditions and specific injuries such as frost bite or burns?
What infectious diseases in the military population have increased since the onset of the war?
What infectious diseases in the civilian population have increased since the onset of the war?
Are you seeing any diarrheal disease in military patients at your facility?
How much of the military population are you seeing for diarrhea disease?
Is there a pattern to who gets diarrhea disease?
Have you identified a source for these illnesses?
Are you seeing any diarrheal disease in civilian patients at your facility? y/n
How much of the civilian population are you seeing for diarrhea disease?
Is there a pattern to who gets diarrhea disease?
Have you identified a source for these illnesses?
Are you seeing sexual assault cases among the military and/or civilian population?
How are they being assessed and treated?
Is the assault conflict related?
If yes, what do you mean?
What disease affecting public health are you seeing that we have not asked about?
What are the barriers to providing care for diseases and injuries not directly caused by the war?
How would you improve care for diseases and injuries not directly caused by the war?
What is the impact of these diseases and injuries on the percentage of military members returning to duty?
Definitive Care Facilities: Other
How is cold weather affecting the care of injured patients?
What other environmental factors impact that care of injured patients?
Do you care for military working animals?
How do you manage dental trauma?
Do you have trained dental care providers at your facility?
Who manages non-trauma dental care such as tooth aches?
Do both military and civilian patients receive dental care?
How do you manage chemical casualties in your facility?
How do you manage radiologic casualties in your facility?

In addition to qualitative questions, these sections contained quantitative questions to describe the current state of DNBI according to respondents. However, given the open-ended nature of the interviews, participants could discuss disease and non-disease battle injuries at any point in the interview. The interview guide section headings and actual questions are in Table 2.

Procedures

We conducted interviews with Ukrainian participants during ASSET training events in Warsaw, Poland from 28

September 2023–28 February 2024. Two researchers and a translator conducted interviews. One researcher asked questions in English and the discussion was translated to Ukrainian, if necessary, while another researcher took digital notes using the KoboToolBox platform. Interviews were recorded. A subset of these interviews occurred virtually over Zoom using the same methodology as in-person interviews. The sample size was determined by saturation, which was reached at 36 interviews.

Data analysis

Deductive thematic content analysis was used to identify data patterns or themes and was guided by the assessment objectives and research questions using NVivo and open coding techniques [19]. We used the G-TSET tool as our framework for analyzing the TSAT to identify patterns that we expected to see in the data [20]. Four researchers participated in formal data analysis. NVivo was used to organize the data and pull out the themes identified. The analysis team then manually summarized, categorized, and compared interview data and NVivo results to identify common themes from transcribed documents including expected themes from the G-TSET tool and any new themes. For this analysis, emphasis was placed on DNBI. Illustrative quotes for each prevailing theme identified were selected after discussion among the four researchers to reach consensus and to limit any subjectivity, assumptions, and experiences that may shape the research process and outcomes. This research was found exempt by the WIRB-Copernicus Group (23-17597) and the Ethics Committee, First Territorial Medical Unit of Lviv. All participants provided oral consent rather than written consent as approved by the IRBs because of the need for this information to remain confidential.

Results

Demographics

Between June 2023 and February 2024, 36 civilian and military healthcare or healthcare-adjacent participants were interviewed including 22 (61%) males and 13 (36%) females, (missing $n = 1$). Participants were between the ages of 28 years and 55 years (mean age: 34.9 years). Participants' occupations included physician, trauma surgeon, anesthesiologist, nurse, medic, mental health services associate, and leadership position such as Chief of Medicine and Directors of various institutions. (Table 3) Most of the participants worked in Eastern and Northern areas of Ukraine. The study obtained experience from across all NATO roles of care. Of those in the military who reported rank, 60% were officers. Participants were mostly from the Ukraine Ministry of Defence or Ministry of Health.

Overview of DNBI

Table 4 reports the responses to quantitative questions related to DNBI. Nearly half of respondents stated that they saw patterns of injury that were not a direct result of enemy action or conflict. Most of those who reported seeing injury patterns that were not directly related to the war stated that they saw associations between these injuries and the environment, equipment, and battle conditions. Less than half of respondents saw diarrheal disease in either the military or civilian population. Less than a quarter of respondents saw any sexual assault cases among the military or civilian population.

> *"Hard to say what is not result of the war. Why are they here if it is not war." (Role 2+, Physician, East).*

Types of non-battle injuries and illnesses

Respondents described types of DNBI including cardiovascular complications, acute cholecystitis, appendicitis, falls, fractures and pain management issues, inflammation of chronic diseases, pulmonary disease, gastroenterology issues, urology issues, hernias, flu, respiratory illness, cancer, joint and back pain, and antimicrobial resistance (AMR). Most respondents mentioned cold weather injuries while others mentioned environmental factors.

Cold weather injuries

Participants reported that cold weather injuries, including hypothermia and frostbite, were an issue in winter. Some participants noted that these were more commonly seen in prehospital care than in the hospital, but others described how hypothermia affects evacuation and higher levels of care.

> *"It's horrible. We had cases when we had to amputate extremities because of hypothermia. It also impacts evacuation and all the levels of care." (Small Unit/Prehospital, Chief Anesthesia, East).*
> *"Hypothermia in this season takes a big role in the severity of the casualties. It increases the amount of blood loss and worse[n]s the general condition among all the patients." (Role 2+, Physician, East).*

Two participants described how the rotation of troops allows for the prevention of frostbite.

> *"We sometimes have frostbite. It depends on the organization because in my brigade, for example, guys are rotating every two days, so you spend two days in the trenches and two days in a warmer place. I know that is not the case for all the brigades and units." (Role 1, Chief Anesthesia, East).*

Table 3 Demographics of study participants

Age, years; mean (range)	**34.9 (28–55)**
Region, *n* (%)	
Southern	4 (11.1)
Eastern	13 (36.1)
Western	4 (11.1)
Northern	13 (36.1)
Missing	2 (5.6)
Sex, *n* (%)	
Male	22 (61.1)
Female	13 (36.1)
Missing	1 (2.8)
Occupation, *n* (%)	
Trauma Surgeon	5 (13.9)
Physician	5 (13.9)
Chief of Medicine	3 (8.3)
Nurse	3 (8.3)
Anesthesiologist	3 (8.3)
Director, Emergency Services	2 (5.6)
Researcher	2 (5.6)
Medic	1 (2.8)
Chief, Rehabilitation	1 (2.8)
Commander, Role II	1 (2.8)
Mental Health Services Associate	1 (2.8)
Head, Moral Psychological Service Branch Combat Stress Control Group	1 (2.8)
Deputy Director, Health Care Innovations	1 (2.8)
Deputy Director, Health Development Department	1 (2.8)
Other[a]	4 (11.1)
Missing	2 (5.6)
NATO Role Equivalent, *n* (%)	
Pre-Hospital/Role 1	4 (11.1)
Role 2	3 (8.3)
Role 2+	7 (19.4)
Role 3	7 (19.4)
Role 4	4 (11.1)
Other	6 (16.7)
Missing	5 (13.9)
Civilian/Military Provider, *n* (%)	
Military	20 (55.6)
Civilian	16 (44.4)
Military Rank, *n* (%) (*n* = 20)	
Major	1 (2.8)
Captain	1 (2.8)
Lieutenant	4 (11.1)
Sargeant	4 (11.1)
Missing	10 (27.8)
Organization Affiliation, *n* (%)	
Ministry of Defence	17 (47.2)
Ministry of Health	12 (33.3)
Ministry of Interior	1 (2.8)
National Guard	2 (5.6)
Commercial Company	1 (2.8)
Charity	1 (2.8)
Missing	2 (5.6)
Years in current position; mean (range)	4.6 (0.33 – 19)

[a]Other: Grant manager, Deputy Director – General, Project Lead – Commercial Company, Sergeant

Table 4 Characteristics of DNBI in Ukraine

Characteristic *N* = 36	Yes *n*(%)	No *n*(%)	Don't Know *n*(%)
Are you seeing any patterns of injury that are not a result of the war?	17 (47)	12 (33)	7 (19)
If yes, are you seeing any associations between the environment, equipment, or battle conditions and specific injuries such as frost bite or burns?	14 (82)	-	3 (18)
Are you seeing any diarrheal disease in military patients at your facility?	14 (39)	19 (53)	3 (8)
Are you seeing any diarrheal disease in civilian patients at your facility?	5 (14)	27 (75)	3 (8)
Are you seeing any sexual assault cases among military and/or civilian population?	7 (19)	16 (44)	12 (33)

Frequently listed methods to manage cold weather injuries included thermal blankets and warm fluids. Some respondents reported using the Hypothermia Prevention and Management Kit (HPMK). Several respondents also noted that stabilization points, ambulances, and other vehicles used for transportation are heated.

> *"When we did not have warmers, we were seeing a lot of trench foot and frostbite." (Role 4, Director of Emergency Services, North).*

Several participants listed trench foot as a condition they had seen; others mentioned that while they had not personally had patients with trench foot, they knew colleagues that had. One participant said that trench foot is *"very common. Unfortunately. It was even in warm period of time. Doesn't matter actually when wet." (Role 2+, Physician, East).*

In contrast, participants noted dehydration and sun exposure as concerns in the summer because *"sometimes guys don't have water for many hours." (Role 1, Medic, South)* Participants also noted an increase in fungal skin diseases due to a lack of sufficient water in the summer months.

> *"Everything has an effect. When it's very hot, hydration. When it's cold, there is frostbite." (Role 2, Commander Role 2 Military Treatment Facility, East).*

Dental

Most respondents noted that general dentists were responsible for the management of non-trauma dental care. Dentists were located at Roles 3 or 4 or in private clinics, and patients were separated into different groups for planned or emergency dental care. One respondent noted that dental care was not available at the stabilization point. A few respondents mentioned the availability of mobile dental clinics while others noted that patients were transferred for advanced care if there was no dentist at their facility. Some respondents reported that non-urgent dental issues were treated with painkillers at lower Roles where dentists are not available.

> *"If it is toothache it is not urgent - ibuprofen. If it is critical - to the hospital." (Role 1, Medic, South).*
> *"Because of the conditions of the water the teeth and kidneys suffer the most." (Role 2+, Physician, East).*

Infectious disease

Respondents listed chicken pox, respiratory disease, measles, hepatitis B and C, tuberculosis, COVID-19, borreliosis, and pneumonia as infectious diseases that have increased since the start of the war. One participant mentioned that there had been higher rates of COVID-19 earlier, but now that vaccination is mandatory for all service members, they are seeing less.

> *"It depends on the season. Respiratory illness is more frequent in autumn, in early spring. RSV, cold, we are waiting for COVID because if we have COVID in civilian population we'll have it in the military. Lyme disease, only one case in my brigade but it was there." (Role 2+, Chief Medicine, East).*
> *"It's an observation, but probably because of the years of war and stress, we have a lot of worsened response to infections. Our department is starting to have more respiratory infections. Taking the day of[f] very often due to these respiratory illness. I personally think this a response to the stress." (Role 4, Mental Health Services, West).*

More than half of the respondents stated that they saw diarrheal disease, although they reported seeing no overall pattern to who gets diarrheal disease. Some mentioned the cause of diarrheal disease to be street food, Meals Ready to Eat (MREs), or poor sanitary conditions. One participant mentioned not seeing many intestinal issues due to drinking bottled water.

> *"When the military is in combat zones they are unable to store food properly. If there are storage issues the food can be spoiled. So there was food poisoning because of that." (Role 2+, Physician, East).*
> *"In the south region because of the last issue with the Russians, the land mines exploded and water is*

flooded after this, a very high risk of spreading disease." (Chief Medicine, North).
One respondent mentioned that while there were some patients with HIV or Hepatitis B or C, the prevalence was not different to the general population.
"All diseases we're having in general population are also present in the military ones [because] a lot of people were mobilized." (Captain, Medical Forces).

Infectious disease in the civilian population

Most respondents were unsure about infectious diseases in the civilian population, and those who were familiar with this population reported that the infectious diseases found in the civilian population were the same as those found in the military population. Only a few respondents saw any diarrheal disease in the civilian population.

"We sometimes see clostridium difficile now but not sure it is different. below 5%. sometimes c.diff just happens from other medication. We treat in our hospital since we test for it." (Role 4, Physician, North).
"The civilians close to the front line live on reservations. If there is a diarrheal disease then the whole village is sick." (Role 2+, Physician, East).

Most respondents did not know if there is a pattern to who gets diarrheal disease, but some suspected that it may be due to exposure to spoiled food or polluted water.

Sexual assault

Nearly all respondents who had seen sexual assault cases mentioned the occupation of Russian troops. One participant specified seeing soldiers who experienced sexual assault while they were captured.

"Of course they are related! In occupied territories, people with power do what they want. Some soldiers, when they are released from captivity, they inform us about the sexual assault but they don't like to talk about it much, especially the men." (Deputy Director of Healthcare Innovations, MOH, West).

Most participants stated that they were unsure of how survivors of sexual assault were being assessed or treated while some mentioned that they are transferred to other facilities for care.

Musculoskeletal injuries

Participants reported injuries received from falls, fractures, sprains, and dislocations. Back pain, spinal injuries, and car accidents were mentioned by several participants. Participants also mentioned injuries from using equipment such as body armor and the lack of physical training before the conflict.

"Of course, no culture of carrying the body armor. No culture of physical exercise. It affects that so much. During the physical training they just kill themselves so much. Obviously they come to me and become not so productive and effective." (Role 2+, Physician, East).

Participants discussed the age of Ukrainian soldiers in reference to musculoskeletal injuries and chronic illnesses such as cardiovascular and pulmonary issues.

"Much more heart problems because during the war the army pushed down the standards for combatants. Much more adult men and women. Older. They for sure have problems with heart and joints." (Role 1, Medic, South).
"Patients can still [do] duty with chronic care. Almost all soldiers have a chronic disease and try to manage somehow." (Chief Medicine, North).

Mental health

Mental health conditions such as post-traumatic stress disorder (PTSD), burnout, and chronic stress were also mentioned by respondents. One respondent noted that mental health services was an area in need of improvement.

"Mental Health. You cannot find any person in Ukraine right now that cannot confidently say that he or she feels fine. So, it is the major public health concern for the country." (Head of Clinical Trials, MOH, West).
"I think chronic stress - this is the most. Both physically and mentally manifested. What I observe in my comrades and people I know - in these past two years people look much older. When people experience chronic stress they look much older." (Other, Moral Psychological Service Branch Combat Stress Control Group – Head, East).

Risks related to DNBI for Ukrainian soldiers

Infectious disease complications in military population

Respondents reported seeing an increased incidence of AMR due to the overprescribing of antibiotics. One participant noted that *"the levels of antimicrobial resistance is off the charts at level 3 and 4 care." (Role 2+, Physician, East)* Participants at Role 3 and 4 facilities mentioned testing patients with wounds or respiratory infections to identify specific bacteria or microbial flora, guiding

antibiotic selection for treatment. In contrast, lower-Role facilities often administered antibiotics, without pathogen identification, to all patients with open wounds due to time constraints and limited testing capabilities. Respondents reported using telemedicine to consult with colleagues regarding AMR.

> *"There are different kinds of infections, sometimes when receiving them they are dirty or have a round in them, we are not dealing with it, we are just washing them and sending them forward." (Role 2, Nurse, North).*
> *"We are now only using type 1 and 2 antibiotics because of the regulation of the Ministry of Health by which we cannot prescribe these antibiotics without concerns. Ceftriaxone, it is more popular before and if we want to use it we need to prescribe a form and explain why we are using this antibiotic because we are having the greatest antibiotic resistance to this. We used to prescribe it for everyone for everything." (Role 3, Anesthesiologist, Ministry of Health, North).*

Impact of DNBI on returning to duty

Most respondents reported that DNBI had no impact on whether military members were able to return to duty, and that usually only serious injury or illness would result in someone not returning to duty.

> *"If about our unit, we can say if someone needs to be undeployed, it is with combat trauma and not diseases. We cannot go out from the Army because of the Martial Law." (Role 1, Chief Anesthesia, East).*

However, some respondents noted that because of this, many soldiers who returned to duty after DNBI continued to have health issues.

> *"They can impact a percentage of the military population returning to duty because not all Ukrainian soldiers are healthy. 10% are healthy, 90% not healthy. When big war was started, we were not checking the health conditions of the people who were drafted or who wanted to join. A lot of people who came to the forces did not have simple disease. I have a lot of guys who in their previous years of life have had strokes, cardiovascular disease, spondyloarthritis, people with one kidney. They fight, I can't send them to their homes because I don't have another person who can replace them for now, and they don't want to go home. These guys have experience that many of the new guys coming to us do not." (Role 2+, Chief Medicine, East).*

Challenges for medical personnel in treating DNBI and proposed solutions

Environmental factors

Respondents described the effects of weather conditions on patient care. Rain, snow, and mud can lead to delays in transportation and evacuation. Fog and thin ice lead to problems with evacuating patients and moving supplies. Infrastructure also contributes to transportation challenges, including poor roads and difficulty moving patients across rivers where bridges have been destroyed.

> *"There is a lot of mud and it sounds like not serious but it is a serious factor because it contaminates the wounds and prolongs the process of undressing and cleaning the patient and prolongs the time that the patient arrives at the facility to the time that the patient is on the operating table." (Role 2+, Physician, East).*
> *"Unfortunately when casualties are transferred to stabilization points they die on the way because the conditions are bad and they die en-route. If they are transferred to stabilization point and they have hypothermia there is a greater chance of death." (Role 3, Trauma Surgeon, East).*

Impact of DNBI on ability to provide care

Most participants said that patients with DNBI do not impact their facilities' ability to provide care. One respondent discussed how patients with DNBI could take beds away from those who are severely wounded.

> *"I think yeah, they lessen our capability - for example if we have some active combat wounds, active battles - and people with such kind of injuries or diseases they can take all beds that we need for other soldiers." (Morale Psychological Service Branch Combat Stress Control Group-Head, East).*

Barriers to effective care delivery

Respondents described the burden on military health facilities as a barrier to providing care. Some respondents described a lack of beds for patients with DNBI; they are transferred in order to make space for higher priority patients with combat trauma. They also mentioned a lack of specialists available to care for illness and injury not directly related to the war. Some respondents mentioned a lack of laboratory capacity and staff to identify and control AMR.

> *"In our unit we had some problems that we had to send these patients to military hospitals. We tried to reduce actually the burden to military hospital as sometimes it's really big load. This is limitation.*

Big load for medical system. So the military, cannot avoid this system. If it was integral of civilian and military it would be way easier." (Role 2+, Physician, East).

Respondents cited issues with infrastructure due to the war, problems with access to medicines, and a lack of medical equipment such as MRIs, imaging technology and EKGs.

"Lack of resources especially the financial burden on the country because of the war. People became more poor/poorer in general because of the war. Medications became more expensive so access to treatment became worse." (Head of Clinical Trials, MOH, West).

Strategies to improve DNBI care

Respondents stated that more money, access to more providers and specialists, an emphasis on prevention strategies, equipment, and training could improve care for these injuries. One participant described the need for a more unified medical system. One participant suggested implementing telemedicine and receiving more support from international physicians.

"The main thing is prevention; if disease wasn't caused by war, we need prevention. But it is impossible for such conditions that they are in." (Captain Medical Forces, Armed Forces).
"Improve training for specialists. Implement international guidelines of treatment for different conditions and diseases. Improve access to medicines and technology in general such as hearing aids or Cochlear implants and prosthetics in general." (Head of Clinical Trials, MOH, West).

Discussion

The war in Ukraine highlights the devastating impact of DNBI on military and civilian personnel. Casualties resulting from DNBI, often exceeding those from combat itself, expose the complex challenges faced by Ukraine's healthcare system and the urgent need for improved Force Health Protection (FHP) strategies [17]. DNBI encompass a broad spectrum of injuries and illnesses, and in Ukraine, these are directly related to the physical and emotional environment, as well as the age and fitness of the military population.

The physical environment, characterized by trench warfare, delayed evacuation, brutal winters, and limited access to hygiene facilities, has created a breeding ground for infections [7]. Respiratory and gastrointestinal illnesses are highly prevalent, and soldiers battle cold-weather injuries such as frostbite and hypothermia. Extreme weather events including heavy rain, snow, and fog significantly impede transportation and evacuation efforts, delaying critical care and increasing mortality rates. The rising incidence of MDR bacteria in both post-traumatic wounds and respiratory infections further complicate an already challenging situation [21–23]. Delayed evacuation, inconsistent antibiotic use, and poor sanitation likely contribute to the MDR infections observed in our study. Historical analysis of prior conflicts shows that under optimal conditions, approximately 34% of survivable wounds become infected [24]. However, the observations of participants in our study suggest a far worse situation, indicative of a struggling healthcare system and limited evacuation capabilities. This underscores the need for comprehensive data on prehospital and hospital acquired MDR infections to inform effective FHP protocols and infection prevention measures.

As noted by many respondents, the war environment severely restricted preventive measures essential for mitigating weather-related illnesses and injuries. In the summer months, dehydration was prevalent due to limited water access, and fungal skin infections were noted, while extreme cold temperatures led to frequent mention of hypothermia and frostbite in the winter. While some respondents noted that having the resources like heaters and warming blankets can reduce frostbite prevalence, others mentioned that continuous exposure in static position, common in trench warfare and limited backfill units, leads to frequent cold weather injuries and respiratory illnesses, including influenza and pneumonia. Cold weather exposure can suppress immune function and exacerbate risk of infection, as well as perpetuate struggling troop morale, resilience, and stress [5, 25].

Respondents in this study described PTSD and chronic stress as a major public health concern not just among soldiers but among themselves, their colleagues, and the general population. Some linked chronic stress to the increasing incidence of infectious diseases in the military population. The relationship between chronic stress and immune dysregulation renders soldiers more susceptible to infectious diseases and infectious disease complications [26]. Pre-war low vaccination rates for certain routine infectious diseases, further compounded by disrupted vaccination campaigns due to the conflict, exacerbate this vulnerability [27]. Additionally, sexual assault emerged as a pervasive and devastating consequence of the war. The long-term physical and psychological impact of these traumatic experiences on survivors is profound and access to specialized care remains limited.

Ukraine's troop shortage has led to a demographic shift within its military. In April 2024, Ukraine expanded the draft by lowering the conscription age from 27 to 25 and reduced the list of medical conditions that exempt people

from military service [28, 29]. The need for experience and manpower means soldiers with pre-existing health issues, like musculoskeletal problems or chronic illnesses like high blood pressure, are being declared "partially fit" for service despite potential limitations [30]. This combination creates a complex healthcare challenge. Soldiers with pre-existing conditions are more vulnerable to DNBI in the harsh environment, and DNBI can limit the effectiveness of even healthy soldiers. Falls, fractures, and dislocations were common occurrences, as well as back pain and spinal injuries. Respondents suggested a potential correlation between inadequate preparation/physical training and increased musculoskeletal injuries. Additionally, oral health has been significantly compromised by the war. The lack of access to routine dental care, compounded by factors such as malnutrition and dehydration, has led to a deterioration of oral health among both military and civilian personnel.

A healthy military population is crucial for operational readiness. The war in Ukraine exposes the critical role military health systems play in treating not only traumatic wounds but the full spectrum of DNBI. DNBI not only contribute to high mortality and morbidity rates but overwhelm already strained medical and logistical resources. Respondents in our study identified the high burden on military hospitals and a lack of medical resources as significant barriers to providing adequate care for DNBI.

The war environment limits many prevention measures for DNBI, however, preventive measures and efforts to strengthen the healthcare system during peacetime can reduce the burden on military hospitals in times of war [31, 32]. Stockpiling drugs and medical supplies, including resources for combating cold-weather injuries such as blankets and heaters, could help alleviate the strain on resources. Improving vaccination coverage and establishing infection prevention protocols could reduce the burden of infectious disease and MDR infections. As one of our respondents suggested, telemedicine can be utilized to reduce the burden on providers and increase access to specialist care. Respondents have noted a reduction in diarrheal disease from drinking bottled water – continued efforts to provide clean water and improve hygiene and sanitation should be supported. While respondents noted that a more unified health system would be beneficial, due to the targeting of military healthcare facilities by Russian officials, the integration of military and civilian facilities can present a security hazard [33]. The challenges and limitations of a war environment must be taken into account when designing solutions for DNBI care in Ukraine.

Limitations

Respondents' perspectives are limited to their location and the timeframe of June 2023-February 2024. As a qualitative study, these data represent those interviewed and cannot be generalized to all healthcare workers or facilities in Ukraine or elsewhere. Interviewers were careful to explain there would be no material gain by participation in the study; however, respondents may have underestimated or exaggerated responses if they thought it would be in their interest to do so.

Conclusions

A military health system with the ability to treat injuries and illnesses beyond traumatic wounds is essential for maintaining a healthy military population. Respondents in this study described a wide range of DNBI that are directly related to the physical and emotional environment and the age and fitness of the military population in Ukraine. Respondents indicated the high burden on military hospitals and lack of medical resources as significant barriers to providing care for patients with DNBI. Resources and infrastructure for DNBI care must be considered for future medical operations in support of Ukraine as well as to mitigate similar challenges in future efforts to provide multinational medical support.

Abbreviations

AMR	Antimicrobial Resistance
ASSET	Advanced Surgical Skills for Exposure in Trauma
DNBI	Disease and Non-Battle Injuries
FHP	Force Health Protection
G-TSET	Global Trauma System Evaluation Tool
HPMK	Hypothermia Prevention and Management Kit
KII	Key Informant Interviews
MDR	Multi-Drug-Resistant
MREs	Meals Ready to Eat
NATO	North Atlantic Treaty Organization
POI	Point of Injury
PTSD	Post-Traumatic Stress Disorder
TSAT	Ukraine Trauma System Assessment Tool

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Author contributions

LLL, TEH, and TPK designed the study. The instruments were adapted by LLL, TEH, JM, and TPK; Interviews were completed by LJ, MJ, JKB, LLL, TPK, TEH, and JM. JKB, LJ, MJ, and LLL completed data analysis. All authors contributed to writing and/or editing of the manuscript and have reviewed the final version prior to submission.

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Data availability
Data that support these findings are curated by the study team and are not available for public distribution.

Declarations

Disclaimer
The contents of this publication are the sole responsibility of the authors and do not necessarily reflect the views, assertions, opinions, or policies of the Uniformed Services University of the Health Sciences (USUHS), the Henry M. Jackson Foundation for the Advancement of Military Medicine, Inc. (HJF), the DOD, or the Departments of the Army, Navy, or Air Force. Mention of trade names, commercial products, or organizations does not imply endorsement by the U.S. Government.

Ethics approval and consent to participate
Ethical approval for this study was granted through the WIRB-Copernicus Group (23-17597) and the Ethics Committee, First Territorial Medical Unit of Lviv. All participants provided consent prior to participation. The study objectives and voluntary nature of the study were explained to participants. All methods were carried out in accordance with relevant guidelines and regulations. Oral rather than written consent was approved by the IRBs because of the need for this information to remain confidential. Confidentiality was assured by using a numerical code for each interview to deidentify transcripts.

Consent for publication
Institutional Clearance Obtained.

Competing interests
The authors declare no competing interests.

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