Exertional Heat Illness during High-Intensity Combat Maneuvers: A Case Series from the "Iron Swords" War

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Abstract

Background: Exertional heat illness (EHI) is a recognized risk in military training, yet its frequency during high-intensity combat ground maneuvers remains unclear. This study aimed to describe the occurrence of EHI and the clinical and environmental circumstances of these events during active combat.

Methods: In this retrospective case series, we screened the Israel Defense Forces (IDF) Medical Corps Institute of Military Physiology database for all suspected EHI cases during the “Iron Swords” War ground maneuver (October 2023 to October 2025). Ten cases met the clinical criteria for EHI and were included.

Results: All cases occurred between June and September, with nine during daylight. All were male infantry soldiers (mean age 22.6 years). Preceding activities included successive tactical bounds (four cases), intensive medical care (three cases), sustained tactical movement (two cases), and a single case during an active urban combat maneuver. Soldiers carried a mean tactical weight of 22.5 kg (30.9% of body weight). The heat load at the time of EHI onset was moderate in two cases, heavy in six, and extreme in two. Mean rectal temperature upon identification was 39.2°C. Active field cooling was initiated within 5 minutes in seven of the 10 cases.

Conclusions: Ten EHI cases were identified during the “Iron Swords” War ground maneuver, all occurring under moderate-to-extreme heat loads and full combat load. The data describe the pattern, not the frequency, of EHI during maneuvers. Rectal thermometry and active cooling were feasible in this setting; no clinical outcome data were available to assess their effect.

Keywords: Exertional heat illness, Heat stroke, Military conflict, Israel Defense Forces, Medical corps.

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Introduction

Exertional heat illness (EHI) is a spectrum of conditions ranging from exercise-associated muscle cramps and heat exhaustion to exertional heat stroke (EHS), a life-threatening emergency characterized by hyperthermia and central nervous system dysfunction [1]. In military populations, EHI is a well-recognized risk primarily associated with training and selection processes [2,3]. In these controlled environments, soldiers are often pushed to maintain a specific, high-intensity pace under time constraints and peer pressure, frequently leading to "over-pacing" and a subsequent breach of physiological reserves [4]. However, high-intensity ground maneuvers in a combat zone introduce a different set of stressors. Combat involves prolonged periods of moderate physical activity, often while carrying full combat load, and is characterized by severe physiological attrition due to chronic sleep deprivation, irregular nutrition, and the psychological stress of active warfare [5]. The operational significance of EHI in a maneuvering unit is considerable; beyond the immediate risk to the individual, a single heat-related collapse can degrade the combat readiness of an entire platoon or company, necessitating the diversion of combat power for medical care and urgent evacuation under fire. Effective management relies on the early identification of the "failing soldier" - the soldier exhibiting subtle signs of cognitive decline or staggering - before they progress to a complete thermal collapse, using immediate rectal thermometry and aggressive on-site water cooling as the current standard for preventing multi-organ failure [6,7].

Given the unique and demanding nature of active warfare, this study aimed to describe the scope of EHI during a large-scale ground maneuver. Specifically, it sought to determine whether deploying large infantry forces in hot-climate combat zones would result in a high volume of heat-related casualties. The secondary aim was to describe the clinical and operational characteristics of the EHI cases identified during the "Iron Swords" War. The study also characterized the environmental conditions and physiological vulnerabilities present at the time of injury, while exploring how these factors converge in an environment where physical intensity is largely intermittent. Finally, we discuss the findings in the context of a large-scale military mobilization.

Methods

Study Design

This retrospective case series included EHI cases recorded by the Israel Defense Forces (IDF) Medical Corps Institute of Military Physiology during the intensive ground maneuver phase of the "Iron Swords" War (27 October 2023 to 9 October 2025). The Institutional Review Board (IRB) of the IDF Medical Corps approved the study (IRB No. 1198-2012-IDF). Informed consent was waived because of the retrospective nature of the analysis and the measures taken to ensure participant anonymity.

Data Collection

We identified EHI cases by screening the IDF Medical Corps Institute of Military Physiology database, supplemented by a systematic review of all operational incident reports of suspected physiological or non-traumatic etiology. For confirmed cases, we synthesized detailed operational and clinical data from direct physiological interviews, unit after-action debriefings, and hospital records.

Evaluated Parameters and Clinical Definitions

While all suspected heat-related events in the field are managed under a uniform protocol, an ad hoc expert panel at the IDF Institute of Military Physiology determines the final diagnosis retrospectively. The panel, comprising a military physician and a senior physiologist, integrates command reports, presenting symptoms, documented temperature measurements, medical evaluations, and individual interviews. Because core temperature measurements under field conditions may be delayed or unreliable – particularly when active cooling begins before thermometry – a strict temperature threshold alone is not used to confirm or exclude EHS. Instead, the panel classifies cases based on an integrated assessment of available clinical, environmental, and operational information. The panel also reviews borderline cases in consultation

with a senior expert in EHI.

Less-severe exertional heat illness (LSEHI): Clinical manifestations of exertional heat stress without CNS dysfunction. Cases involving mild, transient laboratory abnormalities consistent with limited heat-related organ stress were classified as LSEHI when no neurological impairment or sustained end-organ dysfunction was present.

Exertional heat stroke (EHS): Severe exertional hyperthermia accompanied by central nervous system dysfunction, with or without laboratory evidence of systemic or end-organ injury.

Environmental parameters evaluated included time of day, seasonality, and environmental heat load at the time of the event according to the IDF index. The operational context was documented using predefined tactical classifications (e.g., sustained tactical movement, active urban combat maneuver, or successive tactical bounds). Pre-existing physiological vulnerabilities were systematically evaluated. Insufficient sleep was defined as fewer than 7 hours of sleep during the 24 hours preceding the event. Post-event investigations also recorded inadequate nutrition, hydration status, and any recent acute illness. The field-intervention timeline was documented, including time to initial rectal temperature measurement, time to initiate active cooling, and the cooling method used.

Statistical Analysis

Because of the specific nature of this combat series (n=10) and operational security constraints regarding the total denominator of deployed troops, we used descriptive statistics to summarize the findings. We expressed continuous variables as means with the observed range, and categorical variables as counts and percentages. Missing values were retained as "unknown" and were not imputed. Percentages for categorical variables were calculated using all 10 cases as the denominator. For field-intervention variables, missing values were reported explicitly as "unknown" for time to rectal thermometry, time to initiation of active cooling, and cooling volume. We performed all data processing and statistical analyses in R (version 4.3.2).

Results

During the intensive ground maneuver period, we identified and analyzed 10 EHI cases. The series consisted entirely of male infantry soldiers (n=10), with a mean age of 22.6 years (range 18–28) and a mean body mass index of 23.9 kg/m² (range 18.7–28.7). This single-sex study aligns with the male majority of the IDF combat population. Nine of the casualties were active-duty combatants serving in operational battalions, while one soldier was undergoing advanced training but was actively deployed in the maneuver zone. Assessment of baseline physiological vulnerabilities showed that all 10 soldiers had documented insufficient sleep before the event. Five reported poor nutrition in the preceding days, and three reported a recent acute illness, including one soldier with an active fever at the time of the event. Only one case reported insufficient water intake (Table 1).

These events occurred under substantial environmental and tactical stress. All 10 cases occurred during the summer months (June to September), with a cluster in July (n=6). Furthermore, nine events occurred during daylight hours, and one was recorded at night. Among the recorded events, two occurred under moderate environmental heat load, six under heavy heat load, and two under extreme heat load. The physical activities preceding the collapses varied, but all soldiers operated under full combat load. The mean weight carried was 22.5 kg (range 10–40 kg), averaging 30.9% of body weight (range 17%–57%). Categorization of the specific tactical activities revealed that four cases occurred during successive tactical bounds (three of which constituted a cluster within a single mission following one hour of stationary heat exposure). Three cases occurred while providing intensive medical care, two during sustained tactical movement, and one during an active urban combat maneuver (Table 2).

Clinically, the series comprised two cases of EHS and eight cases of LSEHI presenting without profound CNS involvement. The mean initial rectal temperature was 39.2°C (range 38.5–39.8°C). We identified seven of the 10 cases immediately upon collapse, allowing rectal thermometry and initiation of active cooling within 5 minutes of the event. We recorded cooling volume separately and report it in Table 3. The remaining three

cases included one with a brief operational delay, one EHS case with severely delayed recognition, and one LSEHI case with undocumented treatment times owing to the chaotic combat environment.

Detailed clinical evaluation of the two EHS cases revealed distinct operational triggers and treatment timelines. The first EHS casualty collapsed following the completion of a 4 km sustained tactical movement. During the movement, he had struggled to maintain the mandated pace while carrying 50% of his body weight. His initial rectal temperature was 39.5°C, accompanied by profound CNS dysfunction, including confusion and amnesia. In addition to the rapid pouring of water, this casualty was also treated on site with ice-bath immersion and was then evacuated by helicopter to the hospital. In contrast, the second EHS case occurred during the provision of intensive medical care in a multiple-casualty incident under an extreme heat load. Because of the chaotic nature of the event, immediate identification was hindered, and rectal thermometry was delayed by one hour, recording 39.0°C. This casualty exhibited severe CNS manifestations, presenting with confusion, aggressiveness, and amnesia. He was cooled with water (unknown amount) and was then evacuated by helicopter to the hospital.

Characteristic	Value
Demographics	
Age (years), mean (range)	22.6 (18–28)
Male sex, n (%)	10 (100%)
Body mass index (kg/m²), mean (range)	23.9 (18.7–28.7)
Service status, n (%)	
Active-duty operational battalion	9 (90%)
Advanced training deployment	1 (10%)
Baseline vulnerabilities, n (%)	
Insufficient sleep (<7 h)	10 (100%)
Poor nutrition in preceding days	5 (50%)
Recent acute illness (incl. fever)	3 (30%)
Insufficient water intake	1 (10%)

Table 1. Demographics and baseline vulnerabilities of the 10 EHI cases.
Baseline data collected during post-event follow-up. Percentages are based on the 10 cases; vulnerability categories are not mutually exclusive.

Characteristic	Value
Month, n (%)	
June	2 (20%)
July	6 (60%)
August	1 (10%)
September	1 (10%)
Time of day, n (%)	
Daylight	9 (90%)
Night	1 (10%)
Environmental heat load, n (%)	
Moderate	2 (20%)
Heavy	6 (60%)
Extreme	2 (20%)
Operational context	
Weight carried (kg), mean (range)	22.5 (10–40)
% Body weight carried, mean (range)	30.9% (17%–57%)
Tactical activity preceding collapse, n (%)	
Successive tactical bounds	4 (40%)
Intensive medical care	3 (30%)
Sustained tactical movement	2 (20%)
Active urban combat maneuver	1 (10%)

Table 2. Operational and environmental characteristics of the 10 EHI cases.
Data collected from 27 October 2023 to 9 October 2025. Heat load was defined according to the IDF heat load index. Percentages are of the 10 cases.

Characteristic	Value
Diagnosis, n (%)	
Exertional heat stroke (EHS)	2 (20%)
Less-severe EHI (LSEHI)	8 (80%)
Initial rectal temperature (°C)	
Mean (range)	39.2 (38.5–39.8)
Delay in rectal thermometry, n (%)	
< 5 minutes	7 (70%)
10 minutes	1 (10%)
≥ 60 minutes	1 (10%)
Unknown	1 (10%)
Delay in active cooling, n (%)	
< 5 minutes	7 (70%)
20 minutes	1 (10%)
Unknown	2 (20%)
Cooling volume, n (%)	
≥ 100 liters	7 (70%)
80 liters	1 (10%)
Unknown	2 (20%)

Table 3. Clinical characteristics and field treatment of the 10 EHI cases.
Percentages are of the 10 cases. We measured delays in rectal thermometry and active cooling from initial casualty identification. Unknown values were retained as unknown. One case also received ice-bath immersion.

Discussion

The principal observation in this case series is the small number of EHI cases identified (n=10). Operational security precluded reporting the exact total number of deployed troops; therefore, we could not calculate an incidence rate. Although the ground maneuver involved a large deployed combat force, this case count should be interpreted descriptively and cannot be compared directly with incidence rates reported in training populations [2,3].

A previous report by Elefant et al. [8] described heat-injury incidence and operational lessons during combat in the Gaza Strip during the early phase of the "Iron Swords" War, from October 2023 to July 2024. The present case series differs in scope and purpose. Whereas the previous report focused on the overall frequency of heat injuries during combat and on broad operational prevention lessons, the current report provides case-level clinical, environmental, operational, and field-treatment characterization of EHI cases referred to the IDF Medical Corps Institute of Military Physiology during a longer ground-maneuver period. The two exertional heat-stroke cases described in the previous report are included in the present series. The findings are compatible with the possibility that EHI during combat maneuvers may differ in pattern from EHI during structured military training. In training, soldiers are frequently pushed to maintain a specific, high-intensity pace, which can lead to rapid "over-pacing" and a subsequent breach of physiological reserves [9]. During the maneuver described in this series, the physical demands appeared to include stationary phases or sustained tactical movement, punctuated by intermittent anaerobic bursts [8]. This intermittent pattern may have limited rapid, continuous metabolic heat accumulation in some circumstances [10]; however, this interpretation remains hypothesis-generating.

The clinical and operational characteristics of the 10 documented cases are also consistent with cumulative physiological strain. All 10 soldiers had documented insufficient sleep before the event, and inadequate nutrition and intercurrent illness were also recorded [11]. Because the series has no comparison group, these findings describe common case characteristics rather than identifying risk factors. In this combat setting, EHI occurred predominantly during daylight and under moderate-to-extreme heat loads, conditions that would typically restrict or halt routine training activities. These observations suggest that environmental heat load may have been an important contextual factor in the documented events, particularly among soldiers operating under full combat load after cumulative operational stress [12-14].

The operational circumstances surrounding the documented cases further illustrate potential high-risk windows during combat maneuvers. The clustering of cases during specific tactical transitions, such as executing successive tactical bounds immediately following stationary heat exposure under full combat load, suggests that abrupt transitions from relative inactivity to high-intensity movement may be relevant in this setting. Such transitions may generate a sudden metabolic heat load in soldiers already exposed to environmental heat and cumulative operational strain. The EHS case that occurred during intensive medical care in a multiple-casualty incident should be interpreted cautiously, as it represents a single observation. It raises the possibility that thermoregulatory strain may occur when physical effort, cognitive load, and environmental heat converge [15]. Clinically, the series comprised two cases of EHS and eight cases of LSEHI. Because there was no comparison group and no clinical outcome data, this diagnostic distribution should not be interpreted as evidence that field cooling prevented progression to EHS. Rapid identification of soldiers showing signs of heat-related impairment and immediate administration of large volumes of water remain the recommended approach to limiting CNS and multi-organ injury, and this series shows that rectal thermometry and active field cooling were feasible in several cases, even in a harsh tactical environment [1,16].

Limitations

This study faces several inherent operational constraints. First, the small number of cases (n=10) limits the precision of the proportions reported; nevertheless, the low number of documented cases is itself relevant when considered in relation to the scale of the maneuver. Second, case ascertainment relied on

the military physiology institute database and therefore included only cases referred to and documented by that institute. Although severe cases requiring evacuation were probably documented, mild or self-limiting cases managed at the platoon level may not have been referred or reported. Third, the absence of a reliable denominator for the population at risk precluded calculation of incidence rates. Fourth, we estimated environmental conditions at some tactical locations using regional meteorological records rather than direct on-site measurements. Fifth, some field-intervention variables were incompletely documented under combat conditions; missing values were retained as unknown and were included in the descriptive summaries rather than imputed. Sixth, clinical outcomes, complications, length of stay, return to duty, and follow-up were outside the scope of this report, so the effect of field cooling on recovery could not be assessed. Finally, the findings reflect a specific military force operating under particular environmental and operational conditions and should be applied to other forces, settings, and climates only with caution.

Conclusions

Ten EHI cases were identified during the “Iron Swords” War ground maneuver. Because the population at risk could not be determined, interpret these findings as a description of recorded cases rather than an incidence estimate. The cases occurred under moderate-to-extreme heat load and full combat load. They were documented in soldiers with cumulative operational strain, including insufficient sleep and, in some cases, inadequate nutrition or recent illness. These observations suggest that EHI during combat maneuvers may present a different clinical and operational pattern from EHI during structured military training, although this interpretation remains descriptive and hypothesis-generating. Despite the complex operational setting, rectal thermometry and active cooling were initiated within 5 minutes in seven of the 10 cases, suggesting that immediate on-site assessment and cooling can be implemented in at least some active combat settings.

Ethics

The Institutional Review Board (IRB) of the IDF Medical Corps approved the study (IRB No. 1198-2012-IDF). Informed consent was waived because strict measures ensured participant anonymity.

Data availability

Data are held by the IDF and are not publicly available due to military data-security and confidentiality restrictions.

Conflict of interest

The authors declare no conflicts of interest.

Source of Support

None to declare.

Disclaimer

The views expressed are the authors' own and not an official position of the institution, the funder, the IDF, or the IMA.

References

1. Epstein Y, Yanovich R. Heatstroke. N Engl J Med 2019; 380(25):2449-2459. doi:10.1056/NEJMra1810762
2. Alele FO, Malau-Aduli BS, Malau-Aduli AEO, Crowe MJ. Epidemiology of exertional heat illness in the military: a systematic review of observational studies. Int J Environ Res Public Health 2020; 17(19):7037. doi:10.3390/ijerph17197037
3. Périard JD, DeGroot D, Jay O. Exertional heat stroke in sport and the military: epidemiology and mitigation. Exp Physiol 2022; 107(10):1111-1121. doi:10.1113/EP090686
4. Lalli K, Charkoudian N, Moreh Y, Degroot DW. The role of motivation to excel in the etiology of exertional heat stroke. J Spec Oper Med 2024; 24(2):28-33. doi:10.55460/4TIV-HQLO
5. Moran DS, DeGroot DW, Potter AW, Charkoudian N. Beating the heat: military training and operations in the era of global warming. J Appl Physiol (1985) 2023; 135(1):60-67. doi:10.1152/japplphysiol.00229.2023

6. Eifling KP, Gaudio FG, Dumke C, et al. Wilderness Medical Society clinical practice guidelines for the prevention and treatment of heat illness: 2024 update. Wilderness Environ Med 2024; 35(1 Suppl):112S-127S. doi:10.1177/10806032241227924
7. Sorensen C, Hess J. Treatment and prevention of heat-related illness. N Engl J Med 2022; 387(15):1404-1413. doi:10.1056/NEJMcp2210623
8. Elefant Y, Talmi Yaakov Z, Benov A, Ketko I. Low incidence of heat injuries during combat in the Gaza Strip - what we have learned from the "Iron Swords" War. J Isr Mil Med. 2024;21(63):21-25.
9. Epstein Y, Druyan A, Heled Y. Heat injury prevention - a military perspective. J Strength Cond Res 2012; 26(Suppl 2): S82-S86. doi:10.1519/JSC.0b013e31825cec4a
10. Cheung SS, Sleivert GG. Multiple triggers for hyperthermic fatigue and exhaustion. Exerc Sport Sci Rev 2004; 32(3):100-106. doi:10.1097/00003677-200407000-00005
11. Muginshtein-Simkovitch E, Dagan Y, Cohen-Zion M, et al. Heat tolerance after total and partial acute sleep deprivation. Chronobiol Int 2015; 32(5):717-724. doi:10.3109/07420528.2015.1030409
12. Kazman JB, Nelson DA, Ahmed AE, et al. Risk for exertional heat illness among US Army enlistees: climate indexes, intrinsic factors and their interactions. Br J Sports Med. 2025;59(4):231-240. doi:10.1136/bjsports-2024-108441
13. Nelson DA, Deuster PA, O'Connor FG, Kurina LM. Timing and predictors of mild and severe heat illness among new military enlistees. Med Sci Sports Exerc 2018; 50(8):1603-1612. doi:10.1249/MSS.0000000000001623
14. Bolton JPG, Gilbert PH, Tamayo CC. Heat illness on Operation Telic in summer 2003: the experience of the Heat Illness Treatment Unit in northern Kuwait. J R Army Med Corps 2006; 152(3):148-155. doi:10.1136/jramc-152-03-07
15. Murphy CE, DeGroot DW, O'Connor FG. Exertional heat illness in active populations. NEJM Evid 2026; 5(5):EVIDra2500270. doi:10.1056/EVIDra2500270
16. Epstein Y, Charkoudian N, DeGroot DW, et al. Exertional heat illness: international military-oriented lessons learned and best practices for prevention and management. Front Physiol 2025; 16:1456984. doi:10.3389/fphys.2025.1456984