Surgery 195 (2026) 109928

Contents lists available at ScienceDirect

Surgery

journal homepage: www.elsevier.com/locate/surg

Factors associated with independence in activities at hospital discharge, 3 and 6 months after injury in humanitarian settings: A multicenter, prospective cohort study

Bérangère Gohy, PhD[a,b,*], Rafael Van den Bergh, PhD[c], Johan von Schreeb, MD, PhD[d], Christina H. Opava, PhD, PT[a], Brigitte Oundagnon, PT[e], Augustin Kitembo, MD[f], Appolinaire Beme, MD, PhD[g], Jean-Marie Mafuko, MD[h], Eric Ndiramiye, PT[h], Irene Mulombwe Musambi, MD[i], Rachel Wehrung, PT[j], Jacob Navarro, PT[j], Richard Aubrey White, PhD[k], Nina Brodin, PhD, PT[a,l], the AIM-T Study Group[c,e,f,g,h,i,j,m,n,o,*]

[a] Department of Neurobiology, Care Sciences and Society, Division of Physiotherapy, Karolinska Institutet, Huddinge, Sweden
[b] Rehabilitation Technical Direction, Humanity & Inclusion, Brussels, Belgium
[c] Médecins Sans Frontières, Operational Center Brussels, Brussels, Belgium
[d] Department of Global Public Health, Karolinska Institutet, Stockholm, Sweden
[e] Physiotherapy Department, Hopital Communautaire, Bangui, Central African Republic
[f] Médecins Sans Frontières, Operational Center Geneva, Yaounde, Cameroon
[g] Trauma and Orthopedics Department, Hopital Regional de Maroua, Maroua, Far North Region, Cameroon
[h] Médecins Sans Frontières, Operational Center Brussels, Bujumbura, Burundi
[i] Médecins Sans Frontières, Operational Center Paris, Bangui, Central African Republic
[j] Médecins Sans Frontières, Operational Center Paris, Port-au-Prince, Haiti
[k] Department of Infection Control and Vaccines, Norwegian Institute of Public Health, Oslo, Norway
[l] Department of Orthopaedics, Division of Physiotherapy, Danderyd Hospital, Stockholm, Sweden
[m] Médecins Sans Frontières, Operational Center Paris, Paris, France
[n] Médecins Sans Frontières, Operational Center Geneva, Geneva, Switzerland
[o] Innovation, Impact & Information Division, Humanity & Inclusion, Brussels, Belgium

ARTICLE INFO

Article history:
Accepted 29 October 2025
Available online 16 December 2025

ABSTRACT

Background: In humanitarian settings, resuming daily activities after injury is a pivotal aspect of recovery, though under-reported. This study aimed to describe recovery of functioning and identify factors associated with independence in activities up to 6 months after injury in 4 humanitarian settings.
Methods: This prospective cohort study included patients older than 5 years, admitted for acute injury to 4 health facilities managed or supported by Médecins Sans Frontières, located in Cameroon, Central African Republic, Burundi, and Haiti. Aspects of functioning, including independence in activities, using the Activity Independence Measure–Trauma, were assessed at hospital admission and discharge, and at 3 and 6 months after injury. Multivariable logistic regression models were run at discharge, and 3 and 6 months after injury to identify factors associated with independence in activities.
Results: Between June 2020 and January 2022, 554 patients were included, with follow-up data available for 477 and 486 patients at 3 and 6 months, respectively. At 6 months, 257 patients were independent from human and material assistance. Factors associated with independence at several of the time points included being a child, having visceral injury, not having any fracture, having a higher independence at the previous time point, and/or having received early physiotherapy, when adjusted for covariates ($P < .05$).
Conclusion: Nearly half of patients continued to experience difficulties in functioning at 6 months, emphasizing the necessity for trauma care beyond lifesaving procedures. Early physiotherapy was

* Corresponding author: Bérangère Gohy, PhD, Department of Neurobiology, Care Sciences and Society, Karolinska Institutet, Stockholm 141 83, Sweden.
E-mail address: berangere.gohy@ki.se (B. Gohy).
* Membership of the AIM-T study group is provided in the Acknowledgments.

https://doi.org/10.1016/j.surg.2025.109928

significantly associated with recovery of independence, indicating its potential to enhance recovery after injury in humanitarian settings.

Introduction

Injury accounts for 8.6% of the global burden of disease, with a death toll of 4.3 million every year.[1] The burden of injury is disproportionately high in low- and middle-income countries (LMICs), where humanitarian settings are often located.[2] In humanitarian settings, such as armed conflicts, complex injuries may rapidly overstretch the already low-resourced trauma care system, which may consequently fail to address the patients' need for recovery beyond survival.[3]

Recovery after injury can be comprehensively captured by the concept of functioning.[4] Aspects of functioning commonly affected after injury include pain, participation in social and domestic life, professional occupation, and independence in mobility and self-care activities.[5–7] However, there is a scarcity of longitudinal and multicenter research into the recovery of functioning in humanitarian settings, especially from the acute inpatient period.[8] Findings from high-income countries or more stable LMICs cannot easily be applied to humanitarian settings because of differences in patients' sociodemographics, type and causes of injury, and environment, including living conditions and available trauma care along the continuum.[9]

The recovery of functioning after injury is associated with various personal-, injury-, and trauma care–related factors that are either modifiable or nonmodifiable by interventions.[10] The identification of nonmodifiable factors (eg, age and injury type) informs on who to target, whereas the identification of modifiable factors informs on potential interventions to improve the recovery. Among these, the initiation of rehabilitation within the first days of injury has been increasingly recommended as an effective trauma care intervention.[11-13] However, such timely integration of rehabilitation is often not prioritized nor documented in most LMICs, including in humanitarian settings.[8,14–16] The lack of robust studies assessing the effectiveness of early rehabilitation hampers the prioritization of its timely integration by decision-makers in humanitarian settings.

An increased understanding of the recovery process in such settings and its associated modifiable and nonmodifiable factors is thus needed to inform the allocation of scarce trauma care resources in humanitarian settings. This study therefore aimed to assess recovery of different aspects of functioning after acute orthopedic, visceral, and/or skin injury across 4 humanitarian settings, and at identifying factors associated with recovery of independence in activities, at discharge, and at 3 and 6 months after injury.

Methods

The methods are reported here according to the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) statement and are further detailed in Supplementary Section 1.

Study design and study settings

This prospective observational multicenter cohort study was conducted between June 2020 and January 2022 in 4 health facilities located in low or lower middle-income countries experiencing highly to very highly severe humanitarian crises at the time of data collection (ie, Burundi, Far North Region of Cameroon, Central African Republic [CAR], and Haiti).[17] These were protracted humanitarian crises, involving conflict and/or urban violence, coupled with a structural lack of resources across social, financial, and health systems. Hospital-based trauma care in these 4 health facilities was directly managed or supported by the humanitarian nongovernmental organization (NGO) Médecins Sans Frontières (MSF), ensuring free care and adherence to MSF quality standards, including the provision of rehabilitation, through inpatient and outpatient physiotherapy (Supplementary Section 1.2).

The study protocol was approved by the MSF Ethics Review Board, Geneva, Switzerland (reference ID 1934). The protocol was also approved by the respective national ethics review committee: the Burundi National Ethics Committee for the Protection of Human Rights of Participants in Biomedical and Behavioral Research (CNE/05/2020), the Scientific Committee for the Validation of Study Protocols and Research Results on Health in CAR (21/02/2021), the National Ethics Committee for Research in Human Health in Cameroon (2020/01/1202/CE/CNERSH/SP), and the Behavioral Research and Haiti National Committee of Bioethics (Ref. 2021-15). The Swedish Ethical Review Authority (Dnr 2022-02806-01) approved data management of the project at Karolinska Institutet. The approved study protocol has been published on the MSF institutional research repository in September 2019 (https://remit.msf.org/studies/977).

Participants

All patients with orthopedic, visceral, and/or skin injury as primary diagnosis, admitted to 1 of the 4 health facilities over the course of 3 to 4 consecutive months, were considered for inclusion in the study. Exclusion criteria were an age $\leq$5 years, admission >72 hours after injury, hospitalization <24 hours, isolated spinal cord injury and/or moderate to severe traumatic brain injury (ie, Glasgow Coma Scale <13), and current patient residency outside the hospital catchment area.

Each eligible patient was approached by the routine medical staff to explain the purpose of the study. A local research officer with medical background was appointed for the study in each of the health facilities. The research officers administered and collected informed consent from all interested patients. A legal representative gave written informed consent for patients younger than 18 years. A written informed assent was also requested from patients between 12 and 18 years old. A witness was used to confirm verbal consent for patients not able to give written consent.

Procedure

Data were collected at 4 time points: admission (ie, $\leq$48 hours of hospital admission), discharge (ie, within 72 hours of hospital discharge), and at 2 follow-up visits, 3 and 6 months after the admission, with a 2-week flexibility before and after each date. Data collection was mainly conducted in local languages (ie, Kirundi, Fulfulde, Sango, and Creole) or in French, based on the patient's preference, and all information was recorded in French. Follow-up visits were primarily conducted at the health facilities, but some home visits and phone interviews were also used to

accommodate for security and logistic constraints. Patients' transportation costs for each of the follow-up visits were covered by the research project.

Different aspects of functioning were documented for all study participants; these included observed independence in activities (Activity Independence Measure—Trauma [AIM-T]), self-reported independence in activities (Patient Specific Functional Scale), pain (Numeric Rating Scale), secondary complications, and return to occupation (Table I).[18–21] Known covariates of independence in activities were also collected at admission, that is, injury-related factors, personal factors, trauma care interventions, and a variable to account for environmental factors not directly collected. These variables are presented in Table I and further detailed in Supplementary Section 1.4 and Table S1.

Statistical analyses

Descriptive data are presented using frequencies, and medians with interquartile ranges (IQR). All data were analyzed using Statistical Package for the Social Sciences (SPSS version 28; IBM Corp, Armonk, NY). Patients who were not attending one or several time points were excluded from the specific analysis at the corresponding time point but were kept in the total study population.

To describe patients' recovery of functioning across time points, the ranks of nonbinary variables were compared using the Wilcoxon signed-rank test, whereas the McNemar test was used for binary variables. The comparisons were as follows: inpatient (admission versus discharge), outpatient—3 months (discharge versus 3-month follow-up), outpatient—6 months (3-month versus 6-month follow-up).

To identify factors associated with recovery of independence in activities across time points, we aimed to enroll a total sample size at admission of 714 patients. This was based on sample size calculations including an estimated loss to follow-up of 30%. An actual sample size of 500 patients at each of the data collection time points would ensure a power of approximately 90%, assuming an effect size of 2.5 AIM-T units in most of the main exposure variables when running a linear regression. On data analysis, a significant right-censoring in the AIM-T variable was identified, necessitating a change from linear regression to logistic regression. A multivariable logistic regression was performed for each of the 3 follow-up time points, pooling data from the 4 health facilities, with the AIM-T as the primary outcome. The AIM-T is composed of 3 subscales, summing up to a total score (0–60). The total AIM-T score was dichotomized for the analysis using clinically relevant cutoffs in each of its 3 subscales, categorizing patients as being independent or not independent, based on expected recovery at the given time points (ie, independence from human assistance in all 3 subscales at discharge, and independence from human and material assistance in all 3 subscales at 3 and 6 months).

Fully adjusted multivariable models including all potential factors were run. Covariate selection was performed as follows: to account for collinearity in the larger model, stepwise exclusion of variables according to variance inflation factor was performed until the model converged. Adjusted odds ratios (aOR) are provided as a measure of the magnitude of the association between factors and recovery of independence.

Significant differences in baseline characteristics were examined between dropouts (ie, patients having attended no follow-up) and follow-up "completers" (ie, patients having attended at least 1 follow-up) using the Mann-Whitney *U* test for ordinal and interval data and the χ^2 test for nominal data.

Sensitivity analyses and post hoc analyses

To observe the robustness of the models to confounder specification, crude regression models were run for all potential factors, followed by semiadjusted multivariable models that included a minimal number of fixed factors (ie, setting, age, and severity of

Table I
Study variables measurement, definition, data source, data collection points, and use in logistic regression analyses

Construct measured	Measurement used	Definition	Data source	Routine/study specific	Time points of data collection	Variable use in logistic regression analysis
Injury cause	MSF classification	RTA/accident other/GSW/violent other	Medical file	Routine	Dis.	Covariate
Injury type	ICD-10	Skin/fracture/visceral	Medical file	Routine	Dis.	Covariate
Injury location	ICD-10	Upper limb/lower limb/trunk	Medical file	Routine	Dis.	Covariate
Injury severity	NISS	Minor (NISS ≤15)/major (NISS >15)	Medical file	Routine	Dis.	Covariate
Age	Years	6–17, 18–49, ≥50	Self-report	Routine	Adm.	Covariate
Sex	N/A	Male/female	Self-report	Routine	Adm.	Covariate
Pre-existing difficulties	Washington Group SS	No difference/at least some difference	Self-report	Study-specific	Adm.	Covariate
Sensation of pain	NRS	0–10; moderate-severe (≥5)	Self-report	Study-specific	Adm., Dis., 3 M, 6 M	Covariate
Infection in IPD/OPD	Clinical assessment	Yes (superficial or deep)/no	Observation	Routine and study-specific	Dis., 3 M, 6 M	Covariate
Independence in activities	AIM-T	Independence/not independent 0–60	Observation	Study-specific	Adm., Dis., 3 M, 6 M	Outcome Covariate
Hospital length of stay	Admission date, discharge date (d)	1–7, 8–14, ≥15	Medical file	Routine	Dis.	Covariate
Quantity of surgery	Surgical interventions	None, 1 and 2, ≥3	Medical file	Routine	Dis.	Covariate
Timeliness of IPD physiotherapy	Time first IPD session-admission	None, <48 h, ≥48 h	Medical file	Routine	Dis.	Covariate
Timeliness of OPD physiotherapy	Time first OPD session-discharge	None, <2 wk, 2 wk–3 M, >3 M	Medical file	Routine	3 M, 6 M	Covariate
Settings	N/A	1, 2, 3, 4	N/A	N/A	Adm.	Covariate

3 M, 3-month follow-up, *6 M*, 6-month follow-up; *Adm.*, admission; *AIM-T*, Activity Independence Measure-Trauma; *Dis.*, discharge; *GSW*, gunshot wound; *ICD-10*, Tenth Revision of the International Statistical Classification of Diseases and Related Health Problems; *IPD*, inpatient; *MSF*, Médecins Sans Frontières; *N/A*, not applicable; *NISS*, New Injury Severity Score; *NRS*, Numeric Rating Scale; *OPD*, outpatient; *RTA*, road traffic accident; *SS*, short set.

injury). Moreover, a specific sensitivity analysis was performed excluding children.

Missing data handling

All analyses were performed as complete case analyses. The effect of loss to follow-up was minimized by running separate analyses at each of the time points.

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

A total of 554 patients were included in this study: 198 in Burundi, 69 in Cameroon, 163 in CAR, and 124 in Haiti. During the follow-up period, 3 of the 554 patients died, and their information was included in the study until they died. Overall, 477 patients (86%) attended the 3-month follow-up visit within the defined time window and 486 (88%) at 6-month follow-up, with a median follow-up time of 91 days (IQR: 86–97 days) and 184 days (IQR: 180–189 days), respectively. Information on reasons for not attending follow-ups was not collected. Overall, 52 follow-ups were conducted by phone (5%), 10 at home (1%), and 10 in another hospital (1%) to accommodate for security and logistic constraints. Details of the inclusion can be found in Figure 1. Compared with patients with any follow-up(s), patients who dropped out participated in fewer inpatient and outpatient physiotherapy sessions, and a larger proportion presented with major injury, visceral injury, trunk injury, and/or no fracture ($P < .05$).

Personal factors and injury characteristics at baseline are described in Table II.

The patients were mainly men (83%, 461 of 554), of working age (median 30 years, IQR: 23.0–39.3 years), and without preinjury difficulties of functioning (84%, 467 of 554) (Table II). Most participants were injured after a road traffic accident (58%, 321 of 554) and admitted for a minor injury, that is, New Injury Severity Score $\leq$15 (87%, 478 of 551), located in the lower limbs (65%, 366 of 554). Among the 386 patients with fracture(s), 337 (87%) had at least 1 open fracture, of whom 44.5% (150 of 337) had a Gustilo III open fracture(s). For fracture immobilization, 50% (194 of 386) of the patients were treated with at least 1 external fixation, mostly removed after 3 months (59%, 96 of 162).

The majority (86%, 474 of 554) of all patients participated in at least 1 physiotherapy session, more often in inpatient care (82%, 456 of 554) than in outpatient departments (63%, 348 of 554). The timing of these interventions was mostly early, that is, within 48 hours of admission for inpatients (76%, 345 of 456), and within 2 weeks after discharge for outpatients (67%, 233 of 348). Trauma care intervention characteristics are presented in Table II.

Over the 6-month period, patients gradually improved in the different aspects of functioning ($P < .001$), as summarized in Figure 2. At hospital discharge, 34% of patients (185 of 537) were independent from human assistance in most core, lower limb, and upper limb activities (AIM-T), and 42% (225 of 541) reported moderate to severe pain.

At 6 months, 55% patients (257 of 466) were independent from human and material assistance across core, lower limb, and upper limb activities (AIM-T), 47% (229 of 483) reported no pain, and 41% (212 of 522) had returned to occupation. Moderate to severe complications were observed in 11% (60 of 545) of patients during their inpatient stay and 15% (81 of 522) in outpatient care. Overall, 19% (102 of 545) of the patients had an infection over the 6-month period.

At hospital discharge, independence in activities was significantly associated with injury cause (overall $P = .041$; violent injury-gunshot—aOR: 1.821, 95% confidence interval [CI]: 0.916–3.619, $P = .087$; violent injury-others—aOR: 2.760, CI: 1.244–6.123, $P = .013$; with road traffic accidents as a reference), injury type (presence of visceral injury—aOR: 3.153, CI: 1.007–9.873, $P = .049$), injury location (presence of upper limb injury—aOR: 2.591, CI: 1.244–5.396, $P = .011$; presence of trunk injury—aOR: 3.544, CI: 1.452–8.650, $P = .005$), timeliness of IPD

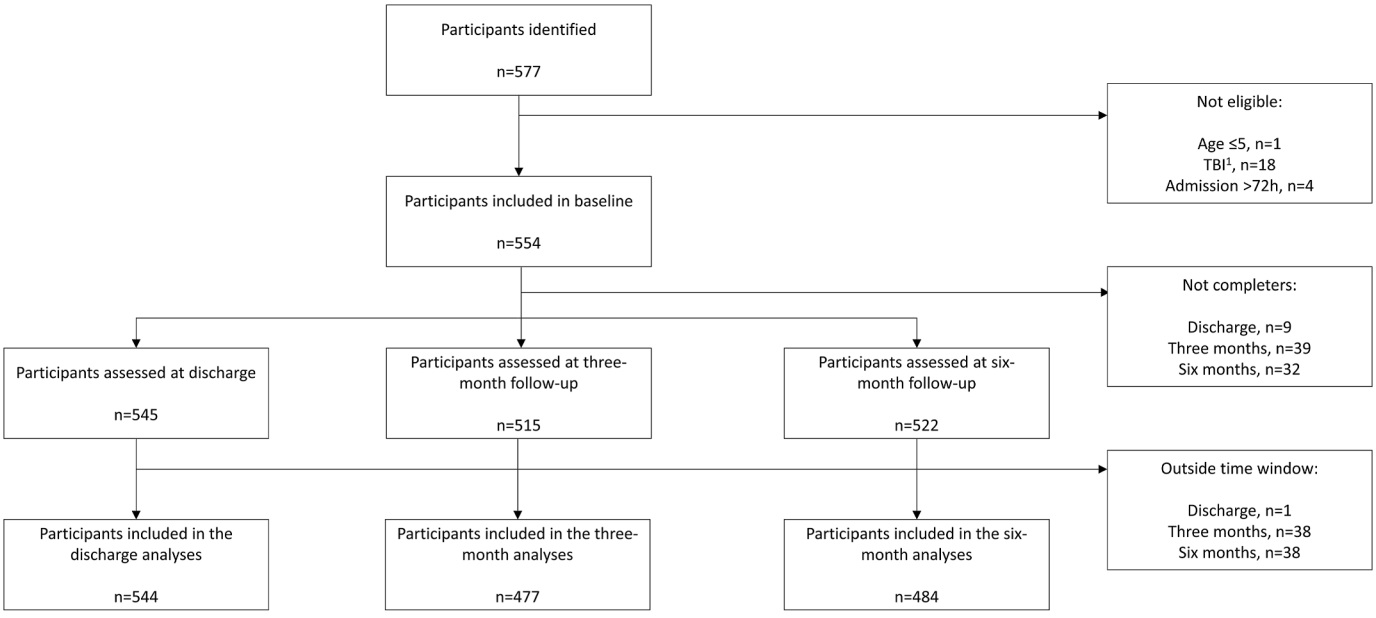

Figure 1. Inclusion flowchart, showing the participants included in the analyses at each of the 4 time points (ie, baseline, hospital discharge, 3-month, and 6-month follow-ups) and reasons for exclusion at the different stages of the cleaning process. [1]*TBI*, traumatic brain injury.

Table II
Personal, injury, and trauma care intervention characteristics of the total sample ($n = 554$) of patients after injury, enrolled in a prospective cohort across 4 health facilities located in humanitarian settings (Burundi, Cameroon, Central African Republic, and Haiti), 2020–2022

Characteristic	Value, n (%)
Personal factors	
Age (y)	
6–17	50 (9.0)
18–49	437 (78.9)
≥50	67 (12.1)
Missing	0 (0)
Sex	
Male	461 (83.2)
Female	93 (16.8)
Missing	0 (0)
Setting	
Rural	127 (22.9)
Urban	423 (76.4)
Missing	4 (0.7)
Type of preinjury occupation	
Manual	420 (75.8)
Nonmanual	126 (22.7)
None	8 (1.5)
Missing	0 (0)
Preinjury difficulties in functioning	
No difficulties	467 (84.3)
At least some difficulties	87 (15.7)
Missing	0 (0)
Preoperative health status (ASA)	
Healthy	420 (75.8)
Mild systemic disease	78 (14.1)
Severe systemic disease not incapacitating	3 (0.5)
Missing	53 (9.6)
Health condition	
Injury category (location and type)	
Only lower limb fracture(s)	264 (47.6)
Only lower limb soft or skin injury (ies)	62 (11.2)
Only upper limb fracture(s)	77 (13.9)
Only upper limb soft or skin injury (ies)	28 (5.1)
At least 1 visceral injury	66 (11.9)
Only trunk soft or skin injury(ies)	36 (6.5)
Others*	21 (3.8)
Missing	0 (0)
Cause of injury	
Accidental, road traffic accident	321 (57.9)
Accidental, others caused by	50 (9.0)
Fall	30 (5.4)
Burn	3 (0.5)
Animal	3 (0.5)
Machine	8 (1.4)
Other accident	6 (1.1)
Violent, gunshot wound	123 (22.2)
Violent, others	60 (10.8)
Bomb/mine	4 (0.7)
Knife	34 (6.1)
Other sharp object	13 (2.3)
Assault	9 (1.6)
Missing	0 (0)
Injury severity (NISS median [IQR])	9 (4–13)
Minor injury (NISS ≤15)	478 (86.8)
Major injury (NISS >15)	73 (13.2)
Missing	3 (0.5)
Trauma care interventions	
Length of hospital stay (d)	
1–7	271 (48.9)
8–14	133 (24.0)
≥15	150 (27.1)
Missing	0 (0)
Surgical interventions (number)	
≥3	118 (21.3)
1–2	407 (73.5)
None	29 (5.2)
Missing	0 (0)
Readmissions	
None	91 (16.4)
At least 1	463 (83.6)
Missing	0 (0)
Timeliness of inpatient physiotherapy	
<48 h	345 (64.4)
≥48 h	111 (20.7)
No inpatient physiotherapy	98 (17.7)
Missing	0 (0)
Timeliness of outpatient physiotherapy	
<2 wk of discharge	233 (42.1)
2 wk to 3 mo	98 (17.7)
>3 mo	25 (4.5)
No outpatient physiotherapy	198 (35.7)
Missing	0 (0)

(*continued on next column*)

Table II (*continued*)

ASA, American Society of Anesthesiologists; *IQR*, interquartile range; *NISS*, New Injury Severity Scale.
* The injury type "others" includes injury to multiple locations or of multiple types.

physiotherapy (overall $P = .029$; physiotherapy <48 hours—aOR: 2.492, CI: 1.256–4.944, $P = .009$; with physiotherapy ≥48 hours as a reference), and higher baseline AIM-T (aOR: 1.151 per AIM-T unit, CI: 1.112–1.191, $P < .001$), when adjusted for other covariates (Figure 3, *A*).

Three months after injury, factors that were significantly or borderline significantly associated with independence in activities were age (overall $P = .013$; 6–17 years—aOR: 5.086, CI: 1.725–14.993, $P = .003$; with 18–49 years as a reference), type of injury (presence of skin injury—aOR: 2.424, CI: 1.220–4.817, $P = .011$; presence of fracture—aOR: 0.325, CI: 0.158–0.667, $P = .002$; presence of visceral injury—aOR: 9.829, CI: 2.020–47.822, $P = .005$), hospital length of stay (LOS) (overall $P = .004$; LOS: 8–14 days—aOR: 0.500, CI: 0.242–1.032, $P = .061$; LOS: ≥15 days—aOR: 0.192, CI: 0.071–0.516, $P = .001$; with LOS <7 days as a reference), timeliness of IPD physiotherapy (overall $P = .065$; physiotherapy <48 hours—aOR: 2.506, CI: 1.161–5.408, $P = .019$; no IPD physiotherapy—aOR: 1.885, CI: 0.504–7.051, $P = .346$, with physiotherapy ≥48 hours as a reference), readmission (≥1 readmission—aOR: 0.169, CI: 0.055–0.516, $P = .002$), and higher AIM-T at discharge (aOR: 1.135 per AIM-T unit, CI: 1.087–1.185, $P < .001$), when adjusted for other covariates (Figure 3, *B*).

At 6 months after injury, factors significantly associated with independence in activities were age (overall $P = .035$; 6–17 years—aOR: 4.547, CI: 1.229–16.822, $P = .023$; with 18–49 years as a reference), type of injury (presence of fracture—aOR: 0.380, CI: 0.153–0.944, $P = .037$), number of surgical interventions in IPD (overall $P = .022$; ≥3 surgical interventions—aOR: 0.264, CI: 0.092–0.755, $P = .013$; with 1–2 interventions as a reference), and higher AIM-T at 3 months after injury (aOR: 1.234 per AIM-T unit, CI: 1.170–1.301, $P < .001$), when adjusted for other covariates (Figure 3, *C*).

Crude, semi-adjusted and fully aOR of each of the 3 models as well as the models' performance are available in Supplementary Material. The sensitivity analyses excluding children showed that some results shifted from significant to borderline significant and that effect estimates remained stable (Supplementary Table S3A–S3D).

Discussion

This prospective study described the recovery of functioning of a large cohort of patients over the first 6 months after orthopedic, visceral, and/or skin injury in 4 humanitarian settings. Acute and

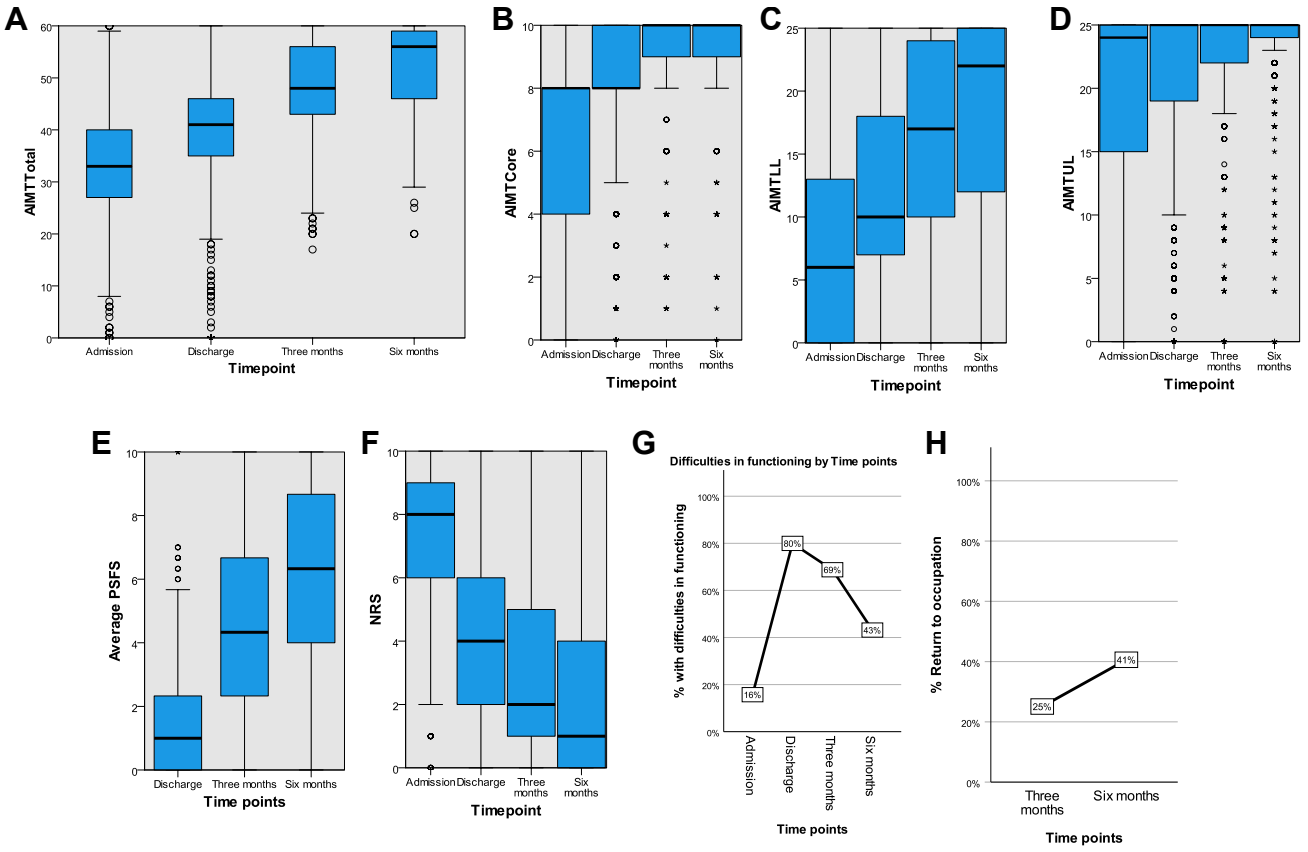

Figure 2. Recovery of different aspects of functioning across time points from hospital admission, discharge, and 3 and 6 months after injury among a prospective cohort of patients after injury across 4 humanitarian settings (Burundi, Cameroon, Central African Republic, and Haiti), 2020–2022: (A–D) Activity Independence Measure-Trauma (AIM-T) total, core, lower limb (LL), and upper limb (UL) subscale scores, respectively; (E) Average Patient Specific Functional Scale (PSFS); (F) Numeric Rating Scale (NRS) for pain; (G) difficulties in functioning, as measured by the Washington group Short set (% with at least some difficulties in 1 of the 6 domains); (H) return to occupation (%). ***$P < .001$.

prolonged difficulties across different aspects of functioning were observed up to 6 months after injury. The recovery of independence in daily activities was associated with several nonmodifiable and modifiable factors. This study thus contributes to quantifying the burden of injury in these humanitarian settings beyond mortality and morbidity, from the acute stage of recovery, while also informing on potential targeted interventions to best address such burden.

In this study, two-thirds of the patients were discharged from hospital while being dependent on another person for several mobility activities. However, independence in these activities is a common criterion for safe discharge home after injury.[22] Being discharged home with a low independence could potentially lead to increased risk of complications and burden of care for the patient's relatives, especially considering the hardship of living conditions in these settings. Moreover, 41% had returned to their preinjury occupation at 6 months, similar to other studies conducted in LMICs.[5] This relatively low return to occupation compared with that often seen in high-income countries could potentially be attributed to environmental factors as well as types of occupation and injury, as observed by others.[5,10] Such low independence in daily life and delayed return to occupation after injury have well-documented socioeconomic consequences, especially in settings with limited social security.[23–25]

The nonmodifiable factors identified, for example, age, type, and location of injury, suggest different trajectories of recovery that require tailored trauma care. In particular, patients with fractures, most often open and complex, were consistently more likely to be dependent over the OPD follow-ups. Similar delayed recovery after such complex open fractures has been reported by others.[7] Prolonged trauma care is therefore necessary, contrasting with humanitarian responses that tend to be short-term.

The modifiable factors identified are among previously reported quality of trauma care indicators and include last measured functioning, length of hospital stay, hospital readmission, and early inpatient rehabilitation, suggesting their relevance in humanitarian settings.[26–28] Across the 4 studied health facilities, 62% of patients participated in physiotherapy within 48 hours of hospital admission. The high inpatient physiotherapy utilization contrasts with that reported in most reports from LMICs, though being similar to some reports from NGO-supported health facilities.[29–32] In a cohort of patients injured after the Beirut port blast, 60% of patients attended their first physiotherapy session more than 2 months after injury, illustrating the delayed provision often observed during such humanitarian crises.[16] Moreover, in our study, the patients participating in early physiotherapy were more likely to be independent in activities at discharge and 3 months, but not at 6 months. These findings align with reports of the effectiveness of early provision of physiotherapy on improving discharge independence and accelerating recovery across different types of injury outside humanitarian settings.[33,34] This indicates potential benefits of early physiotherapy for faster recovery, thereby reducing the burden on inpatient health care professionals and caregivers after discharge from hospital.[34,35]

The observational design of this study reflects the "real world" practice in under-reported settings. The inclusion of health

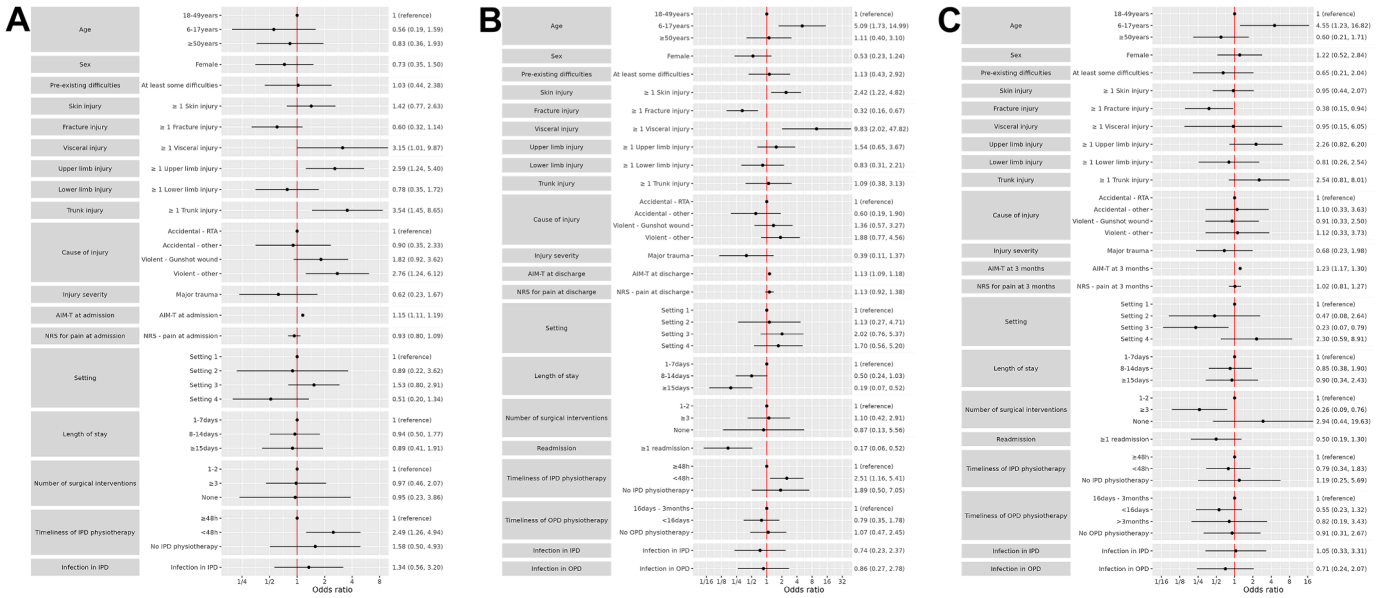

Figure 3. Fully adjusted odd ratios (aORs) for independence in activities based on multivariate logistic regression analyses performed at discharge (A), 3 months (B), and 6 months (C) after injury among a prospective cohort of patients after injury across 4 health facilities located in humanitarian settings (Burundi, Cameroon, Central African Republic, and Haiti), 2020–2022. The aORs (dots) were adjusted for health condition, baseline functioning, personal, and environmental factors listed in each figure, and are presented with their 95% confidence intervals (lines). An aOR of 1 indicates that there is no association, an aOR >1 (right side) indicates higher odds of being independent, and an aOR <1 (left side) indicates higher odds of not being independent. (A) Fully aOR for independence in activities at hospital discharge ($n = 522$). (B) Fully aOR for independence in activities at 3 months after injury ($n = 458$). (C) Fully aOR for independence in activities at 6 months after injury ($n = 394$). *AIM-T*, Activity Independence Measure-Trauma; *IPD*, inpatient; *NRS*, Numeric Rating Scale; *OPD*, outpatient; *RTA*, road traffic accident.

facilities supported or managed by MSF ensured a similar quality of care and routine data collection processes across the 4 health facilities. Patients in the present study were followed until 6 months after injury, mostly in-person, with a follow-up rate higher than or comparable to other reported rates in LMICS.[6,36] This follow-up rate was potentially strengthened by several mitigation strategies, including the reimbursement of transportation costs, dedicated full-time research officers, and the use of alternative administration methods to accommodate local constraints (ie, phone and home visits used for follow-ups), as reported by others.[6,36] Moreover, as called for, different aspects of functioning have been described here, with standardized generic and patient-specific assessments, including a measure that has been developed and reported to be valid and reliable in humanitarian settings with similar patients (ie, the AIM-T).[14,36]

This study has some limitations. First, the external validity of our findings may be challenged, given the relatively well-resourced study sites as well as potential selection bias, compared with other health facilities in the same settings. Moreover, characteristics of those attending follow-up differed from those who dropped out, including the severity of injury and physiotherapy attendance, which could introduce another selection bias.[37–39] Secondly, the observational design implies that trauma care was delivered based on clinical judgment, introducing potential bias in trauma care variables, and their effect estimates should be treated with caution. To mitigate such biases, adjustments were made for other variables assumed to influence clinical judgments, such as injury characteristics. Third, in addition to physiotherapy, occupational therapy and psychosocial support also have a recognized added value within trauma care, as reported by others.[11] However, no occupational therapy was available across the 4 health facilities, despite the identified challenges to return to occupation in humanitarian settings. Psychosocial support was available but to varying extents between and within facilities, preventing rigorous analyses. Moreover, the psychosocial aspects of functioning were not captured in this study, and their description would deserve future research. Finally, the diversity of humanitarian settings was only accounted for in our regression models as part of an overall setting variable, rather than a set of specific setting-related variables (eg, political instability and restricted humanitarian access). Therefore, the association between outcomes and any specific setting-related factors cannot be identified from this study and requires future investigation.[40]

Implications and future research

This study highlights the feasibility of conducting a longitudinal study in humanitarian settings, providing data on recovery from usually under-reported populations and encouraging further longitudinal studies in similar settings. The acute and prolonged difficulties in functioning observed in these patients are likely to represent an important socioeconomic burden for the patient, his/her family, and society. This burden contributes to a more global economic strain observed during and after humanitarian crises, and consequently calls for actions.[3,13]

This study informs these actions through the identification of modifiable and nonmodifiable factors associated with recovery of independence. A timely integration of rehabilitation interventions, including physiotherapy, should be considered by decision-makers as a necessary health strategy within preparedness and response to humanitarian crises.[13] The inpatient stay, however short it may be in humanitarian settings, is sometimes the only way to access rehabilitation after an injury, and this opportunity must be seized. At hospital discharge, instructions for self-management and a more comprehensive and targeted OPD care planning, including rehabilitation, should be offered for patients with remaining dependence. The provision of comprehensive rehabilitation along the continuum of care is also essential to address prolonged difficulties, including the delayed return to occupation. Identifying the factors associated with such delay in these settings would

further inform policy and practice. In addition to timing, the intensity and the type of physiotherapy intervention, as well as coordination with other health care professionals, may influence the recovery and should be explored in future studies.[33] Moreover, feasibility and cost-effectiveness of different types of rehabilitation interventions need to be further assessed in more homogeneous groups of patients, as well as in health facilities not managed or supported by international NGOs. Individual, organizational, and societal barriers to the implementation of early IPD physiotherapy after injury should also be further explored in such settings, in order to develop strategies for its ubiquitous implementation. In addition, future research in prioritization strategies should focus on the nonmodifiable factors identified in this study in order to best allocate the trauma care interventions, including rehabilitation.

Aside from its use in research, the routine use of measures of functioning for monitoring and clinical purposes is crucial and should be further systematized in humanitarian settings, in line with World Health Organization guidances.[12,13] Furthermore, the usability of measures of functioning in clinical practice, such as for clinical reasoning, discharge planning, or screening for a more systematic physiotherapy prescription, is of interest to investigate in humanitarian settings, as well as the potential effects of their use on early mobilization and patient-centered practices.

In conclusion, by highlighting acute and prolonged difficulties in different aspects of functioning after injury, the present study underlines the need for a more comprehensive trauma care in humanitarian settings, going beyond life-saving procedures. Early inpatient physiotherapy was among the modifiable factors associated with better recovery of independence, supporting its potential role in accelerating recovery. Moreover, the nonmodifiable factors identified in this study may inform future research on the prioritization of rehabilitation care in humanitarian settings. However, given the observational design of the study and its location only in health facilities run or supported by an international NGO and in protracted humanitarian crises, future studies across a wider range of settings are required to strengthen these findings.

Funding/Support

This work was funded by an Enhancing Learning and Research in Humanitarian Action (ELRHA) research grant, within their Research for Health in Humanitarian Crises (R2HC) program (no. 32398), funded by the UK Foreign, Commonwealth and Development Office, Wellcome, and the Department of Health and Social Care through the National Institute for Health Research. The R2HC grant funded the salaries for research coordination and data collection, patients' transportation costs, and submission to national ethical review committees. Moreover, Médecins Sans Frontières provided support in the form of salaries for Dr Van den Bergh, Dr Kitembo, Dr Mafuko, Ndiramiye, Dr Musambi, Wehrung, Navarro, Touye, Naguele, Dessables, Dr Ciglenecki, Dr Antierens, Dr Trelles, Dr Dominguez, Dr Nyaruhirira, Dr Letoquart, Dr Osmers, and Van Hulse.

Conflict of Interest/Disclosure

Dr Gohy received her salary as the principal investigator from the ELRHA research grant (No. 32398). Dr Van den Bergh, Dr Kitembo, Dr Mafuko, Ndiramiye, Dr Musambi, Wehrung, Navarro, Touye, Naguele, Dessables, Dr Ciglenecki, Dr Antierens, Dr Trelles, Dr Dominguez, Dr Nyaruhirira, Dr Letoquart, Dr Osmers, and Van Hulse received salaries from Médecins Sans Frontières. The specific roles of these authors are articulated in the “CRediT authorship contribution statement” section. The funders otherwise had no role in study design, data collection, and analysis, decision to publish, or preparation of the manuscript, and the coauthors declare no other competing interest.

Acknowledgments

We would like to thank the patients who have participated in this study over this difficult 6-month period of their lives. We would also like to thank the local teams in each study center, as well as the coordination and headquarters teams at Médecins Sans Frontières and Humanity & Inclusion. Despite working in challenging environments, their commitment and support made this study happen. More particularly, we would like to thank the research officers, as well as Veerle Hermans, Temmy Sunyoto, Debojit Basak, Roy Nobhojit, Vincent Lambert, Yvonne Nzomukunda, Moussa Ousman, Georges Tonamou, Arielle Calmejane, Clair Mills, Felix Kouassi, and Amber Alayyan for their valuable contributions to this research project. The following coauthors are part of the AIM-T study group: Professor Luc Nghario, Professor Bertrand Tekpa, Gedeon Fabrice Touye, Gilbert Naguele, Jean Othniel Dessables, Aude Brus, Iza Ciglenecki, Annick Antierens, Miguel Trelles, Lynette Dominguez, Innocent Nyaruhirira, Jean-Pierre Letoquart, Inga Osmers, Julie Van Hulse, Pauline Falipou, and Eric Weerts.

CRediT authorship contribution statement

Bérangère Gohy: Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Rafael Van den Bergh:** Writing – review & editing, Writing – original draft, Validation, Project administration, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Johan von Schreeb:** Writing – review & editing, Writing – original draft, Validation, Methodology, Funding acquisition, Conceptualization. **Christina H. Opava:** Writing – review & editing, Writing – original draft, Validation, Methodology, Funding acquisition, Conceptualization. **Brigitte Oundagnon:** Writing – review & editing, Validation, Methodology, Conceptualization. **Augustin Kitembo:** Writing – review & editing, Supervision, Project administration. **Appolinaire Beme:** Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Conceptualization. **Jean-Marie Mafuko:** Writing – review & editing, Supervision, Project administration. **Eric Ndiramiye:** Writing – review & editing, Investigation. **Irene Mulombwe Musambi:** Writing – review & editing, Supervision, Project administration. **Rachel Wehrung:** Writing – review & editing, Supervision, Project administration, Investigation. **Jacob Navarro:** Writing – review & editing, Supervision, Project administration, Investigation. **Richard Aubrey White:** Writing – review & editing, Writing – original draft, Validation, Methodology, Formal analysis, Conceptualization. **Nina Brodin:** Writing – review & editing, Writing – original draft, Validation, Project administration, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Data sharing

Because of the sensitive nature of trauma data and in accordance with Médecins Sans Frontières's data sharing policy, the anonymized study dataset is available upon reasonable request (ie, legitimate research proposals outlining a secondary data analysis and approved by a competent ethical review board). Requests for access to data should be made to data.sharing@msf.org.

Supplementary Materials

Supplementary material associated with this article can be found, in the online version, at [https://doi.org/10.1016/j.surg.2025.109928].

References

1. GBD 2021 Diseases and Injuries Collaborators. Global incidence, prevalence, years lived with disability (YLDs), disability-adjusted life-years (DALYs), and healthy life expectancy (HALE) for 371 diseases and injuries in 204 countries and territories and 811 subnational locations, 1990–2021: a systema. *Lancet*. 2024;403:2133–2161.
2. Haagsma JA, James SL, Castle CD, et al. Burden of injury along the development spectrum: associations between the Socio-demographic index and disability-adjusted life year estimates from the Global burden of disease study 2017. *Inj Prev*. 2020;26:i12–i26.
3. Qirbi N, Ismail SA. Health system functionality in a low-income country in the midst of conflict: the case of Yemen. *Health Policy Plan*. 2017;32:911–922.
4. Cieza A, Sabariego C, Bickenbach J, Chatterji S. Rethinking disability. *BMC Med*. 2018;16:14.
5. David SD, Aroke A, Roy N, Solomon H, Lundborg CS, Gerdin Wärnberg M. Measuring socioeconomic outcomes in trauma patients up to one year post-discharge: a systematic review and meta-analysis. *Injury*. 2021;53:272–285.
6. Denu ZA, Yassin MO, Yesuf M, Azale T, Biks GA, Gelaye KA. Disability scores rate changes and predictors among road traffic injury victims admitted at Gondar specialized comprehensive hospital northwest Ethiopia : a prospective follow-up study. *Traffic Inj Prev*. 2022;23:40–45.
7. Schade AT, Hind J, Khatri C, Metcalfe AJ, Harrison WJ. Systematic review of patient reported outcomes from open tibia fractures in low and middle income countries. *Injury*. 2020;51:142–146.
8. Doocy S, Lyles E, Tappis H, Norton A. Effectiveness of humanitarian health interventions: a systematic review of literature published between 2013 and 2021. *BMJ Open*. 2023;13:e068267.
9. Wild H, Stewart BT, LeBoa C, Stave CD, Wren SM. Epidemiology of injuries sustained by civilians and local combatants in contemporary armed conflict: an appeal for a shared trauma registry among humanitarian actors. *World J Surg*. 2020;44:1863–1873.
10. Lotfalla A, Halm JA, Schepers T, Giannakópoulos GF. Parameters influencing health-related quality of life after severe trauma: a systematic review (part II). *Eur J Trauma Emerg Surg*. 2024;50:93–106.
11. National Institute for Health and Care Excellence. Rehabilitation after traumatic injury [Internet]. Rehabilitation after traumatic injury, NICE guideline; 2022. Available at: https://www.ncbi.nlm.nih.gov/books/NBK579697/. Accessed July 18, 2023.
12. World Health Organization (WHO). Minimum standards for rehabilitation in emergency medical teams. WHO, Geneva. Available at: https://www.who.int/publications/i/item/emergency-medical-teams. Accessed April 2, 2016.
13. Wolrd Health Organization (WHO). *Strengthening rehabiltiation in health emergency preparedness, readiness, response and resilience*. Geneva: policy brief; 2023.
14. Barth CA, Wladis A, Roy N, Blake C, Kolo SM, O'sullivan C. Ways to improve surgical outcomes in low-and middle-income countries. *Bull World Health Organ*. 2022;100:726–732.
15. Zhang X, Reinhardt JD, Gosney JE, Li J. The NHV rehabilitation services program improves long-term physical functioning in survivors of the 2008 Sichuan earthquake: a longitudinal quasi experiment. *PLoS One*. 2013;8:1–10.
16. Abou-abbas L, Najmeddine I, Bernhard LM, et al. Building hope : early rehabilitation response of the international committee of the red cross post beirut port blast. *Confl Health*. 2024;18:1–12.
17. Inter-Agency Standing Committee and the European Commission. *INFORM Report 2021; Shared Evidence for Managing Crises and Disasters*. Luxembourg: Publications Office of the European Union; 2021.
18. Gohy B, Opava CH, von Schreeb J, et al. Assessing independence in mobility activities in trauma care : validity and reliability of the activity independence measure-trauma (AIM- T) in humanitarian settings. *PLOS Glob Public Heal*. 2023;3:1–18.
19. Stratford P, Gill C, Westaway M, Binkley J. Assessing disability and change on idividual patients: a report of a patient specific measure. *Physiother Can*. 1995;47:258–263.
20. Scott J, Huskisson EC. Graphic representation of pain. *Pain*. 1976;2:175–1984.
21. Sink EL, Leunig M, Zaltz I, Gilbert JC, Clohisy J, Academic Network for Conservational Hip Outcomes Research Group. Reliability of a complication classification system for orthopaedic surgery. *Clin Orthop Relat Res*. 2012;470:2220–2226.
22. Gledhill K, Bucknall TK, Lannin NA, Hanna L. Defining ready for discharge from sub-acute care : a qualitative exploration from multiple stakeholder perspectives. *BMC Health Serv Res*. 2023;23:1–11.
23. O'Hara NN, Mugarura R, Potter J, et al. The socioeconomic implications of isolated tibial and femoral fractures from road traffic injuries in Uganda. *J Bone Jt Surg*. 2018;100:1–7.
24. Schade AT, Sibande W, Kumwenda M, et al. Don't rush into thinking of walking again ": patient views of treatment and disability following an open tibia fracture in Malawi [version 1 ; peer review : 2 approved]. *Wellcome Open Res*. 2022;7:1–12.
25. Chinweuba AU, Chinweuba IS, Diorgu FC, et al. Economic burden of moderate to severe burns and its association with health - related quality of life of Nigerian women. *BMC Womens Health*. 2021;21:1–13.
26. Coccolini F, Kluger Y, Moore EE, et al. Trauma quality indicators: internationally approved core factors for trauma management quality evaluation. *World J Emerg Surg*. 2021;16:1–10.
27. Whitaker J, Donohoe NO, Denning M, Poenaru D, Guadagno E, Leather AJM. Assessing trauma care systems in low- - income and middle- - income countries : a systematic review and evidence synthesis mapping the three delays framework to injury health system assessments. *BMJ Glob Heal*. 2021;6:1–15.
28. World Health Organization - Eastern Mediterranean Region. Addressing the increasing burden of trauma in humanitarian settings in the Eastern Mediterranean region. EM/RC71/3. WHO, Geneva. Available at: https://applications.emro.who.int/docs/EMRC713-eng.pdf. Accessed May 5, 2025.
29. de Meneses Sousa K, Fonsêca De Oliveira WI, Alves AE, da Silva Gama ZA. Factors associated with access to physical rehabilitation for victims of traffic accidents. *Rev Saude Publica*. 2017;51:1–12.
30. Gohy B, Ali E, Van den Bergh R, et al. Early physical and functional rehabilitation of trauma patients in the Médecins Sans Frontières trauma centre in Kunduz, Afghanistan: luxury or necessity? *Int Health*. 2016;8:381–389.
31. Delauche MC, Blackwell N, Le Perff H, et al. A prospective study of the outcome of patients with limb trauma following the Haitian earthquake in 2010 at One- and Two- year (the SuTra2 study). *Plos Curr*. 2013;1–18.
32. Christian A, Gonzalez-Fernandez M, Mayer RS, Haig AJ. Rehabilitation needs of persons discharged from an African trauma center. *Pan Afr Med J*. 2011;10:32.
33. Bouman AIE, Hemmen B, Evers SMAA, et al. Effects of an integrated "Fast Track" rehabilitation service for multi-trauma patients: a non-randomized clinical trial in the Netherlands. *PLoS One*. 2017;12:1–16.
34. Tipping CJ, Harrold M, Holland A, Romero L, Nisbet T, Hodgson CL. The effects of active mobilisation and rehabilitation in ICU on mortality and function : a systematic review. *Intensive Care Med*. 2017;43:171–183.
35. Hardcastle TC. Trauma rehabilitation services in low - and middle - income countries : the challenge to human recovery. *Adv Hum Biol*. 2021;11:S1–S2.
36. Schade AT, Sabawo M, Nyamulani N, et al. Functional outcomes and quality of life at 1-year follow-up after an open tibia fracture in Malawi : a multicentre , prospective cohort study. *Lancet*. 2023;11:e1609–e1618.
37. De Munter L, Polinder S, Havermans RJM, Steyerberg EW, De Jongh MAC. Prognostic factors for recovery of health status after injury: a prospective multicentre cohort study. *BMJ Open*. 2021;11:e038707.
38. Ruske J, Castillo-Angeles M, Lamarre T, et al. Patients lost to Follow-up after injury: who are they and what are their long-term outcomes? *J Surg Res*. 2024;296:343–351.
39. Smith SM, Zhao X, Kenzik K, Michael C, Jenkins K, Sanchez SE. Risk factors for loss to follow-up after traumatic injury: an updated view of a chronic problem. *Surgery*. 2024;175:1445–1453.
40. Van Zyl C, Badenhorst M, Hanekom S, Heine M. Unravelling "low-resource settings": a systematic scoping review with qualitative content analysis. *BMJ Glob Heal*. 2021;6:e005190.