

War-related limb amputations among soldiers in the Democratic Republic of Congo: a cross-sectional study

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Research Article

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Abstract

Background

Soldiers on the front line are at risk of traumatic limb amputation. In the Democratic Republic of the Congo (DRC), due to recurring clashes in the eastern part of the country, many soldiers have experience disabilities, including amputated limbs. No data is currently available. This preliminary study aimed to describe the epidemiological profile, anatomical characteristics, and post-amputation clinical outcomes of war-related amputations among military personnel in the DRC.

Methods

This was a descriptive cross-sectional study conducted in three defense zones from August 2022 to August 2025. Epidemiological data were collected from administrative and medical records and analyzed using STATA software, version 18.

Results

Three hundred and forty-three soldiers were selected. The 18–30 age group was the largest (47.2%). The average age was 34 ± 8 years. There were 341 men and 3 women. The majority of amputees (68.2%) came from the third defense zone (provinces of North Kivu, South Kivu, Maniema and Orientale). Ground force units represented 96.2%. The lower limbs were affected in 62.4% of cases, while the the upper limbs affected 37.6% of soldiers. In the lower limbs, leg amputations accounted for 58.9%, whilst in the upper limbs, arm amputations accounted for 70.5%. Infection was observed in 84.2% of cases.

Conclusion

War-related amputations among soldiers in the DRC predominantly affect young men in their most productive years, with firearm injuries being the leading mechanism and the lower limbs most commonly involved. The study also reveals a high burden of post-amputation complications, underscoring the need to strengthen the continuum of trauma care, including prevention, evacuation, surgical management, rehabilitation, and trauma surveillance systems.

Background

Amputation is a surgical procedure involving the complete or partial removal of a limb or part of a limb following severe trauma, severe infection, malignant disease, or irreversible vascular injury [1, 2]. Globally, traumatic amputations constitute a major public health problem. According to the Global Burden of Disease (GBD) 2021 study, approximately 10 million new traumatic amputations occurred worldwide in 2021 and 445 million people were living with traumatic amputations. Also, traumatic

amputations accounted for nearly 5.9 million years lived with disability (YLD) [3]. Africa bears a disproportionate share of the burden of traumatic amputations because of the combined effects of armed conflicts, road traffic injuries, occupational trauma, diabetes, and limited access to timely trauma and vascular care [3, 4]. In many sub-Saharan African countries, prolonged armed conflicts have substantially increased the incidence of limb-threatening injuries caused by firearms, landmines, improvised explosive devices, and explosive remnants of war [5]. Limited surgical capacity, delayed evacuation of casualties, and inadequate rehabilitation services further increase the likelihood of amputation and contribute to long-term disability among survivors [4, 5].

The Democratic Republic of the Congo (DRC) ranks among one of the countries most severely affected by protracted armed conflict in the globe. For more than three decades, recurrent violence, particularly in the eastern provinces, has generated one of the world's largest humanitarian crises, with millions of internally displaced persons and thousands of conflict-related injuries each year [6]. According to the GBD 2021 estimates, the DRC recorded approximately 41,000 incident traumatic amputations, about 1.0 million prevalent cases, and 55,000 YLDs attributable to traumatic amputations in 2021 [3]. Despite this substantial burden and the persistent exposure of military personnel to combat-related injuries, epidemiological data describing war-related amputations among Congolese soldiers remain extremely limited.

In conflict settings, amputations are predominantly necessitated by devastating injuries caused by firearms, explosive devices, anti-personnel mines, improvised explosive devices, and shrapnel [6]. These mechanisms often produce extensive destruction of bones, blood vessels, nerves, and soft tissues, making limb preservation impossible despite advances in reconstructive surgery [6, 7]. The decision to amputate is frequently made to save the patient's life, control severe infection, or manage irreparable tissue damage [1, 6]. Consequently, war-related amputations remain a major challenge for military and civilian healthcare systems operating in conflict-affected regions [3].

Despite remarkable advances in battlefield medicine, trauma surgery, vascular reconstruction, and critical care, amputations continue to occur frequently among victims of armed conflicts [6, 8]. Their incidence is particularly high in low- and middle-income countries, where timely evacuation, access to specialized surgical expertise, and advanced limb-salvage techniques are often limited [3, 8]. Delays in receiving definitive surgical care, shortages of equipment, and insufficient rehabilitation services further increase the likelihood that amputation becomes the only viable treatment option [8, 9]. Consequently, conflict-affected countries continue to experience a substantial burden of disability associated with severe limb injuries [3].

Several studies have described the epidemiological characteristics of war-related amputees in countries affected by armed conflicts, providing valuable information on the demographic profile of patients, mechanisms of injury, and patterns of limb loss [10–12]. These findings have informed improvements in trauma management, prosthetic services, and rehabilitation programmes for injured combatants and civilians. However, comparable evidence remains scarce in many African conflict settings. In the DRC,

despite decades of armed violence, no published studies have specifically described the epidemiological profile of military personnel who have undergone limb amputation due to war-related injuries [4, 5].

Generating evidence on war-related amputations among military personnel is essential for strengthening trauma care, rehabilitation services, and military health planning in the DRC [3]. Such information can help identify populations at greatest risk, improve resource allocation, and guide the development of preventive and rehabilitative strategies adapted to the local context [2, 9]. Furthermore, understanding the epidemiological profile of affected soldiers may contribute to improving functional outcomes, quality of life, and long-term reintegration following injury [2]. Therefore, study aimed to describe the epidemiological profile, anatomical characteristics, and post-amputation clinical outcomes of war-related amputations among military personnel in the DRC.

Materials and methods

Study design and period

This was a descriptive cross-sectional study conducted from August 2022 to August 2025.

Study setting

This study was conducted in the DRC, a Central African country that has experienced recurrent armed conflicts for more than three decades, particularly in its eastern provinces. The DRC military healthcare system is organized into three defence zones (DZ) that provide medical services to military personnel across the country. The First DZ covers Kinshasa, Kongo Central, Kwilu, Kwango, Mai-Ndombe, Équateur, Mongala, Nord-Ubangi, Sud-Ubangi, and Tshuapa provinces; the Second DZ includes Haut-Katanga, Haut-Lomami, Lualaba, Tanganyika, Kasai, Kasai Central, Kasai Oriental, Lomami, and Sankuru provinces; while the Third DZ comprises North Kivu, South Kivu, Maniema, Ituri, Bas-Uélé, Haut-Uélé, and Tshopo provinces, where most active armed conflicts occur. Military personnel sustaining combat-related injuries are managed through military health facilities within these DZs, where specialized trauma and surgical care, including limb amputation when required, is provided.

Study population

The study population consisted of military personnel who: (1) had undergone amputation as a result of war; (2) were treated during the study period; and (3) had a usable medical record. Military personnel who had undergone amputation due to diabetic foot, chronic infections, tumours, or road traffic accidents occurring outside a wartime context were not included in this study. Amputations limited to fingers and toes were excluded as well.

Sampling strategy

A consecutive total-population sampling strategy was used. All military personnel who underwent war-related limb amputation and met the eligibility criteria during the study period were included. Eligible participants were identified from the administrative and medical records of military health facilities across the three DZs of the DRC. No formal sample size calculation was performed because the objective was to include the entire accessible population of war-related amputees during the study period.

Data source and collection

Data were collected using a standardized data extraction form, an EXCEL sheet, developed specifically for the study. Information was obtained retrospectively from administrative and medical records of military personnel who underwent war-related limb amputation and was complemented prospectively for newly treated cases during the study period. Data extraction was performed by the first author of this paper. To ensure data quality, all completed forms were reviewed for completeness, consistency, and accuracy before data entry.

The variables extracted included : (1) Sociodemographic characteristics including age, sex, education, marital status, military rank, military unit, and DZ ; (2) Injury-related characteristics including mechanism of injury, province where the injury occurred, injured limb, side affected, and anatomical level of amputation ; (3) Clinical characteristics included indication for amputation, type of amputation, and post-operative complications.

Data processing and statistical analyses

Data extracted in EXCEL were imported to Stata version 18 for statistical analysis. Prior to analysis, the dataset was checked for completeness, consistency, duplicate entries, and implausible values. Descriptive statistics were used to summarize the characteristics of the study population. Age, the continuous variables were summarized as means and standard deviations (SD), after performing the Shapiro-Wilk. Categorical variables were presented as frequencies and percentages.

Results

Patient flow

In this study, 1,027 soldiers underwent amputations, of whom 498 were in a non-war context and 529 in a war context. One hundred and eighty-six war-related amputations were excluded as they did not have a complete medical record. Finally, 343 patients met our inclusion criteria (Figure 1).

Figure 1. Flowchart for the selection of participants

Sociodemographic characteristics

Table 1 shows the socio-demographic characteristics of military personnel who had undergone amputation as a result of war. The average age was 34 ± 8 years. The 18–30 age group was the most represented (47.2%). There were 341 men compared with 3 women. Corporals and privates constituted the most common military rank (40.5%), whilst 13 (3.8%) senior officers had undergone amputation. Almost all service personnel belonged to the land forces (96.2%) (Table 1).

Table1: Sociodemographic characteristics of war Amputated military personnel

Variables	N= 343	%
Age (years)		
18-30	162	47.2
31-40	101	29.4
41-60	80	23.4
Mean (±SD)	34 years (±8 years)	
Sex		
Men	341	99.9
Women	3	0.1
Education		
Primary	213	62.1
Secondary	125	36.4
University/College	5	1.5
Marital status		
Cohabiting	200	58.3
Married	69	20.1
Divorced	30	8.7
single	40	11.7
Widower	4	1.2
Defense zones		
DZ1	81	23.6
DZ2	28	8.2
DZ3	234	68.2
Categories		
Caporals and privates	139	40.5
Non-commissioned	97	28.3
Military ranks		
Junior officers	94	27.4
Senior officers	13	3.8

Military units		
Land forces	330	96.2
Navy	11	3.2
Air force	2	0.6

Distribution of amputees according to the circumstances of the injury, location of the injury and type of amputation

Table 2 describes the circumstances of the injury, the location of the injury, the limb segment and the affected side. Among the war amputees, nearly half of the amputations were caused by firearm injuries (49.0%). Over half of amputations occurred in the lower limb (62.4%). Half of amputations occurred in the left side (49.8%) (Table 2).

Table 2. Circumstances and anatomical characteristics of war-related amputations among soldiers

Variable	N= 343	%
Circumstance		
Firearm	168	49.0
Shrapnel/bombing	101	29.4
Explosion	61	17.8
Other	13	3.8
Location		
Lower limb	214	62.4
Upper limb	129	37.6
Side of the amputated limb		
Left	171	49.8
Right	157	45.8
Left and right	15	4.4

Amputation levels in lower limb

The Figure 2 shows the distribution of amputation levels among 214 war-related amputees. About six out of ten amputations occurred at the leg level (58.9%) (Figure 2).

Figure 2. Anatomical distribution of war-related lower limb amputations among study participants

Amputation levels in upper limb

The Figure 3 shows the distribution of amputation levels among 129 war-related amputees. Seven out of ten amputations occurred at the arm (70.0%) (Figure 3).

Table 3. Anatomical distribution of war-related upper limb amputations among participating soldiers

Post-amputation clinical evolution and complications

Table 3 shows the evolution of amputees. Over seven out of ten amputees had experienced a complication (77.6%). Infection was the most frequent complication observed in amputees after amputations (84.2%) (Table 3).

Table 3: Post-amputation clinical evolution and complications among war-related amputees

Variables	N	%
Evolution (n= 343)		
With complication	266	77.6
Without complication	77	22.4
Type of complications (n= 316)		
Infection	266	84.2
Phantom limb	37	11.7
Neuroma	13	14.1

Discussion

This study aimed to describe the epidemiological profile, anatomical characteristics, and post-amputation clinical outcomes of war-related amputations among military personnel treated in the DRC. The findings revealed that war-related amputations predominantly affected young male soldiers. Firearm injuries were the leading cause of amputation, with the lower limbs being more frequently affected than the upper limbs. Below-knee and arm-level amputations were the most common anatomical levels observed. Furthermore, postoperative complications were highly prevalent, affecting more than three-quarters of amputees, with infection representing the most frequent complication.

Among the 1,027 amputees identified during the study period, more than half (529) sustained amputations related to armed conflict, illustrating the substantial burden that ongoing insecurity places on the military health system in the DRC. However, 186 cases (35.2%) were excluded because of incomplete medical records. This proportion of missing records reflects the challenges of maintaining

comprehensive medical documentation during armed conflicts, where emergency evacuations, repeated transfers between healthcare facilities, and logistical constraints often compromise record keeping. Similar limitations have been reported in conflict settings in Afghanistan, Iraq, Syria, and sub-Saharan Africa, where retrospective military studies frequently encounter incomplete clinical documentation [9–11]. Although these exclusions may have introduced selection bias, the final sample of 343 soldiers remains one of the largest hospital-based series of war-related amputees reported from Central Africa and provides valuable insight into the epidemiology of conflict-related amputations in the DRC.

These findings have important implications for military health services in the DRC. The high burden of war-related amputations highlights the need to strengthen battlefield evacuation, trauma care, and limb-salvage capacity to reduce preventable amputations. The large proportion of incomplete medical records also underscores the importance of implementing standardized trauma registries, electronic medical records, and harmonized documentation protocols to improve continuity of care, patient follow-up, and epidemiological surveillance. Establishing a national military trauma registry would support evidence-based planning, resource allocation, and evaluation of treatment outcomes. Furthermore, the burden of conflict-related amputations calls for comprehensive rehabilitation programmes that integrate prosthetic services, physiotherapy, psychosocial support, and vocational reintegration to improve long-term functional outcomes and quality of life among injured soldiers [12–14].

Most soldiers were young adults

The present study found that war-related amputees were predominantly young adults, with a mean age of 34 years and nearly half aged between 18 and 30 years. This finding is consistent with studies from Afghanistan, Iraq, Syria, Nigeria, and Ukraine, where military amputees are generally concentrated among young adults in their most productive years [15]. Younger soldiers are more frequently deployed to frontline combat operations, increasing their exposure to explosive devices and firearms. The loss of a limb at such a young age carries profound long-term consequences, including reduced physical capacity, psychological distress, social reintegration challenges, and economic dependency.

The predominance of young adults among war-related amputees highlights the need for targeted prevention strategies for frontline soldiers, including enhanced combat safety measures, early trauma care, and injury prevention training. Because amputations occur during the most economically productive years of life, military health programmes should prioritize comprehensive rehabilitation, mental health support, prosthetic services, and vocational reintegration to maximize functional recovery, preserve military or civilian employability, and reduce the long-term social and economic burden on affected soldiers and their families.

Most participants had only primary education (62.1%), suggesting that soldiers with lower educational attainment constitute a substantial proportion of frontline combat units. Lower educational levels may also influence health literacy, understanding of rehabilitation programmes, adherence to prosthetic care, and socioeconomic reintegration following amputation [16]. These findings emphasize the importance

of adapting rehabilitation and psychosocial interventions to the educational background of affected soldiers.

Circumstances and anatomical characteristics of amputations

Firearm injuries accounted for nearly half of all amputations (49.0%), making them the leading mechanism of injury in this study. This differs from many recent military conflicts such as Iraq and Afghanistan, where improvised explosive devices (IEDs) have become the predominant cause of traumatic amputations [15–19]. The predominance of firearm injuries in the DRC likely reflects the nature of ongoing armed confrontations, which frequently involve direct exchanges of gunfire between government forces and multiple armed groups rather than extensive use of sophisticated explosive devices.

The predominance of firearm injuries as the leading cause of war-related amputations underscores the need to strengthen prevention and management of ballistic trauma within military health services. Programmatically, this calls for improved frontline trauma care, rapid evacuation systems, training in damage-control surgery, and adequate availability of surgical and blood transfusion resources to increase limb salvage. These findings also support adapting military preparedness and resource allocation to the injury patterns characteristic of the DRC conflict rather than relying on models from conflicts where explosive devices predominate.

Anatomical levels of lower limb amputations

Lower limb amputations accounted for nearly two-thirds of all war-related amputations, consistent with findings from military conflicts worldwide [20–22]. The lower extremities are particularly susceptible to combat injuries because they are less protected by body armor and are more exposed during patrols, direct firefights, and explosive events. The predominance of below-knee amputations is clinically favorable, as preservation of the knee joint is associated with better mobility, lower energy expenditure during ambulation, improved prosthetic fitting, and superior functional outcomes compared with above-knee amputations. In contrast, arm-level amputations constituted the majority of upper limb amputations, reflecting the severity of proximal injuries that often preclude limb salvage and result in greater long-term functional impairment. Although bilateral amputations were uncommon, they represent a subgroup with particularly complex rehabilitation needs and poorer functional outcomes.

These findings underscore the need to strengthen comprehensive rehabilitation services tailored to the anatomical level of amputation. Health systems should prioritize timely prosthetic fitting, physiotherapy, occupational therapy, and long-term multidisciplinary follow-up, particularly for patients with proximal upper limb or bilateral amputations who require more complex rehabilitation [23]. In addition, preserving the knee joint whenever clinically feasible should remain a key surgical objective to optimize functional recovery. Expanding access to appropriate prosthetic technologies and specialized rehabilitation

services is essential to improve mobility, independence, and quality of life among war-injured soldiers in the DRC.

Post-amputation clinical evolution

A particularly important finding of this study is that more than three-quarters of amputees experienced at least one post-operative complication. This complication rate is substantially higher than those reported in military treatment facilities from high-income countries, where comprehensive trauma systems, rapid evacuation, specialized surgical care, and advanced rehabilitation programmes have contributed to lower complication rates [24]..

Several factors may explain the high complication burden observed in the present study. First, battlefield injuries are frequently heavily contaminated by soil, debris, clothing, and foreign bodies. Second, prolonged evacuation times from remote combat zones delay definitive surgical management. Third, shortages of surgical supplies, antibiotics, sterile operating environments, and specialized postoperative care may further increase the risk of adverse outcomes. Finally, repeated surgical revisions and delayed wound closure may contribute to prolonged hospitalization and increased morbidity.

Post-operative complications

Infection was by far the most common complication, affecting more than four-fifths of patients with complications. This finding is consistent with studies from conflict settings, where wound contamination, delayed debridement, extensive soft tissue destruction, and antimicrobial resistance contribute to high postoperative infection rates [15, 16]. Post-amputation infections increase hospital stay, healthcare costs, risk of revision surgery, and mortality while delaying prosthetic rehabilitation. Strengthening perioperative antibiotic stewardship, surgical debridement, infection surveillance, and wound care protocols should therefore be prioritized.

Phantom limb pain was reported in approximately one in ten patients. Although this prevalence is lower than that reported in many long-term follow-up studies [23–25], it may reflect under-documentation in retrospective hospital records rather than true absence of symptoms. Phantom limb pain remains one of the most debilitating long-term consequences of amputation, significantly impairing quality of life, sleep, mental health, and prosthetic use. Routine assessment and multidisciplinary management of chronic pain should therefore become standard practice in military rehabilitation programmes.

Neuroma formation occurred in a smaller proportion of patients but remains clinically significant because symptomatic neuromas often produce severe neuropathic pain and interfere with prosthetic fitting and functional recovery. Early recognition and appropriate surgical or pharmacological management are essential to optimize rehabilitation outcomes.

Overall, the high frequency of postoperative complications underscores the need for comprehensive post-amputation care extending beyond surgery alone. Such care should integrate infection prevention,

pain management, physiotherapy, prosthetic rehabilitation, psychological support, and long-term follow-up to improve functional recovery and quality of life among military amputees in the DRC.

Study strengths and limitations

This study has several important strengths. First, to our knowledge, it is the first study to comprehensively describe the epidemiological profile of war-related amputations among military personnel in the DRC, thereby filling an important evidence gap in a country that has experienced decades of armed conflict. Second, the study included 343 war amputees from all three military DZs, making it one of the largest hospital-based series of military war amputees reported from Central Africa and enhancing the representativeness of the findings within the military health system. Third, the study provides a comprehensive description of socio-demographic characteristics, injury mechanisms, anatomical patterns of amputation, and post-operative outcomes, generating evidence that can inform military trauma care, rehabilitation planning, and health policy. Finally, the inclusion of patients over a three-year period minimizes the influence of short-term fluctuations in conflict intensity and provides a broader picture of the burden of war-related amputations.

This study also has some limitations. First, its cross-sectional design precludes assessment of causal relationships or long-term outcomes such as prosthetic use, functional recovery, quality of life, return to military service, or mortality. Second, the study relied primarily on retrospective medical records, which are subject to incomplete documentation and information bias. Indeed, over one-third of potentially eligible war amputees were excluded because of incomplete medical records, which may have introduced selection bias. Third, the study was limited to military personnel treated within the military health system and therefore the findings cannot be generalized to civilian war victims or soldiers managed outside military hospitals. Fourth, some clinically relevant variables, including injury severity, time from injury to definitive surgery, comorbidities, rehabilitation outcomes, and psychological consequences, were unavailable in the medical records and could not be analyzed. Finally, because the study was descriptive, no multivariable analyses were performed to identify predictors of complications or poor outcomes. Future prospective cohort studies incorporating standardized trauma registries and long-term follow-up are needed to better characterize the determinants and consequences of war-related amputations in the DRC.

Conclusion

This study provides a comprehensive epidemiological and clinical profile of war-related amputations among soldiers in the DRC. The findings demonstrate that these injuries disproportionately affect young male soldiers in their most productive years, with firearm injuries representing the leading mechanism of trauma. The lower limbs were most frequently involved, particularly at below-knee level, while upper limb amputations predominantly occurred at the arm level.

The study also highlights a substantial burden of post-amputation morbidity, with more than three-quarters of patients experiencing complications. These outcomes reflect the challenges of managing

complex combat-related injuries in resource-constrained and logistically challenging conflict settings, where delayed evacuation, limited surgical resources, and incomplete medical documentation remain major barriers to optimal care.

Overall, the results underscore the urgent need to strengthen the full continuum of military trauma care in the DRC, including battlefield injury prevention, rapid evacuation systems, damage-control surgery, infection control, and structured rehabilitation services. Establishing standardized trauma registries and improving medical record systems are essential to enhance surveillance, guide evidence-based decision-making, and improve continuity of care. Finally, given the profound functional, psychological, and socioeconomic consequences of limb loss in young soldiers, comprehensive long-term rehabilitation should be prioritized to improve recovery, reintegration, and quality of life.

Abbreviations

DRC Democratic Republic of Congo

DZ Defense zone

GBD Global Burden of Disease

IEDs Improvised Explosive Devices

SD Standard Deviation

YLD Years Lived with Disability

Declarations

Ethics approval

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and its subsequent amendments. Ethical approval was obtained from the National Health Ethics Committee of the DRC (Approval No.: 321/2022). Administrative authorization to access military medical records was granted by the Ministry of Defence and Veterans Affairs and the relevant military health authorities.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Author Contribution

MVS & MBL conceptualized the study. MMA analyzed data, interpreted findings and wrote the first draft. MMA, KKG & RP supervised the study. All authors have read and agreed to submit the manuscript to the journal.

Acknowledgments

Not applicable.

Data Availability

Data analyzed in this study can be made available upon reasonable request to the corresponding author.

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Figures

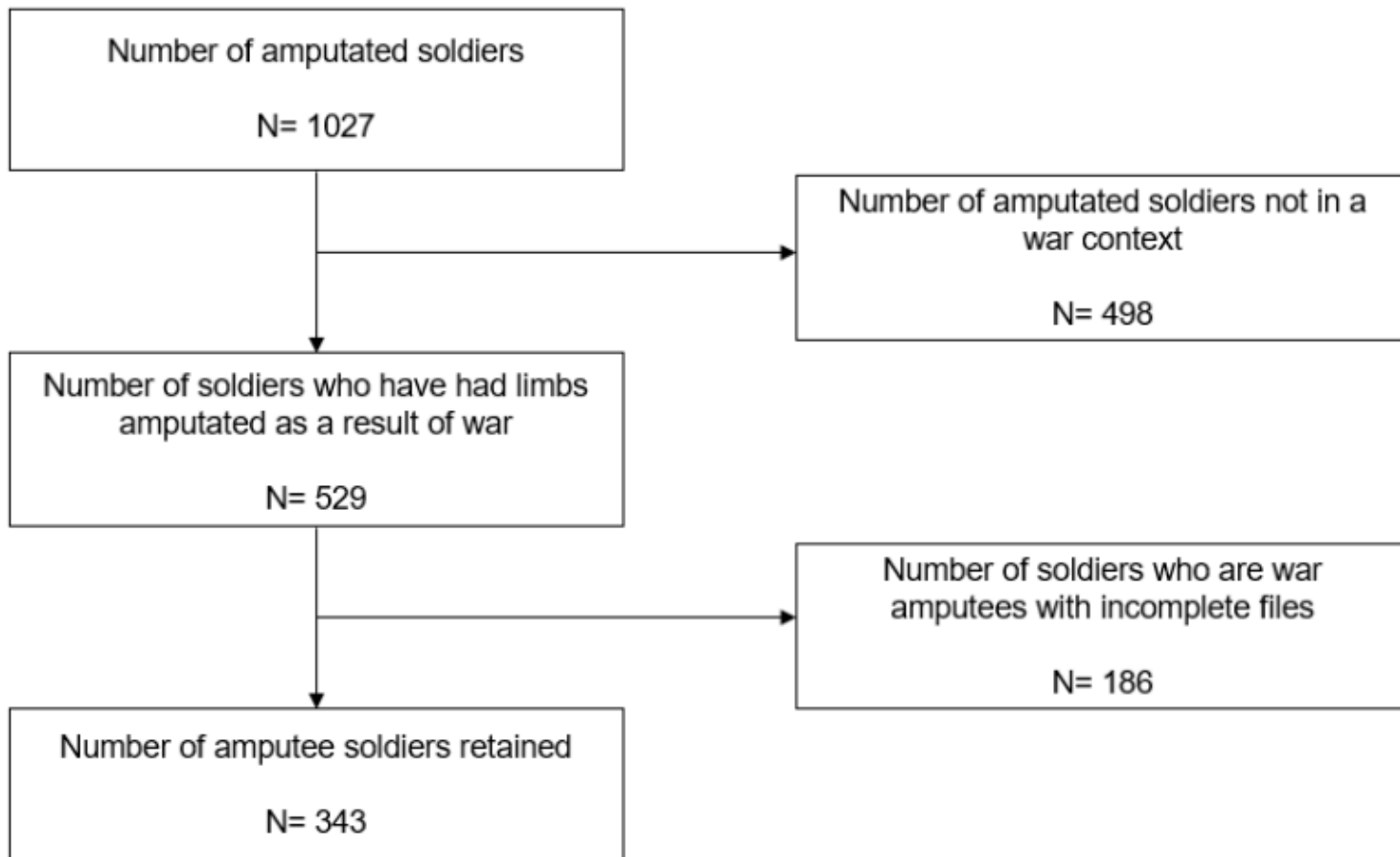


Figure 1

Flowchart for the selection of participants

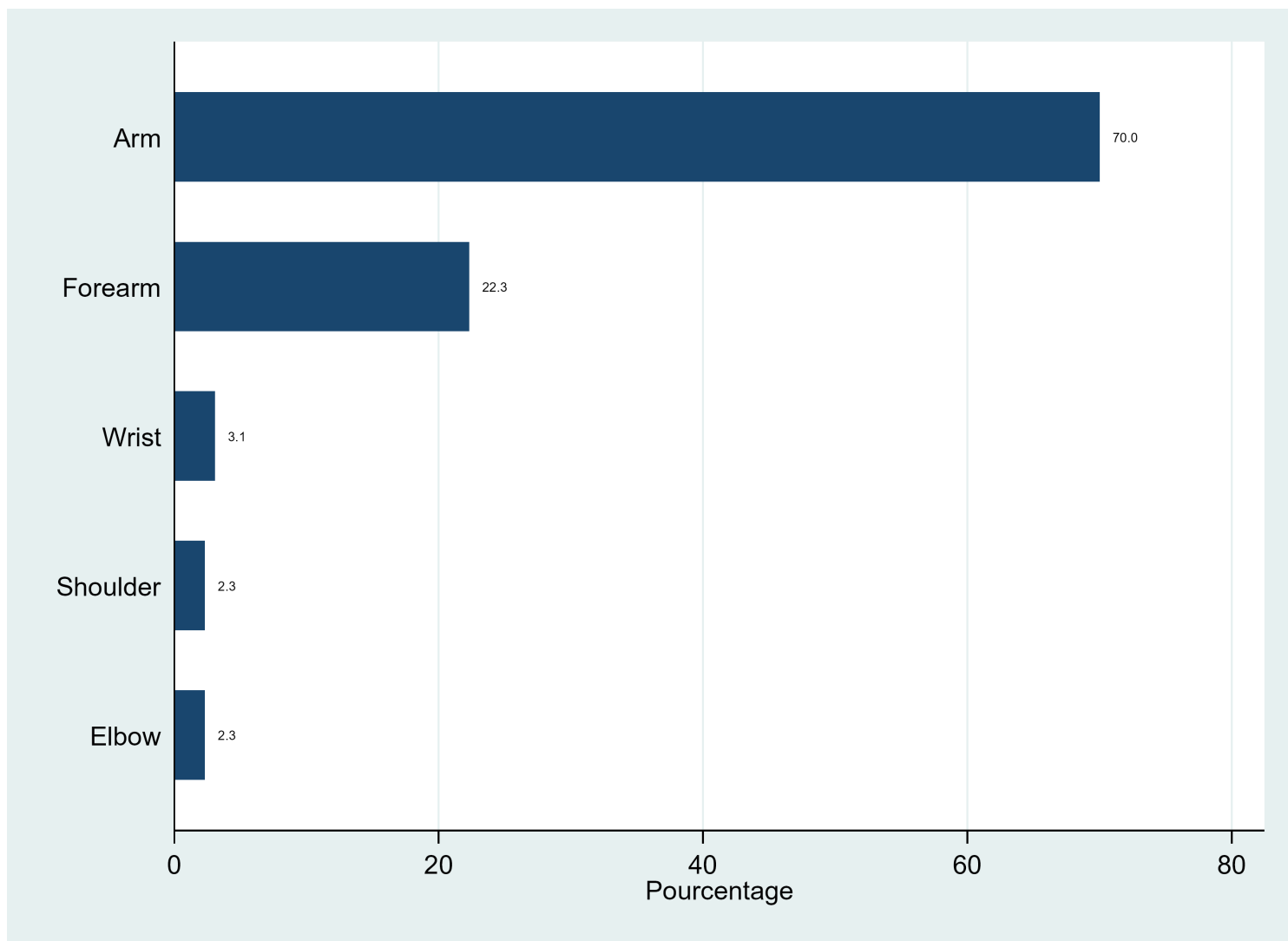


Figure 2

Anatomical distribution of war-related upper limb amputations among participating soldiers

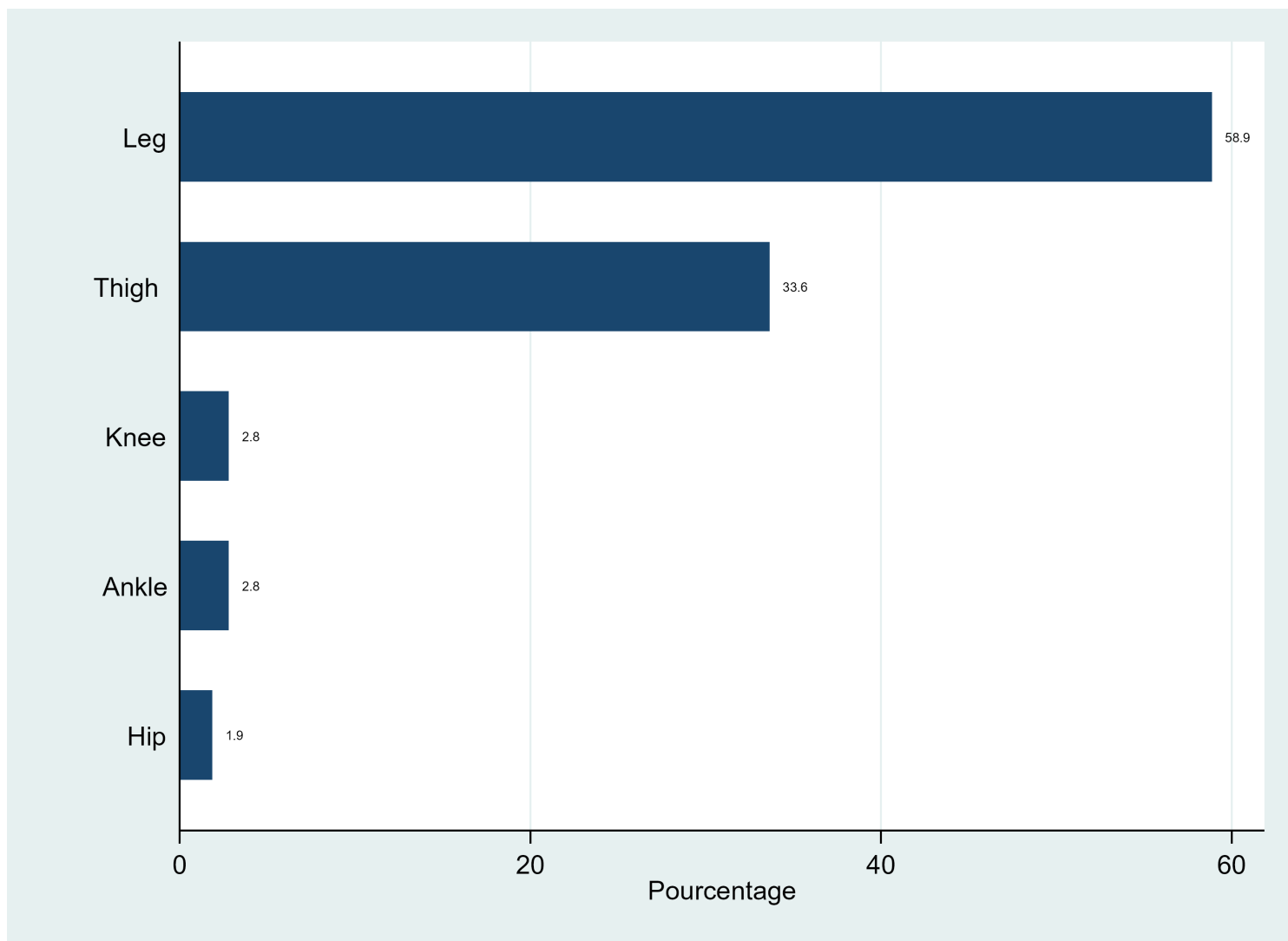


Figure 3

Anatomical distribution of war-related lower limb amputations among study participants