Cureus
Part of SPRINGER NATURE

Open Access Original Article

Orthopaedic Trauma Activity, Outcomes and Tariff-Based Operative Expenditure at a Small Island Hospital: A Six-Year Retrospective Study

Review began 10/27/2026
Review ended 11/12/2026
Published 11/16/2026

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DOI: 10.7759/cureus.119757

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Abstract

Background

Orthopaedic trauma places substantial demands on operating theatres, inpatient beds, implants and workforce planning. This study evaluated six-year trends in operative activity, case mix, clinical outcomes, and tariff-based operative expenditure at Gozo General Hospital in Gozo, Malta.

Methods

A retrospective observational study was conducted of operative orthopaedic trauma records between January 2019 and December 2024. Demographic characteristics, injury mechanisms, anatomical injury patterns, hospital length of stay (LOS), inpatient complications, 30-day readmission, 90-day return to theatre and inpatient mortality were evaluated. Operative procedures were categorised according to complexity for resource-utilisation analysis.

Results

A total of 1,033 operative admissions were eligible for analysis, representing 975 unique patients. Annual operative volume ranged from 124 cases in 2021 to 216 in 2023. Falls from standing height were the commonest mechanism of injury (55.0%). Median LOS decreased from six days in 2020 to three days annually between 2022 and 2024, with an adjusted reduction of 0.22 days per successive year ($p < 0.001$). Inpatient complications occurred in 14.6% of evaluable admissions, 30-day readmission in 4.2%, 90-day return to theatre in 6.5% and inpatient mortality in 1.8%. Major and Major+ procedures accounted for 84.6% of estimated tariff-based expenditure. Cumulative six-year expenditure was €3,720,691, with annual estimates ranging from €450,169 to €772,226.

Conclusion

Orthopaedic trauma at Gozo General Hospital generated sustained operative demand and substantial tariff-based operative expenditure. The findings provide baseline evidence to inform theatre capacity, workforce and trauma-service planning.

Categories: Trauma, Quality Improvement, Orthopedics
Keywords: healthcare expenditure, island healthcare, length of stay, operative workload, orthopaedic trauma, resource utilisation, service planning, trauma surgery

Introduction

Musculoskeletal trauma represents a substantial burden of morbidity, disability and healthcare expenditure. The Global Burden of Disease Study estimated that 178 million new fractures occurred worldwide in 2019, representing a 33.4% increase since 1990 [1]. Operatively managed fractures generate resource requirements extending beyond the procedure itself, including emergency assessment, theatre access, implants, anaesthesia, inpatient care, rehabilitation and the management of complications. A multicountry European analysis demonstrated substantial variation in injury-related hospital expenditure, highlighting the economic implications of fracture management across different healthcare settings [2]. More recently, a retrospective cost analysis of 2,689 orthopaedic trauma procedures in Saudi Arabia demonstrated that operative expenditure varied considerably according to procedure type and patient characteristics, emphasising the importance of understanding surgical case mix when allocating healthcare resources [3].

Operative orthopaedic trauma presents particular organisational challenges because demand is unpredictable, procedural complexity varies and timely surgical intervention must be balanced against finite theatre capacity and competing elective activity. The UK Orthopaedic Trauma Hospital Outcomes-Patient

Operative Delays (ORTHOPOD) study identified substantial variation in operative demand, theatre availability and surgical waiting times across 90 hospitals [4]. A subsequent analysis highlighted how limited regional coordination and differences in available operative capacity contributed to delays in fracture management [5]. Similarly, a longitudinal audit of orthopaedic trauma activity between 2016 and 2024 demonstrated increasing demand for time-sensitive procedures and the need for adaptations in theatre utilisation to accommodate changing workloads [6]. These findings emphasise the importance of longitudinal institutional data in identifying service pressures and informing resource allocation.

Beyond operative volume, orthopaedic trauma services generate considerable financial demands associated with theatre utilisation, procedural complexity and postoperative hospitalisation. Ang et al. demonstrated that inefficiencies in trauma operating theatres contributed to avoidable healthcare expenditure, highlighting the financial implications of suboptimal theatre utilisation [7]. In a retrospective study evaluating the introduction of a dedicated orthopaedic trauma operating room, Lex et al. reported improvements in operative efficiency alongside a favourable financial outcome [8]. Furthermore, a large record-linkage cohort study of hip fracture patients in England and Wales demonstrated associations between organisational characteristics, hospital expenditure and patient mortality, supporting the importance of service configuration in determining healthcare outcomes and resource utilisation [9].

These considerations are particularly relevant to smaller and geographically isolated hospitals, where limited specialist staffing, finite theatre availability and inter-hospital transfer requirements may complicate the provision of emergency surgical care. A retrospective study by Thompson et al. demonstrated that introducing a dedicated orthopaedic trauma list at a regional Australian hospital improved service efficiency and patient outcomes, illustrating the potential benefits of locally informed service planning [10]. However, longitudinal studies integrating operative workload, injury epidemiology, clinical outcomes and standardised procedural expenditure remain relatively limited in smaller hospital settings. Understanding these factors is important for anticipating future service requirements and ensuring that available resources are aligned with operative demand.

Gozo General Hospital provides operative orthopaedic trauma care to the island population and patients visiting the region. As a geographically defined island hospital, it represents a setting in which maintaining accessible emergency surgical services must be balanced against workforce, theatre and inpatient resource constraints. The primary objective of this study was to evaluate six-year trends in operative orthopaedic trauma activity at Gozo General Hospital between January 2019 and December 2024. Secondary objectives were to characterise patient demographics, injury mechanisms, anatomical injury patterns, hospital length of stay (LOS), inpatient complications, 30-day readmission, 90-day return to theatre and inpatient mortality and to estimate tariff-based operative expenditure according to procedural complexity. By integrating clinical workload, patient outcomes and standardised tariff-equivalent procedural valuation, this study aimed to provide baseline evidence to inform theatre-capacity planning, workforce allocation and future trauma-service development.

Materials And Methods

Study design and setting

A retrospective observational study was conducted at Gozo General Hospital, Malta, including operative orthopaedic trauma records between 1 January 2019 and 31 December 2024. A total of 1,047 operative entries were initially identified, of which 14 were excluded because of insufficient data. The final cohort comprised 1,033 eligible operative records involving 975 unique patients. These records formed the basis of both the clinical outcome analyses and the tariff-based operative expenditure analysis.

Data collection

Cases were identified from hospital and departmental operative records. Data were extracted retrospectively with variables including age, sex, residency status, mechanism of injury, primary and secondary fracture sites, open or closed injury and operative procedure. Residency status was classified according to the address and healthcare-entitlement information recorded in the clinical record. Patients with a permanent Maltese address who were entitled to publicly funded healthcare in Malta were classified as residents. Patients without a permanent Maltese address and who were not ordinarily entitled to publicly funded healthcare were classified as non-residents; this group predominantly comprised tourists and other temporary visitors to Malta.

Clinical outcomes included hospital LOS, documented inpatient complications, 30-day all-cause readmission from discharge, return to theatre within 90 days and inpatient mortality. Inpatient complications were identified retrospectively from routinely documented clinical records and defined as medical or surgical adverse events recorded during the index admission. These included respiratory and urinary tract infections, acute kidney injury, cardiovascular and thromboembolic events, postoperative anaemia or haemoglobin reduction, delirium, urinary retention, wound complications, surgical-site infections and fixation-related complications. Complications were recorded as a binary outcome (present or absent) at the admission level, irrespective of the number of individual events documented. Free-text

descriptions were retained to characterise the nature of complications. No formal severity-grading system was applied, and admissions with missing or indeterminate complication status were excluded from the complication-rate analysis.

Clinical outcomes and tariff-based expenditure were analysed using the 1,033 eligible operative records, with each admission contributing one record to the dataset. Where multiple procedures were performed during the same admission, clinical outcomes were recorded once for that admission. Patient identifiers were used to identify repeated admissions involving the same individual and to account for patient-level clustering in the regression analyses.

Operative complexity and expenditure

Operative procedures were classified according to the standardised procedure-level complexity categories provided in the MAPFRE Malta Schedule of Approved Fees, which assigns surgical procedures to categories based on their operative codes and descriptions [11]. For analysis, procedures were grouped into five complexity categories: Minor, Intermediate, Major, Major+ and Complex Major.

Standardised monetary values were assigned using the maximum fee within each corresponding orthopaedic category specified in the Maltese Healthcare (Fees) Regulations (Subsidiary Legislation 35.28, as amended by Legal Notice 105 of 2024) [12]. These were €627 for Minor, €1,566 for Intermediate, €4,124 for Major, €5,492 for Major+ and €7,998 for Complex Major procedures. The same statutory fee schedule was applied retrospectively to all procedures performed between 2019 and 2024 to permit consistent comparison across calendar years. Recorded operative procedures were matched to the corresponding procedure codes and descriptions in the MAPFRE schedule to determine their complexity category. Where an exact code was unavailable, classification was based on the closest applicable procedure description.

Annual tariff-based operative expenditure was calculated by assigning each eligible operative record a standardised tariff value according to its recorded procedure complexity category and summing these values for each calendar year. The same tariff schedule was applied across all study years to permit consistent comparison of tariff-equivalent operative activity. These estimates represent standardised procedural valuations rather than actual insurance reimbursements or patient-level hospital costs.

The resulting figures represent standardised tariff-equivalent estimates and do not constitute comprehensive hospital expenditure, as actual costs associated with implants, staffing, theatre time, inpatient care, imaging, medication and rehabilitation were not individually calculated.

As an exploratory analysis, annual tariff-based operative expenditure was allocated proportionally according to the distribution of resident and non-resident procedure records within each calendar year. This modelled allocation assumed equivalent average procedural complexity between residency groups and was used to estimate their relative contribution to operative workload. It did not represent actual patient-level expenditure or permit comparison of expenditure per procedure between groups.

Statistical analysis

Continuous variables were assessed for distribution and summarised using means and standard deviations or medians and interquartile ranges, as appropriate. LOS was markedly right-skewed and was therefore analysed primarily using medians and interquartile ranges. Categorical variables were reported as frequencies and percentages using available-case denominators.

Differences between calendar years were assessed using the Kruskal-Wallis test for continuous variables and the chi-squared test for categorical variables. Fisher’s exact test was used when expected cell counts were small.

Median regression was used to examine factors associated with LOS. Covariates were calendar year, age per ten-year increase, sex, open-fracture status and anatomical group. To account for patients contributing more than one operative admission, standard errors and 95% confidence intervals were estimated using patient-level clustered bootstrap resampling with 1,000 replications.

Multivariable logistic regression was used to examine factors associated with documented inpatient complications, 30-day readmission and return to theatre. The same covariates were included in each model. Calendar year was entered as a continuous variable, and adjusted odds ratios were reported per successive year. Cluster-robust standard errors were calculated using the patient identifier to account for repeated admissions contributed by the same patient

Because only eighteen inpatient deaths were recorded, mortality was analysed descriptively. Differences in mortality between years were assessed using Fisher’s exact test, while patient age was compared between those who died and those who survived using the Mann-Whitney U test. Multivariable modelling of mortality was not undertaken because of the small number of events.

Complete-case analysis was used for each model. Results were reported with 95% confidence intervals and two-sided p-values below 0.05 were considered statistically significant. Analyses were performed using Stata version 19 (StataCorp LLC, College Station, TX, USA).

Governance

Institutional authorisation for retrospective access to and analysis of clinical data from January 2019 to December 2024 was obtained from the Chief Executive Officer (CEO) of Gozo General Hospital, Malta, in November 2025, with final administrative approval granted by the People Management Division in 2026. No separate research ethics committee review was undertaken, as no further approval was required under the applicable institutional governance arrangements. Individual informed consent was not sought given the retrospective, non-interventional nature of the study and the use of de-identified data for analysis. Patient identifiers were replaced with study-specific codes to enable identification of repeated admissions and patient-level clustering, and all findings were reported in aggregate form without identifiable patient information.

Results

Cohort and injury characteristics

A total of 1,047 operative trauma records were identified between 2019 and 2024. Fourteen records were excluded because of insufficient clinical data, leaving 1,033 eligible operative admissions involving 975 unique patients. Most patients contributed one operative admission (920/975, 94.4%), while 55 patients (5.6%) had multiple admissions during the study period. Of these, 52 patients had two admissions and three patients had three admissions. Annual operative admissions ranged from 124 in 2021 to 216 in 2023.

The overall median age was 59 years (interquartile range (IQR) 34-75), and 513 admissions involved female patients (49.7%). Neither age nor sex distribution differed significantly between years (Kruskal-Wallis $H(5) = 0.46$, $p = 0.994$; $\chi^2(5) = 4.50$, $p = 0.480$, respectively).

The overall distribution of injury mechanisms differed significantly across the study period ($\chi^2(10) = 52.69$, $p < 0.001$), with lower proportions of falls from standing between 2021 and 2023 and higher proportions of other or pathological mechanisms in 2022-2023.

Upper-limb injuries accounted for 446 of 1,010 evaluable admissions (44.2%), hip or proximal femoral injuries for 256 (25.3%) and other lower-limb or pelvic injuries for 308 (30.5%). The overall anatomical distribution did not differ significantly between years ($\chi^2(10) = 17.72$, $p = 0.060$). Open fractures were recorded in 145 of 1,025 evaluable admissions (14.1%), with no significant annual variation ($\chi^2(5) = 8.37$, $p = 0.137$). Demographic and injury characteristics are presented in Table *1*.

Characteristic	2019	2020	2021	2022	2023	2024	Test statistic	p value
Operative admissions, n	183	143	124	185	216	182	—	—
Age, median (IQR), years	60 (33–75)	55 (31–76.5)	59.5 (35.8–75)	57 (34–74)	58 (30–77)	61 (36–75)	H(5) = 0.46	0.994
Female sex, n/N (%)	101/183 (55.2)	68/143 (47.6)	64/124 (51.6)	94/185 (50.8)	98/216 (45.4)	88/182 (48.4)	$\chi^2(5) = 4.50$	0.480
Open fracture, n/N (%)	18/178 (10.1)	25/142 (17.6)	20/124 (16.1)	33/185 (17.8)	23/215 (10.7)	26/181 (14.4)	$\chi^2(5) = 8.37$	0.137
Mechanism of injury, n/N (%)	—	—	—	—	—	—	$\chi^2(10) = 52.69$	<0.001*
Fall from standing, n/N (%)	120/183 (65.6)	78/143 (54.5)	62/122 (50.8)	84/177 (47.5)	101/215 (47.0)	117/182 (64.3)	—	—
Higher-energy trauma, n/N (%)	52/183 (28.4)	59/143 (41.3)	53/122 (43.4)	65/177 (36.7)	73/215 (34.0)	49/182 (26.9)	—	—
Other/pathological, n/N (%)	11/183 (6.0)	6/143 (4.2)	7/122 (5.7)	28/177 (15.8)	41/215 (19.1)	16/182 (8.8)	—	—
Anatomical distribution, n/N (%)	—	—	—	—	—	—	$\chi^2(10) = 17.72$	0.060
Upper limb, n/N (%)	70/174 (40.2)	53/140 (37.9)	54/118 (45.8)	75/184 (40.8)	98/216 (45.4)	96/178 (53.9)	—	—
Hip/proximal femur, n/N (%)	46/174 (26.4)	39/140 (27.9)	36/118 (30.5)	42/184 (22.8)	51/216 (23.6)	42/178 (23.6)	—	—
Other lower limb/pelvis, n/N (%)	58/174 (33.3)	48/140 (34.3)	28/118 (23.7)	67/184 (36.4)	67/216 (31.0)	40/178 (22.5)	—	—

TABLE 1: Demographic and injury characteristics by year

Continuous variables are presented as median (interquartile range [IQR]), and categorical variables as frequency (n/N) and percentage (%). Percentages are calculated using available-case denominators. Differences in age across calendar years were assessed using the Kruskal–Wallis test (H statistic), while categorical variables were compared using Pearson's chi-square test (χ^2 statistic). Degrees of freedom are presented in parentheses. Statistical significance was defined as $p < 0.05$, with statistically significant p-values denoted by an asterisk (*). A hyphen (–) indicates that a separate statistical comparison was not applicable or not performed.

Length of stay and clinical outcomes

The overall median hospital LOS was four days (IQR 2-10). Median LOS differed significantly between years ($p < 0.001$), decreasing from four days in 2019 and six days in 2020 to three days annually between 2022 and 2024. The annual distributions of LOS, including their variability and outliers, are presented in Figure *1*.

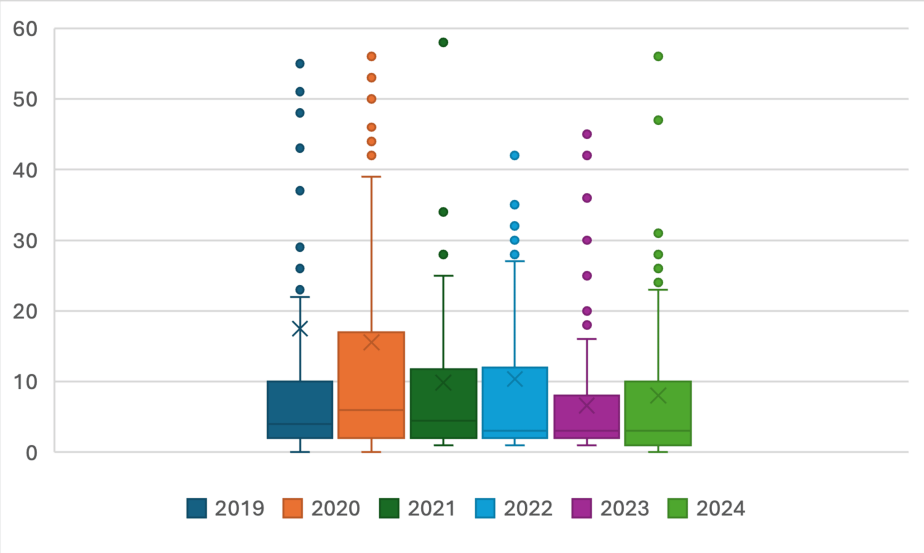


FIGURE 1: Distribution of hospital length of stay following operative orthopaedic trauma admissions, 2019–2024.

Boxes represent the interquartile range, horizontal lines indicate the median, and whiskers extend to the most extreme observations within 1.5 times the interquartile range. Individual points represent outliers. The vertical axis is truncated at 60 days for readability; observations exceeding 60 days were retained in the analysis but are not displayed. Median length of stay differed between years (Kruskal–Wallis $p < 0.001$).

In adjusted median regression with patient-level clustered bootstrap inference, each successive calendar year was associated with a 0.22-day reduction in median LOS (95% CI −0.33 to −0.12; $p < 0.001$). Each additional decade of age was associated with a 0.30-day increase (95% CI 0.22-0.38; $p < 0.001$). Compared with upper-limb procedures, hip or proximal femoral procedures were associated with an adjusted median stay of 12.10 days longer (95% CI 10.86-13.35; $p < 0.001$), while other lower-limb or pelvic procedures were associated with a 2.67-day increase (95% CI 2.14-3.20; $p < 0.001$).

Documented inpatient complications occurred in 150 of 1,027 evaluable admissions (14.6%), encompassing both medical complications, including respiratory and urinary tract infections, acute kidney injury and cardiovascular events, and surgical complications, including wound infections and fixation-related complications. Complication rates differed significantly between years ($\chi^2(5) = 42.80$, $p < 0.001$), ranging from 5.6% in 2023 to 27.6% in 2021. Admissions with documented complications had a median LOS of 21 days (IQR 9-32), compared with three days (IQR 2-7) among those without recorded complications ($p < 0.001$). Complications were analysed as a binary outcome at the admission level, irrespective of the number of adverse events documented.

Thirty-day readmission occurred following 43 of 1,027 evaluable admissions (4.2%), while return to theatre was recorded for 67 of 1,025 evaluable admissions (6.5%). Both outcomes differed significantly between years ($p = 0.002$ and $p = 0.003$, respectively). In adjusted analysis, the odds of readmission decreased with each successive year (adjusted odds ratio (aOR) 0.71, 95% CI 0.59-0.85; $p < 0.001$), as did the odds of return to theatre (aOR 0.79, 95% CI 0.67-0.93; $p = 0.005$).

There were 18 inpatient deaths among 1,027 evaluable admissions (1.8%), with no statistically significant annual variation (Fisher-Freeman-Halton exact test, $p = 0.106$). Patients who died were older than survivors, with median ages of 83 years (IQR 78.8-91.0) and 58 years (IQR 33-75), respectively ($p < 0.001$). Annual clinical outcomes are summarised in Table *2*.

Outcome	2019	2020	2021	2022	2023	2024	Test statistic	p value
LOS, median (IQR), days	4 (2–10)	6 (2.5–17)	4.5 (2–11.8)	3 (2–11.8)	3 (2–7.8)	3 (1–9.8)	H(5) = 27.43	<0.001*
Complication, n/N (%)	23/182 (12.6)	21/143 (14.7)	34/123 (27.6)	41/183 (22.4)	12/216 (5.6)	19/180 (10.6)	$\chi^2(5)$ = 42.80	<0.001*
30-day readmission, n/N (%)	14/183 (7.7)	8/143 (5.6)	10/121 (8.3)	3/183 (1.6)	5/215 (2.3)	3/182 (1.6)	$\chi^2(5)$ = 18.93	0.002*
90-day return to theatre, n/N (%)	22/183 (12.0)	11/143 (7.7)	6/119 (5.0)	15/183 (8.2)	6/215 (2.8)	7/182 (3.8)	$\chi^2(5)$ = 17.68	0.003*
Inpatient mortality, n/N (%)	6/183 (3.3)	2/143 (1.4)	5/123 (4.1)	2/182 (1.1)	1/214 (0.5)	2/182 (1.1)	Fisher's exact	0.106

TABLE 2: Clinical outcomes by year

Hospital length of stay (LOS) is presented as median (interquartile range [IQR]), while categorical outcomes are presented as frequencies (n/N) and percentages (%). Percentages were calculated using available-case denominators, excluding records with missing data for the respective outcome. All clinical outcomes were analysed at the operative admission level. Differences in LOS across calendar years were assessed using the Kruskal–Wallis test (H statistic). Differences in inpatient complications, 30-day readmission and 90-day return to theatre were assessed using Pearson's chi-square test (χ^2 statistic). Inpatient mortality was compared using the Fisher–Freeman–Halton exact test, an extension of Fisher's exact test for a 6 × 2 contingency table, owing to small expected cell frequencies. Degrees of freedom are presented in parentheses alongside the H and χ^2 statistics. No conventional numerical test statistic is reported for Fisher's exact test; only the exact p-value is provided. Statistical significance was defined as $p < 0.05$, and statistically significant p-values are denoted by an asterisk (*). A hyphen (–) indicates that a numerical test statistic is not applicable.

Multivariable analyses

After adjustment for calendar year, age, sex, open-fracture status and anatomical group, increasing age and hip or proximal femoral injury were independently associated with higher odds of inpatient complications. Each additional decade of age was associated with a 54% increase in the odds of complications (aOR 1.54, 95% CI 1.28-1.85; $p < 0.001$), while hip or proximal femoral injuries were associated with more than sevenfold higher odds compared with upper-limb injuries (aOR 7.71, 95% CI 3.68-16.15; $p < 0.001$).

Increasing age was also associated with readmission (aOR 1.35 per decade, 95% CI 1.08-1.68; $p = 0.009$). Other lower-limb or pelvic procedures had higher odds of return to theatre than upper-limb procedures (aOR 2.52, 95% CI 1.41-4.50; $p = 0.002$). The adjusted associations between patient and injury characteristics, LOS and clinical outcomes are summarised in Table *3*.

Predictor	Median LOS coefficient, days (95% CI)	Complication aOR (95% CI)	Readmission aOR (95% CI)	Return-to-theatre aOR (95% CI)
Calendar year, per successive year	−0.22 (−0.33 to −0.12), p < 0.001	0.89 (0.80–0.99), p = 0.028	0.71 (0.59–0.85), p < 0.001	0.79 (0.67–0.93), p = 0.005
Age, per 10 years	0.30 (0.22–0.38), p < 0.001	1.54 (1.28–1.85), p < 0.001	1.35 (1.08–1.68), p = 0.009	1.02 (0.90–1.17), p = 0.725
Female sex	0.01 (−0.40 to 0.42), p = 0.943	0.96 (0.61–1.53), p = 0.878	0.69 (0.32–1.45), p = 0.324	0.74 (0.40–1.38), p = 0.339
Open fracture	−0.27 (−0.60 to 0.07), p = 0.116	0.75 (0.24–2.36), p = 0.620	0.42 (0.09–1.99), p = 0.275	1.03 (0.49–2.14), p = 0.942
Hip/proximal femur	12.10 (10.86–13.35), p < 0.001	7.71 (3.68–16.15), p < 0.001	0.75 (0.29–1.95), p = 0.552	0.54 (0.21–1.41), p = 0.209
Other lower limb/pelvis	2.67 (2.14–3.20), p < 0.001	3.18 (1.55–6.55), p = 0.002	0.88 (0.37–2.06), p = 0.761	2.52 (1.41–4.50), p = 0.002

TABLE 3: Adjusted associations with length of stay and clinical outcomes

Upper limb injuries were the anatomical reference group. Logistic models used patient-clustered robust standard errors. Complete-case sample sizes were 996 for LOS, 998 for complications, 998 for readmission and 996 for return to theatre. All clinical models used the operative admission as the unit of analysis. Patient-level clustering accounted for patients contributing more than one admission during the study period.

Tariff-based expenditure

The tariff-based expenditure analysis included the 1,033 eligible operative records. Each procedure was classified according to operative complexity and assigned a standardised tariff value using the same fee schedule across all six calendar years. Cumulative tariff-based operative expenditure was €3,720,691, with annual estimates ranging from €450,169 in 2021 to €772,226 in 2023.

Major procedures accounted for 574 of the 1,033 eligible operative records (55.6%) and €2,367,176 of estimated tariff-based expenditure (63.6%). Major and Major+ procedures together represented 716 records (69.3%) and generated 84.6% of total tariff-based expenditure. The annual distribution of tariff-based operative expenditure by procedural complexity is illustrated in Figure *2*.

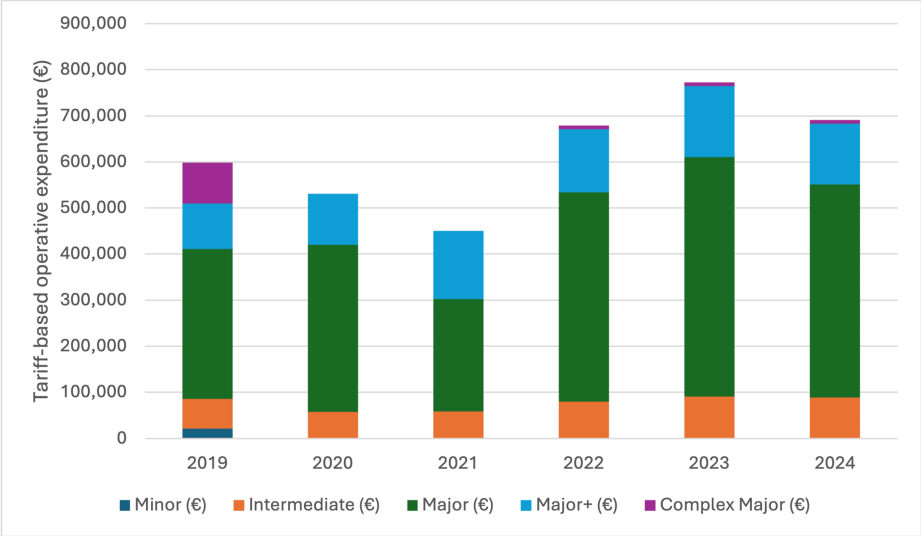


FIGURE 2: Annual tariff-based operative expenditure by procedural complexity, 2019–2024.

Major and Major+ procedures accounted for most estimated operative expenditure throughout the study period. Tariff values represent operative-complexity estimates and do not include the full costs of implants, staffing, inpatient care, imaging or rehabilitation. All procedures were valued using a single 2024 tariff schedule, and the figures therefore represent standardised tariff-equivalent estimates rather than contemporaneous annual expenditure.

These values represent standardised tariff-equivalent estimates rather than actual hospital expenditure, as costs associated with implants, staffing, inpatient care, imaging and rehabilitation were not individually calculated.

Residency status and estimated expenditure

Residency status was available for 1,030 of the 1,033 operative admissions included in the clinical analysis. Residents accounted for 876 admissions (85.0% of admissions with known residency status), while non-residents accounted for 154 admissions (15.0%). The proportion of procedures involving foreign patients varied significantly between years ($\chi^2 = 12.50$, 5 degrees of freedom; $p = 0.029$). Non-residents represented approximately 19% of procedures between 2019 and 2021, compared with 9.2-13.9% between 2022 and 2024.

Under the assumption that average procedural complexity was similar between residency groups, an estimated €3,158,655 (84.9%) of the six-year expenditure was attributable to residents and €551,028 (14.8%) to non-residents. Procedures with missing residency status accounted for an estimated €11,008 (0.3%) of the proportionally allocated expenditure. These figures represent modelled proportional allocations rather than patient-level expenditure and do not determine whether operative complexity or expenditure per procedure differed between residents and non-residents.

Discussion

This six-year retrospective study provides an overview of operative orthopaedic trauma activity, clinical outcomes and tariff-based procedural expenditure at Gozo General Hospital between 2019 and 2024. A total of 1,033 operative admissions were identified, with cumulative tariff-equivalent operative expenditure of €3,720,691. The findings demonstrate sustained demand for emergency orthopaedic surgery within a geographically defined island population, alongside variation in operative workload, injury mechanisms and clinical outcomes. By integrating patient characteristics, longitudinal service activity, procedural complexity and hospital outcomes, this study provides data relevant to healthcare resource allocation and future trauma-service planning.

Operative workload and injury characteristics

Annual operative admissions fluctuated throughout the study period, reaching their lowest level in 2021 before increasing in 2022 and 2023. This pattern may partly reflect the disruption caused by the COVID-19 pandemic, during which restrictions on mobility, altered healthcare-seeking behaviour and changes in clinical service provision affected orthopaedic trauma activity internationally. Wong and Cheung described substantial changes in orthopaedic trauma services during the pandemic [13]. Similarly, Shetty et al. reported a 54.2% reduction in orthopaedic trauma caseload during the initial COVID-19 lockdown across a

UK trauma unit and major trauma centre, demonstrating the considerable impact of restrictions on emergency surgical demand and workforce allocation [14]. More recently, Allen and Crocker examined orthopaedic trauma workload between 2016 and 2024 at a UK major trauma centre, identifying changes in operative case mix and increasing pressure on theatre capacity [6]. However, the present study included only one pre-pandemic year and used annual rather than monthly operative volumes. Consequently, the observed changes cannot be attributed specifically to COVID-19 and may also reflect variation in local activity, referral pathways, inter-hospital transfers or service organisation.

Falls from standing height accounted for 55.0% of recorded injury mechanisms, highlighting the contribution of low-energy trauma to operative workload. Although age and sex distributions remained relatively stable across the six years, injury mechanisms varied significantly. The predominance of low-energy injuries is relevant to service planning because older patients with fragility-related fractures may require prolonged inpatient care, multidisciplinary assessment and rehabilitation. The Global Burden of Disease Study has demonstrated the substantial contribution of fractures to worldwide morbidity, particularly in ageing populations [1]. These findings support the importance of anticipating both operative demand and subsequent inpatient resource requirements rather than estimating service needs from procedure counts alone.

Length of stay and inpatient complications

Hospital LOS decreased across the study period, with median LOS falling from six days in 2020 to three days annually between 2022 and 2024. Adjusted median regression demonstrated a reduction of 0.22 days per successive calendar year, alongside longer admissions associated with increasing age and lower-limb injury. Hip or proximal femoral injuries were associated with an adjusted median stay 12.10 days longer than upper-limb injuries. These findings highlight the considerable variation in inpatient resource utilisation according to patient characteristics and anatomical injury distribution.

Comparable associations have been reported in larger orthopaedic trauma cohorts. Basques et al. analysed 8,434 geriatric hip fracture patients and identified several factors associated with prolonged postoperative LOS, including time to surgery and procedure-related characteristics [15]. Furthermore, Xu et al. conducted a retrospective study involving 155 patients aged 90 years or older undergoing hip fracture surgery and found that postoperative pneumonia was independently associated with prolonged postoperative hospitalisation [16]. The REDUCE study by Baji et al. also demonstrated associations between organisational factors, hospital costs and mortality following hip fracture in England and Wales [9]. Together, these findings suggest that inpatient resource requirements are influenced by both clinical case mix and organisational factors. However, because time to surgery, discharge destination, comorbidity and rehabilitation availability were not consistently available in the present dataset, the observed reduction in LOS cannot be attributed to a specific improvement in service efficiency.

Inpatient complications occurred in 14.6% of evaluable admissions and were strongly associated with prolonged hospitalisation. Patients with documented complications had a median LOS of 21 days, compared with three days among those without recorded complications. Increasing age and hip or proximal femoral injuries were independently associated with greater odds of inpatient complications, while other lower-limb or pelvic injuries were also associated with increased complication risk relative to upper-limb injuries. These findings are clinically plausible given the greater physiological vulnerability, reduced mobility and potentially more complex postoperative requirements of patients undergoing major lower-limb trauma surgery. Nevertheless, the relationship between complications and LOS should be interpreted as an association rather than a causal effect, because prolonged admission may increase opportunities for complications to occur, while complications themselves may delay discharge.

Inpatient complications were identified retrospectively from routine clinical documentation without standardised severity grading. Variations in documentation, patient comorbidities and case mix may have contributed to differences in annual complication rates. Furthermore, the binary classification did not account for complication severity or multiple events within individual admissions, limiting interpretation of these findings as measures of postoperative morbidity.

Readmission, reoperation and mortality

The overall 30-day readmission rate was 4.2%, while 6.5% of evaluable admissions were associated with a return to theatre within 90 days. Both outcomes demonstrated lower adjusted odds in later calendar years, with a 29% reduction in the odds of readmission and a 21% reduction in the odds of return to theatre per successive year. Increasing age was independently associated with readmission, while other lower-limb or pelvic injuries were associated with greater odds of return to theatre compared with upper-limb injuries.

Previous studies have demonstrated that readmission following orthopaedic trauma surgery is influenced by multiple patient-related and clinical factors. Basques et al. reported a 10% 30-day readmission rate following geriatric hip fracture surgery, with increasing age, comorbidity and functional dependence among the associated factors [15]. A large database study of more than 400,000 orthopaedic trauma admissions reported an overall 30-day readmission rate of 6.5% and identified comorbidity and socioeconomic factors

as important predictors [17]. These findings suggest that readmission rates are influenced by differences in patient populations, healthcare systems and case mix, limiting direct comparisons between institutions. Furthermore, readmissions or reoperations occurring outside Gozo General Hospital may not have been captured, potentially leading to underestimation of the true event rates.

Return to theatre may reflect several distinct clinical circumstances, including staged fracture management, infection, loss of fixation or other postoperative complications. The absence of consistently recorded indications for repeat surgery limits interpretation of this outcome as an isolated measure of treatment quality. Accordingly, the observed reduction in return-to-theatre rates should be considered hypothesis-generating rather than evidence of improved operative performance.

Inpatient mortality was 1.8% overall and did not differ significantly across the study period. Patients who died were substantially older than survivors, with a median age of 83 years compared with 58 years. However, only 18 inpatient deaths occurred, limiting statistical power and preventing reliable multivariable adjustment. In addition, the study recorded inpatient rather than 30-day or 90-day mortality, restricting comparison with studies that include deaths following discharge. Mortality should therefore be considered a descriptive secondary outcome rather than a definitive measure of service performance.

Tariff-based operative expenditure and resource utilisation

Cumulative tariff-based operative expenditure over the six-year period was €3,720,691, with annual estimates ranging from €450,169 to €772,226. Major and Major+ procedures accounted for 69.3% of eligible operative records but generated 84.6% of the total tariff-equivalent expenditure. This highlights the importance of considering procedural complexity alongside operative volume when estimating resource requirements.

Albishi et al. conducted a retrospective cost analysis of 2,689 orthopaedic trauma surgeries in Saudi Arabia and reported variation in surgical expenditure according to procedure type and patient characteristics [3]. Their findings support the importance of procedural case mix when evaluating the financial demands of orthopaedic trauma care. However, an important methodological difference exists between the two studies. Albishi et al. incorporated operative costs including implants and anaesthesia, whereas the present study used fixed procedural tariff weights. Therefore, the financial estimates reported here represent standardised tariff-equivalent operative activity rather than actual patient-level expenditure or the complete economic burden of trauma admissions.

The distinction is important because the financial consequences of orthopaedic trauma extend beyond operative procedures to include theatre staffing, implants, imaging, inpatient bed occupancy, complications and rehabilitation. Ang et al. demonstrated the financial consequences of inefficiencies in trauma operating theatres [7] , while Lex et al. reported improvements in operative efficiency following the introduction of a dedicated orthopaedic trauma operating room, with a favourable overall financial outcome [8]. Similarly, Brusalis et al. demonstrated that dedicated trauma theatre provision at a paediatric centre was associated with reduced after-hours operating, shorter hospitalisation and lower estimated inpatient costs [18]. Although these studies evaluated specific organisational interventions, they reinforce the importance of examining operative activity and hospital resource utilisation together when planning trauma services.

The present study also identified a contribution from non-resident patients, who represented approximately 15% of admissions with known residency status. This is particularly relevant to an island healthcare service accommodating both permanent residents and temporary visitors. However, expenditure attributed to residency groups was allocated proportionally rather than calculated from patient-specific resource utilisation. Consequently, these estimates should not be interpreted as evidence of differences in procedural expenditure between residents and non-residents.

Implications for small island hospitals

The findings have particular relevance to smaller hospitals that must maintain emergency orthopaedic trauma services despite finite theatre capacity, specialist staffing and inpatient resources. Thompson et al. reported improved efficiency and patient outcomes following the introduction of a dedicated orthopaedic trauma list at a regional Australian hospital [10]. Their findings demonstrate the potential value of service redesign in hospitals where emergency surgical demand competes with limited operative capacity.

For Gozo General Hospital, the present study provides baseline information that may assist decisions regarding theatre availability, workforce allocation, implant procurement and inpatient capacity. The predominance of higher-complexity procedures within the tariff-equivalent expenditure estimates suggests that planning based exclusively on the annual number of operations may underestimate differences in resource requirements between years. Nevertheless, the study did not directly evaluate theatre utilisation, staffing levels, surgical delays or an organisational intervention. Its findings can therefore inform future service evaluation but cannot establish the benefits or cost-effectiveness of expanding theatre capacity.

Strengths and limitations

The principal strengths of this study include its six-year observation period, inclusion of more than 1,000 operative admissions and evaluation of a geographically defined hospital population. The combination of operative workload, injury characteristics, clinical outcomes, procedural complexity and standardised tariff-equivalent valuation provides a broader description of trauma-service activity than operative volume alone. Furthermore, multivariable analyses accounted for several important demographic and injury-related factors, while patient-level clustering was considered for individuals contributing multiple admissions.

Several limitations should be acknowledged. The retrospective, single-centre design limits generalisability, and incomplete documentation may have influenced the recorded complication rates and clinical outcomes. The statistical models could not adequately account for comorbidities, injury severity, operative complexity or other potentially relevant confounders. Readmissions and reoperations occurring at other hospitals may have been missed. Additionally, the absence of reliable time-to-surgery, operative-duration, discharge-destination and patient-reported outcome data prevented a more comprehensive evaluation of service efficiency and quality of care.

The tariff-based expenditure analysis represents a further limitation. A single tariff schedule was applied retrospectively to procedures performed between 2019 and 2024, allowing standardised comparisons between years but not measurement of contemporaneous expenditure. Actual implant costs, staffing expenditure, bed-day costs, imaging and rehabilitation expenses were not incorporated. The findings should therefore be interpreted as a measure of tariff-weighted operative activity rather than comprehensive hospital costs.

Future prospective studies incorporating detailed operative costs, theatre utilisation, time to surgery, comorbidity, injury severity, rehabilitation requirements and longer-term patient outcomes would provide a more comprehensive assessment of resource utilisation. Such data would also permit evaluation of the clinical and financial consequences of potential service expansion or organisational redesign. Overall, the present study establishes a longitudinal baseline for evaluating orthopaedic trauma activity and supporting evidence-informed service planning at Gozo General Hospital and comparable smaller healthcare facilities.

Conclusions

Orthopaedic trauma surgery at Gozo General Hospital generated sustained operative demand and substantial tariff-based expenditure over the six-year study period. Higher-complexity procedures accounted for most estimated operative costs, demonstrating that case complexity is an important consideration alongside procedure volume when planning trauma services. The reductions in median LOS, readmission and return-to-theatre rates are encouraging, while inpatient mortality did not differ significantly across the study period. Overall, the findings provide baseline evidence to inform future decisions regarding theatre capacity, workforce provision and trauma-service organisation. Prospective data collection incorporating operative duration, implant costs, inpatient expenditure and patient-level outcomes would enable more accurate assessment of resource utilisation and provide a stronger basis for evaluating future service expansion.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. CEO of Gozo General Hospital issued approval dated 16/10/2016. Institutional authorisation for retrospective data access and analysis was granted by Gozo General Hospital and the

People Management Division, with no further ethical approval required under applicable governance arrangements, and formal informed consent was not sought. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

Acknowledgements

Eliza Levinskaia and Darryl Pisani contributed equally to the work and should be considered co-first authors.

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