

Assessing the Osteoporosis Care Gap and Clinical Outcomes Following Fragility Hip Fractures in Saudi Arabia: Implications for Fracture Liaison Services

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Abstract

Background

Osteoporotic hip fractures cause significant morbidity, mortality, and healthcare burden. Substantial gaps persist in osteoporosis diagnosis and secondary fracture prevention, particularly in Saudi Arabia.

Aims

To evaluate the osteoporosis care gap, mortality outcomes, and predictors of mortality among patients with fragility hip fractures at a tertiary care center in Riyadh, Saudi Arabia.

Methods

This retrospective cohort study included 273 patients aged ≥ 50 years admitted with fragility hip fractures between 2016 and 2024. Kaplan–Meier analysis estimated survival; Cox proportional hazards regression identified predictors of mortality.

Results

Mean age was 76.2 ± 9.4 years. Only 12.5% underwent DXA before fracture and 21.6% received post-fracture osteoporosis treatment, leaving 78.4% untreated. Kaplan–Meier-estimated mortality was 2.2% at 30 days, 16.3% at 1 year, and 42.0% at 5 years; median survival was 6.1 years (95% CI 5.3–8.7). Increasing age independently predicted higher mortality (HR 1.05/year; 95% CI 1.02–1.08; $p < 0.001$), and surgical management was associated with lower mortality hazard (HR 0.32; 95% CI 0.13–0.84; $p = 0.02$), though this should be interpreted cautiously given the small non-operative group. Refracture was documented in 32 patients (11.7%); among the 14 patients with recorded refracture dates, the median time to refracture was 1.38 years.

Discussion

These findings highlight persistent missed opportunities for secondary fracture prevention and the need for coordinated post-fracture osteoporosis care.

Conclusion

Fragility hip fractures in Saudi Arabia are associated with substantial mortality and a major osteoporosis care gap. Structured post-fracture pathways, particularly fracture liaison services, are needed to strengthen secondary fracture prevention.

Introduction

Osteoporosis is a systemic skeletal disease characterized by deterioration of bone microarchitecture and reduced bone strength, leading to an increased risk of fragility fractures [1]. Osteoporosis is the most common metabolic bone disorder worldwide and represents a major public health concern [2]. Key risk factors include advanced age, female sex, low body mass index (BMI), smoking, chronic glucocorticoid use, and a personal or family history of fragility fractures [3].

Globally, osteoporotic fractures impose a substantial clinical and economic burden, with an estimated 37 million fractures occurring annually worldwide among individuals aged ≥ 55 years, with hip fractures accounting for approximately 15–20% of cases [4]. In the United States, projections estimate approximately 2 million incident fractures annually; hip fractures represented only 14% of cases but accounted for nearly 72% of the total economic burden, estimated at \$19 billion [5].

In Saudi Arabia, osteoporosis represents an increasing healthcare challenge. In 2019, approximately 174,225 osteoporotic fractures were reported, with a total economic burden of approximately \$636 million [6]. Hip fractures account for a disproportionate share of these costs. With increasing life expectancy and a rapidly aging population, the incidence of osteoporotic fractures in the region is expected to rise significantly in the coming decades [6].

Hip fractures are the most severe complication of osteoporosis and are associated with increased mortality, morbidity, and healthcare utilization [7]. From 2017 to 2018, a total of 2,949 hip fracture cases were reported among Saudi nationals aged ≥ 50 years across 15 hospitals [8]. This number is projected to increase substantially, reaching approximately 20,328 cases by 2050 if current management strategies remain unchanged [8]. Although the lifetime probability of hip fracture at age 50 in Saudi Arabia (4.6% for women and 3.7% for men) is lower than that reported in some neighboring countries, it still represents a significant burden on the healthcare system [8].

Outcomes following hip fractures in Saudi Arabia remain poor, with mortality rates comparable to or exceeding global averages. A study conducted in Al-Khobar reported a one-year mortality rate of approximately 23.4%, with diabetes mellitus, hypertension, cardiac disease, and higher American Society of Anesthesiologists (ASA) scores identified as significant predictors of mortality [9]. Functional recovery is also limited, with approximately 48% of patients regaining their pre-fracture ambulatory status [9]. Similarly, a study conducted in Riyadh reported a one-year mortality rate of 23.5% and demonstrated improved outcomes with structured follow-up and continuity of care [10]. Internationally, higher mortality rates have been reported, with one-year mortality up to 30% in European single-centre cohorts [11].

In response to this growing burden, Saudi health authorities have implemented initiatives such as the 2018 National Plan for Osteoporosis Prevention and Management and updated clinical guidelines in 2023 to enhance screening, prevention, and post-fracture care. Despite these efforts, significant gaps

remain in the continuum of care, particularly in the identification, treatment, and secondary prevention of fragility fractures [9, 12].

Fracture Liaison Services (FLS) have been shown to improve patient outcomes by ensuring systematic identification, treatment initiation, and long-term follow-up of patients with fragility fractures. Therefore, the implementation of FLS programs across healthcare institutions in Saudi Arabia is essential to reduce the burden of osteoporosis and improve patient outcomes.

This study aimed to evaluate the osteoporosis care gap, clinical outcomes (length of hospital stay, refracture), mortality rates, and predictors of mortality among patients aged ≥ 50 years admitted with fragility hip fractures at King Abdulaziz Medical City (KAMC), Riyadh, Saudi Arabia, between 2016 and 2024.

Methods

Study Design and Setting

This retrospective cohort study included patients aged ≥ 50 years who were admitted with fragility hip fractures to King Abdulaziz Medical City (KAMC), Riyadh, Saudi Arabia, between January 1, 2016 and December 31, 2024. Fragility fractures were defined as fractures resulting from low-energy trauma equivalent to a fall from standing height or lower. Patients with pathological fractures, high-energy trauma, or non-fragility fractures were excluded. No a priori sample size calculation was performed; the study included all consecutive eligible patients admitted over the study period.

Data Collection

Data were extracted from the hospital electronic medical record system and included demographic characteristics (age, sex), comorbidities (diabetes mellitus, hypertension, chronic kidney disease), fracture details, surgical management, length of hospital stay, osteoporosis diagnosis, dual-energy X-ray absorptiometry (DXA) testing, osteoporosis treatment before and after fracture, subsequent fractures, and mortality.

Osteoporosis diagnosis prior to fracture was defined as either a documented clinical diagnosis of osteoporosis or a DXA T-score ≤ -2.5 according to World Health Organization (WHO) criteria. Post-fracture osteoporosis treatment included antiresorptive or anabolic therapy initiated after the index fracture. Length of stay was calculated from admission to discharge.

Outcomes

The primary outcome was all-cause mortality following hip fracture. Mortality status was ascertained from institutional electronic medical records. Deaths occurring outside the healthcare system may not

have been captured.

Secondary outcomes included:

1. 30-day, 1-year, and 5-year survival.
2. Length of hospital stay
3. The osteoporosis care gap was defined as the proportion of patients who did not receive anti-osteoporotic therapy after fragility fracture, regardless of whether diagnostic evaluation was performed.
4. Subsequent fragility fractures (refracture)

Refracture was defined as a new fragility fracture occurring after the index hip fracture. Time to refracture was calculated from the date of the index fracture to the date of the subsequent fracture where available.

Survival Analysis

Time-to-event for mortality was calculated from the date of the index hip fracture to death or last follow-up. Survival analyses were restricted to patients with documented mortality status and sufficient follow-up information to calculate survival time. Patients who were alive were censored at the date of their last documented follow-up. For patients confirmed alive but without a documented clinic visit date, follow-up was censored administratively on March 15, 2026.

Time-to-event analyses for refracture included only patients with sufficient information to determine follow-up time for refracture. Patients without a subsequent fracture were censored at their last available follow-up.

Kaplan–Meier survival analysis was used to estimate overall survival and refracture-free survival. Survival was evaluated at 30 days, 1 year, and 5 years. Survival curves were compared using the log-rank test.

Statistical Analysis

Categorical variables were reported as frequencies and percentages. Continuous variables were reported as mean $\pm$ standard deviation or median with interquartile range (IQR) as appropriate.

Comparisons between groups were performed using the chi-square test or Fisher's exact test, as appropriate, with Fisher's exact test used when expected cell counts were less than 5, for categorical variables and the t-test or Mann–Whitney U test for continuous variables.

Kaplan–Meier survival curves were constructed for overall survival, survival by surgical management, and refracture-free survival. Differences between survival curves were assessed using the log-rank test. Multivariable Cox proportional hazards regression analysis was performed to identify independent

predictors of mortality. The proportional hazards assumption was assessed using Schoenfeld residuals and was not violated. Variables included in the model were age, sex, diabetes mellitus, hypertension, chronic kidney disease, and surgical management. Post-fracture osteoporosis treatment was not included in the multivariable model because treatment initiation occurred after the index fracture and therefore represents a time-dependent exposure. Variables included in the multivariable Cox proportional hazards regression model were selected based on clinical relevance and prior literature. Hazard ratios (HR) with 95% confidence intervals (CI) were reported. A p-value < 0.05 was considered statistically significant. All statistical analyses were performed using R statistical software (R version 4.5.2; R Core Team, Vienna, Austria). The analysis was performed using complete-case data, with patients excluded only if required covariates or survival outcomes were missing.

Results

Patient Characteristics

A total of 273 patients with fragility hip fractures were included. The mean age was 76.2 ± 9.4 years, and 122 patients (44.7%) were female. The participant flow is illustrated in Fig. 1. The comorbidity burden was high: diabetes mellitus was present in 183 patients (67.0%), hypertension in 204 patients (74.7%), and chronic kidney disease in 66 patients (24.2%). Surgical management was performed in 261 patients (95.6%), while 12 patients (4.4%) were managed non-operatively. The median length of hospital stay was 11 days (IQR 7–15), and the mean length of stay was 12.9 ± 8.6 days. Baseline characteristics are summarized in Table 1.

Table 1
Baseline characteristics of the study population (N = 273).

Variable	Value
Age, mean $\pm$ SD, years	76.2 $\pm$ 9.4
Female sex, n (%)	122 (44.7)
Male sex, n (%)	151 (55.3)
Diabetes mellitus, n (%)	183 (67.0)
Hypertension, n (%)	204 (74.7)
Chronic kidney disease, n (%)	66 (24.2)
Surgery performed, n (%)	261 (95.6)
Managed non-operatively, n (%)	12 (4.4)
Post-fracture osteoporosis treatment, n (%)	59 (21.6)
No post-fracture osteoporosis treatment, n (%)	214 (78.4)
Length of stay, median (IQR), days	11 (7–15)
Length of stay, mean $\pm$ SD, days	12.9 $\pm$ 8.6
Deaths, n (%)	93 (34.1)
Alive at censoring, n (%)	85 (31.1)
Unknown mortality status, n (%)	95 (34.8)

Osteoporosis Care Gap

Only 91 patients (33.5%) had a diagnosis of osteoporosis prior to fracture. DXA scanning prior to fracture was performed in 34 patients (12.5%), while 112 patients (41.0%) underwent DXA after fracture. Osteoporosis treatment was received by 8 patients (2.9%) prior to fracture and 59 patients (21.6%) after fracture, indicating that 78.4% of patients remained untreated after hip fracture. The osteoporosis care gap cascade is illustrated in Table 2.

Table 2
Osteoporosis assessment and treatment gap (N = 273).

Variable	n (%)
Osteoporosis diagnosis prior to fracture	91 (33.5%)
DXA before fracture	34 (12.5%)
Treatment before fracture	8 (2.9%)
DXA after fracture	112 (41.0%)
Treatment after fracture	59 (21.6%)
Treatment gap after fracture	214 (78.4%)

Mortality

Of the 273 included patients, mortality status was available for 178 (65.2%), who comprised the analytic cohort for survival analyses. Among these patients, 93 (52.2%) died and 85 (47.8%) were alive at last follow-up. Documented deaths represented 34.1% (93/273) of the overall study cohort; however, mortality status was unavailable for 95 patients (34.8%). Therefore, this proportion should not be interpreted as the overall mortality rate of the cohort. The median follow-up duration was 4.62 years (IQR 2.35–6.16), with a maximum follow-up of 10.5 years.

Best-case and worst-case sensitivity analyses were performed to evaluate the range of possible mortality estimates under extreme assumptions regarding missing data. Mortality ranged from 34.1% (93/273), assuming all patients with unknown status were alive, to 68.9% (188/273), assuming all were deceased. Among patients with known mortality status, mortality was 52.2% (93/178).

Kaplan–Meier survival analysis demonstrated an estimated survival rate of 97.8% at 30 days, 83.7% at 1 year, and 58.0% at 5 years (Fig. 2). Corresponding mortality rates were 2.2% at 30 days, 16.3% at 1 year, and 42.0% at 5 years. The median survival was 6.1 years (95% CI 5.30–8.74).

Patients who underwent surgical management had significantly better survival than those managed non-surgically (log-rank $p = 0.037$) (Figure S1). Interpretation of this finding should be cautious because only a small number of patients were managed non-operatively.

Predictors of Mortality

In multivariable Cox regression analysis (Table 3), increasing age was independently associated with higher mortality (HR 1.05 per year; 95% CI 1.02–1.08; $p < 0.001$). Surgical management was independently associated with lower mortality (HR 0.32; 95% CI 0.13–0.84; $p = 0.02$). Sex, diabetes, hypertension, and chronic kidney disease were not significantly associated with mortality. Post-fracture osteoporosis treatment was not included in the multivariable Cox regression because treatment

initiation occurred after the index fracture and exact treatment initiation dates were unavailable. Inclusion of treatment as a baseline covariate could introduce immortal-time bias.

Table 3
Multivariable Cox proportional hazards regression for mortality.
Reference categories: male sex, no diabetes, no hypertension, no chronic kidney disease, and non-operative management. Analytic sample: N = 178; deaths = 93.

Variable	Hazard Ratio (HR)	95% CI	p-value
Age (per year)	1.05	1.02–1.08	< 0.001
Female sex	0.82	0.52–1.29	0.38
Diabetes mellitus	0.90	0.53–1.51	0.70
Hypertension	0.79	0.46–1.39	0.41
Chronic kidney disease	1.02	0.65–1.68	0.93
Surgical management	0.32	0.13–0.84	0.02

Length of Stay and Clinical Outcomes

The median length of hospital stay was 10 days among survivors and 12 days among patients who died, with a trend toward longer hospitalization among patients who died; however, this difference did not reach statistical significance ($p = 0.071$). Mortality outcomes are summarized in Table S1.

Refracture

A subsequent fragility fracture occurred in 32 patients (11.7%). Of 32 patients with documented refracture, 14 had a valid refracture date and were included as events in the time-to-event analysis. The remaining 18 refractures could not be included as events because their dates were unavailable. Overall, 165 patients had sufficient follow-up information for the refracture-free survival analysis. Kaplan–Meier refracture-free survival therefore included the 165 patients with sufficient follow-up information for time-to-event analysis. Among patients with a valid recorded date of second fracture, the median time to refracture was 1.38 years (IQR 0.57–4.49; $n = 14$). Time-to-refracture analysis was limited to patients with available dates, and the impact of missing timing data should be interpreted with caution. Kaplan–Meier analysis demonstrated that among the 14 patients with dated refracture events, most events occurred within the first few years after the index fracture (Figure S2). Refracture occurred in 9.8% of patients who did not receive post-fracture osteoporosis treatment compared with 18.6% of patients who received treatment; however, this difference was not statistically significant ($p = 0.10$ by proportion comparison). Kaplan–Meier analysis demonstrated no significant difference in refracture-free survival between treatment groups (log-rank $p = 0.73$) (Figure S3, Table S2).

Discussion

This retrospective cohort study of 273 patients aged 50 years and older who had fragility hip fractures at a tertiary care center in Saudi Arabia highlights several clinically important findings. Most notably, we identified a substantial osteoporosis care gap, considerable post-fracture mortality and documented subsequent fractures, although refracture timing was available for only a subset of events. In addition, surgical management emerged as an independent predictor of improved survival. Collectively, these findings underscore persistent deficiencies in secondary fracture prevention and reinforce the need for system-level improvement in post-fracture care delivery. This cohort was larger than a previously published Saudi single-center cohort ($n = 232$) [9] and provides extended follow-up data in a region where long-term hip-fracture outcomes remain insufficiently characterized. We observed a substantial osteoporosis care gap, with only 21.6% of patients receiving osteoporosis treatment after fracture and only 33.5% having a documented osteoporosis diagnosis prior to fracture. These findings are consistent with global literature demonstrating that fragility fractures frequently fail to trigger appropriate osteoporosis evaluation and management. Given that hip fracture represents a critical inflection in osteoporosis care, failure to initiate treatment reflects a systemic gap rather than an isolated clinical oversight [13, 14]. The 78.4% treatment gap observed in our study aligns with findings from the International Osteoporosis Foundation's Capture the Fracture program, which has reported treatment gaps exceeding 80% in many healthcare systems [14].

The low rate of pre-fracture DXA scanning (12.5%) further suggests that osteoporosis remains substantially under-recognized prior to fracture occurrence. This finding is consistent with reports from the Middle East, where fragmented care pathways and limited systematic screening contribute to delayed diagnosis and undertreatment [15].

FLS have consistently demonstrated effectiveness in addressing the post-fracture care gap. Meta-analyses and large cohort studies show that FLS implementation increases osteoporosis treatment rates to 38–79%, reduces refracture risk by up to 32%, and is cost-effective in reducing long-term healthcare expenditure [16–18]. Consequently, international position statements now consider FLS the standard of care for secondary fracture prevention [19–21]. These findings provide locally relevant evidence supporting the implementation of fracture liaison services as a standardized quality-of-care model within the Saudi healthcare system. Such implementation aligns with national healthcare transformation goals under Saudi Vision 2030 and represents a scalable strategy to reduce osteoporosis-related morbidity and healthcare burden.

The mortality rates observed in our cohort, 2.2% at 30 days, 16.3% at 1 year, and 42.0% at 5 years, are broadly consistent with international literature, although our short-term mortality estimates fall toward the lower end of reported ranges [22–24]. Our median survival of 6.1 years is comparable to long-term outcomes reported in Asian cohorts [25, 26]. Increasing age emerged as an independent predictor of mortality (HR 1.05 per year), which is well established in the hip fracture literature and likely reflects greater frailty, comorbidity burden, and reduced physiological reserve among older patients [27]. Notably, surgical management was independently associated with lower mortality (HR 0.32; 95% CI 0.13–0.84; $p = 0.02$). However, this finding should be interpreted cautiously, as patients who did not undergo surgery

were likely frailer or deemed unfit for operative intervention, introducing potential confounding by indication.

This finding is consistent with contemporary evidence showing that timely surgical intervention improves survival and reduces postoperative complications [28, 29]. Contemporary evidence supports timely surgery, generally within 24–48 hours when the patient is medically stable, to improve outcomes [30–32].

We could not evaluate the independent association between post-fracture osteoporosis treatment and mortality because exact treatment-initiation dates were unavailable. Treating post-fracture therapy as a baseline exposure could introduce immortal-time bias; therefore, treatment was excluded from the multivariable survival model. Because we could not formally evaluate this association owing to the unavailability of treatment-initiation dates, the potential survival benefit of anti-osteoporotic therapy in our cohort may have been obscured by delayed initiation, limited treatment duration, inadequate statistical power, or residual confounding [33].

The median hospital length of stay in our cohort was 11 days, which is comparable to reports from European populations [11, 22, 34]. Although patients who died had numerically longer hospitalization than survivors, this difference did not reach statistical significance and may reflect greater clinical complexity among patients with poorer outcomes.

A subsequent fragility fracture occurred in 11.7% of patients, consistent with reports from large registry studies [27, 35], with a median time to refracture of 1.38 years, highlighting the early period of heightened fracture vulnerability following an index fracture. This finding reinforces the importance of rapid initiation of secondary fracture prevention strategies soon after the index event.

Interestingly, patients who received post-fracture osteoporosis treatment had a numerically higher refracture rate than untreated patients (18.6% vs. 9.8%, $p = 0.10$). This counterintuitive finding is most likely explained by confounding by indication, whereby patients perceived to be at highest baseline risk were preferentially selected for treatment. Accordingly, this observation should not be interpreted as evidence of treatment inefficacy. Nevertheless, the potential benefits of anti-osteoporotic therapy extend beyond fracture prevention. A large population-based study from Taiwan demonstrated that patients with osteoporotic vertebral fractures who received anti-osteoporotic treatment had a significantly lower mortality risk (hazard ratio: 0.84, 95% CI: 0.81–0.88), with even greater risk reduction observed in those treated for more than three years (hazard ratio: 0.53, 95% CI: 0.50–0.57) [35]. The apparently higher refracture proportion among treated patients was likely influenced by confounding by indication and should not be interpreted as evidence of treatment inefficacy. Observational evidence suggests a possible association between osteoporosis treatment and lower mortality, although residual confounding cannot be excluded [35]. This observation should also be interpreted cautiously given the limited number of patients with complete refracture timing data and potential residual confounding.

This study offers several important clinical insights. First, the marked osteoporosis care gap represents a major opportunity for healthcare quality improvement. Second, the association between surgical management and improved survival reinforces the importance of timely surgical intervention in eligible patients. Third, the early occurrence of refracture emphasizes the need for prompt and aggressive secondary prevention measures following hip fracture. Each fragility hip fracture should be considered both a sentinel event and a critical opportunity to initiate evidence-based osteoporosis management.

Strengths and Limitations

Our study has several strengths, including the relatively large cohort size, extended follow-up duration up to 10.5 years, and comprehensive evaluation of the osteoporosis care cascade from diagnosis through treatment and outcomes. Additionally, the inclusion of refracture and survival analysis contributes important regional data to the limited literature on fragility hip fractures in the Middle East.

However, limitations should be acknowledged. First, the retrospective design introduces potential selection and information biases. Second, mortality status was unknown in approximately one-third of patients, which may have influenced crude mortality estimates despite sensitivity analyses. This may introduce bias, particularly if loss to follow-up was non-random. Third, post-fracture osteoporosis treatment was not included in the multivariable survival model because exact treatment initiation dates were unavailable. Consequently, treatment could not be appropriately modeled as a time-dependent exposure, and inclusion as a baseline covariate could have introduced immortal-time bias. Future prospective studies with accurately recorded treatment initiation dates are needed to evaluate the independent effect of osteoporosis therapy on survival following hip fracture. Fourth, important clinical variables, including functional status, fracture subtype, perioperative risk scores such as ASA classification, treatment adherence, timing of surgery, functional recovery, and cause-specific mortality, were not available and may have influenced outcomes. Fifth, follow-up duration could not be reliably determined for patients with unknown mortality status because valid last-contact dates were unavailable. Finally, the single-center design may limit generalizability to other institutions and healthcare settings.

Conclusion

Fragility hip fractures in older Saudi adults are associated with substantial mortality, considerable refracture risk, and a profound osteoporosis care gap. Surgical management is associated with improved survival, whereas increasing age predicts worse outcomes. The persistent treatment gap represents a major missed opportunity for secondary prevention. These findings strongly support the urgent implementation of structured post-fracture care pathways, particularly fracture liaison services, to improve patient outcomes and reduce osteoporosis-related burden in Saudi Arabia.

Declarations

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Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Author contributions

Fahad Alshahrani conceptualized the study and supervised the project. Meshal Aljarallah contributed to data collection and chart review. Mohammed Almohaya contributed to results and manuscript review. Mussa Almalki contributed to data interpretation and manuscript review. All authors contributed to manuscript drafting, critically revised the manuscript, and approved the final version.

Data availability

The datasets generated and/or analyzed during the current study are not publicly available due to institutional privacy regulations but are available from the corresponding author on reasonable request.

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Language editing support tools were used during manuscript preparation, and all content was critically reviewed by the authors.

Ethics approval

This study was approved by the Institutional Review Board of King Abdullah International Medical Research Center, Riyadh, Saudi Arabia (approval number 00000186025; approved 15 July 2025). The study was conducted in accordance with the Declaration of Helsinki. The requirement for informed consent was waived because of the retrospective study design.

Consent to participate

The requirement for informed consent was waived by the Institutional Review Board because of the retrospective study design.

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Figures

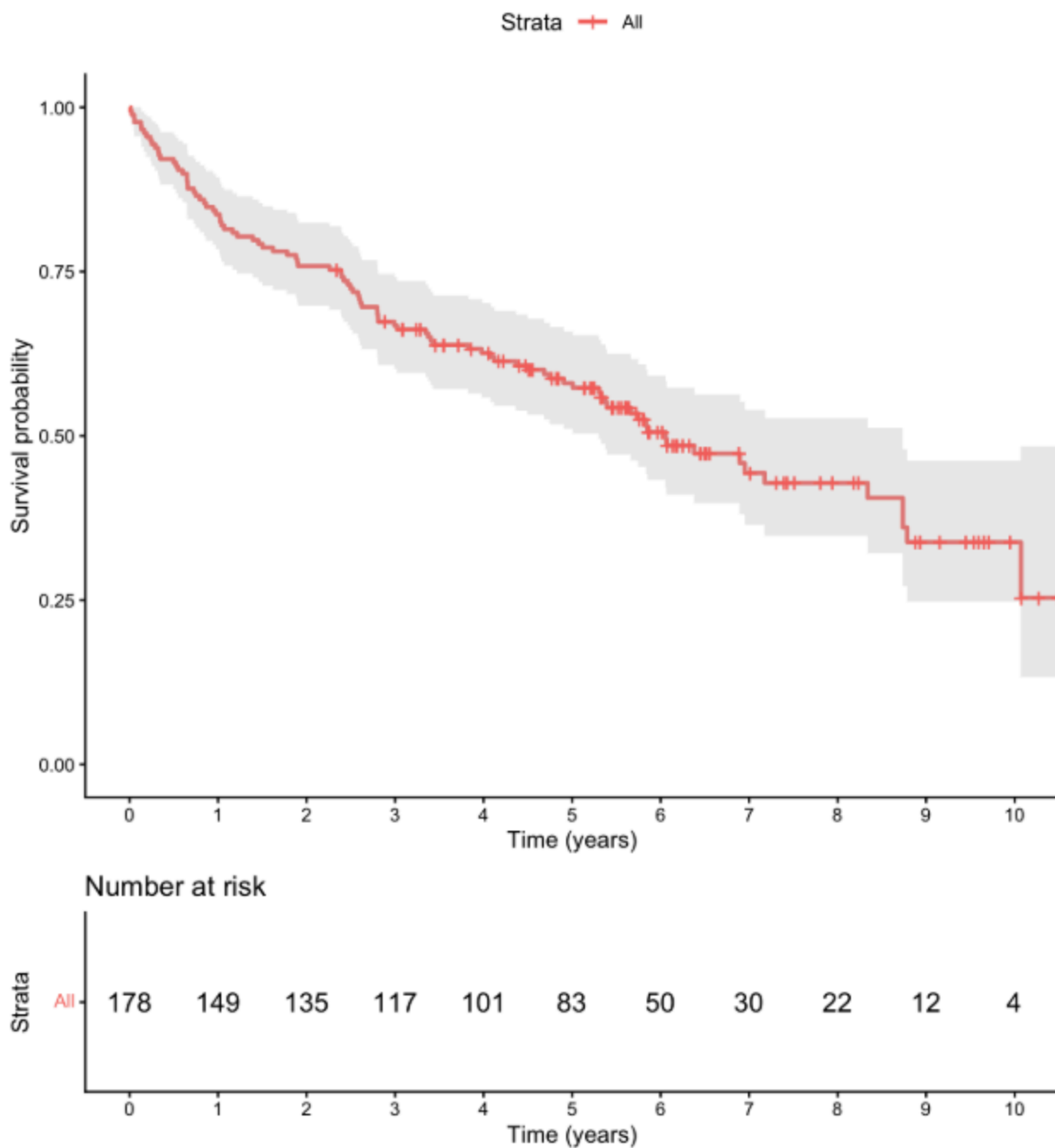


Figure 1

Kaplan–Meier overall survival after hip fracture in patients with ascertainable mortality status ($n = 178$; 93 deaths). Patients with unknown mortality status ($n = 95$) were excluded because valid censoring dates were unavailable.

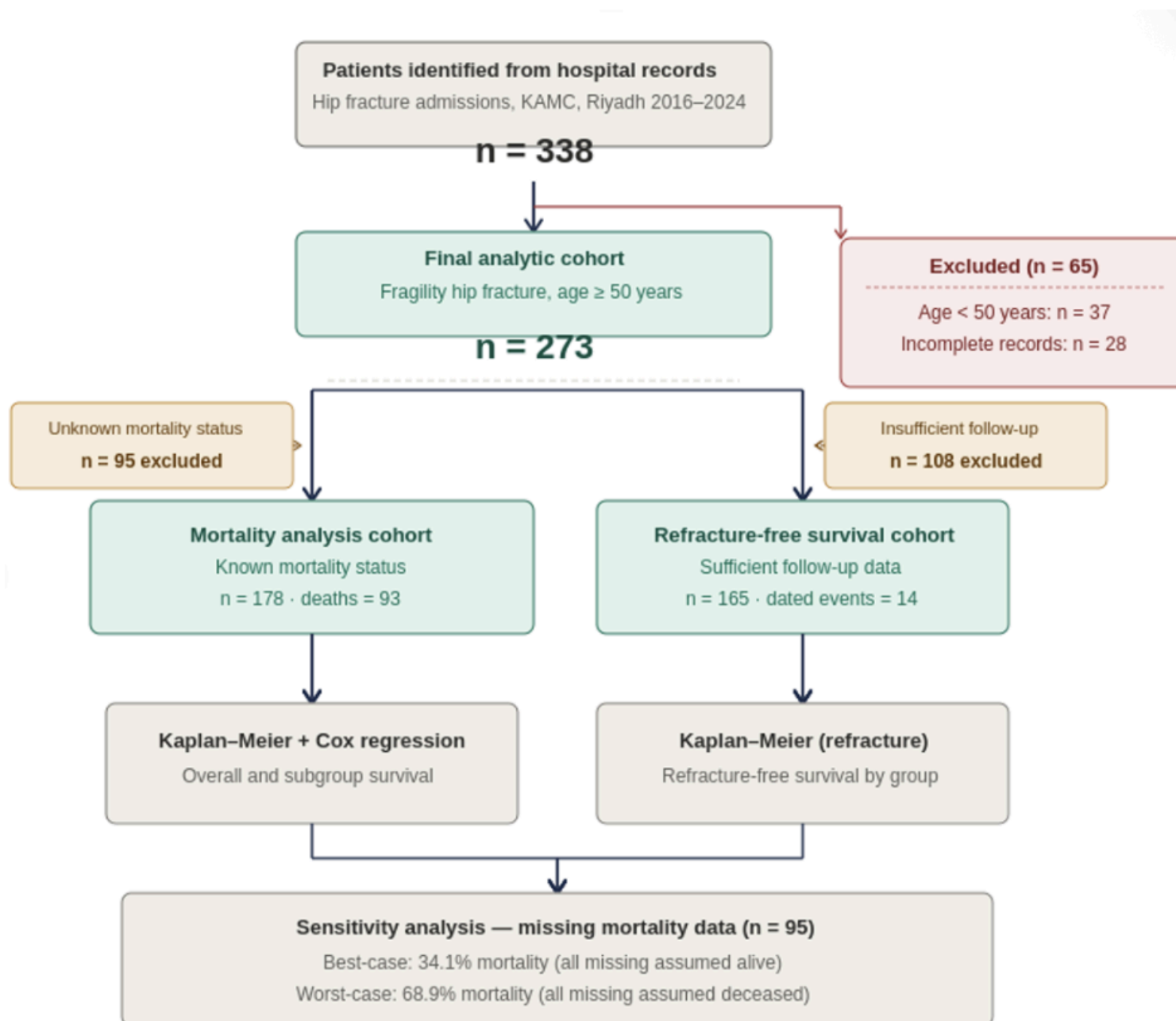


Figure 2

Participant flow diagram. A total of 338 patients were identified; 65 were excluded (37 aged <50 years; 28 with incomplete records), leaving 273 patients in the final cohort. KAMC = King Abdulaziz Medical City.

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