Length of Stay Over a Decade: Insights from an Electronic Health Record Dataset in a Tertiary Hospital in Oman: A 15-Year Retrospective Longitudinal Analysis (2010–2024)

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Abstract

Objectives: We aimed to examine 15-year trends in inpatient length of stay (LOS) and identify demographic and clinical factors independently associated with LOS.

Methods: This retrospective longitudinal study used electronic health records of all inpatient admissions to the Royal Hospital, Muscat, Oman, in 2010–2024. Covariates were age, gender, ICD-10 chapter of the principal diagnosis, admission year, and discharge outcome. A quasi-Poisson generalized linear model with robust standard errors estimated adjusted mean ratios (aMR) with 95% confidence intervals (CI). Sensitivity analyses excluded stays >15 days, duplicates, admissions without a ward stay, and date-inconsistent records.

Results: Among 703,574 admissions, median LOS remained 2 days each year, while mean LOS fell from 4.41 days (95% CI: 4.33–4.49) in 2010 to 3.93 days (95% CI: 3.87–3.99) in 2024, an adjusted annual decline of 1.9% (aMR = 0.981; 95% CI: 0.980–0.982). Stays >15 days comprised 3.6% of admissions but 28.9% of bed-days. Longer LOS was independently associated with male gender (aMR = 1.07), age 5 years (1.27) and 80 years (1.41) versus 40 years, COVID-19 and other special-purpose codes (2.68), perinatal conditions (1.86), infectious diseases (1.64), and in-hospital death (3.39). Findings were robust across sensitivity analyses.

Conclusions: Median LOS remained unchanged over 15 years of rising admissions, while mean LOS and the share of prolonged stays declined modestly, with a temporary dip in 2021–2023 coinciding with more same-day admissions. Age, diagnostic group, and discharge outcome were the main correlates. As care processes were not measured, findings warrant interpretation alongside quality, safety, and post-discharge outcomes.

Keywords: Length of Stay; Hospitalization; Health Services Research; Tertiary Care Centers; Quality of Health Care; Hospital Administration

Introduction

Quality of care is a global concern reflected in Sustainable Development Goal number 3, established by the United Nations in 2015, which aims to ensure healthy lives and promote well-being for all, emphasizing universal health coverage and access to quality healthcare services.[1] As defined by the World Health

Organization (WHO), quality of care involves providing health services that are effective, safe, and people-centered.[2]

One of the key quality indicators in this context is the length of hospital stays (LOS).[3] However, LOS is influenced by various factors, including patient characteristics, comorbidities, complications, and treatment complexity,[4] which are not quality-related factors. Hospitals with fast transitions, discharge planning, and multidisciplinary care teams tend to have short LOS.[5] Extended hospital stays can have a negative impact on both patients and healthcare providers. Additionally, prolonged stays may increase the risk of hospital-acquired complications such as healthcare-associated infections, falls as well as increased costs for both healthcare systems and patients. However, shorter LOS may not always equate to better care, as premature discharge can potentially increase rates of readmissions or mortality. Conversely, longer LOS may be necessary for the management of complex conditions.[6,7]

Internationally, average LOS has declined steadily over the past two decades,[8] even as the clinical complexity of hospital inpatients has increased,[9] and LOS is also shaped by system factors such as bed supply.[10] Evidence from Oman and the wider Gulf Cooperation Council (GCC) region remains limited and fragmented. In Oman, a review of general medicine admissions at a tertiary teaching hospital found that almost one-third of admissions included hospital days that were not clinically justified, mainly because of diagnostic delays and limited access to rehabilitation and palliative care services.[11] In Saudi Arabia, national analyses have identified age, sex, nationality, source of admission and clinical history as determinants of intensive care LOS,[12] and substantial regional variation in LOS among COVID-19 inpatients.[13] However, most regional studies have examined single units, specialties or conditions over short observation periods. In addition, institutional analyses frequently exclude extreme LOS values as outliers, even though prolonged stays consume a disproportionate and growing share of bed capacity.[14]

Despite sustained efforts to improve hospital efficiency, inpatient length of stay (LOS) remains a complex and multifactorial indicator influenced by patient characteristics, disease complexity, care pathways, and system-level processes. While LOS is widely used as a proxy for hospital performance and resource utilization, it often lacks contextual interpretation particularly in tertiary referral settings where clinical complexity is increasing. At the Royal Hospital, the absence of longitudinal, system-wide analyses limits the ability to distinguish between true efficiency gains and shifts driven by demographic or epidemiological change. This creates a critical evidence gap for data-driven capacity planning and service optimization. To our knowledge, no study from Oman or the GCC has described hospital-wide inpatient LOS across all diagnostic groups over more than a decade, quantified its temporal trend after adjustment for patient mix, or examined the contribution of prolonged stays.

Within this context, the present study aimed to (i) describe inpatient LOS at the Royal Hospital over 15 years (2010–2024) and quantify its temporal trend, including during the COVID-19 pandemic; (ii) examine the associations of gender, age, ICD-10 diagnostic chapter and discharge outcome with LOS using multivariable methods; and (iii) characterise prolonged stays (>15 days) and assess how their inclusion or exclusion affects the findings. Unlike previous studies that focused on short observation periods or single specialties, this study provides a hospital-wide, longitudinal analysis across all diagnostic categories in a national tertiary hospital, intended to inform capacity planning and to generate hypotheses for future evaluation of care processes.

Methods

This was a retrospective longitudinal observational study of all inpatient admissions (repeated annual cross-sections of admissions) using electronic health records (EHRs) from the Royal Hospital, Muscat, Oman, for admissions between 1 January 2010 and 31 December 2024 (by date of admission). The Royal Hospital, established in 1987, is the largest tertiary care hospital of the Ministry of Health and the main national referral centre for specialised care, serving around 3 million people. It has approximately 1,241 inpatient beds and provides adult and paediatric medical and surgical specialties, obstetrics and gynaecology, neonatal and paediatric intensive care, and national referral services including cardiology and cardiothoracic surgery, oncology and haematology, neurosciences, nephrology and organ transplantation. Within the Omani health system, it receives patients referred from secondary (regional and wilayat) hospitals and primary care across all governorates.

Data were extracted by the hospital data management team from the Ministry of Health hospital information system (Al-Shifa),[15] which was in use throughout the study period. For each admission, the dataset contained gender, age at admission (years), the principal discharge diagnosis coded with ICD-10, discharge result, admission and discharge date-times, year of admission and LOS. The dataset was anonymised before release to the investigators and did not contain a persistent patient identifier. LOS was recorded by the system in days; same-day admissions have a LOS of 0 days. ICD-10 codes were analysed as recorded in routine practice and mapped to ICD-10 chapters; no additional re-coding or validation was undertaken for this study.

Data analysis was conducted using SPSS (Statistical Package for the Social Sciences) version 30 , Microsoft Excel version 16.78.3 and R version 4.5.1 (R Foundation for Statistical Computing, Vienna, Austria).

All 703,612 inpatient admission records from 2010 to 2024 were eligible. Only admission episodes with admission and discharge within the study period were included. Records with a missing (n = 3) or negative (n = 35) LOS were excluded, leaving 703,574 admissions with a valid LOS, which form the basis of all descriptive analyses. For multivariable analyses, a further 14 records with missing or unknown gender (n = 12), an invalid age (n = 1) or an ICD-10 code that could not be mapped to a chapter (n = 1) were excluded, leaving 703,560 admissions. Because missingness was negligible (<0.01%), a complete-case analysis was performed and no imputation was used. Same-day admissions (LOS = 0 days; n = 91,134, 13.0%) were retained as valid stays. Data quality was assessed by year: gender, age, ICD-10 code, discharge result and LOS were more than 99.9% complete in every year. The free-text diagnosis description was missing for 22,163 admissions in 2024, but the ICD-10 code was available for all of them. Recorded LOS differed from the difference between the admission and discharge calendar dates in 16,252 records (2.3%), almost all by one day and mostly in 2023–2024; 96 records had a discharge recorded before admission or a discrepancy of more than one day. Twelve exact duplicate records were identified.

The unit of analysis was the admission. Because the anonymised dataset did not contain a persistent patient identifier, repeated admissions of the same individual could not be identified or linked; admissions were therefore analysed as independent observations, and clustering of admissions within patients could not be modelled.

Because prolonged hospitalisations are clinically and operationally important, the primary analysis included all admissions with a valid LOS, irrespective of duration. Prolonged stay was defined as LOS >15 days. The number and proportion of prolonged stays, and the share of total bed-days they accounted for, were reported overall and by year, gender, age group, ICD-10 chapter and discharge outcome. The influence of prolonged stays was examined in a sensitivity analysis described below.

Descriptive statistics were used to summarize patient demographics (gender and age groups), clinical characteristics (ICD-10 disease categories), and hospitalization patterns. For descriptive purposes, age at admission was categorised as 0–12, 13–18, 19–39, 40–59 and ≥60 years. Annual admission trends were examined to capture fluctuations in hospital utilization from 2010 to 2024. Cross-tabulations provided insights into variations in LOS by gender, age group, and disease category, with results reported as absolute frequencies and percentages.

Given the skewed distribution of LOS, medians with first and third quartiles (Q1–Q3) were used as the main descriptive measures. Means with 95% confidence intervals (CI), the number of same-day stays, the number and proportion of prolonged stays and the proportion of bed-days they accounted for were also reported, because these capture changes in the tails of the distribution that the median does not.

Independent associations with LOS were estimated with a generalised linear model with a log link and quasi-Poisson variance, which accommodates over-dispersed count data that include zeros without excluding long stays.[16] Standard errors were heteroskedasticity-robust (sandwich) estimates. The primary model included gender, age at admission as a natural cubic spline with four degrees of freedom, ICD-10 chapter (reference: pregnancy, childbirth and the puerperium) and year of admission as a categorical variable (reference: 2010). Results are presented as adjusted mean ratios (aMR) with 95% CI; age effects are summarised as mean ratios at ages 5, 18, 60 and 80 years compared with 40 years. The overall association of year with LOS was tested with a Wald test (14 degrees of freedom). Two further models with the same covariates were fitted: one replacing categorical year with a continuous linear term, to estimate the average

annual change, and one replacing year with period (2010–2019, 2020–2021 and 2022–2024), to describe the pandemic and post-pandemic years. Because discharge outcome is determined at the end of the stay and may lie on the pathway between diagnosis and LOS, it was not included in the primary model; its association with LOS was estimated in a separate model that added discharge outcome to the primary covariates. Because statistical significance is almost guaranteed with more than 700,000 observations, interpretation focused on the magnitude and precision of estimates rather than on P-values.

Four sensitivity analyses re-estimated the primary model (i) excluding stays >15 days (n = 678,256 analysed); (ii) excluding the 12 exact duplicate records; (iii) excluding 1,787 admissions that did not represent a ward stay (cancellation without ward admission, non-availability of beds and outpatient department discharge); and (iv) excluding the 96 records with date inconsistencies.

Discharge outcomes were categorised into four groups: discharged (improved, recovered, unchanged, worse or newborn discharge); death (including deaths within and after 48 hours of admission, neonatal and post-operative deaths); administrative (transfer to another ward, department or hospital, cancellation without ward admission, non-availability of beds and outpatient department discharge), reflecting organisational rather than clinical drivers of discharge timing; and patient-initiated (left against medical advice, absconded, or did not return from leave on pass).

All data were anonymized before analysis to ensure confidentiality. The study was approved by the Research and Ethics Committee # MoH/CSR/24/27981. Because the study used anonymised, routinely collected data, the requirement for individual informed consent was waived by the committee.

Results

A total of 703,574 admissions with a valid LOS between 2010 and 2024 were included (Table 1); 703,560 had complete data for multivariable analysis. Annual admissions increased from 32,269 in 2010 to a peak of 63,644 in 2022. The overall median LOS was 2 days (Q1–Q3 1–4), the mean was 3.95 days (95% CI 3.93–3.97), and 91,134 admissions (13.0%) were same-day stays.

Table 1: Length of stay (days) by year of admission, gender, age group and ICD-10 chapter, all admissions with a valid LOS, 2010–2024 (n = 703,574).

Variable	Admissions, n (%)	Median (Q1–Q3)	Mean (95% CI)	Same-day stays, n (%)	LOS >15 days, n (%)	Bed-days in stays >15 days, %
All admissions	703,574 (100.0)	2 (1–4)	3.95 (3.93–3.97)	91,134 (13.0)	25,305 (3.6)	28.9
Year of admission						
2010	32,269 (4.6)	2 (1–5)	4.41 (4.33–4.49)	2,266 (7.0)	1,446 (4.5)	29.4
2011	33,370 (4.7)	2 (1–5)	4.33 (4.25–4.41)	2,588 (7.8)	1,416 (4.2)	28.2
2012	34,084 (4.8)	2 (1–5)	4.39 (4.30–4.48)	2,614 (7.7)	1,417 (4.2)	29.4
2013	36,357 (5.2)	2 (1–5)	4.39 (4.31–4.48)	2,430 (6.7)	1,511 (4.2)	28.7
2014	39,179 (5.6)	2 (1–5)	4.41 (4.33–4.48)	3,221 (8.2)	1,705 (4.4)	29.9
2015	44,504 (6.3)	2 (1–5)	4.22 (4.16–4.29)	4,177 (9.4)	1,796 (4.0)	28.6
2016	48,652 (6.9)	2 (1–4)	3.99 (3.92–4.06)	4,750 (9.8)	1,700 (3.5)	27.9

Variable	Admissions, n (%)	Median (Q1–Q3)	Mean (95% CI)	Same-day stays, n (%)	LOS >15 days, n (%)	Bed-days in stays >15 days, %
2017	50,152 (7.1)	2 (1–4)	3.96 (3.87–4.05)	5,004 (10.0)	1,705 (3.4)	27.7
2018	52,090 (7.4)	2 (1–4)	3.91 (3.80–4.02)	5,908 (11.3)	1,694 (3.3)	28.3
2019	53,013 (7.5)	2 (1–4)	4.05 (3.93–4.16)	5,801 (10.9)	1,869 (3.5)	30.3
2020	44,044 (6.3)	2 (1–4)	4.17 (4.05–4.28)	5,627 (12.8)	1,706 (3.9)	32.9
2021	59,258 (8.4)	2 (1–4)	3.43 (3.37–3.49)	14,080 (23.8)	1,949 (3.3)	30.4
2022	63,644 (9.0)	2 (1–4)	3.45 (3.39–3.51)	14,657 (23.0)	2,014 (3.2)	30.6
2023	61,917 (8.8)	2 (1–4)	3.29 (3.23–3.35)	13,195 (21.3)	1,712 (2.8)	26.9
2024	51,041 (7.3)	2 (1–4)	3.93 (3.87–3.99)	4,816 (9.4)	1,665 (3.3)	25.0
Gender						
Female	432,769 (61.5)	2 (1–4)	3.54 (3.52–3.56)	56,737 (13.1)	11,682 (2.7)	23.6
Male	270,793 (38.5)	2 (1–5)	4.61 (4.56–4.65)	34,397 (12.7)	13,622 (5.0)	35.4
Age group at admission						
0–12 years	140,251 (19.9)	3 (1–6)	5.55 (5.46–5.63)	14,966 (10.7)	9,212 (6.6)	43.0
13–18 years	19,724 (2.8)	2 (1–4)	3.45 (3.36–3.53)	3,324 (16.9)	648 (3.3)	27.9
19–39 years	265,056 (37.7)	2 (1–4)	3.01 (3.00–3.03)	25,746 (9.7)	3,804 (1.4)	13.7
40–59 years	145,768 (20.7)	2 (1–4)	3.51 (3.47–3.54)	28,878 (19.8)	4,755 (3.3)	27.5
≥60 years	132,774 (18.9)	2 (1–5)	4.69 (4.64–4.74)	18,220 (13.7)	6,886 (5.2)	32.1
ICD-10 chapter of principal diagnosis						
Pregnancy, childbirth and the puerperium (O00–O99)	171,643 (24.4)	2 (1–4)	2.95 (2.94–2.97)	6,449 (3.8)	1,090 (0.6)	5.5
Factors influencing health status and contact with health services (Z00–Z99)	95,300 (13.5)	1 (0–3)	2.72 (2.64–2.80)	28,082 (29.5)	2,227 (2.3)	29.5

Variable	Admissions, n (%)	Median (Q1–Q3)	Mean (95% CI)	Same-day stays, n (%)	LOS >15 days, n (%)	Bed-days in stays >15 days, %
Diseases of the circulatory system (I00–I99)	73,998 (10.5)	2 (1–5)	4.82 (4.76–4.88)	3,835 (5.2)	3,905 (5.3)	32.6
Neoplasms (C00–D48)	61,403 (8.7)	1 (0–4)	3.61 (3.54–3.69)	22,136 (36.1)	2,810 (4.6)	38.3
Diseases of the genitourinary system (N00–N99)	51,998 (7.4)	2 (1–5)	3.85 (3.80–3.90)	4,885 (9.4)	1,556 (3.0)	20.9
Diseases of the digestive system (K00–K93)	45,488 (6.5)	2 (1–4)	3.59 (3.53–3.65)	3,208 (7.1)	1,310 (2.9)	24.3
Diseases of the respiratory system (J00–J99)	31,706 (4.5)	4 (2–7)	6.39 (6.28–6.50)	1,054 (3.3)	2,287 (7.2)	35.7
Diseases of the blood and immune mechanism (D50–D89)	30,886 (4.4)	2 (1–3)	2.75 (2.69–2.81)	6,320 (20.5)	490 (1.6)	17.0
Congenital malformations and chromosomal abnormalities (Q00–Q99)	26,317 (3.7)	3 (1–8)	7.00 (6.79–7.21)	1,856 (7.1)	2,604 (9.9)	50.6
Endocrine, nutritional and metabolic diseases (E00–E90)	23,523 (3.3)	2 (1–4)	4.02 (3.92–4.12)	4,599 (19.6)	901 (3.8)	28.1
Symptoms, signs and abnormal clinical/laboratory findings (R00–R99)	17,531 (2.5)	2 (1–4)	3.26 (3.16–3.35)	1,999 (11.4)	394 (2.2)	21.0
Certain conditions originating in the perinatal period (P00–P96)	15,404 (2.2)	5 (3–9)	9.58 (9.25–9.90)	255 (1.7)	2,041 (13.2)	53.9
Certain infectious and parasitic diseases (A00–B99)	13,953 (2.0)	3 (2–7)	6.70 (6.48–6.91)	718 (5.1)	1,239 (8.9)	46.1
Injury, poisoning and other consequences of external causes (S00–T98)	13,488 (1.9)	3 (1–6)	5.43 (5.28–5.58)	1,341 (9.9)	921 (6.8)	37.7
Diseases of the nervous system (G00–G99)	10,251 (1.5)	2 (1–5)	4.51 (4.33–4.69)	747 (7.3)	471 (4.6)	35.6
Diseases of the musculoskeletal system and connective tissue (M00–M99)	8,553 (1.2)	1 (0–4)	3.38 (3.21–3.55)	2,571 (30.1)	331 (3.9)	34.9
Diseases of the skin and subcutaneous tissue (L00–L99)	7,441 (1.1)	2 (1–3)	3.16 (3.01–3.31)	700 (9.4)	171 (2.3)	20.6
Codes for special purposes, including COVID-19 (U00–U99)	3,035 (0.4)	6 (3–12)	9.79 (9.32–10.26)	107 (3.5)	528 (17.4)	54.0
Mental and behavioural disorders (F00–F99)	806 (0.1)	2 (1–4)	3.21 (2.92–3.49)	97 (12.0)	17 (2.1)	15.2
Diseases of the eye and adnexa (H00–H59)	546 (0.1)	1 (0–2.75)	2.27 (1.85–2.69)	152 (27.8)	5 (0.9)	16.6

Variable	Admissions, n (%)	Median (Q1–Q3)	Mean (95% CI)	Same-day stays, n (%)	LOS >15 days, n (%)	Bed-days in stays >15 days, %
Diseases of the ear and mastoid process (H60–H95)	249 (<0.1)	3 (2–4)	3.67 (3.20–4.14)	11 (4.4)	6 (2.4)	13.3
External causes of morbidity (V01–Y98)	54 (<0.1)	1.5 (1–2)	2.35 (1.45–3.26)	12 (22.2)	1 (1.9)	14.2

CI, confidence interval; ICD-10, International Classification of Diseases, 10th Revision; LOS, length of stay; Q1–Q3, first and third quartiles. Gender was unknown for 12 admissions and age invalid for 1 (not shown).

The median LOS was 2 days in every year. The third quartile decreased from 5 days in 2010–2015 to 4 days in 2016–2024, and the mean LOS decreased from 4.41 days (95% CI 4.33–4.49) in 2010 to 3.29 days (95% CI 3.23–3.35) in 2023, before rising to 3.93 days (95% CI 3.87–3.99) in 2024 (Table 1, Figure 1). After adjustment for gender, age and ICD-10 chapter, year of admission was strongly associated with LOS (Wald χ^2 = 1,654.9, 14 df, P <0.001; Table 3). Compared with 2010, the adjusted mean LOS was similar in 2011–2014 (aMR 0.97–0.99), 7% lower in 2015, 9–14% lower in 2016–2020, 24–26% lower in 2021–2023 and 12% lower in 2024. On average, the adjusted mean LOS declined by 1.9% per year (aMR 0.981, 95% CI 0.980–0.982). The proportion of same-day admissions rose from 10.9% in 2019 to 23.8% in 2021, 23.0% in 2022 and 21.3% in 2023, before returning to 9.4% in 2024.

Table 3: Factors associated with length of stay: adjusted mean ratios from the quasi-Poisson regression model (n = 703,560).

Variable	Adjusted mean ratio (95% CI)
Gender	
Female	1 (reference)
Male	1.07 (1.06–1.08)
Age at admission (natural spline; contrasts vs age 40 years)	
5 years	1.27 (1.24–1.29)
18 years	0.87 (0.86–0.89)
40 years	1 (reference)
60 years	1.18 (1.16–1.19)
80 years	1.41 (1.38–1.44)
ICD-10 chapter (reference: pregnancy, childbirth and the puerperium)	
Pregnancy, childbirth and the puerperium (O00–O99)	1 (reference)
Factors influencing health status and contact with health services (Z00–Z99)	0.72 (0.71–0.74)
Diseases of the circulatory system (I00–I99)	1.21 (1.19–1.24)
Neoplasms (C00–D48)	1.02 (0.99–1.04)
Diseases of the genitourinary system (N00–N99)	1.05 (1.03–1.07)
Diseases of the digestive system (K00–K93)	0.97 (0.95–0.99)
Diseases of the respiratory system (J00–J99)	1.47 (1.43–1.51)

Variable	Adjusted mean ratio (95% CI)
Diseases of the blood and immune mechanism (D50–D89)	0.80 (0.79–0.82)
Congenital malformations and chromosomal abnormalities (Q00–Q99)	1.54 (1.48–1.60)
Endocrine, nutritional and metabolic diseases (E00–E90)	1.09 (1.06–1.13)
Symptoms, signs and abnormal clinical/laboratory findings (R00–R99)	0.86 (0.84–0.89)
Certain conditions originating in the perinatal period (P00–P96)	1.86 (1.77–1.96)
Certain infectious and parasitic diseases (A00–B99)	1.64 (1.58–1.71)
Injury, poisoning and other consequences of external causes (S00–T98)	1.42 (1.38–1.46)
Diseases of the nervous system (G00–G99)	1.18 (1.13–1.23)
Diseases of the musculoskeletal system and connective tissue (M00–M99)	1.01 (0.96–1.06)
Diseases of the skin and subcutaneous tissue (L00–L99)	0.90 (0.86–0.94)
Codes for special purposes, including COVID-19 (U00–U99)	2.68 (2.54–2.82)
Mental and behavioural disorders (F00–F99)	0.88 (0.81–0.96)
Diseases of the eye and adnexa (H00–H59)	0.68 (0.57–0.82)
Diseases of the ear and mastoid process (H60–H95)	0.85 (0.74–0.97)
External causes of morbidity (V01–Y98)	0.63 (0.43–0.91)
Year of admission (reference: 2010)	
2010	1 (reference)
2011	0.97 (0.95–1.00)
2012	0.99 (0.96–1.02)
2013	0.98 (0.96–1.01)
2014	0.98 (0.96–1.01)
2015	0.93 (0.91–0.95)
2016	0.87 (0.85–0.90)
2017	0.87 (0.84–0.89)
2018	0.86 (0.83–0.89)
2019	0.89 (0.86–0.92)
2020	0.91 (0.88–0.94)
2021	0.75 (0.73–0.77)
2022	0.76 (0.75–0.78)
2023	0.74 (0.72–0.75)
2024	0.88 (0.86–0.90)
Linear trend, per calendar year (separate model)†	0.981 (0.980–0.982)
Period (separate model; reference 2010–2019)‡	
2020–2021	0.89 (0.87–0.90)

Variable	Adjusted mean ratio (95% CI)
2022–2024	0.85 (0.84–0.86)
Discharge status (separate model, additionally adjusted for discharge status)§	
Discharged	1 (reference)
Death	3.39 (3.20–3.59)
Administrative	2.48 (2.39–2.57)
Patient-initiated	1.07 (1.04–1.10)

Primary model: gender, age at admission (natural cubic spline, 4 df), ICD-10 chapter and year of admission (categorical); robust standard errors. Overall effect of year: Wald χ^2 = 1,654.9, 14 df, P <0.001. † Year entered as a continuous term instead of categories. ‡ Year replaced by period. § Primary model with discharge status added.

Females accounted for 61.5% of admissions. Both genders had a median LOS of 2 days, but males had a wider distribution (Q1–Q3 1–5 vs 1–4 days) and a higher mean LOS (4.61 vs 3.54 days). After adjustment, the mean LOS of males was 7% longer than that of females (aMR 1.07, 95% CI 1.06–1.08).

Children aged 0–12 years had the longest stays (median 3 days, Q1–Q3 1–6; mean 5.55 days), followed by adults aged ≥60 years (median 2 days, Q1–Q3 1–5; mean 4.69 days); adults aged 19–39 years, among whom obstetric admissions predominated, had the shortest stays (mean 3.01 days). In the adjusted model, the association between age and LOS was U-shaped: compared with age 40 years, the mean LOS was 27% longer at age 5 (aMR 1.27, 95% CI 1.24–1.29), 13% shorter at age 18 (0.87, 0.86–0.89), and 18% and 41% longer at ages 60 (1.18, 1.16–1.19) and 80 years (1.41, 1.38–1.44).

LOS differed markedly across ICD-10 chapters (Table 1). The longest median stays were observed for COVID-19 and other special-purpose codes (U00–U99; 6 days), conditions originating in the perinatal period (5 days) and respiratory diseases (4 days), followed by infectious diseases, injuries, congenital malformations and ear diseases (3 days each). The shortest median stays (1 day) were observed for neoplasms, factors influencing health status (Z00–Z99), musculoskeletal and eye conditions, which had the highest proportions of same-day admissions (28–36%). Pregnancy, childbirth and the puerperium, the largest chapter (24.4% of admissions), had a median LOS of 2 days (Q1–Q3 1–4). After adjustment (Table 3), the longest mean stays relative to pregnancy-related admissions were observed for special-purpose codes (aMR 2.68, 95% CI 2.54–2.82), perinatal conditions (1.86, 1.77–1.96), infectious diseases (1.64, 1.58–1.71), congenital malformations (1.54, 1.48–1.60), respiratory diseases (1.47, 1.43–1.51) and injuries (1.42, 1.38–1.46), whereas Z-coded admissions (0.72, 0.71–0.74) and eye diseases (0.68, 0.57–0.82) had the shortest. The adjusted mean LOS for neoplasms did not differ from that for pregnancy-related admissions (1.02, 0.99–1.04).

Figure 1 shows the annual mean, median and quartiles of LOS. The median and first quartile were constant throughout, whereas the mean and third quartile fell, indicating that the decline was concentrated in longer stays rather than in typical stays.

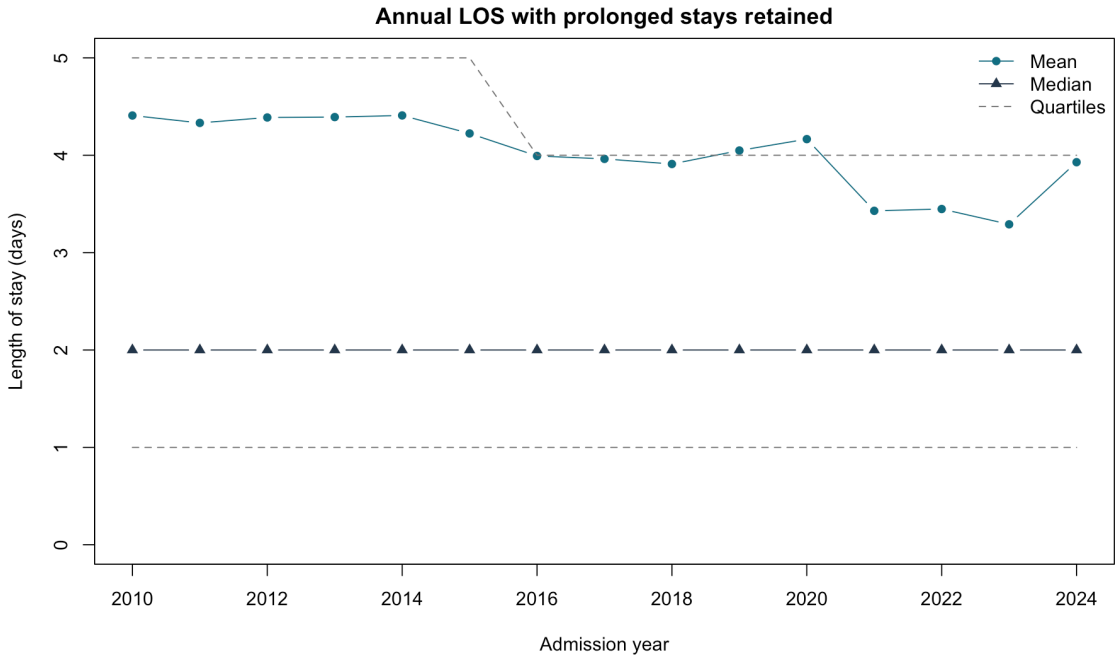


Figure 1: Annual mean, median and first and third quartiles of length of stay, all admissions with a valid LOS, 2010–2024 (n = 703,574).

Table 2 shows LOS by discharge status. Most admissions (94.2%) ended in discharge, with a median LOS of 2 days (Q1–Q3 1–4). Patients who died (1.8%) had a median LOS of 7 days (Q1–Q3 3–17) and administrative discharges (2.0%) a median of 5 days (Q1–Q3 2–12); patient-initiated discharges (1.9%) had a median of 2 days (Q1–Q3 1–5). In a model additionally adjusted for discharge status, the mean LOS was longer for patients who died (aMR 3.39, 95% CI 3.20–3.59), had an administrative discharge (2.48, 2.39–2.57) or a patient-initiated discharge (1.07, 1.04–1.10) than for those discharged.

Table 2: Length of stay (days) by discharge status (n = 703,574).

Discharge status	Admissions, n (%)	Median (Q1–Q3)	Mean (95% CI)	Same-day stays, n (%)	LOS >15 days, n (%)	Bed-days in stays >15 days, %
Discharged (improved, recovered, unchanged, worse, newborn discharge)	662,868 (94.2)	2 (1–4)	3.57 (3.56–3.59)	87,111 (13.1)	18,726 (2.8)	22.9
Death (including neonatal and post-operative deaths)	12,903 (1.8)	7 (3–17)	15.39 (14.66–16.13)	654 (5.1)	3,545 (27.5)	74.0
Administrative (transfer to another ward, department or hospital; cancellation without ward admission; non-availability of beds; OPD discharge)	14,221 (2.0)	5 (2–12)	11.06 (10.66–11.45)	1,617 (11.4)	2,612 (18.4)	65.8
Patient-initiated (left against medical advice, absconded, did not return from leave on pass)	13,582 (1.9)	2 (1–5)	3.96 (3.86–4.06)	1,752 (12.9)	422 (3.1)	21.3

OPD, outpatient department; other abbreviations as in Table 1.

Prolonged stays (>15 days) comprised 25,305 admissions (3.6%) but accounted for 803,725 of 2,778,373 bed-days (28.9%). Their proportion fell from 4.5% in 2010 to 3.3% in 2024. It was highest for special-purpose codes (17.4%), perinatal conditions (13.2%), congenital malformations (9.9%) and infectious diseases (8.9%), for children aged 0–12 years (6.6%) and males (5.0% vs 2.7% in females), and for patients who died (27.5%) or had administrative discharges (18.4%). Prolonged stays accounted for 74.0% of bed-days among patients who died, 65.8% among administrative discharges, 53.9% for perinatal conditions and 43.0% among children aged 0–12 years (Tables 1 and 2).

During the pandemic, admissions fell by 16.9% in 2020 (44,044 vs 53,013 in 2019) and rebounded in 2021 (59,258). The adjusted mean LOS in 2020 was similar to that in 2016–2019 (aMR vs 2010: 0.91 in 2020 vs 0.86–0.89), whereas it was markedly lower in 2021–2023. Compared with 2010–2019, the adjusted mean LOS was 11% lower in 2020–2021 (aMR 0.89, 95% CI 0.87–0.90) and 15% lower in 2022–2024 (0.85, 0.84–0.86); because this period model contains no separate secular trend, these contrasts include the pre-existing downward trend.

Sensitivity analyses are presented in Table 4. Excluding duplicate records, admissions without a ward stay or records with date inconsistencies did not materially change any estimate. Excluding stays >15 days preserved the direction of all associations and the year pattern (aMR for 2023 vs 2010, 0.77 vs 0.74 in the primary analysis) but attenuated the associations with diagnostic chapter (for example, perinatal conditions 1.38 vs 1.86; special-purpose codes 1.73 vs 2.68), showing that these groups contribute disproportionately to the upper tail of the distribution. Additional adjustment for discharge status also left the year pattern unchanged.

Table 4: Sensitivity analyses: adjusted mean ratios (95% CI) for selected variables under alternative inclusion criteria.

Model (n)	Male vs female	Perinatal conditions	Respiratory diseases	Special purposes incl. COVID-19	2016 vs 2010	2023 vs 2010	Year, Wald χ^2 (14 df)
Primary analysis (all valid stays) (n = 703,560)	1.07 (1.06–1.08)	1.86 (1.77–1.96)	1.47 (1.43–1.51)	2.68 (2.54–2.82)	0.87 (0.85–0.90)	0.74 (0.72–0.75)	1,654.9
Excluding stays >15 days (n = 678,256)	1.05 (1.05–1.06)	1.38 (1.36–1.40)	1.25 (1.23–1.26)	1.73 (1.68–1.79)	0.89 (0.88–0.90)	0.77 (0.76–0.78)	5,890.2
Excluding 12 exact duplicate records (n = 703,548)	1.07 (1.06–1.08)	1.87 (1.77–1.96)	1.47 (1.43–1.51)	2.68 (2.54–2.82)	0.87 (0.85–0.90)	0.74 (0.72–0.75)	1,655.3
Excluding 1,787 admissions without a ward stay* (n = 701,773)	1.07 (1.05–1.08)	1.87 (1.78–1.97)	1.47 (1.43–1.52)	2.70 (2.57–2.85)	0.87 (0.85–0.90)	0.74 (0.72–0.75)	1,669.7
Excluding 96 records with date inconsistencies† (n = 703,464)	1.07 (1.06–1.08)	1.87 (1.78–1.97)	1.47 (1.43–1.51)	2.68 (2.54–2.82)	0.87 (0.85–0.90)	0.73 (0.72–0.75)	1,671.3
Additionally adjusted for discharge status (n = 703,560)	1.07 (1.05–1.08)	1.62 (1.54–1.71)	1.29 (1.25–1.33)	1.62 (1.53–1.73)	0.87 (0.85–0.89)	0.75 (0.73–0.77)	1,550.7

*All models adjusted for gender, age (spline), ICD-10 chapter and year of admission. Reference categories: female; pregnancy, childbirth and the puerperium; 2010. * Cancellation without ward admission, non-availability of beds and outpatient department discharge. † Discharge before admission, or recorded LOS differing from the calendar-date difference by more than one day.*

Discussion

The study draws on a large administrative dataset covering more than 700,000 hospital admissions over 15 years, providing a comprehensive view of hospitalization dynamics in a major tertiary care center.

Situated within a period of demographic and epidemiological transition, this study shows that the typical (median) inpatient LOS at a major tertiary hospital in Oman remained at 2 days for 15 years, while annual admissions increased from about 32,000 to more than 60,000. Over the same period, the mean LOS and the third quartile decreased, and prolonged stays became less frequent. The direction of this trend is consistent with the long-term decline in LOS reported internationally,[8] although its magnitude in our setting (about 1.9% per year in the adjusted mean) was modest, was not reflected in the median and did not follow a straight line, with a step down around 2015–2016 and a temporary dip in 2021–2023.

The narrowing of the upper part of the distribution indicates less dispersion in hospitalisation duration. This pattern is compatible with more consistent inpatient processes, but it may also reflect changes in case mix not captured by ICD-10 chapters, changes in the way short admissions were recorded, or the growing complexity of inpatient populations described elsewhere.[9] Because care processes were not measured, our data cannot distinguish between these explanations.

Stratified analysis revealed expected variations in LOS by gender, age group, disease categories, and discharge outcome. Although male and female patients shared the same median LOS, male patients exhibited a wider distribution, possibly reflecting the higher proportion of male admissions for circulatory and other non-obstetric conditions. Female admissions were dominated by pregnancy and childbirth related diagnosis, which were frequent but associated with a more standardized and predictable length of stay. These findings reinforce evidence that gender differences in LOS are largely explained by disease type and severity.[17–20] Consistent with this, the adjusted difference between males and females was modest (aMR 1.07).

Age-related patterns were also consistent with international evidence. Pediatric patients experienced longer median stays, reflecting the complexity of pediatric care and cautious discharge practices while older adults demonstrated greater variability in LOS, likely driven by multimorbidity and increased care needs; after adjustment, the association between age and LOS was U-shaped, with the longest stays in young children and in the oldest patients. These findings align with studies identifying age and disease burden as primary determinants of LOS across diverse health systems.[4,17]

Diagnostic chapter was the factor most strongly associated with LOS. The longest stays were observed for COVID-19 and other special-purpose codes, perinatal conditions, infectious and respiratory diseases, congenital malformations and injuries, which typically involve acute illness, neonatal or paediatric intensive care, or complex procedures. Neoplasms and factors influencing health status (Z codes) had the shortest median stays, consistent with a high proportion of planned day-case admissions such as chemotherapy; after adjustment, however, the mean LOS for neoplasms was similar to that for pregnancy-related admissions, and both chapters contributed a considerable number of prolonged stays, illustrating heterogeneity within chapters. While absolute LOS in this study is shorter than in many international settings, the relative diagnostic gradients resemble those reported elsewhere.[4,17,21,22] Broad ICD-10 chapters combine conditions with very different expected LOS, so these gradients may mask important differences between individual diseases; analyses at the level of ICD-10 blocks or diagnosis-related groups would be needed to guide condition-specific pathway redesign.

Prolonged stays (>15 days) were uncommon (3.6% of admissions) but used almost 29% of bed-days, in line with reports that a small proportion of long-stay patients consumes a disproportionate share of hospital capacity.[14,23] These admissions were concentrated among young children, patients with perinatal conditions, congenital malformations, infectious diseases and COVID-19, and patients who died or had administrative discharges; in the last two groups, prolonged stays accounted for two-thirds to three-quarters of all bed-days. The administrative group, which includes transfers and waiting for beds elsewhere, suggests that some prolonged stays may relate to transitions of care rather than acute clinical need, as reported for inappropriate hospital days in Oman.[11] From a management perspective, these high-risk groups are natural targets for early discharge planning, case management and step-down or community care, and excluding them from routine LOS reporting would underestimate the true burden of hospitalisation; in our sensitivity analysis, excluding stays >15 days reduced the estimated excess LOS for several diagnostic groups by one-half or more.

Discharge outcomes provided additional insight into LOS dynamics. Patients who died during hospitalization had substantially longer stays, reflecting prolonged treatment courses and higher disease severity or complexity. Conversely, patients who left against medical advice had shorter LOS. Although superficially suggestive of efficiency, extensive evidence indicates that leaving against medical advice (LAMA) is associated with significantly higher rates of readmission, morbidity and, in some settings, mortality.[24–26] These findings highlight how LOS can be artificially shortened without reflecting improved quality of care and reinforce the importance of interpreting LOS alongside outcome and continuity of care indicators.

The COVID-19 pandemic affected admission patterns. Admissions fell by about 17% in 2020, as reported in other health systems,[27] and rebounded in 2021. The adjusted mean LOS in 2020 was in line with the preceding years, whereas the lowest values were observed in 2021–2023, when the proportion of same-day admissions doubled, before returning towards earlier levels in 2024. This pattern suggests that the post-2020 fall in mean LOS reflected, at least partly, a change in the type of admissions recorded rather than shorter stays for comparable patients. Admissions with COVID-19 and other special-purpose codes had the longest stays, as reported in Saudi Arabia,[13] and studies of non-COVID care have described longer stays among patients admitted during the pandemic.[28] Pandemic-period data should therefore be interpreted with caution in long-term LOS series.

Changes in recording practices may also influence long-term EHR-based trends. The marked increase in same-day admissions in 2021–2023, and the concentration of discrepancies between recorded LOS and calendar dates in 2023–2024, suggest changes in admission policies (for example, recording day-case treatments as inpatient admissions) or in data recording. Because same-day admissions lower the mean LOS, part of the observed decline in the mean may be attributable to such administrative changes. Studies of LOS trends should therefore document changes in information systems and admission definitions over time, and LOS should be interpreted in the context of bed supply and other system changes.[10]

The stability of the median LOS, together with modest declines in the mean and in prolonged stays during a period of rising admissions, should not be interpreted as evidence of improved hospital performance. Several mechanisms could plausibly contribute, including standardised clinical pathways, earlier discharge planning, digital integration and multidisciplinary coordination, as well as changes in case mix, admission policies and bed availability. None of these factors was measured in the present dataset, and they should be regarded as hypotheses for future research rather than as explanations of our findings. Conceptual frameworks describing health systems as operating across overlapping time horizons, from day-to-day service delivery to long-term system reform, may help to structure such evaluations.[29]

Within this temporal framework, length of stay (LOS) functions differently across decision layers. At the operational level, it provides near real-time signals of patient flow and bed utilization, supporting day-to-day capacity management. At the strategic and governance levels, however, LOS alone is insufficient as a performance or quality metric. Meaningful assessment of hospital performance requires triangulating LOS with complementary indicators, including readmissions, patient safety events, post-discharge outcomes, and patient experience.[2,6,7]

From a system planning perspective, these findings suggest that, with a typical stay of only 2 days, further gains are more likely to come from addressing prolonged stays and transitions of care than from shortening routine stays. Improvement efforts could therefore focus on strengthening ambulatory substitution models, post-discharge continuity of care, early supported discharge programs, and digital integration across care settings. In parallel, capacity planning strategies should integrate LOS analytics with dynamic demand forecasting to inform adaptive bed management, workforce allocation, and service configuration, particularly in high-volume domains such as maternity care, chronic disease management, and geriatric services.

Shorter LOS should not be interpreted uncritically as improved performance, as premature discharge may increase adverse outcomes, while longer stays may be clinically appropriate for patients with complex conditions.[5,7,30] Reduced variation in LOS is one of the aims of Lean and Agile approaches to healthcare, and such approaches have been implemented in Omani tertiary hospitals, including during the COVID-19 pandemic.[31,32] However, our study did not assess whether such initiatives were implemented at the Royal Hospital during the study period or whether they influenced LOS, and readmission and post-discharge outcomes were not available. The observed narrowing of the LOS distribution should therefore not be attributed to specific improvement initiatives.

This study has several limitations. First, it is an observational analysis of routinely collected data; the associations reported are not causal, and the explanations offered for temporal patterns are hypotheses. Second, the anonymised dataset did not contain a persistent patient identifier, so repeated admissions of the same patient could not be identified, readmissions could not be examined, and clustering of admissions within patients could not be accounted for; standard errors may therefore be somewhat underestimated, although, given the very large sample, this is unlikely to alter the conclusions. Third, important determinants of LOS were not available, including comorbidities and severity of illness, admission type (elective or emergency), intensive care admission, surgical procedures, admitting specialty, socioeconomic factors and post-discharge support; residual confounding is therefore likely, and the role of these factors could not be assessed. Fourth, diagnoses were analysed at the level of broad ICD-10 chapters of the principal diagnosis, which may mask differences between individual diseases, and codes were not validated for this study. Fifth, changes in admission recording, coding practice and information systems over 15 years, including the increase in same-day admissions in 2021–2023 and date discrepancies in 2023–2024, may have influenced the observed trends. Sixth, although prolonged stays were included in the primary analysis, analyses that exclude long stays can substantially underestimate the burden of hospitalisation and the excess LOS of high-risk groups, as our sensitivity analysis showed. Seventh, the COVID-19 pandemic disrupted admission patterns from 2020 onwards. Finally, the study was conducted in a single tertiary hospital, which may limit generalisability to other hospitals in Oman and the GCC. Despite these limitations, the large sample size and long observation period provide valuable insights into hospitalisation patterns during a period of demographic and epidemiological transition.

Conclusion

In this 15-year analysis of more than 700,000 admissions to a national tertiary hospital in Oman, the median LOS remained at 2 days despite substantial growth in admissions, while the mean LOS and the frequency of prolonged stays declined modestly after adjustment for patient characteristics. Part of this decline, particularly in 2021–2023, may reflect changes in the recording of same-day admissions. Age, diagnostic chapter and discharge outcome were the main factors associated with LOS, and a small proportion of prolonged stays accounted for more than a quarter of bed-days.

Because this was an observational study that did not measure care processes, quality or post-discharge outcomes, these patterns should not be interpreted as evidence of improved hospital performance. Rather, they support monitoring LOS as a distribution, including the mean and prolonged stays and not only the median, alongside complementary quality and safety indicators, particularly in health systems undergoing demographic and epidemiological transition.

Integrating longitudinal LOS monitoring with outcome-based metrics may support capacity planning and governance, especially in the context of population aging and the rising burden of non-communicable diseases in Oman.

Future studies integrating multi-hospital datasets and patient-level identifiers, comorbidity, admission type and readmission data are needed to strengthen evidence for data-driven hospital planning and health system performance monitoring in the region.

Disclosure

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