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Recorded non-cancer comorbidity burden and inpatient service use among cancer-related admissions at a secondary hospital in China, 2014–2025

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Research Article

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Recorded non-cancer comorbidity burden and inpatient service use among cancer-related admissions at a secondary hospital in China, 2014–2025

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Background

Evidence on non-cancer chronic comorbidity and inpatient service use among cancer-related admissions to secondary hospitals in China remains limited. This study examined recorded comorbidity patterns and their associations with length of stay (LOS) and hospitalization expenditure at a Chinese secondary hospital.

Methods This retrospective observational study included 26,562 adult admissions with an ICD-10 C00–C97 code in any diagnosis field during 2014–2025. Comorbidity burden was measured using 17 selected non-cancer chronic condition categories and grouped as 0, 1, 2, 3, or ≥4 conditions. Outcomes included LOS, cumulative inpatient days, and hospitalization expenditure expressed in US dollars at 2025 prices. Negative binomial and gamma-log generalized linear models estimated adjusted mean ratios for LOS and expenditure, respectively, controlling for age, sex, discharge year, cancer diagnosis position, and recorded cancer site group. Sensitivity analyses examined alternative specifications, recent periods, and patient-level clustering.

Results Cancer appeared only in secondary diagnosis fields in 85.3% of admissions. Overall, 55.1% had ⩾1 selected condition and 22.7% had ⩾2. These proportions increased from 47.6% and 17.5% in 2014 to 62.2% and 29.1% in 2025, respectively, and were higher among older admissions. Hypertension, diabetes, and chronic liver disease were the most commonly recorded

conditions. Admissions accounted for 229,888 inpatient days; median LOS was 6 days (IQR, 4–10), and median expenditure was US$810.44 (IQR, 435.76–1,484.68). Admissions with ⩾2 conditions contributed 25.9% of inpatient days. Higher burden corresponded to longer LOS and higher expenditure in unadjusted comparisons. After adjustment, mean LOS ratios were 1.07 (95% CI, 1.02 – 1.12) for three conditions and 1.13 (95% CI, 1.02 – 1.25) for ⩾4 conditions versus none. Neither comparison met the significance threshold after multiple-testing correction. Adjusted expenditure ratios remained close to 1. In patient-clustered analyses for 2020 – 2025, all burden-category confidence intervals included 1 for both outcomes.

Conclusions Recorded non-cancer chronic conditions were common, and admissions with multiple conditions contributed a greater share of inpatient days than of admissions. Evidence for adjusted LOS differences was limited, and expenditure showed no consistent gradient. These findings provide a local basis for planning integrated cancer and chronic disease care.

Keywords: Cancer-related admissions; Comorbidity; Multimorbidity; Length of stay; Hospitalization expenditure; Secondary hospitals; China.

Background

Cancer remains a major cause of the global disease burden, with an estimated 20 million new cases and 9.7 million deaths worldwide in 2022[1]. China accounted for approximately 4.82 million new cases and 2.57 million deaths in the same year[2]. Patients with cancer frequently have coexisting non-cancer chronic conditions, and a systematic review reported an increasing trend in recorded comorbidity prevalence after adjustment for study and population characteristics[3]. Coexisting chronic conditions add to the complexity of cancer care, influencing

treatment selection, tolerance, survival, and quality of life[4–6]. These clinical challenges are accompanied by greater healthcare utilization and readmission risk, with implications for healthcare resource allocation[7, 8].

Although previous studies have linked cancer comorbidity to greater healthcare use and expenditure, their applicability to secondary hospitals remains uncertain[9–11]. Studies restricted to specific cancers, active antineoplastic treatment, or principal-cancer admissions may capture different care needs from broader cancer-related admission populations. Within China's tiered healthcare system, secondary hospitals also provide chronic disease management and continuing care[12]. Examining admissions with cancer recorded in any diagnosis position may therefore offer a broader view of their inpatient service needs. Such analyses must account for case mix, changes in admission composition over time, and repeated admissions. Evidence addressing these factors remains limited, particularly for adjusted associations of recorded non-cancer comorbidity with LOS and hospitalization expenditure.

To address this gap, we conducted a retrospective study of 26,562 adult cancer-related admissions to a secondary hospital in China between 2014 and 2025. We characterised recorded comorbidity burden and disease combinations across 17 selected non-cancer chronic condition categories and examined their adjusted associations with LOS and hospitalization expenditure. Sensitivity analyses assessed whether these associations were consistent across recent study periods and after accounting for patient-level clustering. The study aimed to provide setting-specific evidence to inform inpatient service planning and resource allocation at this hospital.

Methods

Study design and data source

We conducted a retrospective observational study of adult cancer-related admissions to a secondary hospital in China during 2014–2025. Routinely collected discharge records included demographics, diagnoses, admission route, LOS, and total hospitalization expenditure. Eligible admissions involved adults aged ≥18 years with an ICD-10 malignant neoplasm code (C00–C97) in any diagnosis field. These records did not necessarily represent admissions for active cancer treatment.

Admissions with an obstetric principal diagnosis were excluded, as were records with prespecified discordance between recorded sex and sex-specific malignancy codes. Specifically, records coded as female with C61 or male with C51–C58 were excluded. These exclusions relied on recorded fields and could not be verified against source clinical records. The sequential selection process is presented in Supplementary Figure S1.

The admission was the primary analytical unit, and repeated admissions were counted separately. Year was assigned by discharge date. Reliable patient identifiers were available only for 2020–2025.

Cancer characteristics and recorded comorbidity

Cancer diagnosis position was classified as principal diagnosis or secondary diagnosis only. Recorded cancer site groups were assigned using all C00–C97 codes. Admissions with one identifiable primary site group were assigned to that group regardless of accompanying metastatic codes. Multiple recorded primary site groups or C97 were classified separately, as were records containing only secondary or unspecified malignancy codes (C77–C80). Detailed classification rules and the 15 underlying site groups are provided in the Supplementary Methods and Supplementary Table S4.

We identified 17 selected non-cancer chronic condition categories using ICD-10 codes and, where required, diagnosis text: hypertension, diabetes, chronic lung disease, asthma, bronchiectasis, chronic ischaemic heart disease, atrial fibrillation/flutter, chronic heart failure, stroke sequelae, chronic kidney disease, chronic liver disease, dyslipidaemia, thyroid dysfunction, osteoporosis, dementia, parkinsonism, and rheumatic disease. Operational definitions are provided in Supplementary Table S1.

Each selected condition category was counted once per admission; cancer and metastatic disease were excluded. Recorded non-cancer comorbidity was defined as at least one selected category and recorded non-cancer multimorbidity as at least two. Burden was grouped as 0, 1, 2, 3, or ⩾4 conditions, with additional summaries for ⩾1 and ⩾2 conditions. An unrecorded condition was not assumed to be clinically absent.

Descriptive analyses

We summarized comorbidity burden by discharge year, age group (18–44, 45–64, 65–74, and ≥75 years), sex, cancer diagnosis position, and recorded cancer site. Heatmaps displayed annual age-specific proportions with ≥1 and ≥2 conditions.

Exact combinations required the specified conditions without any additional condition among the 17 categories. An UpSet plot displayed the five most frequent single-condition patterns, five two-condition combinations, and three three-condition combinations. Marginal bars showed any recorded occurrence of each displayed condition. Pattern percentages used all eligible admissions as the denominator.

Categorical variables were reported as counts and percentages, and continuous variables as medians with interquartile ranges (IQRs) and means with standard deviations (SDs), as

appropriate. Annual admission shares used the full cohort as the denominator; subgroup comorbidity percentages used the corresponding subgroup admission count.

Exploratory networks represented the 17 selected conditions as nodes, with edges weighted by either inclusive co-occurrence counts or positive phi coefficients. We calculated centrality measures, examined Louvain community assignments across resolution parameters, and performed hierarchical clustering of the full phi matrix. These analyses were descriptive and unadjusted; detailed specifications are provided in the Supplementary Methods.

Inpatient service use and expenditure

LOS was obtained from the recorded actual inpatient-days field. Cumulative inpatient days were calculated by summing LOS within each subgroup and expressed as a share of all inpatient days. Hospitalization expenditure was defined as the total recorded charge per admission. LOS and expenditure were summarized by comorbidity burden, demographic and cancer characteristics, and selected condition patterns. Single-condition summaries required exactly one selected condition, whereas inclusive disease-pair summaries allowed additional conditions and could overlap.

Nominal hospitalization expenditure was winsorized at the pooled 1st and 99th percentiles of the 2014–2025 distribution (CNY 151.7215 and 49,033.5788), adjusted to 2025 prices using annual national Consumer Price Index ratios from the National Bureau of Statistics of China[13], and converted to USD at a fixed rate of CNY 7.14 per USD. Ten zero-expenditure records were assigned the lower winsorization threshold. LOS was not winsorized.

Multivariable analyses

Associations between comorbidity burden and LOS were estimated using negative binomial regression with a log link and an estimated NB2 dispersion parameter. Expenditure was analyzed using a gamma generalized linear model with a log link. Burden categories were entered categorically, with no selected condition as the reference. Exponentiated coefficients were reported as adjusted mean ratios with 95% confidence intervals (CIs).

Model 1 included age, sex, and discharge year. Age was modelled using a centred natural cubic spline with four degrees of freedom. Model 2 additionally included cancer diagnosis position and the 15 underlying recorded cancer site groups and served as the principal model. All admissions had complete data for these variables. Full-period models used admission-level HC0 sandwich standard errors without patient clustering because reliable patient identifiers were available only for 2020 – 2025. Joint Wald tests assessed the overall association of burden categories with each outcome.

Sensitivity analyses examined temporal variation, within-patient correlation, and model specification. We restricted analyses to 2018–2025 and 2020–2025 and, within the latter period, compared admission-level and patient-clustered standard errors using identical models and observations. Additional analyses adjusted for admission route, used a gamma-log model for LOS, and examined alternative expenditure specifications with and without winsorization. Detailed specifications are provided in the Supplementary Methods.

Five common disease pairs were examined in separate exploratory models using Model 2 covariates. Each model compared admissions containing the specified pair, allowing additional conditions, with admissions containing no selected condition; other admissions were excluded.

Because additional conditions were permitted and the pair groups overlapped, these comparisons described overall recorded profiles rather than the effects of individual diseases.

All P values were two-sided. Benjamini–Hochberg correction was applied separately to the eight principal burden–outcome comparisons and the ten exploratory pair–outcome comparisons; q <0.05 defined the false-discovery threshold. CIs were nominal, and findings were interpreted as adjusted associations rather than causal effects. Model checks included convergence, dispersion, variance diagnostics, and calibration. Analyses used Python 3.13.3 and statsmodels 0.15.0.

Ethics approval

The hospital's ethics committee approved the study (approval No. 2026-033) and waived informed consent because the analysis used anonymised retrospective medical records.

Results

Recorded comorbidity burden across demographic and clinical subgroups

The study included 26,562 cancer-related admissions during 2014–2025; 40.7% were among women, and the overall median age was 60 years (IQR, 46–73). Overall, 55.1% had ≥1 recorded non-cancer chronic condition, and 22.7% had ≥2 conditions. The corresponding proportions increased from 47.6% and 17.5% in 2014 to peaks of 67.6% and 33.4% in 2019, and were 62.2% and 29.1% in 2025, respectively (Table 1; Supplementary Table S2).

Recorded burden was higher in older age groups: the proportions with ≥1 and ≥2 conditions were 33.8% and 8.6% among admissions aged 18–44 years, compared with 76.5% and 41.3% among those aged ≥75 years (Table 2; Figure 1). In both sexes, 55.1% of admissions had ≥1 condition, whereas ≥2 conditions were more frequent among women than men (23.9% versus 21.8%; Table 2).

Cancer was recorded as the principal diagnosis in 14.7% of admissions. These admissions had higher proportions with ≥1 and ≥2 conditions than those with cancer recorded only as a secondary diagnosis (63.2% versus 53.7% and 27.9% versus 21.8%, respectively). Secondary or unspecified malignancy codes alone (C77–C80) accounted for 37.2% of admissions. Tracheal and lung cancer was the most frequent specified site group (14.7% of all admissions) and had the highest proportions with ≥1 and ≥2 conditions among the five leading specified site groups (59.6% and 26.2%, respectively) (Table 2).

Hypertension, diabetes, and chronic liver disease were the most frequently recorded conditions, occurring in 31.1%, 15.7%, and 10.8% of admissions, respectively (Supplementary Table S6). Hypertension alone was the most frequent exact single-condition pattern, and hypertension with diabetes was the most frequent exact two-condition combination (Figure 2; Supplementary Table S7).

In exploratory network analyses, hypertension had the highest node strength in the co-occurrence-frequency network, whereas chronic ischaemic heart disease ranked highest in the positive-phi network. Community assignments varied with the resolution parameter and were interpreted as exploratory rather than established clinical groupings (Supplementary Tables S8 – S9; Supplementary Figures S4 – S5).

Inpatient service use and hospitalization expenditure

The 26,562 admissions accounted for 229,888 inpatient days. Median LOS was 6 days (IQR, 4 – 10), and median hospitalization expenditure was $810.44 (IQR, $435.76 – $1,484.68), expressed in USD at 2025 prices. In unadjusted comparisons, median LOS increased from 6 days among admissions with no selected condition to 8 days among those with ⩾4 conditions, while median

197 expenditure increased from $720.84 to $1,153.12. Admissions with ⩾2 conditions accounted for
198 22.7% of admissions but 25.9% of total inpatient days (Table 3; Figure 3).
199 Median LOS and expenditure increased across age groups, from 5 days and $548.31 among
200 admissions aged 18–44 years to 8 days and $1,091.56 among those aged ≥75 years. Admissions
201 with cancer as the principal diagnosis had longer median LOS (9 versus 6 days) and higher
202 median expenditure ($1,334.15 versus $759.72) than those with cancer recorded only as a
203 secondary diagnosis. Among the five most frequent specified cancer-site groups, biliary tract and
204 pancreatic cancers had the highest median LOS and expenditure, whereas tracheal and lung
205 cancers contributed the largest share of total inpatient days (17.4%) (Table 3).
206 Among the single-condition patterns presented, hypertension alone contributed the largest share of
207 total inpatient days (14.6%). Among the displayed co-occurring pairs, which allowed additional
208 conditions, hypertension with diabetes contributed the largest share (8.6%), whereas hypertension
209 with chronic lung disease had the longest median LOS (9 days; IQR, 6–13) and highest median
210 expenditure ($1,200.73; IQR, $757.53–$1,804.94) (Table 3).
211 *Multivariable-adjusted associations with LOS and hospitalization expenditure*
212 The burden categories were jointly associated with LOS in the fully adjusted model (global Wald
213 P = 0.002). Compared with admissions with no selected condition, adjusted mean LOS ratios were
214 1.070 (95% CI, 1.018 – 1.124) for three conditions and 1.130 (95% CI, 1.022 – 1.249) for ⩾4
215 conditions. Ratios for one and two conditions were close to unity. Neither of these
216 category-specific comparisons met the false-discovery threshold after correction across eight
217 burden – outcome comparisons (q = 0.064 and 0.069). Adjusted expenditure ratios ranged from
218 0.975 to 1.027, with all confidence intervals including unity (global Wald P = 0.202; Table 4).

Alternative expenditure specifications produced similar findings (Supplementary Table S14). In the 2020–2025 subset of 8,023 admissions from 4,536 patients, all burden-category confidence intervals included unity under both admission-level and patient-clustered standard errors (Supplementary Table S13; Supplementary Figure S6). The recent-period analyses therefore provided no clear evidence of category-specific differences for either outcome.

In exploratory disease-pair analyses, admissions with hypertension and either chronic ischaemic heart disease or chronic lung disease had longer adjusted mean LOS than admissions with no selected condition (mean ratios, 1.109 [95% CI, 1.036 – 1.187] and 1.101 [95% CI, 1.030 – 1.177], respectively; q = 0.024 for both). These pair groups allowed additional selected conditions. No clear expenditure differences were identified for the five pairs examined (Supplementary Table S15).

Discussion

This study characterised recorded non-cancer chronic comorbidity and inpatient resource use across 26,562 cancer-related admissions to a secondary hospital in China. More than half of admissions involved at least one selected chronic condition, and admissions with multiple conditions contributed a greater share of inpatient days than of admissions. These descriptive differences were not accompanied by a consistent gradient in adjusted outcomes: evidence for longer LOS was limited, and expenditure ratios remained close to unity. The study therefore provides evidence on local service demand while distinguishing this demand from adjusted associations with comorbidity burden.

The composition of this cohort is central to interpreting the findings. Cancer appeared only in secondary diagnosis fields in 85.3% of admissions, and 37.2% contained only secondary or unspecified malignancy codes without an identifiable primary site. Inclusion of cancer codes in any diagnosis field captures a broader admission population than studies restricted to principal-cancer diagnoses. Nevertheless, diagnosis position and cancer codes alone cannot establish treatment intent, disease stage, or whether an admission primarily involved supportive or palliative care. Administrative diagnoses may also incompletely capture chronic conditions, and validation studies have demonstrated variation in coding accuracy across diagnostic categories[14]. Our estimates consequently describe recorded conditions among eligible admissions rather than the underlying prevalence of comorbidity among all patients with cancer.

Comparisons with other healthcare settings provide context but require attention to differences in eligibility and measurement. Wang et al. reported comorbidity in 76.2% of patients with five selected cancers at a Chinese tertiary hospital using hospital information system data[11], whereas Ding et al. reported a prevalence of 31.3% among patients with lung cancer in an urban insurance claims study[10]. Differences in cancer eligibility, condition definitions, observation periods, and analytical units limit direct comparison with our admission-level estimates. Similarly, Xu et al. reported a median LOS of 9 days among principal-cancer admissions in Hunan, where 68.6% of admissions occurred in tertiary hospitals[9]. This resembles the median in our principal-cancer subgroup rather than the 6-day median for the entire cohort. These comparisons highlight the importance of eligibility and case mix; they do not establish equivalent treatment pathways or differences in clinical complexity or efficiency.

The disease patterns and age gradient help identify the types of care needs represented in this cohort. Hypertension, diabetes, and chronic liver disease were frequently recorded, and hypertension commonly co-occurred with other selected conditions. The higher burden among older admissions is consistent with a nationwide study of cancer-related hospitalizations in Chile, although differences in definitions and populations limit direct prevalence comparisons[15]. The different node-strength rankings in the frequency and positive-phi networks also distinguish common co-occurrence from stronger association relative to marginal recording frequencies. Together, these findings suggest concurrent management needs, but neither condition counts nor network prominence captures disease severity, functional impairment, or treatment interactions. They should therefore inform further assessment rather than define clinical priorities or intervention targets.

Interpretation of temporal changes requires particular caution because the admission population changed substantially during the study period. Annual admission volume declined sharply after 2017, median age increased from 49 years in 2014 to 69 years in 2025, and the proportion of female admissions fluctuated. The accompanying increase in recorded comorbidity may therefore partly reflect changes in case mix, admission practices, referral pathways, or diagnostic recording rather than increasing disease burden in the local cancer population. These processes were not directly measured. Transparent reporting of cohort selection and coding procedures is particularly important when routinely collected health data span extended periods[16]. Covariate adjustment and period-restricted analyses help assess the sensitivity of findings but cannot eliminate differences in patient selection or recording practices.

283 The resource-use findings distinguish observed service demand from adjusted associations.
284 Admissions with ⩾2 conditions represented 22.7% of admissions but 25.9% of cumulative
285 inpatient days. After adjustment, LOS differences were modest: the overall burden association was
286 statistically evident, but individual comparisons did not meet the false-discovery threshold.
287 Recent-period analyses provided no clear evidence of category-specific differences under either
288 admission-level or patient-clustered standard errors. Case-mix differences may contribute to the
289 contrast between crude summaries and adjusted estimates, although their contribution was not
290 quantified. For local planning, admission and inpatient-day distributions identify where demand is
291 concentrated, while the regression findings provide limited support for a consistent adjusted LOS
292 gradient.
293 The expenditure findings similarly require attention to the unit of analysis. Previous studies have
294 reported higher expenditure among patients with comorbidity[17, 18], whereas our adjusted
295 analyses showed no consistent increase in expenditure per admission. Differences in populations
296 and expenditure measures may help explain this contrast. Ding et al. examined comorbidity in
297 relation to medical service costs among patients with lung cancer[10], while population-based
298 research in China has associated multimorbidity with a greater risk of household catastrophic
299 health expenditure[19]. Patient-level and household measures capture dimensions of financial
300 burden that expenditure per admission does not. Accordingly, expenditure ratios close to unity
301 neither establish equivalence between groups nor indicate a low cumulative financial burden.
302 Analyses incorporating repeated admissions, outpatient care, and out-of-pocket expenditure are
303 needed to assess cumulative financial burden.

For secondary hospitals, the substantial recorded burden among older admissions supports considering integrated, patient-centred care adapted to local resources. Structured assessment could identify functional, nutritional, medication-related, and chronic disease management needs, with more comprehensive geriatric assessment for patients requiring further evaluation[20, 21]. Chinese cancer comorbidity guidance and geriatric assessment recommendations support linking identified needs to individualised care plans[22, 23]. Prognostic tools such as the Charlson Comorbidity Index may complement, but cannot replace, assessments of function, frailty, and medication safety[24, 25]. Needs-based multidisciplinary collaboration could then address specific clinical problems through appropriate team participation, shared decisions, and clear implementation responsibilities[26]. The cardiopulmonary combinations identified here may prompt further assessment but should not alone determine consultation or treatment. Beyond discharge, explicit referral criteria, information transfer, and assigned follow-up responsibilities could strengthen hospital–community coordination within China's tiered healthcare framework [27]. Digital support should initially improve diagnostic completeness and linkage across admissions; rule-based reminders and AI-assisted tools could subsequently be explored following local validation[28, 29]. Early clinical evaluations should address safety, clinical performance, workflow, and workload, with reporting guided by DECIDE-AI[30]. Whether these approaches improve continuity, patient outcomes, or resource use requires prospective evaluation.

This study provides a 12-year account of recorded comorbidity and inpatient resource use at a Chinese secondary hospital, supported by several sensitivity analyses. However, its single-centre design and changing case mix limit generalizability. Routine coding may under-record or misclassify conditions, and record-based exclusions could not be clinically verified. Unmeasured

cancer stage, treatment intensity, and functional status may introduce residual confounding. Incomplete patient identifiers prevented full-period clustering adjustment, while admission-level analyses overrepresent frequent users and do not capture cumulative patient-level costs. Network findings were exploratory, unadjusted, and lacked resampling validation. Multicentre studies with harmonised definitions and linked patient records are needed to assess generalizability and prospectively evaluate integrated care strategies.

Conclusions

Overall, recorded comorbidity was common and identified substantial inpatient service demand at this hospital. Evidence for adjusted LOS differences was limited, and expenditure showed no consistent increasing gradient. These findings provide local evidence for service planning while supporting further evaluation of integrated care strategies rather than assumptions about their effectiveness.

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Authors' contributions

Yuan-Yuan Li conceptualized the study, collected the data, and drafted the manuscript. Hanyue Xu contributed to data analysis and interpretation. Changgui Chen conceptualized the study, data interpretation, and wrote the manuscript. Yidong Wu contributed to study design, data interpretation, wrote the manuscript,and critical revision of the manuscript.

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Data availability

The anonymized dataset supporting this study is available from the corresponding author upon reasonable request, subject to institutional approval and ethical requirements for participant confidentiality.

Abbreviations

CPI, Consumer Price Index; USD, US dollar; ICD-10, International Classification of Diseases, 10th Revision; LOS, length of stay; IQR, interquartile range; CI, confidence interval.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of the Hangzhou Ninth Hospital (Approval No.2026—033). Informed consent was waived by the Ethics Committee due to the retrospective nature of the study, and all data were anonymized.

Clinical Trial Number

Clinical trial number: not applicable.

Human Ethics and Consent to Participate declarations

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Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Table 1. Annual admission characteristics and recorded comorbidity burden, 2014–2025.

Year	Admissions, n (%)	Age, median (IQR), years	Female, n (%)	Principal cancer, n (%)	Number of recorded non-cancer chronic conditions				
					0 (%)	1 (%)	2 (%)	3 (%)	≥4 (%)
2014	2,520 (9.5)	49 (37 – 64)	950 (37.7)	305 (12.1)	52.4	30.0	13.1	3.5	1.0
2015	3,658 (13.8)	50 (37 – 64)	1,472 (40.2)	442 (12.1)	51.6	32.6	11.9	2.9	1.0
2016	4,174 (15.7)	52 (39 – 67)	1,653 (39.6)	559 (13.4)	50.7	32.4	12.7	3.6	0.6
2017	5,039 (19.0)	54 (41 – 69)	1,961 (38.9)	388 (7.7)	47.3	31.0	15.0	5.4	1.3
2018	1,921 (7.2)	64 (50 – 76)	808 (42.1)	330 (17.2)	42.1	31.7	16.8	7.4	2.0
2019	1,227 (4.6)	71 (62 – 80)	458 (37.3)	257 (20.9)	32.4	34.2	17.4	11.8	4.2
2020	969 (3.6)	69 (59 – 78)	388 (40.0)	211 (21.8)	35.9	34.8	17.4	9.6	2.3
2021	957 (3.6)	68 (56 – 79)	401 (41.9)	255 (26.6)	34.4	35.4	19.3	8.3	2.6
2022	1,119 (4.2)	67 (55 – 77)	547 (48.9)	262 (23.4)	38.7	33.4	18.9	7.0	2.1
2023	1,378 (5.2)	69 (58 – 77)	620 (45.0)	254 (18.4)	37.1	33.4	19.0	7.1	3.4
2024	1,687 (6.4)	68 (60 – 76)	713 (42.3)	332 (19.7)	39.5	34.3	17.8	6.3	2.1
2025	1,913 (7.2)	69 (60 – 77)	828 (43.3)	314 (16.4)	37.8	33.1	20.4	6.1	2.5
Total	26,562 (100.0)	60 (46 – 73)	10,799 (40.7)	3,909 (14.7)	44.9	32.4	15.5	5.5	1.7

Note: Admission percentages use all 26,562 admissions as the denominator. Percentages for female sex, principal cancer diagnosis, and comorbidity burden use the corresponding annual admission count, or all admissions for the total row. Comorbidity counts refer to the 17 selected non-cancer chronic condition categories. The five burden categories (0, 1, 2, 3, and ≥4 conditions) are mutually exclusive. All results are unadjusted admission-level summaries, with repeated admissions counted separately. Age is presented as the median (25th–75th percentiles). Percentages may not sum to 100% because of rounding. IQR, interquartile range.

Table 2. Distribution of recorded non-cancer chronic condition counts by demographic and clinical characteristics, 2014–2025

Group	Admissions, n (%)	0 (%)	1 (%)	2 (%)	3 (%)	⩾4 (%)	⩾1 (%)	⩾2 (%)
Age group, years								
18 – 44	6,101 (23.0)	66.2	25.2	7.2	1.2	0.2	33.8	8.6
45 – 64	9,542 (35.9)	51.3	32.8	12.3	2.9	0.7	48.7	15.9
65 – 74	5,027 (18.9)	32.1	37.1	20.4	8.1	2.4	67.9	30.8
⩾75	5,892 (22.2)	23.5	35.2	24.9	12.2	4.2	76.5	41.3
Sex								
Female	10,799 (40.7)	44.9	31.2	16.5	5.6	1.8	55.1	23.9
Male	15,763 (59.3)	44.9	33.3	14.7	5.5	1.6	55.1	21.8
Cancer diagnosis position								
Principal diagnosis	3,909 (14.7)	36.8	35.3	18.9	6.9	2.0	63.2	27.9
Secondary diagnosis only	22,653 (85.3)	46.3	31.9	14.9	5.3	1.6	53.7	21.8
Recorded cancer site group								
Trachea and lung (C3 – C34)	3,917 (14.7)	40.4	33.3	18.0	6.3	2.0	59.6	26.2
Colorectal and anus (C18 – C21)	1,822 (6.9)	42.0	33.0	15.5	7.1	2.3	58.0	25.0
Stomach (C16)	1,140 (4.3)	51.9	29.5	10.8	5.5	2.3	48.1	18.6
Breast (C50)	1,099 (4.1)	57.1	24.7	10.6	6.0	1.6	42.9	18.2
Biliary tract and pancreas (C23 – C25)	1,032 (3.9)	42.5	34.3	15.7	6.2	1.3	57.5	23.2
Other major primary sites	4,409 (16.6)	34.7	35.2	19.4	7.8	2.9	65.3	30.0
Remaining specified or ill-defined primary sites	2,253 (8.5)	51.4	29.3	13.3	4.4	1.6	48.6	19.4
Secondary or unspecified malignancy only (C77 – C80)	9,877 (37.2)	48.8	32.1	14.1	4.2	0.9	51.2	19.1
Multiple recorded site groups (including C97)	1,013 (3.8)	40.9	35.3	17.0	5.2	1.6	59.1	23.8

Note: Admission percentages use all 26,562 admissions as the denominator; condition-count percentages use the row total. Counts reflect the 17 selected non-cancer chronic conditions. Categories 0 to ≥4 are mutually exclusive, whereas ≥1 and ≥2 are overlapping summary columns. Repeated admissions are counted separately. Cancer site groups reflect all recorded ICD-10 C00–C97 codes (treating C77–C80 as non-primary); other named groups comprise liver, oesophageal, prostate, female genital, urinary tract, and haematological malignancies (see Methods for detailed classification rules).

Table 3. Inpatient LOS, cumulative inpatient days and hospitalization expenditure by recorded comorbidity burden and clinical characteristics, 2014–2025.

Group	LOS, median (IQR), days	LOS, mean (SD), days	Cumulative inpatient days, n (%)	Total hospitalization expenditure, median (IQR), 2025 USD
Total	6 (4–10)	8.65 (9.14)	229,888 (100.0)	810.44 (435.76–1,484.68)
Number of recorded non-cancer chronic conditions				
0	6 (3–9)	7.93 (8.82)	94,561 (41.1)	720.84 (379.17–1,363.64)
1	6 (4–10)	8.80 (9.34)	75,855 (33.0)	812.12 (441.68–1,479.62)
2	7 (4–11)	9.40 (8.52)	38,574 (16.8)	932.66 (536.69–1,649.44)
3	8 (5–13)	10.72 (9.79)	15,785 (6.9)	1,049.44 (636.81–1,800.28)
⩾4	8 (5–13)	11.54 (13.52)	5,113 (2.2)	1,153.12 (695.99–1,673.84)
Age group, years				
18–44	5 (3–7)	6.28 (6.76)	38,290 (16.7)	548.31 (287.26–1,042.51)
45–64	6 (4–9)	7.83 (7.66)	74,685 (32.5)	747.64 (416.24–1,386.38)
65–74	7 (4–12)	9.72 (9.85)	48,838 (21.2)	937.22 (541.77–1,735.73)
⩾75	8 (5–14)	11.55 (11.62)	68,075 (29.6)	1,091.56 (640.27–1,910.85)
Sex				
Female	6 (3–10)	8.26 (8.97)	89,206 (38.8)	789.04 (422.59–1,448.09)
Male	6 (4–11)	8.92 (9.24)	140,682 (61.2)	826.50 (445.02–1,510.83)
Cancer diagnosis position				
Principal diagnosis	9 (5–15)	12.18 (11.63)	47,611 (20.7)	1,334.15 (657.55–2,535.14)
Secondary diagnosis only	6 (4–10)	8.05 (8.49)	182,277 (79.3)	759.72 (409.40–1,336.27)
Recorded cancer site group				
Trachea and lung (C33–C34)	7 (4–12)	10.19 (11.21)	39,923 (17.4)	913.62 (478.40–1,687.45)
Colorectal and anus (C18–C21)	6 (3–11)	8.84 (8.64)	16,098 (7.0)	886.15 (500.65–1,755.69)
Stomach (C16)	7 (4–11)	9.49 (9.55)	10,816 (4.7)	907.63 (518.47–1,679.84)
Breast (C50)	3 (2–7.5)	5.83 (6.68)	6,403 (2.8)	896.17 (523.49–1,453.59)
Biliary tract and pancreas (C23–C25)	8 (4–16)	12.67 (14.53)	13,080 (5.7)	981.30 (532.20–1,934.98)
Other named cancer site groups	7 (4–12)	9.46 (8.96)	41,695 (18.1)	950.51 (534.17–1,720.97)

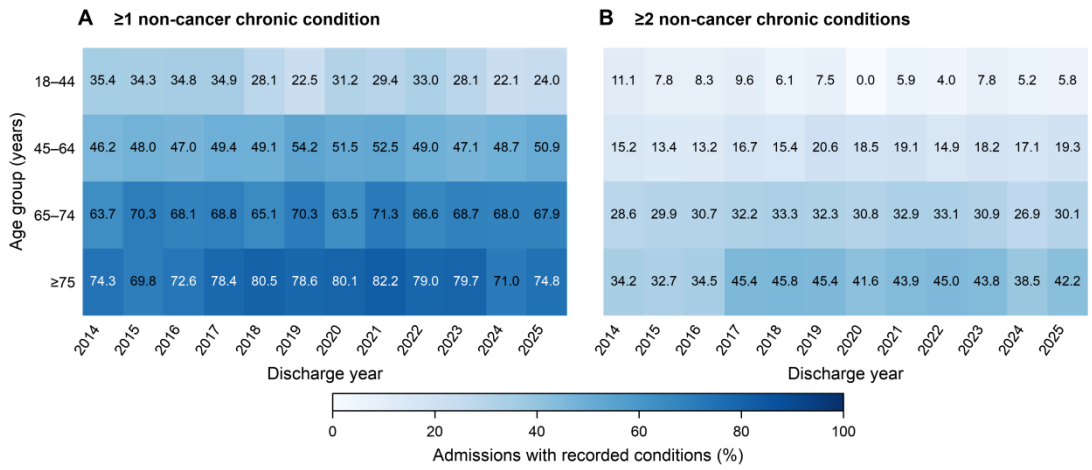
Group	LOS, median (IQR), days	LOS, mean (SD), days	Cumulative inpatient days, n (%)	Total hospitalization expenditure, median (IQR), 2025 USD
Other specified or ill-defined sites	6 (4–9)	8.51 (10.62)	19,163 (8.3)	831.90 (430.20–1,661.21)
Secondary or unspecified malignancy only (C77–C80)	6 (4–9)	7.16 (6.28)	70,765 (30.8)	652.55 (348.81–1,163.69)
Multiple recorded site groups (including C97)	8 (4–15)	11.79 (12.23)	11,945 (5.2)	1,057.96 (552.28–2,128.64)
Most frequent single conditions (exactly one)				
Hypertension only	6 (4–10)	8.92 (9.50)	33,458 (14.6)	791.97 (428.11–1,471.35)
Diabetes only	6 (4–9)	7.93 (7.60)	11,580 (5.0)	712.83 (372.84–1,278.73)
Chronic liver disease only	6 (4–10)	8.50 (9.18)	11,070 (4.8)	890.75 (497.58–1,695.74)
Chronic lung disease only	7 (5–11)	10.04 (10.73)	7,379 (3.2)	904.64 (515.97–1,450.15)
Chronic IHD only	7 (4–11)	8.88 (9.11)	3,615 (1.6)	774.93 (405.10–1,442.98)
Common co-occurring pairs (additional conditions allowed)				
Hypertension + Diabetes	7 (4–12)	9.62 (8.94)	19,809 (8.6)	956.24 (537.98–1,645.07)
Hypertension + Chronic IHD	8 (5–13)	11.11 (11.74)	11,963 (5.2)	1,057.88 (600.88–1,760.15)
Hypertension + Chronic liver disease	7 (5–11)	9.39 (8.11)	9,605 (4.2)	1,022.01 (627.64–1,766.65)
Hypertension + Chronic lung disease	9 (6–13)	11.59 (9.80)	8,752 (3.8)	1,200.73 (757.53–1,804.94)
Diabetes + Chronic liver disease	7 (5–11)	9.19 (7.61)	5,338 (2.3)	970.69 (597.64–1,689.15)

Note: Analyses include 26,562 admissions and 229,888 inpatient days. Cumulative-day percentages use all inpatient days as the denominator. Expenditure represents the total recorded charge per admission, not cumulative expenditure. Nominal CNY charges were winsorized at the pooled 2014–2025 1st and 99th percentiles (CNY 151.7215 and 49,033.5788) before adjustment to 2025 prices using the national all-items annual Consumer Price Index (National Bureau of Statistics of China), then divided by 7.14 to express values in USD. There were no missing or negative charges; ten zero-charge records were retained and raised to the lower winsorization threshold. In total, 266 records below and 266 above the thresholds were replaced. LOS was not winsorized. Five condition-count groups are mutually exclusive; single-condition rows require exactly one of the 17 selected conditions, whereas disease-pair rows allow additional conditions and overlap. Demographic and clinical classifications are separate; cancer site groups follow Table 2. All summaries are unadjusted and admission-based; repeated admissions are counted separately. IQR, interquartile range; SD, standard deviation; LOS, length of stay; IHD, ischaemic heart disease; CNY, Chinese yuan; USD, US dollars.

Table 4 Adjusted associations of recorded comorbidity burden with inpatient outcomes

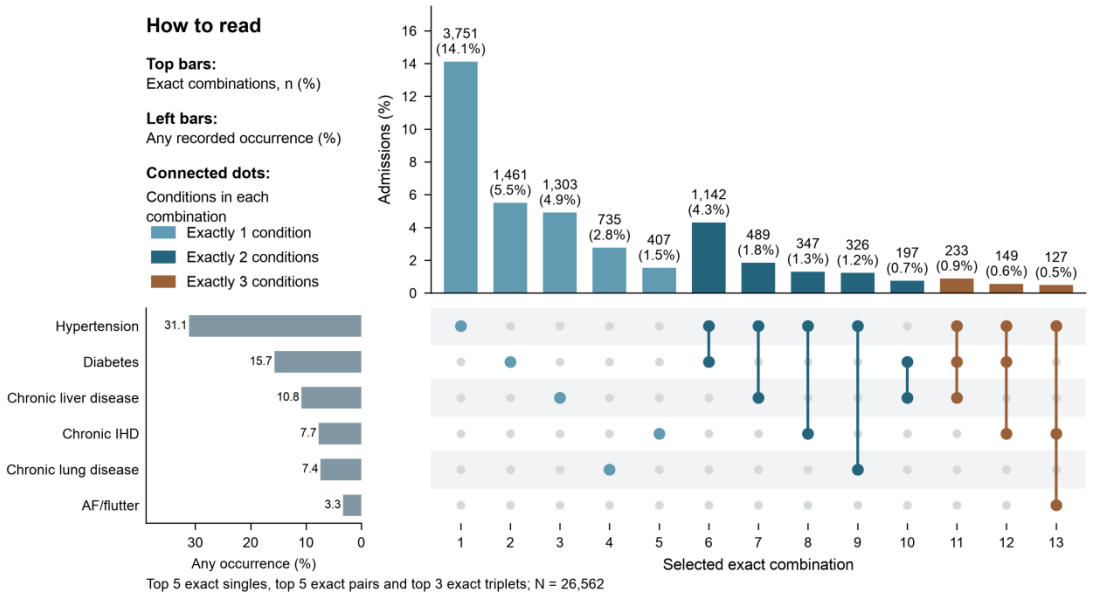
Recorded conditions	Admissions	Adjusted mean LOS ratio (95% CI)	P for LOS	Adjusted mean expenditure ratio (95% CI)	P for expenditure
0	11927	Reference	—	Reference	—
1	8615	0.984 (0.958–1.011)	0.248	0.975 (0.947–1.004)	0.086
2	4104	0.994 (0.962–1.027)	0.714	1.002 (0.967–1.039)	0.899
3	1473	1.070 (1.018–1.124)	0.008	1.027 (0.976–1.081)	0.299
≥4	443	1.130 (1.022–1.249)	0.017	0.987 (0.910–1.072)	0.762

Note: N = 26,562 admission records. Reference: no selected non-cancer chronic condition. Model 2 adjusts for age (natural cubic spline, 4 df), sex, discharge year, cancer diagnosis position and 15 recorded cancer site groups. LOS uses NB2 regression with an estimated dispersion parameter; expenditure uses gamma-log GLM. Ratios describe conditional means, not medians. Expenditure is winsorized, CPI-adjusted to 2025 and converted at CNY 7.14/USD. Confidence intervals use admission-level HC0 sandwich standard errors without patient clustering. Patient-clustered analyses for 2020 – 2025 are reported separately in Supplementary Table S11 and Figure S6.



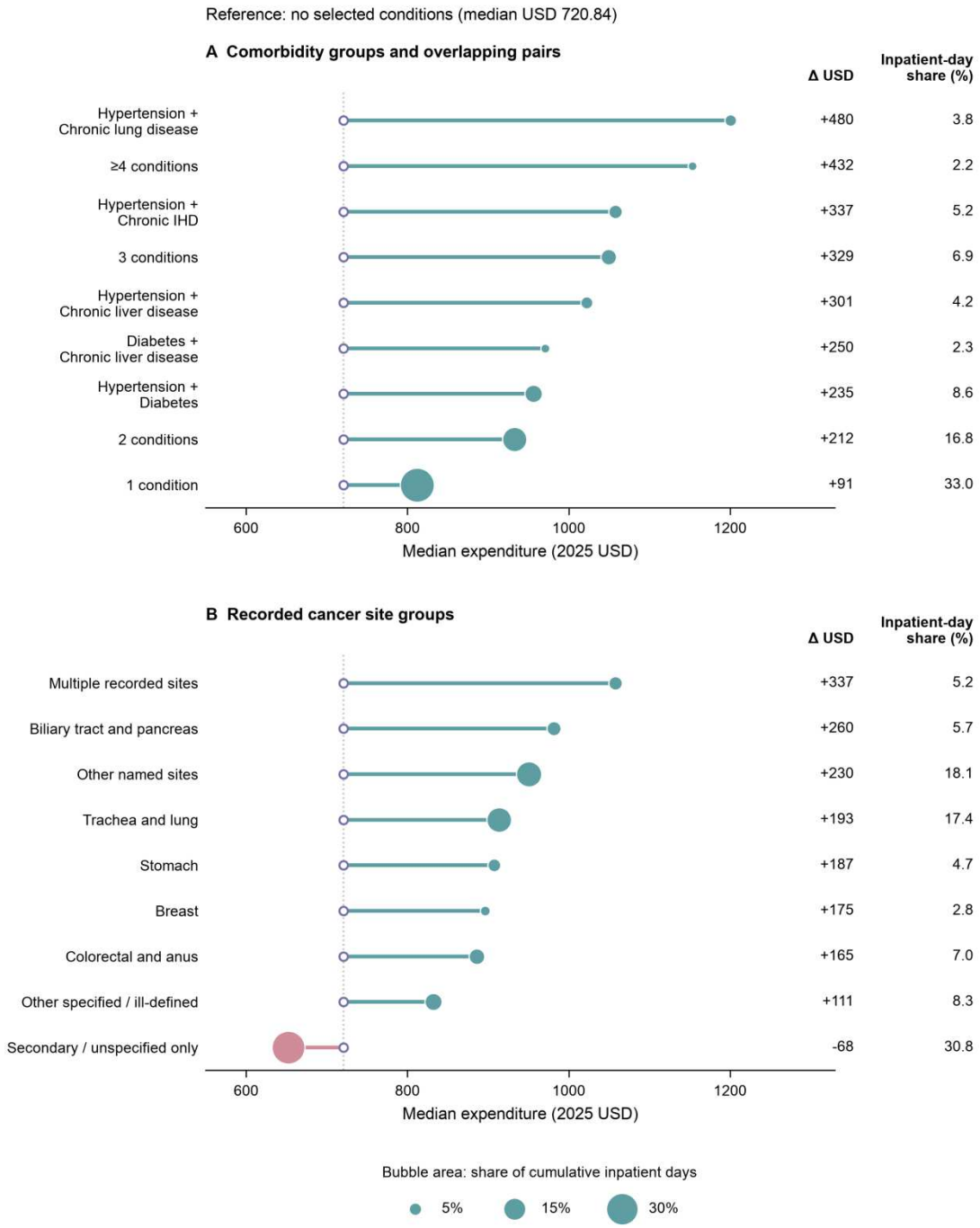
Notes: Panels A and B show unadjusted percentages with ≥1 and ≥2 of the 17 selected non-cancer chronic conditions, respectively. Denominators are admissions within each age–year stratum. Repeated admissions are counted separately. Both panels share a colour scale. The 0.0% in 2020 among those aged 18–44 years represents 0/32 admissions, not missing data.

Figure 1. Age-specific proportions of cancer-related admissions with recorded non-cancer chronic conditions, 2014—2025.



Notes: Upper bars show admission counts and percentages for 13 selected exact patterns: 1 – 5, hypertension alone, diabetes alone, chronic liver disease alone, chronic lung disease alone, and chronic IHD alone; 6 – 10, HTN+DM, HTN+liver, HTN+IHD, HTN+lung, and DM+liver; and 11 – 13, HTN+DM+liver, HTN+DM+IHD, and HTN+IHD+AF/flutter. These comprise the five most frequent single-condition patterns, five most frequent exact two-condition combinations, and three most frequent exact three-condition combinations, ranked within each group. Filled dots identify the conditions in each pattern; no other selected chronic conditions were recorded in these admissions. Lower-left bars show the percentage of all admissions in which each displayed condition was recorded, regardless of other conditions. All percentages use 26,562 admissions as the denominator; repeated admissions are counted separately. HTN, hypertension; DM, diabetes; liver, chronic liver disease; lung, chronic lung disease; IHD, ischaemic heart disease; AF, atrial fibrillation.

Figure 2. UpSet plot of the most frequent exact non-cancer chronic condition patterns among cancer-related admissions, 2014–2025.



Notes: Δ USD represents the difference in median hospitalization expenditure compared with the reference group (0 selected conditions). Inpatient-day share (%) denotes each subgroup's share of total cumulative inpatient days (229,888 days in total), with bubble areas scaled proportionally. Comparisons are unadjusted.

Disease-pair groups overlap; their shares must not be summed. Cancer-site comparisons use an overall, not site-matched, reference.

Figure 3. Median expenditure differences and cumulative inpatient days distribution by clinical subgroups.

Supplementary Files

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- SupplementaryInformation1018.docx