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Path analysis of factors influencing length of stay and hospitalisation expenses for oral cancer patients in tertiary hospitals in southeastern China: a cross-sectional study

Yi Fan ,[1,2,3] Qiujiao Yang,[1,3] Chen Chen,[1,3] Xiaoying Hu,[1,3] Mingming Xu,[1,3] Yanfeng Weng,[1,3] Yanni Li,[1,3] Yaping Wang,[1,3] Lisong Lin,[4] Yu Qiu,[4] Jing Wang,[5] Fa Chen,[1,3] Baochang He,[1,3] Fengqiong Liu [1,3]

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YF, QY and CC contributed equally.

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For numbered affiliations see end of article.

Correspondence to
Dr Fengqiong Liu; lfq@fjmu.edu.cn and Dr Baochang He; hbc517@163.com

ABSTRACT

Aims To investigate the associations between influencing factors with length of stay (LOS) and hospitalisation expenses in oral cancer (OC) patients, and to explore the potential pathways through which these factors influence hospitalisation expenses using path analysis.

Design Cross-sectional.

Setting A comprehensive tertiary hospital in southeastern China.

Participants A total of 810 patients with histologically confirmed primary OC admitted to the First Affiliated Hospital of Fujian Medical University, Fujian Province, between 2015 and 2020.

Main outcome measures LOS and hospitalisation expenses for OC patients.

Results The median hospitalisation expenses and LOS for OC patients in southeastern China were substantial, amounting to $6330 and 29 days, respectively. Treatment and surgery fees constituted the largest proportion of total expenses (28.59%), followed by inspection and laboratory test fees (20.63%), comprehensive medical service fees (19.27%), drug fees (18.09%) and medical consumables fees (11.69%). LOS was significantly associated with tumour site, surgery and chemotherapy. Factors such as longer LOS, poor oral hygiene, advanced tumour stage (II–IV), larger tumour size (>2 cm^3), surgery and bilateral neck dissection were strongly linked to higher hospitalisation expenses. Path analysis revealed that neck dissection had the highest total effect on hospitalisation expenses (β=0.307), while surgery exerted an indirect effect on expenses via LOS (β=0.021).

Conclusion This study highlights the significant economic burden imposed by OC on patients and healthcare systems. While prevention and early diagnosis remain critical, our findings underscore several modifiable factors, including improving oral hygiene and optimising surgical protocols, such as chemotherapy and lymph node dissection, that present opportunities to reduce costs and enhance cost-effectiveness. These insights provide actionable targets for mitigating financial burdens and improving patient outcomes.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The study included 810 patients, with a wide range of clinical and demographic factors systematically collected, allowing for a robust analysis of factors influencing hospitalisation costs and length of stay.

⇒ The use of path analysis enabled the identification of mediating effects, offering deeper insights into how various factors interact to influence hospitalisation outcomes.

⇒ As a retrospective study, the reliance on existing medical records may introduce biases or missing data that affect the results.

⇒ The research was conducted at a single tertiary hospital, which may limit the generalisability of the findings to other regions or healthcare settings.

⇒ The relatively small number of oral cancer patients from years outside 2016–2018 may potentially affect the generalisability of the results and introduce selection bias in the analysis.

INTRODUCTION

Oral cancer (OC) accounted for 377 713 new cases and 177 757 deaths globally in 2020,[1] with China ranking second in both incidence and mortality. According to the Global Cancer Observatory (https://gco.iarc.fr/today/home), China reported 135 929 new cases and 14 785 deaths in 2020, with Fujian Province exhibiting an age-standardised OC incidence rate (3.76/100 000) higher than the national average (2.69/100 000). The majority of OC cases are diagnosed at advanced stages, resulting in poor prognoses[2–4] and imposing substantial financial burdens on patients, families and healthcare systems.[5 6] Identifying the factors influencing hospitalisation expenses is therefore critical for developing strategies to mitigate this economic impact.[7]

The determinants of hospitalisation expenses in OC treatment have garnered increasing research attention. Studies across China and other countries have highlighted disparities in treatment costs driven by regional, demographic and clinical differences.[8–11] For instance, Yang *et al*[12] demonstrated that gender, age and tumour site significantly influence hospitalisation expenses, while research in Italy identified elective treatments and cancer recurrence as primary cost drivers.[13] Additionally, comorbidities and treatment modalities have been underscored as key determinants.[8] Despite these insights, substantial heterogeneity in patient demographics, treatment approaches and healthcare infrastructure necessitates region-specific investigations. Evidence from China remains sparse, particularly regarding the detailed associations between influencing factors and categorised hospitalisation expenses. A related challenge is the role of the length of hospital stay (LOS) in driving costs. Evidence shows that reducing LOS can substantially decrease expenses,[14 15] improve quality of life and lower the risk of iatrogenic complications and psychological distress.[16] Conversely, prolonged LOS may delay postoperative adjuvant therapies, potentially compromising outcomes.[17] Thus, elucidating the factors influencing LOS and their impact on hospitalisation expenses is essential for advancing cost-reduction strategies.

This study aims to characterise the distribution of hospitalisation expenses and LOS for OC patients in recent years in southeastern China. We investigate the effects of demographic characteristics, exposure history, tumour characteristics, and treatment modalities on hospitalisation expenses and LOS. Furthermore, we employ path analysis to elucidate the direct and indirect pathways through which these factors influence hospitalisation expenses, offering insights into the mechanisms underlying financial burdens in OC care.

MATERIALS AND METHOD

Patients and data source

In this retrospective study, 810 patients were admitted with histologically confirmed primary OC (International Classification of Diseases-10, code C00-C14) who were admitted to the First Affiliated Hospital of Fujian Medical University (a comprehensive tertiary hospital) in Fujian Province in Southeast China between July 2015 and October 2020. To be eligible, patients had to be between 18 and 80 years old and have complete data available. Patients who were transferred to other hospitals or received treatment for other cancers during hospitalisation were excluded.

We collected data on hospitalisation expenses, length of stay (LOS) and clinical characteristics from the Electronic Medical Record of the hospital for each patient. Epidemiological data were collected prospectively at admission using a standard questionnaire. To ensure data reliability, two collectors abstracted the same record using standardised definitions.

Hospitalisation expenses and length of stay

Hospitalisation expenses were categorised into eight components, as follows:

1. Comprehensive medical services fee: includes general medical service fees, general treatment and operation fees, nursing fees, diagnostic consultation fees, general ward fees, intensive care unit ward fees and other related costs.
2. Inspection and laboratory test fees: encompasses fees for pathological diagnosis, laboratory diagnostics, imaging diagnostics and clinical diagnostic items.
3. Treatment and surgery fees: includes fees for non-surgical treatments, anaesthesia and surgeries.
4. Rehabilitation fee.
5. Alternative treatment fee.
6. Drug fee: includes expenses for western medicines and traditional Chinese medicines.
7. Blood products fee: comprises costs for blood, blood protein products, globulin products, coagulation factors and cytokine products.
8. Medical consumables fee: includes costs for disposable medical materials used in examinations, treatments and surgeries.

To facilitate meaningful comparisons of hospitalisation expenses over time, all expenses were adjusted using the Consumer Price Index (CPI) based on the price level in 2015. The CPI values and real prices for the period from 2015 to 2020 are presented in online supplemental table 1, with the CPI of 100 in 1978 as the reference point. The transformation formula used was as follows:

Real price=Nominal price × (CPI of base year / CPI of object year)

For example, the CPI for 2015 and 2016 was 615.2 and 627.5, respectively. The real price for 2016 was calculated as [¥100 × (615.2/627.5)], using the real price of ¥100 in 2015 as the reference. This same procedure was applied to all other years in the study period. Detailed results for the hospitalisation expenses across 8 categories and 32 subcategories for each year are provided in online supplemental table 2.

For each patient, LOS was calculated by subtracting from the date of admission from the date of discharge.

Covariates

Covariates include individual (1) demographic characteristics: year of hospitalisation, sex (male/female), age (≤60/>60), body mass index (BMI) (<18.5/18.5~24/>24, defined as underweight, normal weight and overweight), education level (primary school and below/junior-senior high school/ junior college or above), residence (urban/rural area); (2) exposure history: smoking status (no/yes), alcohol drinking (no/yes), oral hygiene (well/moderate/poor), history of virus infection (eg, hepatitis B, hepatitis C and other virus infection) (no/yes), comorbidities (eg, cardiovascular, pulmonary and hepatic diseases) (no/yes); (3) tumour characteristics: tumour site (tongue/oral floor and oropharynx/others), pathological type (squamous cell carcinoma/others), TNM stage (I/II–III/IV), tumour size (≤2 cm^3/>2 cm^3, division according to the median of all the tumour size), histological classification (G3/G2/G1), lymph node metastasis at diagnosis (no/yes); and (4) treatment modalities: surgery (no/yes), chemotherapy (no/yes), radiotherapy (no/yes), neck dissection (no/unilateral/bilateral).

Statistical analysis

Hospitalisation expenses and LOS were reported as medians with interquartile ranges (IQRs), while categorical variables were expressed as number and percentages. Group comparisons for hospitalisation expenses and LOS were conducted using the Mann-Whitney U test or Kruskal-Wallis H test, as appropriate. Univariate linear regression analyses examined associations between demographic characteristics, exposure history, tumour characteristics, treatment modalities, and hospitalisation expenses and LOS. Factors identified as significant in univariate analyses were further evaluated through multivariate linear regression to identify independent predictors.

Pathway analysis was employed to investigate the mediating effects of LOS on the relationship between significant factors and hospitalisation expenses. To identify multivariate associations between patient characteristics and categorised hospitalisation expenses, the MaAsLin2 package in R was used. Correlations between categorised hospitalisation expenses and patient factors were visually explored using heatmaps and Sankey diagrams.

Sensitivity analyses were performed to evaluate the robustness of the findings. First, the analyses of factors influencing hospitalisation expenses and LOS were repeated without excluding OC patients aged under 18 or over 80 years. Second, data from 2016 to 2018 were re-analysed to assess the consistency of identified factors affecting hospitalisation expenses and LOS.

R V.4.1.3 was used to perform all of the analyses. A p value <0.05 with two-tailed was considered statistically significant.

RESULTS

Descriptive analysis

A total of 810 OC patients hospitalised between 2015 and 2020 were included in this study. The median hospitalisation expenses for OC patients demonstrated a linear increase over the study period, reaching $8470 in 2020 (online supplemental table 1). Most patients had a normal BMI (61.4%) and a junior or senior high school education (74.6%) and resided in rural areas (66.2%). Over half of the patients had no history of smoking (67.0%) or alcohol consumption (74.9%). Additionally, 59.8% of the patients reported moderate oral hygiene, and the majority had no history of tumours (97.7%) or viral infections (88.1%).

The left-skewed distribution of hospitalisation expenses and LOS for OC patients is depicted in online supplemental figure 1. The median (IQR) hospitalisation expenses and LOS for OC patients were $6.33 (3.30, 10.69) thousand and 29 (20, 39) days, respectively. As results shown in table 1, significant differences in hospitalisation expenses were observed across groups according to oral hygiene, pathological type, TNM stage, tumour size, grade, lymph node metastasis at diagnosis, surgery, radiotherapy treatment and neck dissection (all p values <0.05). Notably, significant differences in the distribution of LOS were observed across groups based on hospitalisation year, TNM stage, tumour size, lymph node metastasis at diagnosis, surgery treatment, chemotherapy treatment and neck dissection (all p values <0.05).

Furthermore, the composition of total hospitalisation expenses of 6 years for OC patients was analysed and is presented in figure 1A. The results showed that the highest hospitalisation expenses were associated with treatment and surgery fees, which accounted for 28.59% of the total hospitalisation expenses. Inspection and laboratory test fees (20.63%) were the second highest, followed by comprehensive medical service fee (19.27%) in terms of overall total hospitalisation expenses. The remaining overall total hospitalisation expenses were occupied by drug fee (18.09%), medical consumables fee (11.69%), blood products fee (1.64%), rehabilitation fee (0.07%) and alternative treatment fee (0.02%). Figure 1B displays the distribution pattern of hospitalisation expenses during the period of 2015–2022. In general, treatment and surgery fees accounted for the highest proportion of hospitalisation expenses during this period. Furthermore, the drug fee exhibited a significant decrease, while the proportion of medical consumables fee showed a substantial increase throughout the study period.

Identified factors influencing length of stay and hospitalisation expenses

The results of univariate and multivariate linear regression analyses for LOS and total hospitalisation expenses are displayed in table 2. The results of the univariate linear analysis revealed a significant association between a longer LOS and higher hospitalisation expenses (β=0.04, 95% CI: 0.03 to 0.05, p<0.001). The multivariate linear analysis demonstrated that LOS remained significantly associated with hospitalisation expenses (β=0.02, 95% CI: 0.01 to 0.03, p<0.001), emphasising its independent effect on hospitalisation expenses. Moreover, patients with poor oral hygiene had higher hospitalisation expenses compared with those with good oral hygiene, with an average difference of $1.39 thousand. Patients with other types of OC tended to have significantly less hospitalisation expenses by $1.54 thousand at the mean, than did those with oral squamous cell carcinoma. Additionally, patients with tumour stage IV, tumour size >2 cm^3, surgery and bilateral neck dissection tended to have significantly higher hospitalisation expenses than their counterparts, with average differences of $2.82, $0.71, $2.91 and $4.21 thousand, respectively.

Moreover, the results of the univariate linear analysis revealed that significant differences of LOS were observed across various groups by age, tumour site, TNM

Table 1 Hospitalisation expenses and length of stay of oral cancer patients across groups by different factors

Influencing factors	N (%)	Hospitalisation expenses, in thousand dollars P_{50} (P_{25}, P_{75})	P value	Length of stay P_{50} (P_{25}, P_{75})	P value
All	810 (100%)	6.33 (3.30, 10.69)		29 (20, 39)	
Demographics					
Hospitalisation year			0.475		<0.001
2015	63 (7.8%)	6.60 (4.03, 10.78)		29 (23, 40)	
2016	221 (27.3%)	6.13 (3.18, 11.05)		31 (24, 45)	
2017	219 (27.0%)	6.53 (3.63, 10.70)		28 (17, 36)	
2018	215 (26.5%)	6.39 (3.02, 9.91)		32 (25, 48)	
2019	64 (7.9%)	7.68 (5.21, 12.33)		32 (27, 44)	
2020	28 (3.5%)	8.47 (3.86, 11.71)		34 (16, 40)	
Sex			0.375		0.854
Male	525 (64.8%)	6.44 (3.13, 10.95)		29 (20, 40)	
Female	285 (35.2%)	6.10 (3.85, 10.01)		29 (19, 38)	
Age (year)			0.137		0.060
≤60	394 (48.6%)	6.40 (3.68, 11.46)		31 (21, 42)	
>60	416 (51.4%)	6.32 (3.07, 10.15)		28 (18, 37)	
BMI			0.107		0.407
<18.5	103 (12.7%)	5.29 (1.85, 11.85)		30 (20, 46)	
18.5~24	497 (61.4%)	6.70 (3.96, 11.03)		29 (19, 39)	
>24	210 (25.9%)	5.83 (2.98, 9.62)		29 (20, 37)	
Education level			0.177		0.432
Primary school and below	119 (14.7%)	5.77 (3.62, 9.03)		30 (21, 36)	
Junior-senior high school	604 (74.6%)	6.39 (3.13, 10.80)		29 (18, 39)	
Junior college or above	87 (10.7%)	7.11 (4.11, 11.06)		31 (22, 40)	
Residence			0.097		0.066
Urban area	274 (33.8%)	6.78 (3.65, 11.04)		30 (23, 39)	
Rural area	536 (66.2%)	5.96 (3.20, 10.23)		28 (18, 38)	
Exposure history					
Smoking status			0.319		0.343
No	543 (67.0%)	6.08 (3.51, 10.53)		29 (21, 54)	
Yes	267 (33.0%)	6.77 (3.01, 11.27)		28 (18, 62)	
Alcohol drinking			0.154		0.586
No	607 (74.9%)	6.08 (3.47, 10.54)		29 (30, 39)	
Yes	203 (25.1%)	6.81 (3.01, 11.27)		29 (18, 38)	
Oral hygiene			0.001		0.052
Well	54 (6.7%)	2.03 (0.76, 4.42)		19 (15, 36)	
Moderate	484 (59.8%)	3.40 (1.63, 5.95)		29 (21, 38)	
Poor	272 (33.6%)	3.82 (2.04, 7.99)			
History of virus infection			0.229		0.438
No	714 (88.1%)	6.36 (3.56, 10.64)		29 (19, 38)	
Yes	96 (11.9%)	5.98 (3.04, 10.99)		30 (23, 40)	
Comorbidities			0.166		0.981
No	250 (30.9%)	5.92 (2.89, 10.87)		29 (19, 39)	
Yes	560 (69.1%)	6.47 (3.72, 10.61)		29 (10, 38)	
Tumour characteristics					
Tumour site			0.123		0.191
Tongue	276 (34.1%)	4.33 (2.05, 6.37)		29 (20, 39)	

Continued

Table 1 Continued

Influencing factors	N (%)	Hospitalisation expenses, in thousand dollars P_{50} (P_{25}, P_{75})	P value	Length of stay P_{50} (P_{25}, P_{75})	P value
Oral floor and oropharynx	108 (13.3%)	3.33 (1.45, 8.12)		31 (20, 48)	
Others	426 (52.6%)	2.89 (1.54, 6.00)		29 (19, 36)	
Pathological type			<0.001		0.212
Squamous cell carcinoma	640 (79.0%)	7.24 (4.23, 11.48)		30 (20, 39)	
Others	170 (21.0%)	3.74 (2.47, 5.97)		28 (18, 38)	
TNM stage			<0.001		<0.001
I	242 (29.9%)	3.78 (2.12, 6.04)		26 (14, 34)	
II–III	278 (34.3%)	6.06 (4.21, 10.14)		28 (20, 35)	
IV	290 (35.8%)	9.70 (16.33, 13.74)		32 (24, 44)	
Tumour size			<0.001		0.001
≤2 cm^3	394 (48.6%)	5.48 (2.93, 8.80)		27 (18, 35)	
>2 cm^3	416 (51.4%)	7.49 (3.96, 12.22)		31 (21, 42)	
Grade			<0.001		0.504
G3	442 (54.5%)	4.94 (2.51, 9.79)		29 (18, 40)	
G2	190 (23.5%)	7.63 (4.72, 12.25)		31 (20, 38)	
G1	178 (22.0%)	7.41 (4.88, 11.27)		29 (21, 38)	
Lymph node metastasis at diagnosis			<0.001		0.002
No	578 (71.4%)	5.66 (2.99, 9.72)		28 (19, 36)	
Yes	232 (28.6%)	8.03 (4.69, 1.281)		31 (22, 43)	
Treatment modality					
Surgery			<0.001		<0.001
No	132 (16.3%)	2.14 (1.29, 3.27)		23 (13, 30)	
Yes	678 (83.7%)	7.09 (4.39, 11.38)		30 (21, 40)	
Chemotherapy			0.600		<0.001
No	706 (87.2%)	6.29 (3.27, 10.49)		28 (19, 37)	
Yes	104 (12.8%)	6.71 (3.43, 11.68)		34 (26, 58)	
Radiotherapy			<0.001		0.068
No	627 (77.4%)	5.74 (2.99, 10.00)		29 (18, 38)	
Yes	183 (22.6%)	8.16 (4.81, 12.47)		31 (23, 43)	
Neck dissection			<0.001		<0.001
No	369 (45.6%)	3.77 (2.13, 6.18)		27 (16, 35)	
Unilateral	368 (45.4%)	8.49 (5.64, 11.35)		30 (22, 39)	
Bilateral	73 (9.0%)	13.33 (8.83, 16.22)		34 (28, 50)	

Data are presented as number (percentage) or median (IQR).

stage, tumour size, lymph node metastasis at diagnosis, surgery, chemotherapy, radiotherapy and neck dissection ($p<0.05$). Moreover, by incorporating pairs of the aforementioned variables into a multivariate linear model, chemotherapy emerged as a major influencing factor of LOS, with patients who received chemotherapy experiencing an average increase of 17.57 days in LOS compared with those who did not receive chemotherapy. Additionally, an increase in LOS was significantly increased in patients with oral floor and oropharynx cancers (β=6.67, 95% CI: 0.07 to 13.26, p=0.047) and with surgery (β=9.52, 95% CI: 3.49 to 15.55, p=0.002).

In this study, we in further examined the relationship between the eight distinct categories of patient hospitalisation expenses and patient characteristics, as demonstrated in online supplemental table 3. Our analysis indicated that seven categories of hospitalisation costs exhibited a statistically significant association with varied patient characteristics (FDR $p<0.05$). As expected, surgery was positively correlated with comprehensive medical services fee, treatment and surgery fees, drug fee and medical consumables fee, with coefficients of 0.123, 0.474, 0.424 and 0.312, respectively. Notably, patients with higher levels of education exhibited lower rehabilitation

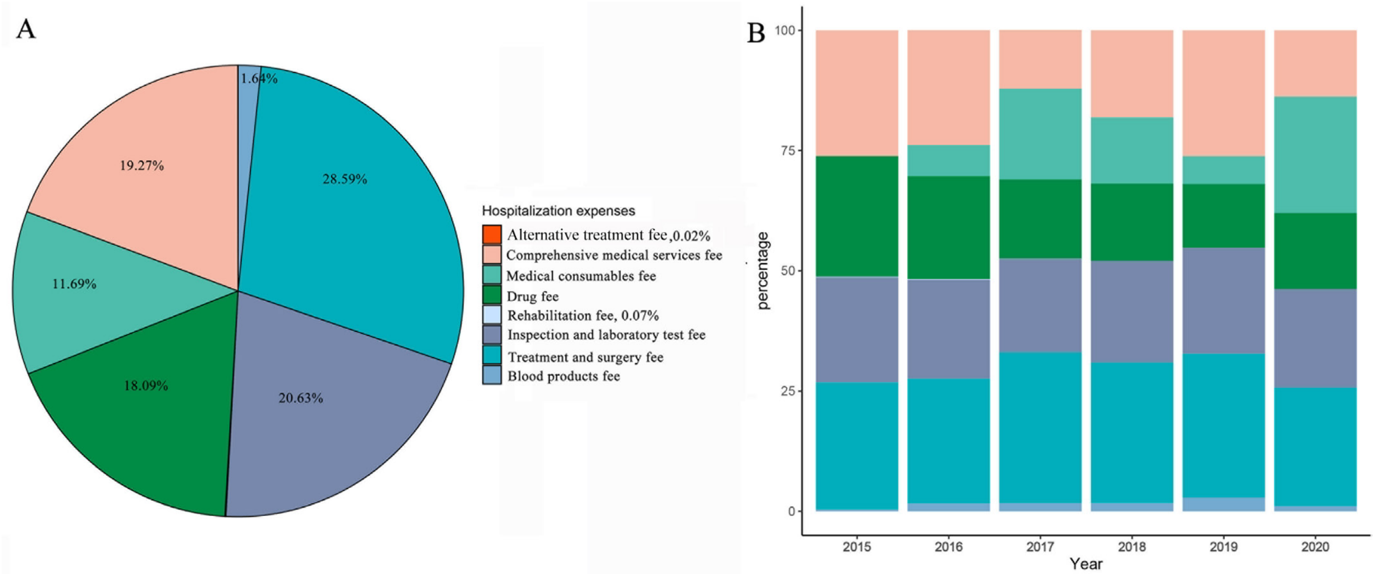

Figure 1 Distribution of total hospitalisation expenses and annual changes in cost composition. (A) Distribution of total hospitalisation expenses. (B) Annual trends in cost composition.

fee. Moreover, positive correlations were also observed between neck dissection and rehabilitation fee, drug fee, and blood products fee, with coefficients of 0.011, 0.116 and 0.086. Of particular significance, the LOS, which was positively associated with the overall total hospitalisation expenses, was negatively correlated with medical consumables fee. A summary of the significant associations is provided in the form of a heatmap in figure 2A. The Sankey diagram visualised the significant associations between each category of hospitalisation expenses and its correspondent influence factors (figure 2B). The diagram showed that three factors exhibit significant impact on medical consumables fee and blood products fee, and two factors exhibit significant impact on rehabilitation fee and drug fee, whereas only one patient characteristic exhibits a significant impact on comprehensive medical services fee and treatment and surgery fees.

Path analysis of hospitalisation expenses

Path analysis was conducted to investigate the potential pathways of the identified factors exerting effects on hospitalisation expenses. The path model was visualised in figure 3, with the standardised regression coefficient β labelled in the pathway chart. The total effects, direct effects and indirect effects of these identified factors on hospitalisation expenses in path analysis were calculated and are presented in online supplemental table 4. The factors which ranked in the order of total effect on hospitalisation expenses were listed as follows: neck dissection, TNM stage, surgery, LOS, pathological type, oral hygiene, tumour size, chemotherapy, BMI and tumour site, with standardised coefficients β of 0.307, 0.260, 0.243, 0.153, –0.145, 0.093, 0.074, 0.034, –0.020 and 0.004, respectively. Path analysis revealed that surgery exerted indirect effect on hospitalisation cost through LOS (β=0.021). Chemotherapy and tumour site only had indirect effects on hospitalisation expenses for OC patients, with chemotherapy having the highest indirect effect (β=0.034) on hospitalisation expenses by affecting LOS.

We conducted sensitivity analyses to evaluate the robustness of our findings (online supplemental tables 5 and 6). These analyses included (1) reanalysing the data without excluding patients younger than 18 or older than 80 years and (2) restricting the analysis to data from 2016 to 2018. In both cases, the conclusions remained consistent with the primary results, indicating the robustness of our findings.

DISCUSSION

Hospitalisation expenses and LOS are critical components of the economic burden faced by OC patients. In this study, we analysed data from 810 OC patients hospitalised between 2015 and 2020 in southeastern China. Our findings demonstrate that the median hospitalisation expenses amounted to \$6330, with a median LOS of 29 days. Over the study period, hospitalisation expenses exhibited a linear annual increase, peaking at \$8470 in 2020. Treatment and surgery fees were the largest contributors, accounting for 28.59% of total expenses. These results highlight the growing financial burden associated with OC management, underscoring the urgent need for cost-effective interventions.

Comparable hospitalisation expenses for OC have been reported globally, reflecting significant economic burdens across diverse healthcare systems. For instance, Brazil faces substantial out-of-pocket expenses for OC patients, while in the USA, treatment costs for OC can exceed 215% of the gross domestic product (GDP) per capita.[18] In Italy, the median total expense for OC treatment over a 2-year period was €20 184,[13] whereas in England,

Table 2 Influencing factors of length of stay and hospitalisation expenses for oral cancer patients

Influencing factors	Length of stay (LOS)		Hospitalisation expenses	
	Univariable linear regression *β* (95% CI)	Multivariable linear regression *β* (95% CI)	Univariable linear regression *β* (95% CI)	Multivariable linear regression *β* (95% CI)
LOS			0.04 (0.03, 0.05)	0.02 (0.01, 0.03)
Demographics				
Hospitalisation year				
2015	Reference		Reference	
2016	4.92 (−3.37, 13.22)		0.04 (−1.33, 1.42)	
2017	−3.49 (−11.79, 4.82)		−0.18 (−1.56, 1.19)	
2018	−7.94 (−16.26, 0.38)		−0.59 (−1.97, 0.78)	
2019	4.22 (−6.09, 14.52)		0.95 (−0.74, 2.66)	
2020	−3.53 (−16.72, 9.66)		0.33 (−1.84, 2.52)	
Sex				
Male	Reference		Reference	
Female	−2.50 (−6.83, 1.81)		0.09 (−0.61, 0.81)	
Age (year)				
≤60	Reference	Reference	Reference	
>60	−5.51 (−9.63, to 1.39)	−3.68 (−7.75, 0.39)	−0.55 (−1.23, 0.12)	
BMI				
<18.5	5.30 (−1.05, 11.60)		−0.47 (−1.51, 0.56)	−0.23 (−1.04, 0.58)
18.5~24	Reference		Reference	Reference
>24	−1.8 (−6.73, 2.93)		−1.04 (−1.83, 0.25)	−0.65 (−1.27, 0.02)
Education level				
Primary school and below	Reference		Reference	
Junior-senior high school	0.69 (−5.21, 6.59)		0.62 (−0.34, 1.58)	
Junior college or above	0.32 (−7.98, 8.62)		1.26 (−0.08, 2.62)	
Residence				
Urban area	Reference		Reference	
Rural area	−2.30 (−6.67, 2.05)		−0.60 (−1.31, 0.11)	
Exposure history				
Smoking status				
No	Reference		Reference	
Yes	0.29 (−4.10, 4.69)		0.21 (−0.51, 0.93)	
Alcohol drinking				
No	Reference		Reference	
Yes	−0.78 (−5.55, 3.98)		0.32 (−0.45, 1.10)	
Oral hygiene				
Well	Reference		Reference	Reference
Moderate	1.43 (−7.00, 9.88)		1.31 (−0.05, 2.67)	0.60 (−0.47, 1.68)
Poor	−0.04 (−8.81, 8.72)		2.58 (1.16, 4.01)	1.39 (0.27, 2.51)
History of virus infection				
No	Reference		Reference	
Yes	0.81 (−5.58, 7.20)		−0.32 (−1.37, 0.72)	
Comorbidities				
No	Reference		Reference	
Yes	−0.74 (−5.22, 3.72)		0.30 (−0.42, 1.04)	
Tumour characteristics				
Tumour site				

Continued

Table 2 Continued

Influencing factors	Length of stay (LOS) Univariable linear regression β (95% CI)	Multivariable linear regression β (95% CI)	Hospitalisation expenses Univariable linear regression β (95% CI)	Multivariable linear regression β (95% CI)
Tongue	Reference	Reference	Reference	Reference
Oral floor and oropharynx	7.95 (1.29, 14.61)	6.67 (0.07, 13.26)	0.83 (–0.24, 1.92)	0.85 (–0.02, 1.72)
Others	0.59 (–3.93, 5.12)	2.38 (–2.14, 6.90)	–1.06 (–1.80, 0.33)	–0.09 (–0.70, 0.51)
Pathological type				
Squamous cell carcinoma	Reference		Reference	Reference
Others	2.04 (–3.02, 7.12)		–3.18 (–3.99, 2.39)	–1.54 (–2.29, 0.78)
TNM stage				
I	Reference	Reference	Reference	Reference
II–III	3.96 (–1.14, 9.08)	1.56 (–3.79, 6.92)	2.73 (1.96, 3.49)	1.02 (0.31, 1.73)
IV	10.69 (5.62, 15.76)	5.34 (–0.36, 11.05)	5.23 (4.47, 5.99)	2.82 (2.06, 3.58)
Tumour size				
≤2 cm^3	Reference	Reference	Reference	Reference
>2 cm^3	5.44 (1.33, 9.56)	2.23 (–2.08, 6.56)	1.85 (1.18, 2.51)	0.71 (0.13, 1.29)
Grade				
G3	Referenc		Reference	Reference
G2	–3.53 (–8.62, 1.57)		1.89 (1.07, 2.71)	0.11 (–0.59, 0.82)
G1	0.62 (–4.59, 5.83)		1.92 (1.08, 2.76)	0.07 (–0.64, 0.79)
Lymph node metastasis at diagnosis				
No	Reference	Reference	Reference	Reference
Yes	6.64 (2.09, 11.19)	1.77 (–3.04, 6.59)	1.98 (1.25, 2.72)	–0.34 (–0.98, 0.29)
Treatment modality				
Surgery				
No	Reference	Reference	Reference	Reference
Yes	9.24 (3.68, 14.80)	9.52 (3.49, 15.55)	5.12 (4.28, 5.97)	2.91 (2.11, 3.71)
Chemotherapy				
No	Reference	Reference	Reference	
Yes	18.43 (12.38, 24.48)	17.57 (11.43, 23.71)	0.59 (–0.42, 1.60)	
Radiotherapy				
No	Reference	Reference	Reference	Reference
Yes	7.06 (2.14, 11.98)	2.06 (–2.91, 7.03)	1.83 (1.03, 2.63)	0.41 (–0.23, 1.06)
Neck dissection				
No	Reference	Reference	Reference	Reference
Unilateral	3.83 (–0.48, 8.14)	0.02 (–4.68, 4.73)	3.79 (3.16, 4.41)	1.89 (1.25, 2.53)
Bilateral	10.26 (2.76, 17.76)	3.49 (–4.27, 11.27)	7.09 (6.01, 8.17)	4.21 (3.17, 5.24)

OC-related hospitalisations cost the government approximately €255.5 million over 5 years, despite the universal healthcare system.[5] In the Netherlands, the average cost per newly diagnosed OC patient was €31 829.[19] Similarly, medical care expenses for oropharyngeal cancer in Texas averaged $140 000 within the first 2 years post diagnosis among commercially insured patients.[20] Comparatively, our study's median hospitalisation expense of $6340 was higher than that reported for melanoma ($1120)[21] and breast cancer ($4370)[22] in eastern and southern China but lower than costs for gastric cancer ($6850).[23] Median OC hospitalisation costs in other Chinese regions, such as Taiwan ($17 525)[24 25] and Hunan Province ($9870),[12] were significantly higher, likely due to differences in patient populations and treatment modalities.

The economic ramifications of OC underscore the urgent need for efficacious preventive and therapeutic measures. Further research is necessary to elucidate the contributing factors underlying the escalation in hospitalisation expenses and to identify potential interventions aimed at mitigating the financial repercussions on patients and their families. In the current study, several

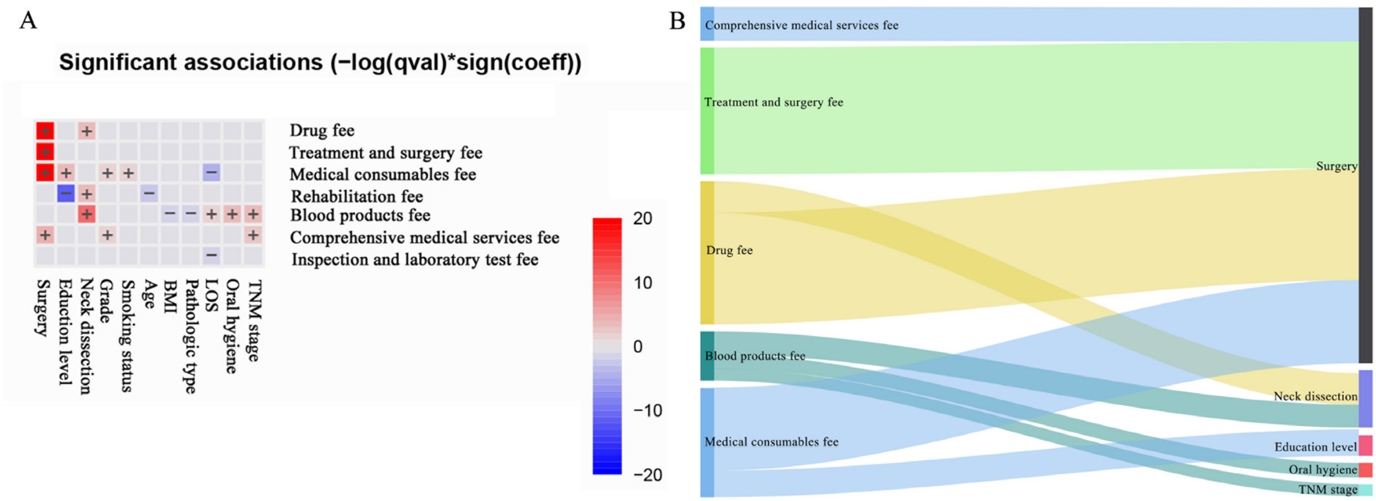

Figure 2 Associations between hospitalisation expenses and patient characteristics. (**A**) Associations of each category of hospitalisation expenses and patient characteristics. (**B**) The Sankey diagram of each category of hospitalisation expenses with their corresponding influencing factors.

independent factors were identified as significant drivers of hospitalisation expenses and LOS, including LOS itself, BMI, oral hygiene, pathological type, TNM stage, tumour size, surgery and neck dissection. Longer LOS correlated with increased hospitalisation expenses, reflecting the indirect costs of extended inpatient care.[11 26] Notably, data demonstrated that oral squamous cell carcinoma presented with ascending hospitalisation expenses more than other pathological types. To facilitate interpretation of the differences across groups, baseline characteristics according to pathological type are shown in online supplemental table 7. Elderly patients were more commonly observed in patients with oral squamous cell carcinoma, and previous studies have illustrated that older patients were associated with higher hospitalisation expenses.[27] Moreover, patients with oral squamous cell carcinoma were more likely to present with advanced stages and grades, which can greatly influence the hospitalisation expenses of patients.[6 28] Patients with larger tumours were more likely to incur higher hospitalisation expenses. This finding aligns with a study conducted in Spain, which demonstrated that the economic burden of OC was closely associated with tumour extent.[29] This is likely due to the increased surgical complexity and resource demands required to treat larger lesions. The significant association between tumour size and hospitalisation expenses underscores the importance of early detection and timely intervention. Expediting diagnosis and treatment for patients with smaller tumours may not only improve clinical outcomes but also reduce the complexity and associated costs of surgery. Targeted public health campaigns promoting early OC screenings could help in identifying patients at earlier, more treatable stages, leading to reduced treatment costs.[30]

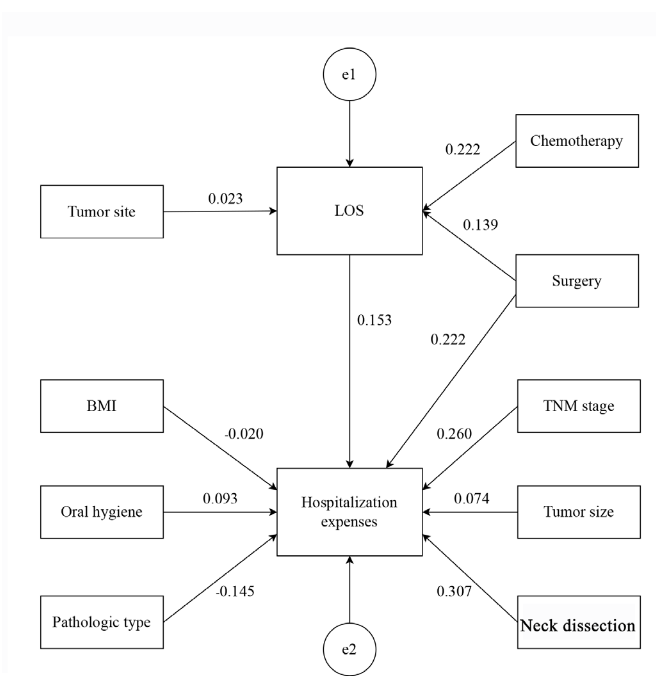

Figure 3 Potential pathways of the identified factors exerting effects on hospitalisation expenses.

Furthermore, neck dissection had the most substantial overall effect on hospitalisation expenses. Neck dissection of patients with OC was associated with higher costs in hospitalisation, a finding that has been illustrated previously.[12] In essence, the implementation of neck dissection has been pursued as a means to reduce the occurrence of local-regional recurrences, thereby improving the prognosis for patients with cancer. While this additional surgical procedure initially entails increased treatment expenses, its long-term benefits have demonstrated improved health outcomes, making it a cost-effective strategy for OC patients.[12 31] Path analysis revealed that surgery was the driver of hospitalisation expenses and could indirectly influence hospitalisation expenses through LOS. Currently, surgery is the dominant treatment for OC,[8 32] and the complex ablative and reconstructive procedures required impose a substantial financial burden on patients and their families.[26] As a result, these complicated surgical procedures are generally associated with a longer LOS,[33] which in turn impacts patient prognosis and leads to a loss of charge. Developing and implementing more standardised, less invasive surgical techniques could potentially reduce hospital stays and lower overall treatment costs. This might include refined surgical planning based on tumour characteristics, minimising unnecessary procedures and improving postoperative care to shorten recovery time. Our study also demonstrated a positive and significant correlation between chemotherapy and LOS (table 2), highlighting that patients receiving chemotherapy may undergo a relatively longer hospital stay and subsequently experience increased hospitalisation expenses. While chemotherapy plays an essential role in treatment, its indirect effect on hospitalisation expenses, particularly through influencing LOS, suggests that optimising chemotherapy regimens and improving patient management during treatment may help reduce costs. Tailoring chemotherapy to individual patient needs, based on tumour characteristics and response, could lead to more efficient use of resources.

Many studies have reported on the hospitalisation cost and influence factors incurred by patients with OC, but few have provided detailed description about the composition of hospitalisation expenses for these patients. This information is crucial for understanding the financial burden that OC places on patients and their families, as well as for developing strategies to reduce healthcare costs and improve patient outcomes. In light of this gap in the literature, it is essential that future studies focus on elucidating the composition of hospitalisation expenses for OC patients. Regarding the composition of hospitalisation costs for patients with OC, treatment and surgery fees were found to be the most significant contributor to the overall cost. This was supported by a study conducted in Sri Lanka, which showed that 41% of the total costs were directly related to treatment and surgery fees.[34] Similar evidence was found in Malaysian public hospitals, where treatment and surgery fees accounted for a staggering proportion of the total hospitalisation costs.[26] The decreasing proportion of drug fee during 2015–2020 may be attributed to the implementation of ‘Sanming health care reform’ in China, which has had a long-term effect in reducing total drug fee, and drug expenditures in hospitals of China.[35]

The findings from this study offer valuable insights with practical implications for healthcare policy, clinical practice and cost management in the treatment of OC. By identifying key factors influencing hospitalisation expenses, such as tumour size, surgical procedures and the presence of comorbidities (eg, poor oral hygiene and elevated BMI), healthcare providers and policymakers can focus on cost-effective interventions aimed at reducing these drivers of financial burden.

Hospitalisation expenses for OC have received limited attention in existing research. A notable strength of this study lies in its detailed characterisation of the hospitalisation expense profile for OC patients, leveraging a relatively large sample size from southeastern China. Our findings highlight the substantial financial burden and prolonged LOS associated with OC treatment in this region. Importantly, several factors, some of which are modifiable, were identified as being significantly associated with both hospitalisation expenses and LOS, presenting potential targets for cost-reduction interventions. In addition to conventional regression analyses, we employed path analysis to explore the intricate pathways through which clinical characteristics, LOS, and hospitalisation expenses are interrelated. This approach offers novel insights into the mechanisms driving these associations and provides a more comprehensive understanding of the factors influencing hospitalisation expenses in OC care.

This study has the following limitations: (1) Our study relies on single-centre data, which can be susceptible to selection bias, which limit the generalisability of the study results. So further multi-centric study is warranted to corroborate the present findings. (2) The relatively small number of OC patients from years outside 2016–2018 is due to incomplete data regarding demographic characteristics, exposure history, tumour characteristics and treatment modalities. Data before 2016 were missing because certain study variables, apart from hospitalisation costs, were not systematically collected. The missing data from 2018 onwards can be attributed to the impact of the COVID-19 pandemic, which affected patient admissions and data collection due to lockdowns and mobility restrictions.[36,37] This exclusion may introduce selection bias. To mitigate these concerns, a sensitivity analysis including only patients from 2016 to 2018 was performed. The results were consistent with the primary analysis, suggesting that the exclusion of data from other years did not substantially affect the study's conclusions. (3) Our study did not account for the potential impact of the COVID-19 pandemic on OC management. The pandemic likely led to delays in diagnosis and treatment due to lockdowns, mobility restrictions and patients' fear of contracting COVID-19. These factors may have resulted in a lower number of hospital admissions, increased disease severity and worse outcomes for OC patients during the pandemic.[33,34] Future studies focusing on the effects of COVID-19 on OC care and outcomes are warranted to better understand and address these challenges.

CONCLUSION

In conclusion, our study observed that half of the hospitalisation expense is attributed to treatment and laboratory fees in OC patients. Patient characteristics including LOS, BMI >24, poor oral hygiene, pathological type, TNM stage, tumour size, surgery and neck dissection exert impact hospitalisation expenses for OC patients. Notably, neck dissection was the most important driver of hospitalisation expenses in path analysis. Moreover, the analysis revealed that both surgery and chemotherapy exerted indirect effects on hospitalisation expenses by influencing the LOS. These results underscore the significant economic burden that OC places on both patients and healthcare systems. While comprehensive efforts to reduce this burden must prioritise prevention and early diagnosis, our study highlights several modifiable factors, such as improving oral hygiene and optimising surgical protocols (eg, chemotherapy and lymph node dissection), that may offer opportunities to reduce costs and improve cost-effectiveness.

Author affiliations
[1]Department of Epidemiology and Health Statistics, Fujian Provincial Key Laboratory of Environment Factors and Cancer, School of Public Health, Fujian Medical University, Fuzhou, Fujian, China
[2]Department of Occupational and Environmental Health Sciences, Peking University, Beijing, China
[3]Key Laboratory of Ministry of Education for Gastrointestinal Cancer, Fujian Key Laboratory of Tumor Microbiology, Fujian Medical University, Fuzhou, Fujian, China
[4]Department of Oral and Maxillofacial Surgery, The First Affiliated Hospital of Fujian Medical University, Fuzhou, Fujian, China
[5]Laboratory Center, The Major Subject of Environment and Health of Fujian Key Universities, School of Public Health, Fujian Medical University, Fuzhou, Fujian, China

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Patient consent for publication Not applicable.

Ethics approval This research involving human subjects complies with all the relevant national regulations and institutional policies, was performed in accordance with the tenets of the Helsinki Declaration, and has been approved by the Institutional Review Board of Fujian Medical University (Approval number: 2011053; Approval date: 10 March 2011). Participants gave informed consent to participate in the study before taking part.

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ORCID iDs
Yi Fan http://orcid.org/0000-0003-2981-5337
Fengqiong Liu http://orcid.org/0000-0001-7786-7305

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