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# Supportive care demands in digestive and respiratory malignancies: a hospital-based comparative study

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## CITATION

Wang L, Zi Y, Tong H, et. al. Supportive care demands in digestive and respiratory malignancies: a hospital-based comparative study. *Psycho-Oncologie*. 2026; 20(5): 5730.  
<https://doi.org/10.18282/po5730>

## ARTICLE INFO

Received: 4 February 2026

Revised: 18 May 2026

Accepted: 26 May 2026

Available online: 19 June 2026

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**Abstract:** Inpatient supportive care in oncology is complex and heterogeneous, reflecting variations in symptom burden, functional status, and treatment intensity. This study aimed to quantify and compare nursing workload in patients with digestive-related and respiratory-related malignancies using a retrospective dataset of hospital admissions between 2022 and 2025. Key measures included daily nursing care intensity, total nursing fees, and total hospitalisation cost. Descriptive statistics, non-parametric Mann–Whitney U tests, and Pearson correlation analyses were employed to examine group differences and associations between cumulative and daily nursing workload. Scatter plots with regression lines and R<sup>2</sup> annotations visualized relationships between nursing fees and daily care intensity. The results demonstrated substantial variability in all metrics, but median daily nursing care intensity and total nursing fees were largely comparable between tumor groups. Positive correlations were observed between cumulative nursing expenditure and daily nursing intensity, indicating that total nursing fee is a practical indicator of workload. These findings highlight that tumor type alone does not determine nursing resource requirements and underscore the importance of individualized, patient-centered staffing strategies. The generalizability of these findings is limited by the single-center retrospective design and the small sample size of the respiratory malignancy group. Leveraging administrative and nursing data for evidence-based workforce planning may optimize resource allocation, enhance patient care quality, and improve staff sustainability in oncology inpatient settings.

**Keywords:** cancer; daily nursing care; digestive malignancy; hospitalization cost, respiratory malignancy; supportive care

## 1. Introduction

Cancer represents a significant global health burden, accounting for millions of deaths annually and placing substantial strain on healthcare systems worldwide. Among the most prevalent and clinically challenging malignancies are digestive-related tumors, including those of the esophagus, stomach, pancreas, liver, and colorectal regions, as well as respiratory-related tumors, primarily lung cancer. These malignancies differ in pathophysiology, treatment paradigms, and symptom profiles, which can lead to heterogeneous demands on inpatient supportive care [1,2]. From a supportive care perspective, hospitalization represents a critical period during which symptom burden, functional decline, and psychological distress often intensify. Cancer inpatients frequently experience fluctuations in clinical stability that require continuous assessment and rapid nursing response. Unlike outpatient

settings, inpatient care demands are characterized by sustained bedside presence, frequent reassessment, and coordination across multidisciplinary teams. As such, the inpatient environment magnifies the importance of nursing care as both a clinical and organizational resource, particularly for patients with advanced disease or treatment-related complications [3].

Digestive-related tumors frequently present with anorexia, nausea, vomiting, diarrhea, and malnutrition, requiring intensive monitoring, individualized dietary management, and frequent nursing interventions [4]. Respiratory-related malignancies are often complicated by dyspnea, hypoxemia, chronic cough, and susceptibility to infection, necessitating specialized respiratory support, vigilant monitoring, and symptom management [5,6]. The complex interplay between disease-specific clinical features and patient-level variability underscores the importance of understanding inpatient care demands beyond conventional tumor classification [2]. Importantly, patient-level variability often exceeds tumor-level differences in determining care needs. Factors such as age, comorbidities, functional status, treatment phase, and psychosocial support availability can substantially modify nursing workload, even among patients with the same diagnosis. Two patients admitted with identical tumor types may require markedly different levels of nursing attention depending on symptom severity, treatment toxicity, or cognitive and emotional needs. This heterogeneity challenges simplistic assumptions that tumor system alone can serve as a reliable proxy for inpatient care intensity [7].

Hospitalization for cancer patients is associated with both high financial costs and intensive nursing requirements. Traditional metrics such as length of stay or total hospital expenditure are often used as proxies for inpatient resource utilization; however, these measures may not accurately reflect the daily intensity of nursing care, which can fluctuate substantially within and across different cancer types [8]. Length of stay and aggregate cost metrics primarily capture cumulative resource consumption but offer limited insight into how care demands are distributed over time. Two admissions with identical lengths of stay may differ substantially in daily nursing intensity, with one characterized by prolonged low-intensity monitoring and the other by sustained high-intensity care [9].

Consequently, reliance on aggregate indicators may obscure periods of peak workload and underestimate the operational demands placed on nursing staff. Understanding daily care intensity is therefore essential for aligning staffing levels with real-time patient needs. Staffing models and resource allocation strategies based solely on diagnosis or admission duration may inadequately capture the true workload of nursing personnel, potentially impacting both quality of care and staff wellbeing [10]. Inadequate recognition of nursing workload variability has important implications for both patient safety and workforce sustainability. Underestimation of care intensity may lead to insufficient staffing, increased risk of missed care, and heightened occupational stress among nurses. Conversely, overgeneralization of workload assumptions may result in inefficient resource allocation and reduced operational flexibility [11]. A nuanced understanding of inpatient nursing demands is therefore critical for balancing care quality, staff wellbeing, and institutional efficiency. Previous studies have highlighted the importance of considering symptom clusters, functional status, and treatment complexity when assessing nursing workload, yet few investigations have quantitatively compared these demands across distinct tumor systems using real-world patient data [12].

Nursing care in oncology encompasses clinical interventions, psychosocial

support, patient education, coordination of complex treatment regimens, and management of adverse events; this variety is essential to address the diverse needs of patients with cancer [13]. In patients with digestive-related tumors, frequent interventions for fluid and electrolyte management, nutritional support, and postoperative monitoring are common. In contrast, patients with respiratory-related tumors typically require continuous oxygen monitoring and airway management to swiftly address respiratory complications [14]. While these differences imply that the intensity of nursing care may vary systematically across different tumor types, empirical evidence for quantifying and comparing these variations is limited [15].

Most prior research on nursing workload assessment has relied on aggregate measures or retrospective administrative data, which often lack the granularity needed for accurate insights [13]. Few studies effectively integrate both financial and operational indicators, such as total nursing fees and daily nursing intensity, as well as overall hospitalization costs to present a more comprehensive view of inpatient care demands [13]. Financial indicators derived from nursing services offer a pragmatic means of quantifying workload in real-world hospital settings. When interpreted appropriately, nursing fees may reflect the cumulative intensity of care delivered, capturing both direct clinical activities and associated supportive tasks [16]. Examining the relationship between cumulative nursing expenditure and average daily care intensity can therefore provide valuable insight into how workload accumulates over time and whether total nursing costs meaningfully represent sustained care demands rather than isolated high-intensity events. Investigating correlations among these metrics can help clarify how cumulative workload relates to daily care intensity, which is vital for informing predictive staffing models and resource allocation [17].

Understanding the variability and determinants of nursing care demands has implications for both patient outcomes and operational management. Patients requiring high-intensity nursing care may benefit from enhanced monitoring, early symptom management, and structured psychosocial support, which can improve clinical outcomes and patient satisfaction [18]. Furthermore, evidence-based workforce planning that accounts for heterogeneity within tumor groups can optimize nurse-to-patient ratios, allocate specialized supportive services appropriately, and improve efficiency in high-volume oncology units [19].

Clarifying how nursing workload varies across tumor systems has direct relevance for inpatient oncology management. Hospitals increasingly face pressure to optimize staffing efficiency while maintaining high standards of patient-centered care. Evidence-based insights into workload patterns can support the development of flexible staffing models, targeted deployment of specialized nursing skills, and data-informed planning of supportive care services. Such approaches are particularly important in high-volume oncology units, where mismatches between patient needs and nursing capacity can have far-reaching consequences [20].

To address these gaps, this study leverages a retrospective dataset of inpatient admissions between 2022 and 2025 to evaluate daily nursing care intensity, total nursing fees, and total hospitalization costs in patients with digestive-related and respiratory-related tumors. By integrating descriptive statistics, non-parametric comparative testing, correlation analyses, and visualizations of workload distributions, the study aims to provide a detailed, evidence-based characterization of supportive care demands. The findings are intended to inform hospital staffing and resource allocation strategies, emphasizing patient-centered care and operational efficiency in inpatient oncology settings. This investigation aims to elucidate patterns of nursing

workload across two clinically distinct tumor systems, offering insights that can guide individualized resource allocation and optimize supportive oncology care delivery.

## **2. Methods**

### **2.1. Study design and setting**

This study employed a retrospective observational design to investigate inpatient nursing care demands among patients with digestive-related and respiratory-related malignancies. The study was conducted at the General Medicine Department, Gastroenterology, 903rd Hospital of the Joint Logistics Support Force of the Chinese People's Liberation Army, a tertiary care center with comprehensive oncology services. Structured nursing documentation and administrative cost accounting systems allowed for the collection of detailed patient-level data. The study period included all eligible inpatient admissions between January 2022 and December 2025, providing a representative sample of hospital activity over this three-year interval.

### **2.2. Study population and eligibility criteria**

The study population comprised adult inpatients admitted with either digestive-related tumors or respiratory-related tumors, classified according to the primary diagnosis recorded in the hospital electronic health records. Patients with incomplete nursing or cost data were excluded from inferential analyses but were retained in descriptive analyses where appropriate. Non-tumor admissions were included for descriptive comparison but were not incorporated into primary group analyses. The final dataset consisted of 346 digestive-related tumor admissions and 57 respiratory-related tumor admissions, with 577 non-tumor admissions retained for contextual purposes.

### **2.3. Data collection and variables**

Data were extracted from hospital electronic health records and nursing administration systems, including total nursing fee, daily nursing care intensity, and total hospitalisation cost. Daily nursing care intensity was calculated by dividing the total nursing fee for each admission by the number of inpatient days, providing a standardized measure of average daily nursing workload. Total nursing fee represented the cumulative expenditure associated with nursing services per admission, while total hospitalisation cost encompassed the overall inpatient expenditure, including nursing, treatment, diagnostics, and consumables. Additional administrative data, such as length of stay, demographic variables, and discharge disposition, were collected to contextualize nursing workload but were not analyzed as primary outcomes. The rationale for selecting total nursing fees and daily nursing care intensity as proxies for nursing workload is twofold. First, these metrics are routinely and systematically collected in hospital administrative databases, making them readily available for real-world analyses without additional data collection burden. Second, nursing fees directly reflect the volume of billed nursing services, which, despite limitations, provide a standardized and quantifiable unit of nursing activity that can be compared across admissions and time periods.

### **2.4. Data quality and processing**

All datasets were screened for completeness and consistency. Missing values for nursing-related variables were minimal (< 2%), and complete-case analysis was applied for inferential comparisons. Data cleaning included verification of numeric ranges, cross-checking of admission and discharge dates, and standardization of cost

variables. Continuous variables were evaluated for distributional properties, with descriptive statistics presented as both mean  $\pm$  standard deviation and median to account for skewed distributions.

## 2.5. Statistical analysis

All analyses were conducted using SPSS version 25 (IBM Corp., Armonk, NY, USA). Descriptive statistics were computed for continuous variables, including daily nursing care intensity, total nursing fee, and total hospitalisation cost, using mean  $\pm$  standard deviation, median, minimum, and maximum. Skewness and kurtosis were examined to assess the normality of distributions. Comparisons of daily nursing care intensity between digestive-related and respiratory-related tumor groups were performed using Mann–Whitney U tests due to non-normal distributions, with effect sizes derived from the standardized test statistic. Pearson correlation coefficients were calculated to examine the associations between daily nursing care intensity, total nursing fee, and total hospitalisation cost within tumor groups, with statistical significance set at  $P < 0.05$  (two-tailed). Visualizations, including scatter plots with regression lines and  $R^2$  annotations, were employed to illustrate relationships between cumulative nursing fee and daily nursing care intensity. Jitter was applied to scatter points to reduce overlap, and logarithmic transformation was used on the x-axis to accommodate the right-skewed distribution of nursing fees. All variable derivations and data transformations were fully documented to ensure reproducibility.

## 2.6. Ethical Considerations

Ethical approval was obtained from the Institutional Review Board of the 903rd Hospital of the Joint Logistics Support Force of the Chinese People's Liberation Army (approval number: L9032022089). Given the retrospective nature of the study and use of de-identified data, the requirement for informed consent was waived in accordance with national regulations and institutional policies. All procedures complied with the principles outlined in the Declaration of Helsinki.

## 3. Results

### 3.1. Sample characteristics and descriptive statistics

A total of 980 inpatient admissions were included in the descriptive analysis, comprising 346 digestive-related tumor cases, 57 respiratory-related tumor cases, and 577 non-tumor admissions. Tumor-related cases formed the analytical focus of the study, while non-tumor admissions were retained for descriptive context only. Descriptive statistics for total hospitalisation cost, total nursing fee, and daily nursing care intensity are presented in **Table 1**. Across all variables, distributions were markedly right-skewed, with means substantially exceeding medians and large standard deviations, indicating considerable heterogeneity in resource utilisation and nursing workload among individual admissions.

For total hospitalisation cost, mean values were  $8,755.0 \pm 9,117.2$  RMB for digestive-related tumors and  $7,431.6 \pm 8,872.7$  RMB for respiratory-related tumors. Median costs were lower and comparable between groups, at 5,980.8 RMB for digestive-related tumors and 5,140.3 RMB for respiratory-related tumors. Similar patterns were observed in the non-tumor group, further illustrating the presence of extreme high-cost admissions across all categories. With respect to total nursing fees, digestive-related tumor admissions demonstrated a mean value of  $172.6 \pm 337.7$  RMB, while respiratory-related tumor admissions had a mean of  $142.4 \pm 263.5$  RMB. Despite these differences in mean values, median nursing fees were identical across

all groups (78.0 RMB), highlighting substantial within-group variability and the influence of outlier cases.

For the primary outcome, daily nursing care intensity, mean values were similar between digestive-related and respiratory-related tumor groups ( $29.10 \pm 9.51$  RMB/day and  $28.84 \pm 9.43$  RMB/day, respectively). Median daily nursing care intensity was 26.0 RMB/day in both groups, with comparable dispersion, indicating broadly similar distributions of daily nursing workload across tumor systems.

Overall, the descriptive findings demonstrate pronounced heterogeneity in both nursing care measures and hospitalisation costs, with largely overlapping central tendencies between digestive-related and respiratory-related tumor admissions. Given the non-normal distributions observed, subsequent inferential analyses were conducted using non-parametric methods, with emphasis placed on median values.

**Table 1.** Descriptive statistics of nursing care and hospitalisation variables by tumor group

| Variable                               | Tumor group                      | Mean $\pm$ SD        | Median |
|----------------------------------------|----------------------------------|----------------------|--------|
| Total nursing fee (RMB)                | Digestive related ( $n = 346$ )  | $172.6 \pm 337.7$    | 78.0   |
|                                        | Respiratory related ( $n = 57$ ) | $142.4 \pm 263.5$    | 78.0   |
|                                        | Non-tumor ( $n = 577$ )          | $159.9 \pm 668.7$    | 78.0   |
| Daily nursing care intensity (RMB/day) | Digestive related ( $n = 346$ )  | $29.10 \pm 9.51$     | 26.0   |
|                                        | Respiratory related ( $n = 57$ ) | $28.84 \pm 9.43$     | 26.0   |
|                                        | Non-tumor ( $n = 577$ )          | $29.56 \pm 11.78$    | 26.0   |
| Total hospitalisation cost (RMB)       | Digestive related ( $n = 346$ )  | $8755.0 \pm 9117.2$  | 5980.8 |
|                                        | Respiratory related ( $n = 57$ ) | $7431.6 \pm 8872.7$  | 5140.3 |
|                                        | Non-tumor ( $n = 577$ )          | $8396.9 \pm 12649.8$ | 5597.8 |

### 3.2. Comparison of daily nursing care intensity between tumor groups

Daily nursing care intensity was compared between digestive-related and respiratory-related tumor groups using non-parametric methods due to the non-normal distribution of the data. A total of 346 digestive-related tumor admissions and 57 respiratory-related tumor admissions with complete daily nursing care data were included in the analysis. Rank-based analysis demonstrated similar distributions of daily nursing care intensity between the two tumor groups. The mean rank for daily nursing care intensity was 201.15 in the digestive-related tumor group and 193.11 in the respiratory-related tumor group, indicating minimal difference in rank ordering between groups. The Mann–Whitney U test showed no statistically significant difference in daily nursing care intensity between digestive-related and respiratory-related tumor admissions ( $U = 9354.0$ ,  $Z = -0.543$ ,  $P = 0.587$ ) (**Table 2**). The effect size, calculated as  $r = Z/\sqrt{N}$ , was approximately -0.027, indicating a negligible magnitude of difference between the two groups. Median daily nursing care intensity was 26.0 RMB/day in both groups, with overlapping interquartile ranges. An effect size estimate calculated from the standardised test statistic indicated a negligible magnitude of difference between groups. Overall, the distributional characteristics of daily nursing care intensity were comparable between digestive-related and respiratory-related tumor admissions.

**Table 2.** Comparison of daily nursing care intensity between tumor groups

| Outcome variable             | Tumor group         | <i>n</i> | Median (RMB/day) | Mean rank | Mann–Whitney U | Z value | <i>p</i> value |
|------------------------------|---------------------|----------|------------------|-----------|----------------|---------|----------------|
| Daily nursing care intensity | Digestive related   | 346      | 26.0             | 201.15    | 9354.0         | −0.543  | 0.587          |
|                              | Respiratory related | 57       | 26.0             | 193.11    |                |         |                |

### 3.3. Correlations between total hospitalisation cost and daily nursing care intensity

Pearson correlation analyses were conducted to examine associations between total hospitalisation cost and daily nursing care intensity within tumor groups. The results are summarised in **Table 3**. In digestive-related tumor admissions ( $n = 346$ ), a weak but statistically significant positive correlation was observed between total hospitalisation cost and daily nursing care intensity ( $r = 0.284$ ,  $P < 0.001$ ). For respiratory-related tumor admissions ( $n = 57$ ), total hospitalisation cost was also positively correlated with daily nursing care intensity ( $r = 0.276$ ,  $P = 0.038$ ). Among non-tumor admissions ( $n = 577$ ), a moderate positive correlation was observed between total hospitalisation cost and daily nursing care intensity ( $r = 0.454$ ,  $P < 0.001$ ). Overall, positive correlations between total hospitalisation cost and daily nursing care intensity were consistently observed across all groups, with statistical significance achieved in each group. The strength of the correlation varied, with the highest correlation observed in the non-tumor group.

**Table 3.** Pearson correlations between total hospitalisation cost and daily nursing care intensity by tumor group

| Tumor group         | Pearson <i>r</i> | <i>p</i> -value | <i>n</i> |
|---------------------|------------------|-----------------|----------|
| Digestive-related   | 0.284            | <0.001          | 346      |
| Respiratory-related | 0.276            | 0.038           | 57       |
| Non-tumor           | 0.454            | <0.001          | 577      |

### 3.4. Correlations between total nursing fee and daily nursing care intensity

Pearson correlation analyses were conducted to examine the relationship between total nursing fee and daily nursing care intensity within tumor groups. Results are summarised in **Table 4**. In digestive-related tumor admissions ( $n = 346$ ), a moderate positive correlation was observed between total nursing fee and daily nursing care intensity ( $r = 0.491$ ,  $P < 0.001$ ). Among respiratory-related tumor admissions ( $n = 57$ ), a weak positive correlation was detected ( $r = 0.271$ ,  $P = 0.042$ ). For non-tumor admissions ( $n = 577$ ), a moderate positive correlation was observed between total nursing fee and daily nursing care intensity ( $r = 0.578$ ,  $P < 0.001$ ). Across all groups, the correlations were statistically significant, with variation in strength among tumor types. The relationship between total nursing fee and daily nursing care intensity is illustrated in **Figure 1**. Blue points and regression line represent digestive-related tumor admissions; red points and regression line represent respiratory-related tumor admissions.

**Table 4.** Pearson correlations between total nursing fee and daily nursing care intensity by tumor group

| Tumor group         | Pearson <i>r</i> | <i>p</i> -value | <i>n</i> |
|---------------------|------------------|-----------------|----------|
| Digestive-related   | 0.491            | <0.001          | 346      |
| Respiratory-related | 0.271            | 0.042           | 57       |
| Non-tumor           | 0.578            | <0.001          | 577      |

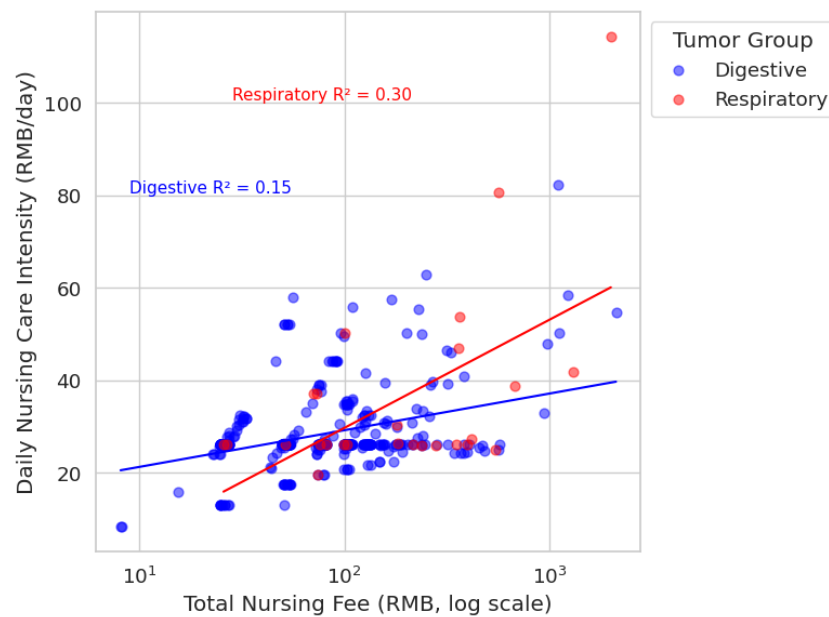


**Figure 1.** Scatter plot of daily nursing care intensity versus total nursing fee by tumor group

## 4. Discussion

Inpatient nursing care in oncology is multifaceted, shaped not only by the underlying malignancy but also by a complex interplay of patient-specific, clinical, and organizational factors. While tumor type provides a clinical classification, it is increasingly recognized that nursing workload is driven by the individual complexity of care needs, including symptom severity, functional limitations, comorbidities, and psychosocial support requirements. This complexity requires a nuanced approach to workforce planning, emphasizing patient-centered assessment and flexible staffing, rather than relying solely on diagnosis-based proxies or traditional length-of-stay metrics [21–23]. Translating daily nursing care intensity into actionable staffing strategies. The findings of this study have direct implications for clinical management. Daily nursing care intensity, as a standardized metric, can be integrated into shift-based staffing models. For instance, units can establish intensity thresholds (e.g., low: < 20 RMB/day; moderate: 20-35 RMB/day; high: > 35 RMB/day) based on historical data distribution. When the average daily intensity on a ward exceeds the high threshold, nurse managers may implement surge protocols such as calling in float pool nurses, deferring non-essential tasks, or increasing the nurse-to-patient ratio for the following shift. Furthermore, tracking intensity trends over consecutive days can serve as an early warning system, enabling proactive adjustments before staff burnout or missed care events occur. This operationalization bridges the gap between retrospective data analysis and real-time workforce management. The

ability to quantify and visualize these relationships allows hospital administrators to implement evidence-based staffing strategies, ensuring that nursing resources are aligned with actual patient needs, thereby enhancing both patient safety and staff well-being [33,34].

From an organizational perspective, these insights have significant implications for hospital policy and operational management. In practical terms, these findings support a shift toward flexible and adaptive staffing strategies in inpatient oncology units. Rather than allocating nursing resources based primarily on tumor type or bed occupancy, hospitals may benefit from incorporating indicators of care intensity into daily staffing decisions. Such an approach allows nurse managers to anticipate periods of elevated workload, allocate experienced staff strategically, and adjust skill mix in response to patient complexity [35,36]. Over time, this may contribute to improved workload balance, reduced burnout, and enhanced continuity of care. In complex oncology units, variability in nursing intensity necessitates flexible scheduling, task prioritization, and cross-training of staff to respond to fluctuating care demands. Institutions may benefit from predictive models that incorporate patient-level data, historical workload metrics, and environmental factors to inform staffing decisions [37,38]. This data-driven approach can reduce periods of understaffing, mitigate the risk of nurse burnout, and improve overall efficiency in patient care delivery [9,39,40].

Beyond operational efficiency, aligning nursing resources with actual care demands has important implications for patient safety and quality of care. High nursing workload has been associated with missed care, delayed symptom management, and reduced patient satisfaction [41,42]. By more accurately identifying admissions associated with sustained high-intensity nursing needs, healthcare institutions may enhance early intervention, optimize monitoring, and support timely clinical decision-making. This patient-centered allocation of nursing resources is particularly critical in oncology, where symptom escalation and clinical deterioration can occur rapidly [43,44].

Furthermore, the methodological framework applied in this study demonstrates the potential of real-world hospital datasets for informing clinical and administrative practice. The methodological approach adopted in this study demonstrates the feasibility of using routinely collected administrative and nursing data to generate actionable insights into workload patterns. By integrating descriptive analysis, non-parametric testing, and visual exploration of workload relationships, the study provides a pragmatic template that can be replicated in other hospital settings [38]. This approach is particularly relevant for institutions seeking scalable, data-driven solutions to workforce planning without the need for extensive additional data collection. By combining descriptive statistics, correlation analyses, and visual representation of workload distributions, the study provides a template for other institutions seeking to monitor and optimize nursing resources in oncology [33,45]. Such approaches contribute to the development of learning health systems, in which routine operational data is systematically harnessed to improve patient outcomes and service delivery [46–48].

The broader implications of these findings extend to supportive oncology care and health policy. Understanding that nursing demands are multifactorial supports the need for integrated care planning, in which psychosocial support, symptom management, and functional interventions are considered alongside clinical treatment. Policies that allocate resources based solely on diagnostic categories may

inadequately capture the complexity of patient needs. Evidence-based workforce planning those accounts for heterogeneity within tumor groups can enhance the quality and safety of care, particularly in high-intensity oncology settings.

This study emphasizes the importance of future research to develop predictive frameworks for nursing workload. Incorporating variables such as symptom clusters, functional status, and psychosocial burden into predictive models may improve the precision of staffing and resource allocation. Additionally, evaluating the impact of such approaches on patient outcomes, nurse satisfaction, and operational efficiency represents an important avenue for advancing supportive oncology practice. By bridging administrative data with clinical insight, healthcare institutions can adopt a holistic, patient-centered approach to workforce management that aligns with contemporary priorities in oncology care delivery.

#### **4.1. Strengths and limitations**

This study has several strengths, including the use of real-world inpatient data, the integration of multiple nursing workload indicators, and the focus on daily care intensity rather than aggregate metrics alone. The inclusion of both tumor-related and non-tumor admissions also provides valuable context for interpreting workload variability.

However, several limitations should be acknowledged. First, the single-center retrospective design substantially limits the external validity and generalizability of the conclusions. Our findings reflect the patient population, staffing models, and cost accounting practices of one tertiary hospital in China and may not be directly transferable to other hospital types or different healthcare systems. Second, the sample size for the respiratory malignancy group ( $n = 57$ ) is notably smaller than that of the digestive group ( $n = 346$ ). This sample imbalance reduces statistical power and may affect the stability and reliability of the comparison. A post-hoc power analysis using G\*Power (two-tailed independent samples t-test,  $\alpha=0.05$ , power = 0.80) indicated that with the current sample sizes ( $n_1 = 346$ ,  $n_2 = 57$ ), the minimum detectable effect size (Cohen's  $d$ ) is approximately 0.45, suggesting that the study is underpowered to detect small-to-moderate differences ( $d < 0.45$ ). Therefore, the null finding should be interpreted with caution, and the study is best considered exploratory. Third, the analysis did not control for important confounding factors that likely influence nursing workload more than tumor type, including age, comorbidities, disease stage, treatment phase (surgical, chemotherapy, palliative), functional status, and psychosocial needs. Due to the limited sample size, particularly in the respiratory group, multivariable regression was not feasible. Readers should therefore recognize that the observed comparability in daily nursing intensity may be influenced by unmeasured differences in these patient-level characteristics. Fourth, this study relies heavily on nursing fees as a proxy for nursing workload. While pragmatic, this measure has important limitations. Importantly, nursing fees are influenced by hospital billing policies, reimbursement structures, and documentation practices, which may vary across institutions and over time. They do not fully capture qualitative aspects of care complexity, such as emotional labor, patient education, family counseling, or interdisciplinary coordination. Therefore, our findings should be interpreted as indicative of relative workload patterns within this specific hospital context, rather than as absolute measures of nursing effort. Fifth, data on disease stage and treatment type were not systematically available in the administrative dataset, preplanned subgroup analyses (e.g., early-stage vs. advanced, surgical vs. medical oncology) could not be conducted. Future prospective studies are needed to explore

these clinically relevant stratifications. Sixth, the small number of primary studies in this single-center analysis precludes formal assessment of publication bias. Despite these limitations, the findings provide a robust foundation for future, larger-scale investigations into nursing workload assessment.

Future research directions. Building upon these findings, future studies should: (1) validate the observed workload patterns in multi-center cohorts across different healthcare systems to enhance generalizability; (2) integrate clinical symptom data (e.g., pain, dyspnea, fatigue), functional status indicators (e.g., Karnofsky Performance Status), and standardized psychosocial distress measures into predictive nursing workload models; (3) conduct prospective longitudinal studies to examine how workload patterns evolve over the course of hospitalization and in response to specific clinical events; (4) evaluate the impact of workload-informed staffing interventions on patient outcomes (e.g., symptom control, satisfaction, adverse events), nurse outcomes (e.g., burnout, job satisfaction), and organizational performance (e.g., cost-efficiency, staff retention); and (5) explore the potential of machine learning approaches to develop real-time predictive algorithms for nursing workload based on routinely collected electronic health record data.

## **5. Conclusion**

This study provides a comprehensive examination of inpatient nursing care demands among patients with digestive-related and respiratory-related malignancies using real-world hospital administrative and nursing data. By focusing on daily nursing care intensity, cumulative nursing workload, and overall hospitalization costs, the study offers an operationally relevant perspective on supportive care demands in oncology inpatient settings. The analysis was designed to move beyond traditional diagnosis-based assumptions and to examine whether tumor system classification meaningfully differentiates nursing workload in routine clinical practice.

The findings demonstrate that inpatient nursing care demands are highly heterogeneous across individual admissions but broadly comparable between digestive-related and respiratory-related malignancies at the median level. Despite differences in clinical presentation and symptom profiles between tumor systems, daily nursing care intensity did not differ significantly between groups. This suggests that tumor classification alone does not adequately capture the complexity of inpatient nursing workload and that patient-level factors likely play a more substantial role in shaping care demands during hospitalization.

The results highlight the importance of individualized, patient-centered staffing strategies that account for variability in clinical complexity, symptom burden, and functional status, rather than relying solely on diagnosis or length-of-stay metrics. Administrative and nursing data can be leveraged to inform evidence-based workforce planning, optimize resource allocation, and ensure that care intensity aligns with patient needs. These insights are particularly relevant for high-volume oncology units where effective nursing management is critical for both patient outcomes and staff sustainability. From an operational standpoint, these findings underscore the limitations of staffing models that rely primarily on diagnosis or length-of-stay metrics. The generalizability of these conclusions is constrained by the single-center retrospective design and the small sample size of the respiratory malignancy group; therefore, the findings should be considered exploratory and hypothesis-generating rather than definitive.

This study emphasizes that supportive care in oncology is multifactorial and

heterogeneous, and that a data-driven approach integrating descriptive metrics, correlations, and visualizations of nursing workload can enhance both operational efficiency and quality of patient care. Future research should explore predictive models incorporating clinical, functional, and psychosocial variables to further refine nursing resource allocation and optimize supportive oncology practices. In conclusion, recognizing and quantifying the heterogeneous nature of inpatient nursing care demands is essential for optimizing supportive oncology care, ensuring workforce sustainability, and advancing data-driven approaches to healthcare management in increasingly complex clinical environments.

**Author contributions:** Conceptualization, LW, Y, HT, YZ, NW and QX; methodology, LW, Y; software, LW and HT; validation, NW and QX; formal analysis, HT and YZ; investigation, LW; resources, NW and QX; data curation, HT and YZ,; writing—original draft preparation, LW; writing—review and editing, LW; visualization, Y; supervision, HT; project administration, ML; funding acquisition, LW, Y, HT, NW and QX. All authors have read and agreed to the published version of the manuscript.

**Funding:** None.

**Ethical approval:** This study was reviewed and approved by The Ethics Committee of the 903rd Hospital of the Joint Logistic Support Force (approval number: L9032022089).

**Informed consent statement:** For this retrospective study, an application for waiver of informed consent was submitted and approved.

**Conflict of interest:** The authors declare no conflict of interest.

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