Research Square

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In-hospital Mortality Among Patients with Intracranial Tumors at a Tertiary Hospital in Luanda, Angola: A Retrospective Cohort Study

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Abstract

Background

In-hospital death among patients admitted with intracranial tumors is a clinically important short-term outcome because it reflects acute neurological deterioration, treatment timing, and the capacity of hospital care pathways. Outcome reporting from African neuro-oncology settings remains limited.

Methods

We performed a retrospective cohort study of 93 admissions recorded between 2020 and 2025 at a tertiary neurosurgical services in Luanda, Angola. The unit of analysis was the admission. The primary outcome was in-hospital death. Univariable analyses examined age, sex, surgery, length of stay, registry-based diagnostic group, and admission year. Because only 21 deaths occurred, a pre-specified, restricted Firth penalized logistic regression sensitivity analysis was limited to three predictors: age (per 10-year increase), surgery, and a high-risk diagnosis category defined as glioblastoma or metastatic disease versus other registry diagnoses. Reporting followed STROBE and RECORD principles.

Results

Twenty-one of 93 admissions ended in in-hospital death (22.6%). Age ≥ 50 years was associated with death (odds ratio [OR] 5.66, 95% confidence interval [CI] 1.86–17.24; p = 0.002), and admissions ending in death were older on continuous analysis (p = 0.019). Sex, surgery, and length of stay were not associated with death in univariable analysis. Mortality differed across registry diagnostic groups overall (p = 0.034). In the penalized complete-case model (89 admissions, 21 deaths), high-risk diagnosis remained independently associated with death (OR 5.70, 95% CI 1.58–20.52; p = 0.008), whereas age (OR 1.32 per 10 years, p = 0.117) and surgery (OR 0.79, p = 0.669) were not.

Conclusions

In this exploratory Angolan cohort, older age was associated with in-hospital death in univariable analysis, but restricted adjustment suggested that high-risk tumor biology may be the stronger short-term determinant. The observed null association for surgery should not be interpreted causally because of likely confounding by indication.

Introduction

Brain and other intracranial tumors represent a clinically heterogeneous group of diseases whose presentation, treatment pathways, and outcomes vary substantially according to tumor biology, neurological status at admission, and the availability of specialist care [1]. In sub-Saharan Africa, the

evidence base remains comparatively thin, with most published data deriving from single-centre hospital cohorts rather than population-based registries [2,3]. Existing African reports suggest that meningiomas, gliomas, sellar tumors, and metastatic lesions form an important part of neurosurgical practice, but the depth of epidemiological description and outcome reporting remains uneven [2–5].

In-hospital mortality is a particularly relevant outcome in this context. Although it does not substitute for overall survival or progression-free survival, it captures the period in which delayed presentation, raised intracranial pressure, acute neurological decline, perioperative decision-making, access to imaging, and critical care capacity intersect. For institutions managing neurosurgical admissions in resource-constrained settings, death before discharge is therefore both a clinical endpoint and a service-level quality indicator [2–5].

Angolan data on intracranial tumors are scarce in indexed literature, and structured reporting from routine clinical practice is limited. This contributes to a broader African gap in institutional audit data, especially for short-term outcomes. The present study examined admissions with intracranial tumors treated at two tertiary neurosurgical services in Luanda between 2020 and 2025. The primary objective was to identify factors associated with in-hospital death. Because the number of deaths was modest, we also performed a restricted, pre-specified Firth penalized logistic regression sensitivity analysis to determine whether the main univariable signal persisted after limited adjustment [2–5].

Methods

Study design and setting

We conducted a retrospective cohort study of intracranial tumor admissions managed between 2020 and 2025 at the Neurosurgery Services of Hospital do Prenda. The study used anonymized institutional clinical records; no patient contact occurred during data collection. Across the two services, 93 admissions of patients with a registry-recorded intracranial tumor diagnosis were analysed: 21 admissions ended in in-hospital death and 72 ended in discharge, transfer, or indeterminate non-fatal outcome.

Unit of analysis and outcome

The unit of analysis was the admission rather than the individual patient. The primary outcome was in-hospital death. Admissions ending in discharge, transfer, or indeterminate non-fatal status were grouped as “no in-hospital death” for binary analysis.

Variables

Pre-specified variables were age, age ≥ 50 years, sex, surgery status, length of stay, registry-based diagnostic group, and admission year. Registry diagnoses were grouped as unspecified brain tumor,

meningioma, glioblastoma, macroadenoma, metastatic disease, and other diagnoses. For the sensitivity analysis, diagnostic categories were simplified a priori into a high-risk group defined as glioblastoma or metastatic disease versus all other registry diagnoses, to avoid over-parameterization.

Statistical analysis

Univariable analyses were exploratory. Odds ratios (ORs) were calculated for binary predictors. Fisher's exact test was used for categorical comparisons with sparse data, the Mann–Whitney test for non-normally distributed continuous variables, and the chi-square test for multi-category comparisons, as appropriate. "SD" entries in the source registry were treated as missing values.

Because only 21 in-hospital deaths were observed, we did not fit a conventional unrestricted multivariable model. Instead, we performed a restricted penalized logistic regression sensitivity analysis using Firth's penalized likelihood. The model was limited to three clinically selected predictors: age modelled continuously per 10-year increase, surgery (yes versus no), and high-risk registry diagnosis (glioblastoma/metastatic versus other). Adjusted ORs, 95% confidence intervals (CIs), and Wald p values from the penalized covariance matrix were reported. Complete-case analysis was used for the penalized model; four admissions with missing age data were excluded.

The study was prepared in line with STROBE and RECORD reporting principles for observational analyses using routinely collected data [6,7]. Registry concepts and handling of routine clinical data were informed by standard guidance for patient outcome registries [8].

Results

Ninety-three admissions were analyzed. Twenty-one admissions resulted in in-hospital death, 67 in discharge, four in transfer, and one in an indeterminate non-fatal outcome. Surgery was recorded in 41 admissions (44.1%). The largest registry category was unspecified brain tumor (49.5%), followed by meningioma (22.6%). Table 1 summarizes admission-level characteristics by outcome.

Table 1

Baseline and admission characteristics of 93 intracranial tumor admissions, stratified by in-hospital mortality status. Values are shown for the full admission-level cohort. Four admissions had missing age values and were excluded from the penalized complete-case model. (Fig. 1)

Variable	No in-hospital death (n = 72)	In-hospital death (n = 21)
Age, years — median (IQR)	37 (24–52)	55 (40–65)
Age ≥ 50 years — n (%)	18 (25.0)	13 (61.9)
Male sex — n (%)	37 (51.4)	11 (52.4)
Surgery performed — n (%)	32 (44.4)	9 (42.9)
Length of stay, days — median (IQR)	23 (11–34)	21 (9–31)
Registry diagnostic group — n (%)		
Unspecified brain tumor	33 (45.8)	13 (61.9)
Meningioma	19 (26.4)	2 (9.5)
Glioblastoma	2 (2.8)	4 (19.0)
Macroadenoma	8 (11.1)	1 (4.8)
Metastatic disease	3 (4.2)	4 (19.0)
Other diagnosis	8 (11.1)	1 (4.8)
Admission year — n (%)		
2020	13 (18.1)	6 (28.6)
2021	13 (18.1)	3 (14.3)
2022	13 (18.1)	4 (19.0)
2023	12 (16.7)	3 (14.3)
2024	14 (19.4)	5 (23.8)
2025	7 (9.7)	0 (0.0)

The restricted Firth penalised complete-case sensitivity analysis included 89 admissions (4 excluded for missing age) with all 21 in-hospital deaths retained.

Older age was the clearest signal in univariable analysis. Age ≥ 50 years was associated with death (OR 5.66, 95% CI 1.86–17.24; p = 0.002), and admissions ending in death were also older on continuous age comparison (p = 0.019). Male sex was not associated with death (OR 1.05; p = 1.000). Surgery was not associated with death in crude analysis (OR 0.94; p = 1.000). Length of stay did not differ materially between death and non-death admissions (median 21.0 versus 23.0 days; p = 0.892). Mortality varied

across registry diagnostic groups overall (p = 0.034), while admission year showed a non-significant overall trend (p = 0.097). (Fig. 2) See also Fig. 3 for a forest-plot summary of the univariable estimates.

Only age ≥ 50 years reached conventional statistical significance (OR 5.66, 95% CI 1.86–17.24, p = 0.002). Male sex and surgery were not associated with death in univariable analysis.

For the pre-specified sensitivity analysis, 89 complete cases were available, including 21 in-hospital deaths. Thirteen admissions belonged to the high-risk diagnostic group; eight of these ended in death, compared with 13 deaths among 76 admissions in the remaining diagnostic groups. In the restricted Firth penalized model, age retained a positive direction of effect but was no longer statistically significant after limited adjustment (OR 1.32 per 10-year increase, 95% CI 0.93–1.88; p = 0.117). Surgery also showed no independent association (OR 0.79, 95% CI 0.28–2.29; p = 0.669). By contrast, high-risk diagnosis remained independently associated with death (OR 5.70, 95% CI 1.58–20.52; p = 0.008) (Table 2, Fig. 4).

Table 2
Firth penalized logistic regression sensitivity analysis (n = 89 complete cases, 21 in-hospital deaths). The model was restricted, a priori, to three pre-specified predictors to avoid over-parameterization given the small number of events.

Predictor	Adjusted OR	95% CI	p value
Age (per 10-year increase)	1.32	0.93–1.88	0.117
Surgery (yes vs. no)	0.79	0.28–2.29	0.669
High-risk diagnosis (glioblastoma or metastatic disease vs. other)	5.70	1.58–20.52	0.008

(n = 89 complete cases; 21 in-hospital deaths). .

Discussion

This exploratory admission-level cohort provides one of the few structured reports of short-term intracranial tumor outcomes from Angola. Three findings merit emphasis. First, in-hospital death was frequent, affecting nearly one quarter of admissions. Second, age emerged as the clearest predictor in crude analysis. Third, after restricted adjustment with a penalized model appropriate for the small number of deaths, the most robust association was with high-risk diagnostic profile rather than with age or surgery alone.

The magnitude of in-hospital mortality observed here should be interpreted in light of the setting and the case mix. African neuro-oncology literature remains dominated by hospital-based retrospective series, and cross-study comparisons are difficult because tumor classification, referral patterns, and treatment access differ substantially [2–5]. Even so, the present data support the importance of institutional reporting from sub-Saharan Africa, where delayed presentation, incomplete pathology linkage, and

inconsistent access to perioperative critical care may shape short-term outcomes more strongly than in high-income registries.

The penalized analysis adds an important layer of interpretive caution. Although older age was clearly associated with death in univariable analysis, that association attenuated after limited adjustment, whereas the high-risk category of glioblastoma or metastatic disease remained independently associated with death. This pattern is biologically plausible. Glioblastoma is an aggressive primary tumor with rapid neurological decline and high early morbidity, while intracranial metastatic disease often reflects advanced systemic cancer and complex intracranial burden [9,10]. By contrast, meningiomas and some sellar lesions may follow a more indolent course, even when they generate significant mass effect [11]. In low-detail registry data, a simplified high-risk category therefore captures clinically meaningful prognostic information when full histomolecular classification is unavailable [12].

Age nevertheless remains clinically relevant. Older patients with brain tumors often present with frailty, lower physiological reserve, and reduced tolerance of neurological and systemic complications [13,14]. The attenuation of the age effect in the penalized model should therefore not be read as proof of no age-related risk. Rather, in this small cohort, part of the crude age signal may have been explained by diagnostic mix, sparse data, or both. The finding is best interpreted as hypothesis-generating.

The lack of association between surgery and in-hospital death must also be handled carefully. In retrospective neuro-oncology cohorts, treatment is not randomly allocated. Operability, tumor location, performance status, emergency presentation, and palliative intent influence whether surgery is attempted. A null crude or adjusted association therefore does not imply absence of benefit. Instead, it probably reflects confounding by indication. The same caution applies to length of stay, which may reflect postoperative monitoring, discharge barriers, or end-of-life care rather than severity alone [15].

Limitations

This study has limitations. It was retrospective, single-setting, and based on admissions rather than unique patients; repeat admissions could therefore contribute more than once. Diagnostic categories were registry-based and only partly linked to definitive pathology, which explains the large “unspecified brain tumor” group. The number of deaths was small, restricting multivariable modelling and widening confidence intervals. These limitations also point to a practical agenda: institutional audit. In settings where neuro-oncology registries remain immature, even limited structured outcome reporting can support service planning and improve the quality of subsequent research.

Strengths

The cohort reflects an unselected, consecutive series of admissions managed in a real-world resource-limited neurosurgical service and uses a clinically meaningful short-term outcome. The use of Firth’s

penalized likelihood for the small number of events limits bias from sparse-data separation. Reporting conforms to STROBE and RECORD principles.

Conclusions

In this first Angolan exploratory cohort, older age was associated with in-hospital death in univariable analysis, but restricted adjustment suggested that high-risk tumor biology may be the stronger short-term determinant. The observed null association for surgery should not be interpreted causally because of likely confounding by indication. Structured institutional outcome reporting is feasible and should be expanded to inform service planning and clinical research in resource-limited neuro-oncology settings.

Declarations

Ethics approval and consent to participate

This study was a retrospective observational analysis of routinely collected institutional clinical records. Ethics committee approval was obtained from the Ethics Committee of Hospital do Prenda, Luanda, Angola (Approval Reference: DPHP 44/2026, dated 6 May 2026). No direct patient contact occurred and no intervention was performed for research purposes. The requirement for informed consent to participate was waived by the Ethics Committee under its standard retrospective-research protocol, in accordance with Law No. 7/25 of 24 July 2025 (Law on Biomedical and Clinical Research), Law No. 22/11 of 17 June 2011 (Angolan Data Protection Law), and the Declaration of Helsinki.

Consent for publication

Not applicable. This manuscript contains no individual person’s data in any form (including images, videos, or identifying details).

Availability of data and materials

The full patient-level analytical dataset generated and analysed during the current study is not publicly available, because open release of patient-level clinical data would conflict with the institutional data-protection obligations under which the records were originally collected and with the terms of the approving ethics committee. Bona fide researchers may request a fully de-identified, analysis-ready version of the dataset from the corresponding author (Sérgio Gonçalves da Silva Neto; sgsnnc@gmail.com), subject to: (i) a written request describing the research purpose and the data fields required; (ii) approval from Hospital do Prenda\u2019s institutional data-governance office; (iii) signature of a data-use agreement consistent with Angolan health-data regulation and the Declaration of Helsinki; and (iv) use of the data solely for the approved research purpose. No custom statistical code, bespoke data-extraction tool, or software source code was generated for this study, and the analysis relied on standard statistical routines applied in a commercially available statistical environment. No materials

(biological samples, chemical reagents, plasmids, cell lines, survey instruments, or experimental apparatus) were generated, collected, or reproduced for this study, therefore not applicable.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

BSM and SN conceived and designed the study. BSM, MX, MCM, and CP contributed to data acquisition and curation. SN performed the statistical analysis. BSM drafted the manuscript. SN critically revised the manuscript for important intellectual content. All authors read and approved the final manuscript. All authors agree to be accountable for all aspects of the work.

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Figures

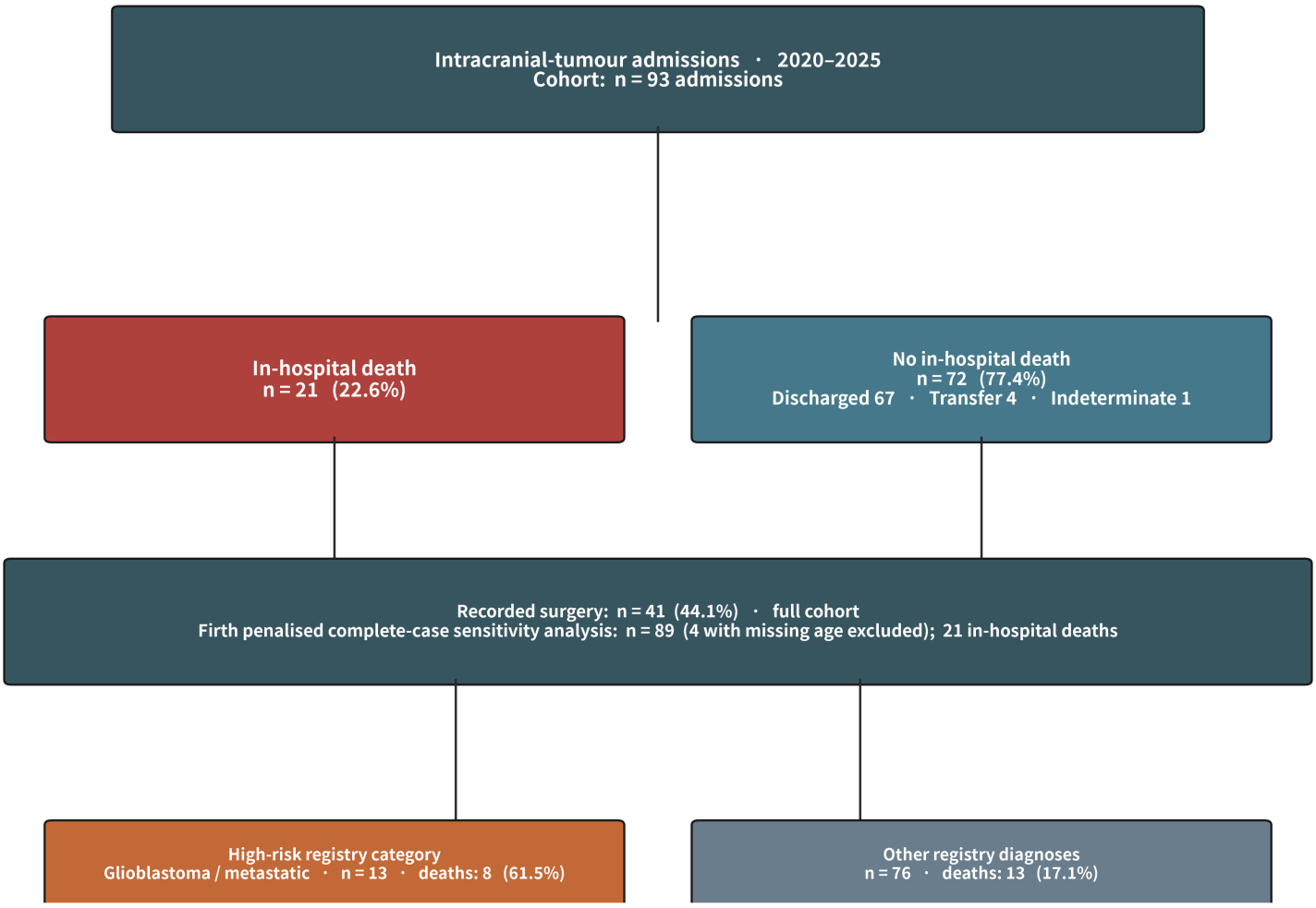


Figure 1

Cohort flow and analytic disposition of the 93 intracranial-tumour admissions (2020–2025).

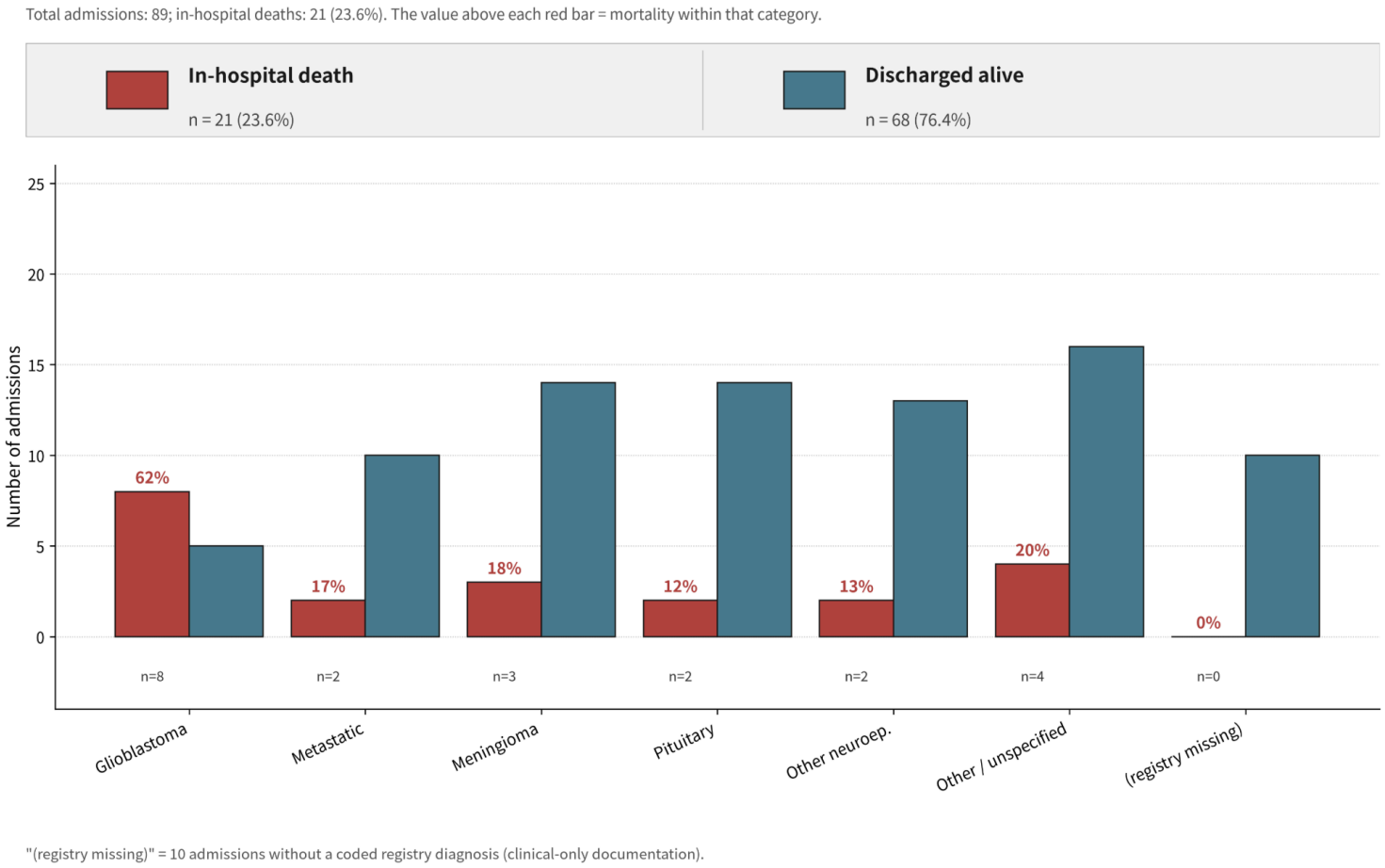


Figure 2

In-hospital mortality by diagnostic category.

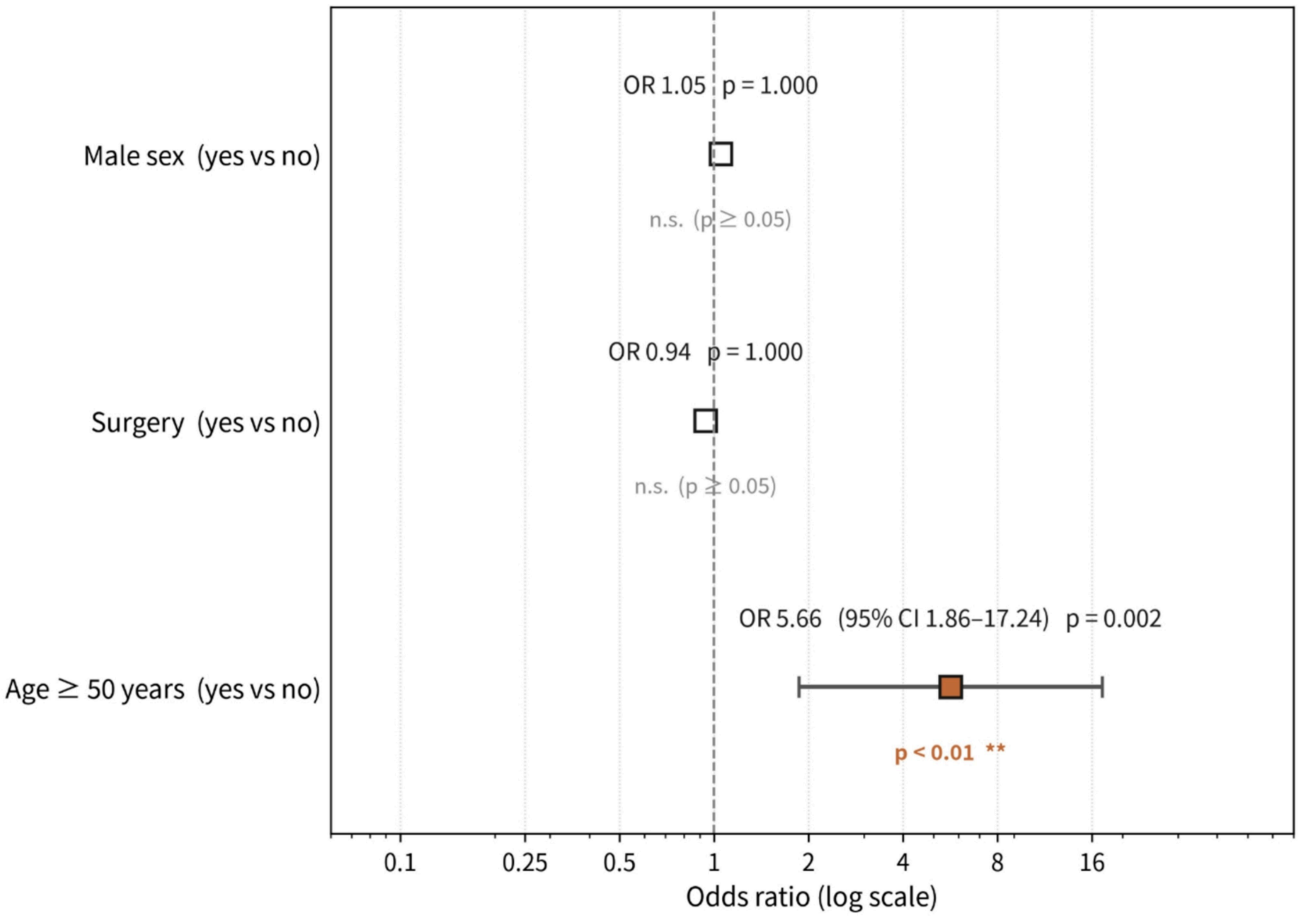


Figure 3

Univariable associations with in-hospital death (all 93 admissions; exploratory).

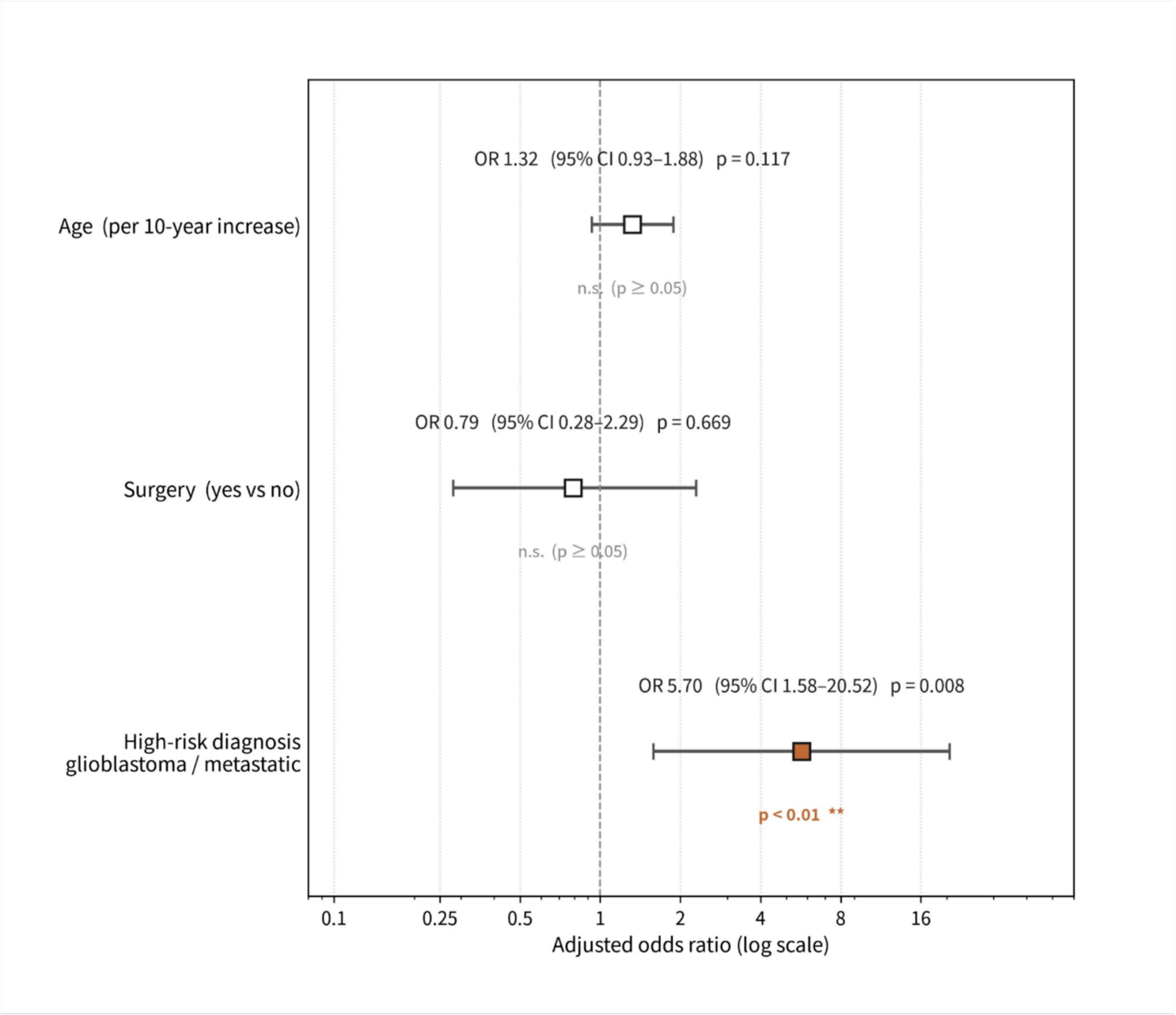


Figure 4

Forest plot of adjusted odds ratios from the restricted Firth penalised logistic regression sensitivity analysis (n = 89 complete cases; 21 in-hospital deaths).