HEMATOLOGICAL AND CLINICAL PREDICTORS OF SURVIVAL IN CERVICAL CANCER PATIENTS IN NIGERIA: A RETROSPECTIVE 11-YEAR STUDY

Ajibike Ayomide Orekoya[1], Ayorinde Mobolanle Folasire[2], Bolaji Lateef Salako[3], Abbas A. Abdus-Salam[2], Adeniyi Abidemi Adenipekun[2], Atara Isaiah Ntekim[2]

1- Federal Medical Centre Ebute-Metta, Lagos State, Nigeria
2- Department of Radiation Oncology, University College Hospital, Oyo state, Nigeria
3- Federal Medical Centre Abeokuta, Ogun State, Nigeria.

Corresponding author: Folasire, Ayorinde, Department of Radiation Oncology, University College Hospital, Oyo state, ayofolayemisi@yahoo.com, 08028879622

Citation: Orekoya AA, Folasire AM, Salako BL, Abdus-Salam AA, Adenipekun AA, Ntekim AI. Hematological and Clinical Predictors of Survival in Cervical Cancer Patients in Nigeria: A Retrospective 11-Year Study. *Niger J Oncol* 2026;2(2):91- 111

ABSTRACT

Background: Cervical cancer remains a leading cause of cancer mortality in low-resource settings. Hematological parameters such as anemia and leukocytosis are common and may influence prognosis.

Objective: To use hematologic parameter derangement as a predictor of overall survival among cervical cancer patients treated at the Radiotherapy Clinic, University College Hospital, Ibadan, Nigeria.

Methods: A retrospective descriptive 11-year study of 344 patients with histologically confirmed cervical cancer treated between 2003 and 2013 was conducted. Baseline hematological parameters included hemoglobin (Hb) level, white blood cell (WBC) count, and platelet count. Survival was analyzed using Kaplan–Meier method with log-rank tests. Independent predictors of survival were determined using Cox proportional hazards regression.

Results: The median overall survival was 203 weeks (3.9 years). Kaplan–Meier analysis showed significantly shorter survival among patients with anemia than those without anemia (137 vs. 242 weeks; $p = 0.026$), and among patients with leukocytosis compared with patients with normal WBC counts or leukopenia (102 vs. 277 and 259 weeks, respectively; $p = 0.001$). Survival also differed significantly by stage at presentation, with median survival of 259 weeks for early-stage disease, 172 weeks for locally advanced disease, and 62 weeks for metastatic disease ($p = 0.003$). Patients who received treatment had markedly longer survival than untreated patients (259 vs. 41 weeks; $p < 0.001$). On multivariable analysis, leukocytosis (aHR = 1.52, 95% CI: 1.06–2.18; $p = 0.024$), advanced stage disease (aHR = 1.56, 95% CI: 1.07–2.28; $p = 0.022$), and treatment status (aHR = 0.22, 95% CI: 0.13–0.39; $p < 0.001$) independently predicted survival, whereas anemia was not independently significant.

Conclusion: Leukocytosis, advanced stage, and treatment status are independent predictors of survival in cervical cancer patients, whereas anemia is associated with survival on univariate analysis only. Routine hematological assessment remains valuable for risk stratification in resource-limited settings.

Keywords: Cervical cancer, hematological profile, anemia, leukocytosis, thrombocytosis, survival, prognostic factors, Nigeria

INTRODUCTION

Cervical cancer remains a leading cause of cancer morbidity and mortality among women in low- and middle-income countries (LMICs), including Nigeria.[1–3] In Nigeria, advanced stage at presentation and gaps in screening and treatment contribute to the poor outcomes.[3–10] Apart from stage at presentation and access-to-care determinants, baseline hematological abnormalities (particularly anemia, leukocytosis, and thrombocytosis) are increasingly being recognized as low-cost, readily obtainable biomarkers with prognostic relevance in cervical cancer.[11–20]

Tumour biology has shown that anemia reduces oxygen delivery to tumours, fostering hypoxia. Hypoxia is an established driver of radioresistance, genomic instability, angiogenesis, and aggressive phenotypes in tumours via Hypoxia-Inducible-Factor (HIF)-mediated pathways.[15,16,21,22] Recent data in cervical cancer patients show that lower pretreatment hemoglobin correlates with poorer progression-free survival (PFS) and overall survival (OS) across various settings, including at high altitudes and with modern radiotherapy.[23] Clinical practice has increasingly emphasized identifying and correcting clinically significant anemia before and during chemoradiation to mitigate hypoxia-induced radioresistance.[24]

Leukocytosis in cancer patients often reflects tumor-induced systemic inflammation, paraneoplastic cytokine signaling (e.g., G-CSF, GM-CSF, IL-1, IL-6, and TNF-α), infection, or hemorrhage. Mabuchi et al. (2011, 2014) demonstrated that pretreatment leukocytosis was independently associated with shorter survival and radioresistance and may serve as a marker of highly metastatic tumor biology.[13,14]

Thrombocytosis has also been linked to adverse outcomes through platelet-mediated shielding from immune surveillance, facilitation of intravasation/extravasation, and pro-angiogenic signaling.[18–20] Several studies and meta-analyses report that pretreatment thrombocytosis is associated with poorer outcomes, including lower overall survival, recurrence-free survival (RFS), and progression-free survival.[25,26] Kawano et al. also showed that thrombocytosis correlates with more advanced clinical stage, larger tumour size, and lymph node involvement, all of which are associated with worse prognosis.[27] Due to its accessibility and low cost, platelet count could be explored as a simple marker for risk stratification in cervical cancer, especially in resource-limited settings.

From a Nigerian and sub-Saharan African perspective, the appeal of hematological indices is their universality, low cost, and feasibility in resource-limited oncology clinics. Studies among Nigerian cohorts show that baseline anemia independently predicts mortality.[12,28] Also, delays to definitive therapy shape the outcome of cervical cancer patients in Nigeria.[11,12,28] A recent study from Africa in Ethiopia, by Berta et. al., similarly reported substantial

burdens of anemia, leukocytosis, and thrombocytosis around treatment of cervical cancer patients.[29] This underscores the clinical relevance of monitoring and managing these derangements before and during the course of chemoradiation.[29]

Building on this evidence, we evaluated the distribution of baseline hematological parameters and their association with survival among cervical cancer patients treated at a high-volume radiotherapy clinic in Ibadan, Nigeria (2003–2013). We hypothesized that anemia, leukocytosis, and thrombocytosis at presentation would be associated with significantly worse survival, independent of other clinical factors. Our aim is to support context-appropriate risk stratification and pragmatic interventions (e.g., timely transfusions, infection control, nutritional support) that could improve outcomes where resources are constrained.[5,11–13,15,16,27]

MATERIALS AND METHODS

Study Design and Setting

This was a retrospective descriptive 11-year study conducted at the Radiotherapy Clinic, University College Hospital (UCH), Ibadan, Nigeria. Data were collected for patients diagnosed with cervical cancer between January 2003 and December 2013.

Study Population

Inclusion criteria were histologically confirmed cervical cancer and availability of pretreatment complete blood count test results. Patients with incomplete records were excluded.

Ethical approval

Ethical approval was obtained from the Joint Ethical Committee of the University of Ibadan/University College Hospital, Ibadan.

Data Collection

Information was extracted from patient records and included demographic and clinical characteristics such as age and marital status, histology, FIGO stage, and baseline hematological parameters.

Hematological indices were categorized as follows: Anemia was defined as a hemoglobin concentration <10.0 g/dL. Although the WHO defines anemia in non-pregnant women as hemoglobin <12.0 g/dL,[30] we selected the <10.0 g/dL threshold because it represents clinically significant anemia commonly used in oncology practice to identify patients who may require treatment modification or supportive interventions such as blood transfusion. Leukocytosis was defined as a white blood cell (WBC) count greater than 11,000/mm³. Leukopenia was defined as a white blood cell count <4,000/mm³, consistent with commonly used clinical and oncology reference standards. We acknowledge that baseline white blood cell counts may be lower in African populations due to benign ethnic neutropenia;[31] however, a uniform cutoff was applied across the study cohort to ensure consistency in analysis. Thrombocytosis was defined as a platelet count greater than 450,000/mm³, and thrombocytopenia as a platelet count less than 100,000/mm³.

Age was categorized as <60 years and ≥60 years to facilitate comparison between younger and older patients while ensuring

adequate numbers within each group for statistical analysis.

Outcome Measures

The primary outcome measure was overall survival (OS), defined as the time from diagnosis to death or last follow-up. Survival status was obtained from clinic records and confirmed through telephone follow-ups where necessary.

Statistical Analysis

All data were analyzed using SPSS version 26 (IBM Corp., Armonk, NY, USA). Overall survival was analyzed using the Kaplan–Meier method, with survival time calculated from the date of presentation to the date of death or last follow-up. Differences in survival between groups were compared using the log-rank test. Variables assessed included anemia status, white blood cell count category, platelet count category, stage at presentation, histology, age group, and treatment status. Variables with statistical significance on univariate analysis were entered into a multivariate Cox proportional hazards regression model to identify independent predictors of survival. Hazard ratios (HRs) with 95% confidence intervals were reported, and statistical significance was set at $p < 0.05$.

RESULTS

A total of 344 cervical cancer patients were included in the analysis. The median age was 55 years (range: 26–90 years), with 60.5% of patients aged below 60 years. Most patients were of Yoruba ethnicity (57.8%), married (68.0%), and predominantly engaged in unskilled occupations (74.7%). This is depicted in Table 1.

Clinically, the majority of patients presented with locally advanced disease (stage IIA to IVA) (68.7%), while 20.7% had early-stage disease (stage IA to IIA) and 10.6% had metastatic disease (stage IVB) at presentation, using the 2009 FIGO (International Federation of Gynecology and Obstetrics) classification. Squamous cell carcinoma was the predominant histological subtype (87.8%). More than half of the patients (57.2%) had symptoms lasting longer than six months before presentation. Comorbidities were present in 34.0% of patients, most commonly hypertension (27.7%), and only 3.4% were HIV positive. This is shown in Table 2.

Table 1: Sociodemographic Characteristics of Cervical Cancer Patients (N = 344)

Variable	Frequency (n)	Percentage (%)
Age Group		
< 60 years	208	**60.5**
≥ 60 years	136	**39.5**
Age Categories		
Median Age (Range)	55 years (26–90)	
Tribe		
Yoruba	199	**57.8**
Igbo	84	**24.4**
Other tribes	61	**17.7**
Marital Status		
Single	6	**1.7**
Married	234	**68.0**
Widowed	92	**26.7**
Divorced	12	**3.5**
Occupation Groups*		
Professional	2	**0.6**
Skilled	34	**10.0**
Semi-skilled	2	**0.6**
Unskilled	254	**74.7**
Unemployed	32	**9.4**
Unspecified civil servants	16	**4.7**

*Occupation data available for 340 patients

At baseline, anemia was observed in 36.8% of patients, while 22.1% had leukocytosis and 10.8% had leukopenia. Thrombocytosis and thrombocytopenia were less common, occurring in 14.8% and 1.7% of patients, respectively. This is shown in Table 3.

Most patients (86.0%) received some form of treatment, with chemoradiation-based regimens being the most common. About 14.0% received no treatment.

Table 2: Clinical Characteristics of Cervical Cancer Patients

Variable	Frequency (n)	Percentage (%)
Stage Grouping*		
Early stage (IA–IIA)	68	20.7
Locally advanced (IIB–IVA)	226	68.7
Metastatic (IVB)	35	10.6
Histology*		
Squamous cell carcinoma	289	87.8
Adenocarcinoma	24	7.3
Adenosquamous carcinoma	5	1.5
Other histologies	11	3.3
Duration of Symptoms Before Presentation*		
≤ 6 months	145	42.8
> 6 months	194	57.2
Comorbidities*		
None	217	66.0
Present	112	34.0
Specific comorbidities*		
Hypertension	91	27.7
Diabetes mellitus	20	6.1
Peptic ulcer disease	15	4.6
Asthma	4	1.2
Retroviral Status*		
Negative	311	96.6
Positive	11	3.4

*Some variables had missing data

Table 3: Hematological Profile of Cervical Cancer Patients

Variable	Frequency (n)	Percentage (%)
(Haemoglobin (Hb) level) Grouping		
Anemia (<10g/dL)	126	36.8
Normal Hb (≥10g/dL)	216	63.2
Mean Hb ± SD	10.3± 2.2	
Median Hb (Range)	10.1 (4.3–18.7)	
White Blood Cell Count Grouping		
Leucopenia (<4000/mm³)	37	10.8
Normal WBC (4000–11000/mm³)	231	67.2
Leucocytosis (>11000/mm³)	76	22.1
Mean WBC ± SD	8339.7 ± 5143.2 cells/mm³	
Median WBC (Range)	6725 cells/mm³ (1480–45300)	
Platelet Count Grouping		
Thrombocytopenia (<100,000/mm³)	6	1.7
Normal platelet count	287	83.4
Thrombocytosis (>450,000/mm³)	51	14.8
Mean Platelet Count ± SD	310,649 ± 172,528/mm³	
Median Platelet Count (Range)	270,000/mm³ (24,200–1,671,000)	

At last follow-up, 5.8% were alive, 33.7% had died, and 60.5% had unknown or unrecorded outcomes. The mean overall survival was 113.1 ± 140.9 weeks, with a median survival of 60 weeks (range: 0–696 weeks). This is depicted in Table 4.

Table 4: Treatment Pattern and Survival Outcomes

Variable	Frequency (n)	Percentage (%)
Treatment Received		
No treatment	48	14.0
Any treatment	296	86.0
Treatment Modality		
Brachytherapy only	6	1.7
Chemotherapy only	13	3.8
Chemotherapy + brachytherapy	16	4.7
Chemotherapy + EBRT	104	30.2
Chemotherapy + EBRT + brachytherapy	86	25.0
EBRT only	62	18.0
EBRT + brachytherapy	9	2.6
No treatment	48	14.0
Outcome Status		
Alive	20	5.8
Dead	116	33.7
Outcome not obtained	208	60.5
Survival Duration		
Mean follow up time ± SD	113.1 ± 140.9 weeks	
Median follow up time (Range)	60 weeks (0–696)	

Kaplan-Meier Survival Analysis

Kaplan–Meier survival analysis demonstrated an overall mean survival time of 301.8 weeks (95% CI: 259.3–344.3) and a median survival time of 203 weeks (95% CI: 125.6–280.4), corresponding to approximately 5.8 years and 3.9 years, respectively.

The estimated 2-year overall survival rate was 67.9%, while the 5-year overall survival rate was approximately 45.0%.

Kaplan-Meier Analysis by Clinicopathological Variables

The Kaplan-Meier survival analysis is summarized in Table 5.

Age

There was no statistically significant difference in survival between patients aged <60 years and those ≥60 years (log-rank $\chi^2 = 0.490$, $p = 0.484$). See Figure 1.

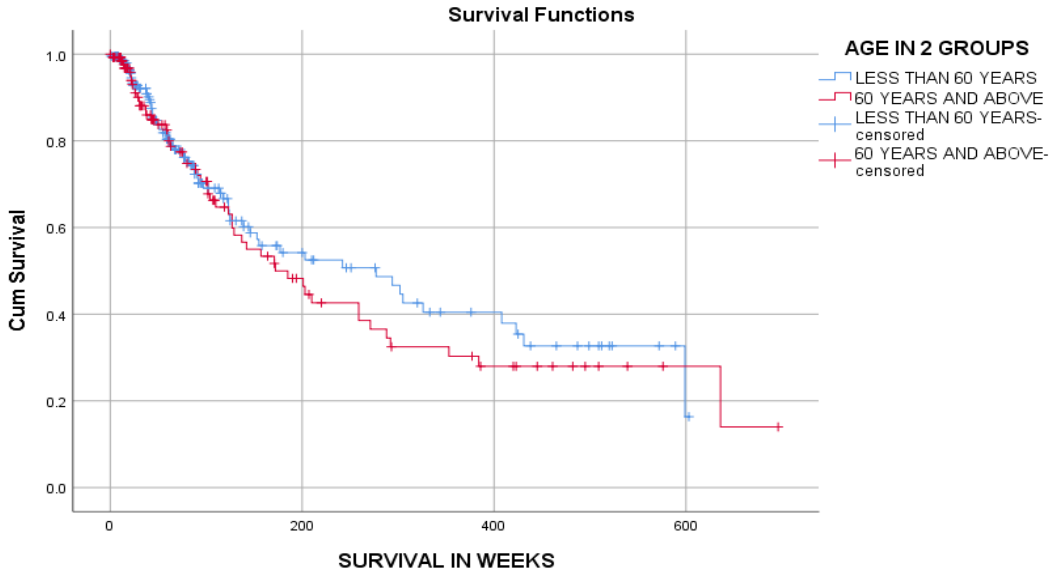

Figure 1: Kaplan-Meier curve by Age at Presentation

Stage at presentation

Stage significantly influenced survival outcomes (log-rank $\chi^2 = 11.718$, $p = 0.003$). Patients with early-stage disease had the longest median survival (259 weeks), compared with 172 weeks for locally advanced disease and 62 weeks for metastatic disease. See Figure 2.

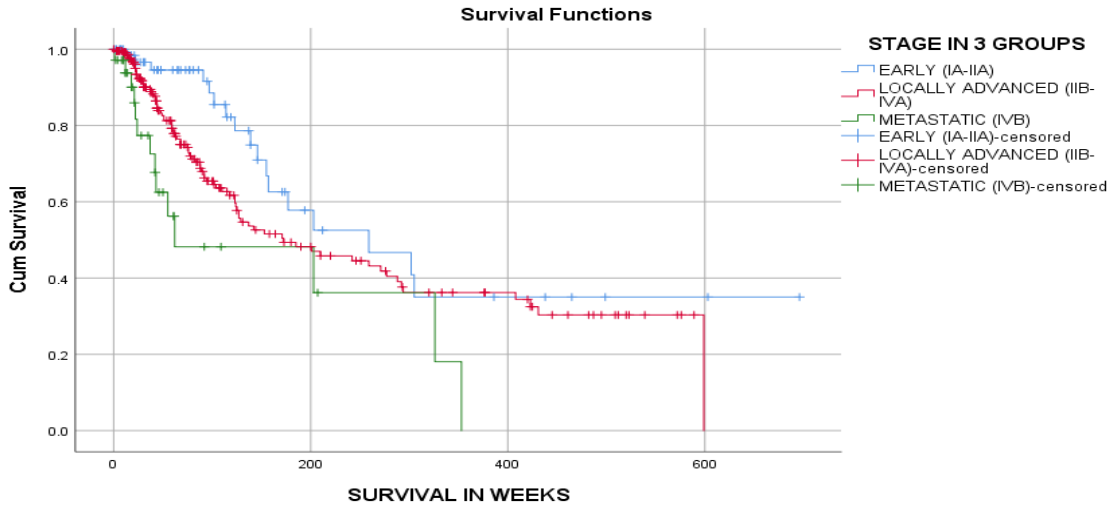

Figure 2: Kaplan-Meier curve by Stage at Presentation

Histology

No significant survival difference was observed between squamous and non-squamous histologies (log-rank $\chi^2 = 0.597$, $p = 0.440$). See Figure 3.

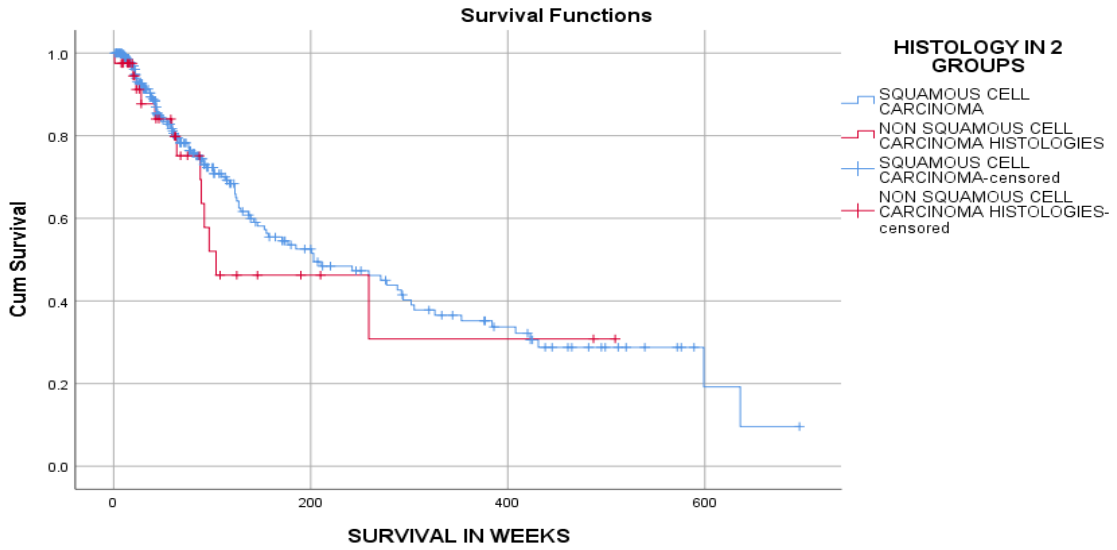

Figure 3: Kaplan-Meier curve by Histological Type

Retroviral status

No statistically significant difference in survival was observed based on HIV status (log-rank $\chi^2 = 0.453$, $p = 0.501$). See Figure 4.

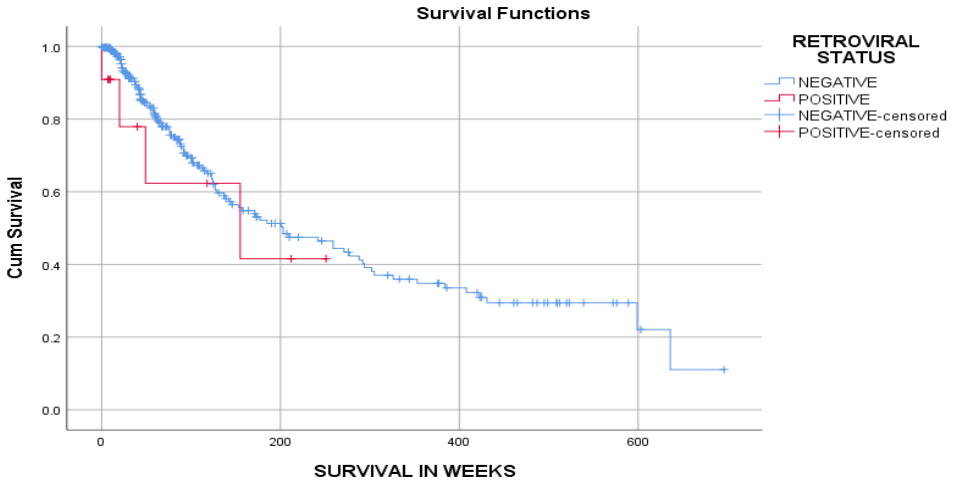

Figure 4: Kaplan-Meier curve by Retroviral Status

Comorbidities

Comorbid conditions were not significantly associated with survival (log-rank $\chi^2 = 0.034$, $p = 0.854$). See Figure 5.

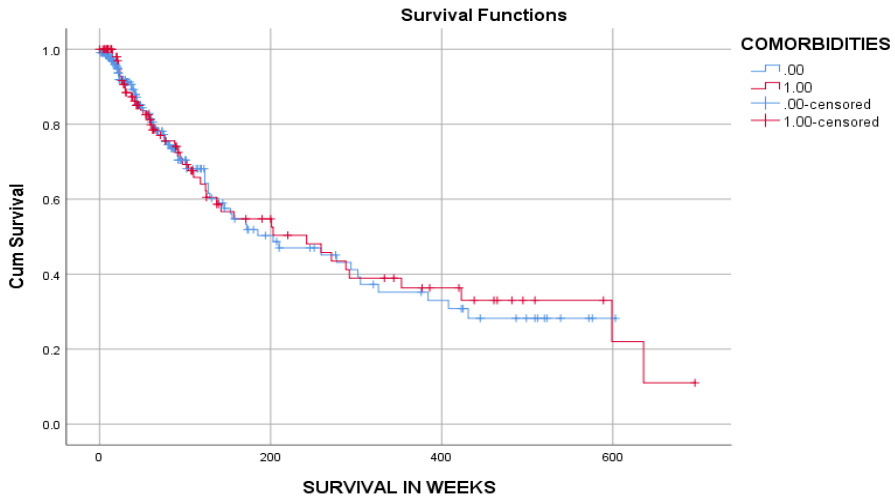

Figure 5: Kaplan-Meier curve by Presence of Comorbidities

Hemoglobin level (Hb)

Patients with normal Hb levels had significantly better survival than those with anemia (log-rank $\chi^2 = 4.974$, $p = 0.026$). See Figure 6.

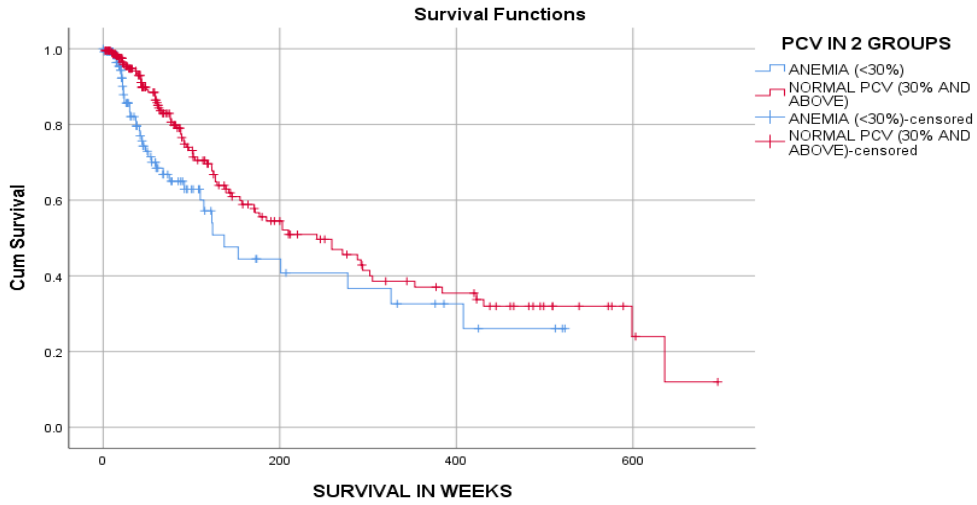

Figure 6: Kaplan-Meier curve by Hemoglobin Level

White blood cell count

Survival differed significantly across WBC categories (log-rank $\chi^2 = 14.023$, $p = 0.001$). Patients with leucocytosis had the poorest survival (median: 102 weeks), while those with normal WBC had the best survival (277 weeks). See Figure 7.

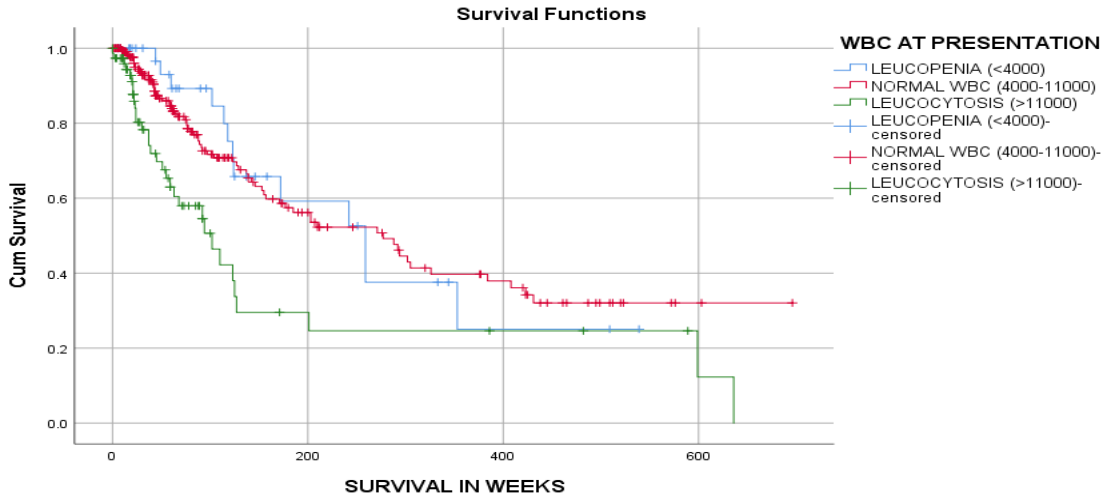

Figure 7: Kaplan-Meier curve by White Blood Cell Count Group

Platelet count

There was no significant difference in survival according to platelet count (log-rank $\chi^2 = 1.272$, $p = 0.529$). See Figure 8.

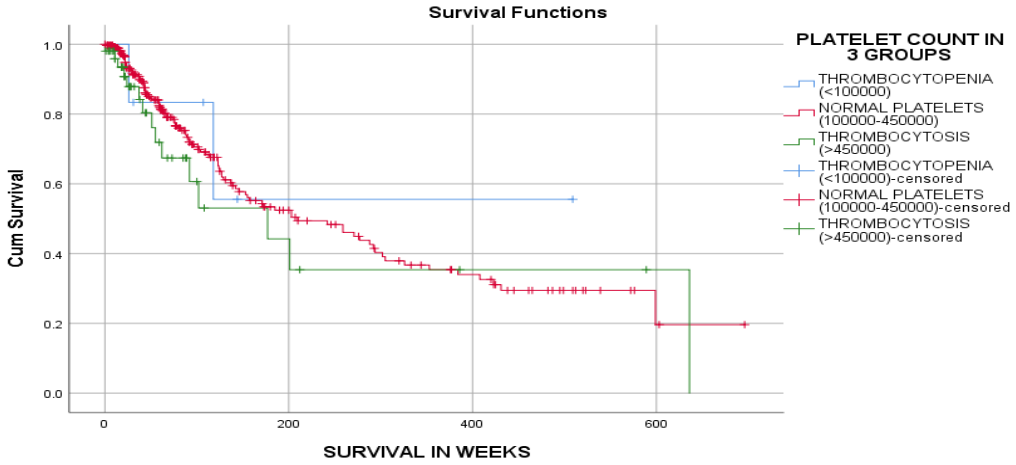

Figure 8: Kaplan-Meier curve by Platelet Count Group

Treatment status

Treatment status significantly influenced survival (log-rank $\chi^2 = 52.061$, $p < 0.001$). Patients who received treatment had markedly improved survival (median: 259 weeks) compared with untreated patients (41 weeks). See Figure 9.

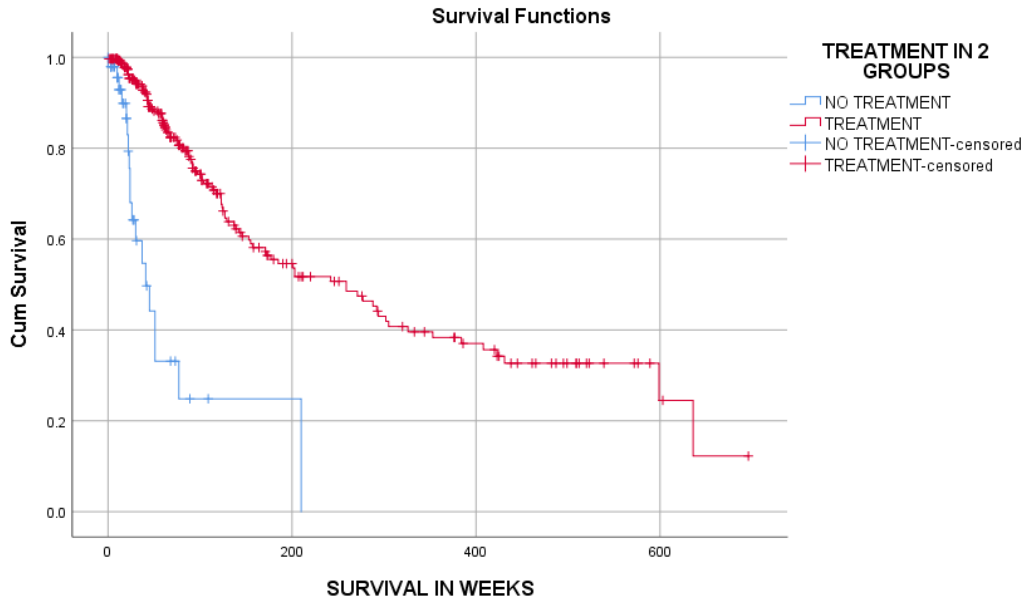

Figure 9: Kaplan-Meier curve by Treatment

A total of 328 patients were included in the Cox regression analysis, comprising 115 deaths and 213 censored observations.

On univariate analysis, anemia (HR=0.646, p=0.027), leukocytosis (HR=1.686, p=0.003), advanced stage disease (HR=1.817, p=0.001), and treatment status (HR=0.179, p<0.001) were significantly associated with survival, while age was not.

On multivariate analysis, leukocytosis (aHR=1.518, p=0.024), advanced stage disease (aHR=1.560, p=0.022), and treatment status (aHR=0.222, p<0.001) remained independent predictors of overall survival. Anemia and age were not independently associated with survival after adjustment. This is shown in Table 6

Table 5: Kaplan–Meier Survival Analysis of Clinicopathological and Hematological Variables

Variable	Median Survival (weeks)	Log-rank χ^2	p-value
Age group		0.490	0.484
<60 years	277		
≥60 years	172		
Stage at presentation		11.718	0.003*
Early (IA–IIA)	259		
Locally advanced (IIB–IVA)	172		
Metastatic (IVB)	62		
White blood cell count		14.023	0.001*
Leucopenia	259		
Normal	277		
Leucocytosis	102		
Platelets		1.272	0.529
Thrombocytopenia	-		
Normal platelet count	210		
Thrombocytosis	177		
Comorbidity		0.034	0.854
No comorbidities	203		
Comorbidities present	242		
Histology		0.597	0.440
Squamous cell carcinoma	203		
Non squamous cell carcinoma histologies	104		
Treatment		52.061	<0.001*
No treatment	41		
Treatment received	259		
Hemoglobin level		4.974	0.026*
Anemia	137		
Normal Hb level	242		
Retroviral status		0.453	0.501
Negative	203		
Positive	105		

*Significant at $p < 0.05$

Cox Regression Analysis

.

Table 6: Univariate and Multivariate Cox Regression Analysis of Factors Associated with Overall Survival

Variable	**Unadjusted Hazard Ratio (HR)**	**95% CI**	**p-value**	**Adjusted Hazard Ratio (aHR)**	**95% CI**	**p-value**
Anemia (Hb <10g/dL)	0.646	0.439–0.952	0.027	0.928	0.601–1.434	0.738
WBC at presentation	1.686	1.200–2.369	0.003	1.518	1.058–2.178	0.024
Stage at presentation	1.817	1.258–2.625	0.001	1.560	1.066–2.283	0.022
Age group	1.140	0.789–1.646	0.485	1.079	0.735–1.585	0.698
Treatment status	0.179	0.106–0.302	<0.001	0.222	0.127–0.390	<0.001

DISCUSSION

In this retrospective descriptive study of cervical cancer patients treated at the Radiotherapy Department, University College Hospital in Ibadan, Nigeria, baseline hematological abnormalities, particularly anemia, leukocytosis, and thrombocytosis, were common. Hematological abnormalities demonstrated prognostic relevance. On multivariate analysis, however, only leukocytosis, advanced stage at presentation, and treatment status remained independent predictors of overall survival. Although anemia was associated with reduced survival on univariate analysis, it did not retain statistical significance after adjustment, suggesting its effect may be mediated by disease burden and treatment-related factors.

The prevalence of anemia at presentation (~37%) is consistent with findings from other sub-Saharan African cohorts, where late presentation, chronic vaginal bleeding, malnutrition, and limited access to early care contribute significantly to low baseline hemoglobin levels.[11,12,32–34] The observed univariate association between anemia and reduced survival aligns with established radiobiological principles. Tumor hypoxia secondary to anemia has been shown to impair radiotherapy efficacy through hypoxia-inducible factor (HIF)-mediated pathways, promoting angiogenesis, genomic instability, and treatment resistance.[15,16,21,34] Contemporary data reaffirm this relationship using modern techniques, suggesting the association is robust across eras and care contexts.[23] However, the loss of independent significance in multivariate analysis in our study suggests that anemia may function more as a surrogate marker of advanced disease and poor general condition rather than as an independent driver of mortality in this population.

Leukocytosis was observed in approximately one-fifth of patients and remained an independent predictor of poor survival. The prevalence is higher than many historical reports from high-income settings (often 1–10%), but comparable to some LMIC settings

and recent African cohorts.[13,29,35] This could plausibly be due to more advanced disease, infectious comorbidities, and delayed presentation.[13,29] Consistent with Japanese and international series, leukocytosis portended significantly worse survival and may signify a distinct, cytokine-driven, radioresistant phenotype.[14]

Stage at presentation emerged as a strong independent predictor of survival, which is consistent with extensive global literature.[7,8,36–41] Patients with early-stage disease demonstrated markedly better survival compared with those presenting with locally advanced or metastatic disease. This finding reflects the well-established relationship between tumor burden, treatment feasibility, and curability in cervical cancer, particularly in settings where delayed presentation remains common.

Treatment status was the strongest independent predictor of survival in this study. Patients who received any form of definitive treatment had significantly improved survival compared with untreated patients. This finding underscores the critical role of access to radiotherapy and chemotherapy in determining outcomes in low-resource settings. The large survival gap between treated and untreated patients highlights ongoing challenges related to late presentation, treatment delays, and system-level constraints in oncology care delivery in Nigeria.

Thrombocytosis was present in ~15% and trended toward worse survival but was without statistical significance. Several meta-analyses across cancers and gynecologic malignancies support thrombocytosis as an adverse marker. However, results in cervical cancer are not uniformly consistent, potentially due to heterogeneous thresholds, stages, and treatment eras.[17–20,25,42] These associations suggest that thrombocytosis might reflect higher tumour burden, more aggressive disease, and potentially a systemic inflammatory milieu that facilitates tumour progression. The non-significant trend in this study likely reflects limited power and unmeasured confounding (e.g., intercurrent infection, iron deficiency). Clinically, monitoring platelet counts may inform prognosis and guide more aggressive or tailored treatment. For example, close follow-up, earlier intervention, or consideration of adjunctive anti-inflammatory therapies. However, as with other retrospective indicators, platelet count has limitations including variability in cutoffs and potential confounding by comorbid conditions (infection, bleeding, etc.).

From a clinical perspective, these findings support the utility of baseline hematological parameters, particularly WBC count, as inexpensive adjuncts for early risk stratification in cervical cancer patients. While anemia may not independently predict survival after adjustment, it remains clinically important due to its association with functional status, treatment tolerance, and quality of life. Leukocytosis, in contrast, appears to represent a more robust marker of aggressive tumor biology and poor prognosis.

Biological plausibility

The anemia–outcome link is biologically compelling. Tumor hypoxia triggers HIF-dependent transcriptional programs that enhance angiogenesis, epithelial–

mesenchymal transition, genomic instability, and DNA repair capacity, collectively fostering metastasis and resistance to chemoradiation.[21,22] Conversely, leukocytosis reflects tumor-promoted myelopoiesis and a pro-inflammatory milieu (G-CSF/GM-CSF/IL-6/TNF-α), favoring immune evasion, neutrophil extracellular trap formation, and pro-metastatic niche conditioning.[14] Platelets facilitate hematogenous spread and shield circulating tumor cells, offering mechanistic support for thrombocytosis as a risk marker.[18,20]

Clinical implications

Our results emphasize three pragmatic actions for similar Nigerian clinics:

Baseline risk stratification: Incorporate hemoglobin, WBC, and platelet counts into the initial assessment to flag high-risk patients for closer monitoring and supportive care.[11,28]

Address inflammation/infection and nutrition: Evaluate and treat sources of leukocytosis (infection, tumor necrosis/bleeding), and implement nutritional support, which may indirectly improve hematologic status and treatment tolerance.[28,29]

Optimize oxygenation before/during RT: Consider timely correction of clinically significant anemia (e.g., transfusion per institutional thresholds), ideally before and early during chemoradiation to mitigate hypoxia-related radioresistance; a recent consensus supports liberal transfusion thresholds in curative RT when hypoxia is a concern.[24]

Strengths and limitations

The strengths of this study include a sizeable, real-world Nigerian cohort and long follow-up. The limitations of the study relate to the retrospective design and incomplete control for treatment heterogeneity (e.g., transfusion practices, chemotherapy dose intensity, delays or interruption), infection burden, and nutritional indices. We also lacked standardized anemia management pathways and inflammatory markers (C-Reactive Protein (CRP), Neutrophil-to-Lymphocyte Ratio (NLR)/ Platelet-to-Lymphocyte Ratio (PLR)), which recent studies suggest are prognostically informative.[43] Although comorbidities were included in the survival analyses and were not significantly associated with overall survival, information on disease severity, medication use, and adequacy of control was unavailable, which may have influenced the observed outcomes.

Future directions

Prospective, multicenter Nigerian/African studies should embed standardized anemia/leukocytosis pathways, track time-to-treatment and adherence, integrate systemic inflammatory and nutritional indices (e.g., NLR, PLR, Prognostic Nutritional Index (PNI)), and evaluate protocolized transfusion strategies and infection control on survival and treatment completion. Prospective trials or implementation studies could be highly impactful.

CONCLUSION

In conclusion, leukocytosis, advanced stage at presentation, and treatment status are independent predictors of overall survival in cervical cancer patients in this Nigerian cohort. Hematological parameters, particularly white

blood cell count, may serve as practical, low-cost prognostic tools in resource-limited settings, but should be interpreted alongside established clinical factors such as stage and treatment access.

REFERENCES

1. 566-nigeria-fact-sheet.pdf [Internet]. [cited 2025 Jul 12]. Available from: https://gco.iarc.who.int/media/globocan/factsheets/populations/566-nigeria-fact-sheet.pdf
2. Jedy-Agba E, Curado MP, Ogunbiyi O, Oga E, et al. Cancer incidence in Nigeria: a report from population-based cancer registries. Cancer epidemiology. 2012;36(5):e271–8.
3. Bray F, Laversanne M, Sung H, Ferlay J,, et al. Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2024;74(3):229–63. doi:10.3322/caac.21834 PubMed PMID: 38572751.
4. Denny L. Cervical cancer: prevention and treatment. Discovery medicine. 2012;14(75):125–31.
5. (PDF) Hematological abnormalities before and after initiation of cancer treatment among breast cancer patients attending at the University of Gondar comprehensive specialized hospital cancer treatment center. ResearchGate. doi:10.1371/journal.pone.0271895
6. Torre LA, Bray F, Siegel RL, Ferlay J, et.al. Global cancer statistics, 2012. CA A Cancer J Clinicians. 2015 Mar;65(2):87–108. doi:10.3322/caac.21262
7. Adewuyi SA, Shittu SO, Rafindadi AH. Sociodemographic and clinicopathologic characterization of cervical cancers in northern Nigeria. European journal of gynaecological oncology. 2008;29(1):61–4.
8. Orekoya AA, Abdus-Salam AA, Oyesegun AR, Ntekim AI, et al. EGFR and HER2 expression in cervical cancer patients in Ibadan, Nigeria. Ecancermedicalscience. 2023 Oct 2;17:1607. doi:10.3332/ecancer.2023.1607 PubMed PMID: 38414930; PubMed Central PMCID: PMC10898916.
9. Abdus-Salam AA, Ogunnorin OB, Abdus-Salam RA. HIV seroprevalence in patients with carcinoma of the cervix in Ibadan, Nigeria. Ghana medical journal. 2008;42(4):141.
10. Folasire A, Folorunso S, Orekoya A, Ehiedu C, et.al. Pattern and outcome of admission of cancer patients at radiation oncology ward University College Hospital Ibadan Nigeria. Journal of Radiation Medicine in the Tropics. 2020;1(2):67–71.
11. Ahmed Y, Okwesili A, Malami I, Udomah et.al. Some haematological and haemostatic parameters among women with cervical cancer in Sokoto, North Western Nigeria. Sokoto J Med Lab Sci. 2017;2(1):236–51.
12. Jimoh MA, Onifade AA, Abbiyesuku FM, Edem VF, et.al. Haemocytometric profile and plasma levels of selected cytokines in patients at various stages of cervical cancer [Internet]. 2023 [cited 2024 Oct 13]. Available from: https://repozytorium.ur.edu.pl/handle/item/9496

13. Mabuchi S, Matsumoto Y, Isohashi F, Yoshioka Y, et al. Pretreatment leukocytosis is an indicator of poor prognosis in patients with cervical cancer. Gynecologic oncology. 2011;122(1):25–32.
14. Mabuchi S, Matsumoto Y, Kawano M, Minami K, et al. Uterine cervical cancer displaying tumor-related leukocytosis: a distinct clinical entity with radioresistant feature. JNCI: Journal of the National Cancer Institute. 2014;106(7):dju147.
15. Dunst J, Kuhnt T, Strauss HG, Krause U, et al. Anemia in cervical cancers: impact on survival, patterns of relapse, and association with hypoxia and angiogenesis. International Journal of Radiation Oncology* Biology* Physics. 2003;56(3):778–87.
16. Haensgen G, Krause U, Becker A, Stadler P, et al. Tumor hypoxia, p53, and prognosis in cervical cancers. International Journal of Radiation Oncology*Biology*Physics. 2001 Jul 15;50(4):865–72. doi:10.1016/S0360-3016(01)01523-1
17. Tal O, Eitan R, Gemer O, Helpman L, et al. Prognostic significance of pretreatment thrombocytosis in endometrial cancer: an Israeli Gynecologic Oncology Group study. International Journal of Gynecological Cancer. 2021;31(11):1437–42.
18. Yu M, Liu L, Zhang BL, Chen Q, et al. Pretreatment thrombocytosis as a prognostic factor in women with gynecologic malignancies: a meta-analysis. Asian Pacific Journal of Cancer Prevention. 2012;13(12):6077–81.
19. Shu C, Wang X, Li C, Huang J, et al. Revisiting the association between pretreatment thrombocytosis and cancer survival outcomes: an umbrella review of meta-analyses. BMC Cancer. 2024 Oct 9;24(1):1246. doi:10.1186/s12885-024-13027-6 PubMed PMID: 39385116; PubMed Central PMCID: PMC11462685.
20. Sharma D, Singh G. Thrombocytosis in gynecological cancers. Journal of Cancer Research and Therapeutics. 2017;13(2):193–7.
21. Höckel M, Schlenger K, Aral B, Mitze M, et.al. Association between tumor hypoxia and malignant progression in advanced cancer of the uterine cervix. Cancer research. 1996;56(19):4509–15.
22. Otrock ZK, Hatoum HA, Awada AH, Ishak RS, Shamseddine AI. Hypoxia-inducible factor in cancer angiogenesis: structure, regulation and clinical perspectives. Critical reviews in oncology/hematology. 2009;70(2):93–102.
23. Díaz JFR. Hemoglobin level and survival in cervical cancer with chemoradiotherapy at high altitude, 2020–2022. ecancermedicalscience. 2024;18:1767.
24. Zayed S, Nguyen TK, Lin C, Boldt G, et al. Red blood cell transfusion practices for patients with cervical cancer undergoing radiotherapy. JAMA network open. 2021;4(4):e213531–e213531.
25. Cheng J, Zeng Z, Ye Q, Zhang Y, et al. The association of pretreatment thrombocytosis with prognosis and clinicopathological significance in cervical cancer: a systematic review and meta-analysis. Oncotarget. 2017;8(15):24327.
26. Cao W, Yao X, Cen D, Zhi Y, Zhu N, Xu L. Prognostic role of pretreatment

thrombocytosis on survival in patients with cervical cancer: a systematic review and meta-analysis. World J Surg Onc. 2019 Dec;17(1):132. doi:10.1186/s12957-019-1676-7

27. Kawano M, Mabuchi S, Matsumoto Y, Sasano T, et al. Prognostic Significance of Pretreatment Thrombocytosis in Cervical Cancer Patients Treated With Definitive Radiotherapy. Int J Gynecol Cancer. 2015 Nov;25(9):1656–62. doi:10.1097/IGC.0000000000000533 PubMed PMID: 26332391.
28. Ola IO, Okunowo AA, Habeebu MY, Miao Jonasson J. Clinical and non-clinical determinants of cervical cancer mortality: A retrospective cohort study in Lagos, Nigeria. Front Oncol. 2023 Feb 16;13:1105649. doi:10.3389/fonc.2023.1105649 PubMed PMID: 36874121; PubMed Central PMCID: PMC9978796.
29. Berta DM, Teketelew BB, Chane E, Bayleyegn B, et al. Hematological changes in women with cervical cancer before and after cancer treatment: retrospective cohort study. Sci Rep. 2024 Nov 12;14(1):27630. doi:10.1038/s41598-024-75937-6
30. Geneva S, Organization WH. Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. Vitamin and mineral nutrition information system Document Reference WHO. 2011.
31. Atallah-Yunes SA, Ready A, Newburger PE. Benign ethnic neutropenia. Blood reviews. 2019;37:100586.
32. Emenuga V. Some Haematological and Haemostatic Parameters Among Women with Cervical Cancer in Sokoto, North Western Nigeria. [Internet]. [cited 2024 Oct 13]. Available from: https://www.researchgate.net/profile/Osaro-Erhabor/publication/319163159_Some_Haematological_and_Haemostatic_Parameters_Among_Women_with_Cervical_Cancer_in_Sokoto_North_Western_Nigeria/links/59962c3daca27283b11be9d1/Some-Haematological-and-Haemostatic-Parameters-Among-Women-with-Cervical-Cancer-in-Sokoto-North-Western-Nigeria.pdf
33. Choi YS, Yi CM, Sin JI, Ye GW, et.al. Impact of hemoglobin on survival of cervical carcinoma patients treated with concurrent chemoradiotherapy is dependent on lymph node metastasis findings by magnetic resonance imaging. International Journal of Gynecologic Cancer. 2006 Sep 1;16(5). doi:10.1136/ijgc-00009577-200609000-00019 PubMed PMID: 17009981.
34. Grogan M, Thomas GM, Melamed I, Wong FLW, et al. The importance of hemoglobin levels during radiotherapy for carcinoma of the cervix. Cancer. 1999;86(8):1528–36. doi:10.1002/(SICI)1097-0142(19991015)86:8<1528::AID-CNCR20>3.0.CO;2-E
35. Koulis TA, Kornaga EN, Banerjee R, Phan T, et al. Anemia, leukocytosis and thrombocytosis as prognostic factors in patients with cervical cancer treated with radical chemoradiotherapy: A retrospective cohort study. Clinical and Translational Radiation Oncology. 2017 Jun 1;4:51–6. doi:10.1016/j.ctro.2017.05.001

36. Orekoya AA, Adenipekun A, Abdus-Salam AA, Ntekim AI, et al. Outcome Of Management Of Cervical Cancer Patients In A Tertiary Hospital In South Western, Nigeria. Nigerian Journal Of Oncology. 2025 Jan 16;1(1):30–51.
37. Wassie M, Argaw Z, Tsige Y, Abebe M, Kisa S. Survival status and associated factors of death among cervical cancer patients attending at Tikur Anbesa Specialized Hospital, Addis Ababa, Ethiopia: a retrospective cohort study. BMC cancer. 2019;19:1–11.
38. Sung H, Ferlay J, Siegel RL, Laversanne M, et al. Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA: a cancer journal for clinicians. 2021;71(3):209–49.
39. Wadhwani R, Bamnia R, Meena M. Clinico-pathological analysis of cancer cervix in tertiary care centre. Journal of Evolution of Medical and Dental Sciences. 2013;2(39):7381–6.
40. Musa J, Nankat J, Achenbach CJ, Shambe IH, et al. Cervical cancer survival in a resource-limited setting-North Central Nigeria. Infectious agents and cancer. 2016;11(1):1–7.
41. Gizaw M, Addissie A, Getachew S, Ayele W, et al. Cervical cancer patients presentation and survival in the only oncology referral hospital, Ethiopia: a retrospective cohort study. Infectious agents and cancer. 2017;12:1–7.
42. Hernandez E, Lavine M, Dunton CJ, Gracely E, Parker J. Poor prognosis associated with thrombocytosis in patients with cervical cancer. Cancer. 1992 Jun 15;69(12):2975–7. doi:10.1002/1097-0142(19920615)69:12<2975::AID-CNCR2820691218>3.0.CO;2-A
43. Jia S zheng, Yang X jiao, Yang D, Wang R, et al. Low pretreatment prognostic nutritional index predicts unfavorable survival in stage III-IVA squamous cervical cancer undergoing chemoradiotherapy. BMC Cancer. 2025 Feb 28;25(1):377. doi:10.1186/s12885-025-13752-6