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p53 Protein Expression in Epithelial Ovarian Cancer and its Association with Clinicopathological Features as Seen in Selected Histopathology Laboratories in Kampala

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Abstract

Background: *Ovarian cancer ranks as the seventh most common cancer among women globally, with epithelial ovarian cancer (EOC) comprising the majority of cases. In low- and middle-income countries, late-stage diagnoses contribute to high mortality. Altered p53 protein expression, linked to p53 gene mutations, increases EOC risk and has prognostic implications.*

Objective: *To determine p53 protein expression prevalence and its association with clinicopathological features in EOC from selected laboratories in Kampala, Uganda.*

Materials and Methods: *A cross-sectional laboratory study was conducted at the Department of Pathology, Makerere University College of Health Sciences. Archived formalin-fixed paraffin-embedded tissue blocks from patients diagnosed with EOC (2008–2023) were retrieved from Makerere University, Mulago National Referral Hospital, Uganda Cancer Institute, and Multisystem Clinical Laboratory. Serial sections were stained with hematoxylin and eosin (H&E) for histological confirmation and immunohistochemistry (IHC) using a mouse-derived monoclonal p53 antibody. Data were analyzed using SPSS and presented in tables, graphs, and pie charts.*

Result: *Of 104 analyzed EOC tissue blocks, the mean patient age was 49 years (SD ± 13). Serous carcinoma predominated (89.4%, 93/104), followed by well-differentiated (33.7%), poorly differentiated (31.7%), and moderately differentiated (26.9%) grades. p53 expression was positive in 68.3% (71/104) of cases. No significant associations were found between p53 expression and age, histological type, or grade ($p > 0.05$).*

Conclusion: *p53 expression was prevalent in 68.3% of EOC cases in Kampala but showed no significant association with age, histological subtype, or tumor grade.*

Keywords: *Epithelial ovarian cancer, p53 expression, immunohistochemistry, clinicopathological features*

1. BACKGROUND

Ovarian cancer is the seventh most common cancer among women worldwide, with an estimated 238,700 new cases and 151,900 deaths each year (1). In developing countries, it ranks eighth and is the fourth most frequently diagnosed gynecologic malignancy, accounting for the highest mortality among such cancers (2, 3). In East Africa, approximately 4,700 new cases and 3,300 deaths are reported annually. The Kampala Cancer Registry recorded 626 ovarian cancer cases from 1991 to 2015, with an incidence rate of 8.3 per 100,000 women between 2011 and 2015, peaking at 8.5 per 100,000 women from 2001 to 2005 (4).

Epithelial ovarian cancer (EOC) is the predominant subtype (5), with 11% to 90% of cases showing altered p53 protein expression due to mutations in the p53 gene, located on the short arm of chromosome 17 at position 21 (6,7). This

gene, essential for DNA repair, is the most frequently mutated in high-grade serous carcinoma, significantly increasing EOC risk (8). These mutations have critical therapeutic and prognostic implications, with drugs like COTI-2 targeting p53 for treatment (9, 10).

Immunohistochemistry (IHC) staining provides a cost-effective approach to evaluate p53 expression in EOC, becoming increasingly available in low- and middle-income countries like Uganda (11). IHC-detected alterations in p53 expression correlate closely with p53 gene mutations, supporting its use in routine clinical practice. This study aimed to determine the proportion of epithelial ovarian cancer (EOC) cases with altered p53 protein expression using immunohistochemistry (IHC) analysis on archived tissue blocks from the Department of Pathology at Makerere University, Mulago National Referral Hospital, Multisystem Clinical Laboratory, and Uganda Cancer Institute's Histopathology Laboratory, for cases diagnosed between 2008 and 2023. It also investigated associations with age, histologic type, and tumor grade.

2. MATERIALS AND METHODS

2.1. Study Design and Settings

This cross-sectional, laboratory-based study was conducted at the Department of Pathology, Makerere University College of Health Sciences, within the School of Biomedical Sciences, Kampala, Uganda. Archived tissue samples were obtained from four key pathology laboratories: Makerere University College of Health Sciences, Mulago National Referral Hospital, Uganda Cancer Institute, and Multisystem Clinical Laboratory. These institutions collectively serve as national hubs for teaching, research, and diagnostic biopsy services, processing over 12,000 tissue biopsies annually. The study was conducted over an eleven-month period, from March 2022 to February 2023, allowing sufficient time for sample collection, processing, and analysis.

2.2. Study Population

The study population consisted of archived formalin-fixed paraffin-embedded (FFPE) tissue blocks from patients diagnosed with epithelial ovarian cancer (EOC) between January 2008 and February 2023. These blocks were retrieved from the pathology archives of Makerere University College of Health Sciences, Mulago National Referral Hospital, Uganda Cancer Institute, and Multisystem Clinical Laboratory. This population included all available FFPE blocks with a histologically confirmed EOC diagnosis, ensuring a comprehensive representation of cases diagnosed over the 15-year period.

2.3. Sample Size Estimation

The sample size was calculated using the Kish-Leslie (1965) formula: $n = (z^2 \times p(1-p))/e^2$, where n is the required sample size, z is the standard normal deviate (1.96 for a 95% confidence interval), p is the estimated proportion of epithelial ovarian cancer (EOC) cases with p53 expression (set at 50% due to the absence of local prevalence data), and e is the margin of error (5%). Substituting these values: $n = (1.96^2 \times 0.5 \times 0.5)/(0.05^2) = (3.8416 \times 0.25)/0.0025 = 384.16$. Considering a finite population of approximately 150 eligible tissue blocks meeting the inclusion criteria, a finite population correction was applied (12): N = (n × Population size)/(n + (Population size - 1)), resulting in $N = (384.16 \times 150)/(384.16 + (150 - 1)) = 57624/533.16 \approx 108$. Thus, a minimum sample size of 108 tissue blocks was required. Samples were proportionally allocated to ensure balanced representation: 30 from Uganda Cancer Institute, 10 from Mulago National Referral Hospital, 30 from Multisystem Clinical Laboratory, and 34 from Makerere University College of Health Sciences

2.4. Sample Collection and Processing

A proportionate sampling technique was used to select 108 EOC tissue blocks from the four laboratories. Each block was assigned a unique identification number to ensure traceability and confidentiality. For cases with multiple blocks, the block containing the most representative tumor tissue was selected based on hematoxylin and eosin (H&E) evaluation. Laboratory technicians retrieved FFPE blocks using histology numbers and corresponding request forms or reports. Two sections were cut from each block: one stained with H&E for histological confirmation and the other processed for immunohistochemistry (IHC) to evaluate p53 protein expression. All procedures adhered to standard operating procedures (SOPs). H&E staining followed the protocol while IHC staining used a mouse monoclonal primary antibody for p53, with colorectal carcinoma tissue as a positive control, consistent with established methods (13).

2.5. Data Collection

Data were collected by the Principal Investigator using a standardized paper-based data abstraction

form, with each tissue block assigned a unique identifier to maintain anonymity. H&E-stained slides were evaluated by the Principal Investigator and independently reviewed by two supervising pathologists using the World Health Organization (WHO) classification and grading system for EOC (Appendix 4). Evaluations were performed using a Leica MD500 microscope. Disagreements between pathologists were resolved through re-examination under a multi-headed microscope to reach a consensus. IHC-stained slides were scored based on the percentage of tumor cells with nuclear staining: 0 (<10%), 1 (11–25%), 2 (26–50%), or 3 (>50%). Scores of 2 or 3 were classified as p53-positive, following (14). IHC evaluations were similarly verified by supervising pathologists, with consensus reached for any discrepancies.

2.6. Statistical Analysis

Data from the paper-based forms were entered into Epi Data Entry software and exported to SPSS version 17 for cleaning and analysis. Categorical variables, including histological subtype and tumor grade, were summarized as percentages and visualized using bar graphs. Continuous variables, such as age at diagnosis, were reported as means, medians, and standard deviations. The Chi-square test was used to assess associations between p53 expression and categorical variables, with a p-value of ≤ 0.05 considered statistically significant. This rigorous statistical approach ensured robust analysis of relationships between p53 expression and clinical or histological factors.

2.7. Quality Control

All laboratory procedures strictly adhered to SOPs to ensure reliability. Microtome blades were cleaned or replaced regularly to prevent artifacts. Staining was performed by a qualified technician in collaboration with the Principal Investigator. Reagents were checked for expiry dates and stored under optimal conditions. IHC staining was optimized using control tissues with varying antibody dilutions, incubation times, and antigen retrieval buffers. Freshly prepared IHC reagents were used to ensure consistency. All slides were evaluated using a single, regularly cleaned Leica MD500 microscope. H&E and IHC assessments were independently confirmed by two pathologists, with discrepancies resolved through consensus. Data analysis was supported by a qualified biostatistician, and data were securely backed up at multiple locations to protect against loss.

3. RESULTS

3.1. Clinicopathologic Characteristics of Epithelial Ovarian Cancer Study Cases

Of the 108 epithelial ovarian cancer (EOC) specimens collected, 104 were analyzed; four were excluded due to insufficient tumor tissue for immunohistochemistry (IHC) analysis. Patient ages ranged from 20 to 80 years, with a mean of 49 years (SD ± 13) and a peak at 50 years. The 50–59-year age group was the most prevalent, and 52% of patients (54/104) were aged 50 years or older, as presented in Table 1.

Table 1. *Characteristics of specimen of patients with epithelial ovarian cancer*

Characteristics	Frequency(n=104)	Proportion (%)
Age		
<50	50	48
≥50	54	52
Total	104	100

3.2. Histological Types and Grades of Epithelial Ovarian Cancer

Following the World Health Organization (WHO) classification, serous adenocarcinoma was the predominant histological type, comprising 89.4% (93/104) of cases (Figure 1), followed by Brenner tumors at 7.7% (8/104, Figure 2), mucinous adenocarcinoma at 1.9% (2/104, Figure 3), and endometrioid adenocarcinoma at 1.0% (1/104, Figure 4). The eight Brenner tumors were not graded due to their histological characteristics. Among graded tumors, well-differentiated adenocarcinomas were the most common, followed by poorly differentiated and moderately differentiated adenocarcinomas, as shown in Table 2.

Table 2. *Histological types and grade of Epithelial Ovarian Cancer*

Histological parameters	Frequency n = 104	Proportion%
Histological type		
Serous type	93	89.4

Mucinous type	2	1.9
Brenner type	8	7.7
Endometroid type	1	0.96
Histological grade		
Well-differentiated	35	33.7
Moderately differentiated	28	26.9
Poorly differentiated	33	31.7

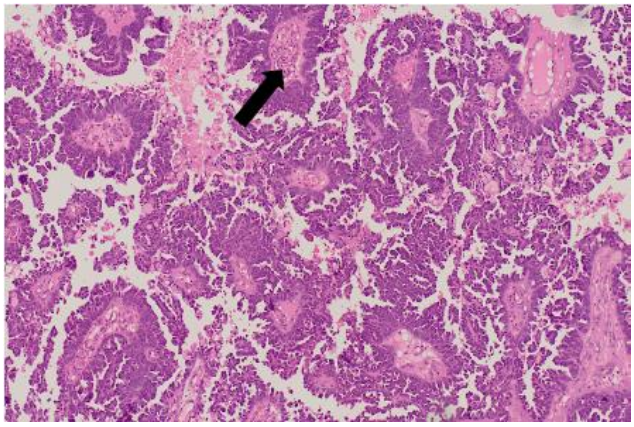

Figure 1. *Photomicrograph showing moderately differentiated serous adenocarcinoma under H&E stain (X200).*

The above micrograph shows malignant epithelial cells forming papillary projections with fibrovascular cores (black arrow)

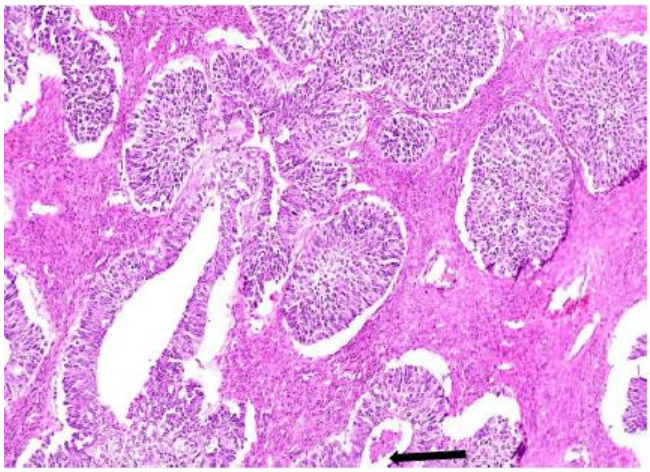

Figure 2. *Photomicrograph showing atypical transitional cells under (H&E stain X200)*

The above micrograph shows atypical neoplastic cells infiltrating a desmoplastic stroma with luminal necrosis (black arrow).

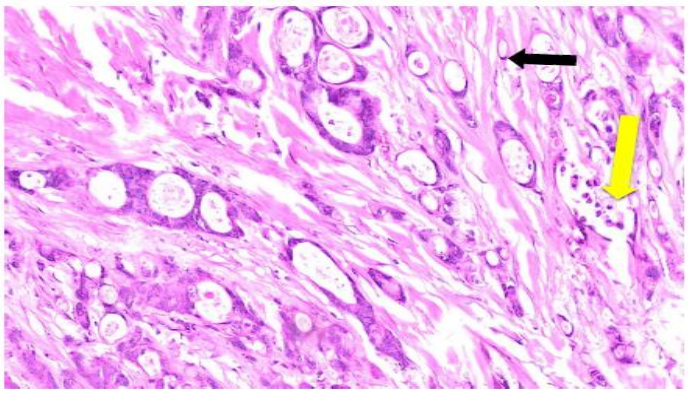

Figure 3. *Photomicrograph showing moderately differentiated mucinous under H&E stain (X200)*

The above photomicrograph shows poorly formed neoplastic glands, irregular clusters of neoplastic cells and scattered signet ring cells (black arrow) floating in mucinous pools (yellow arrow)

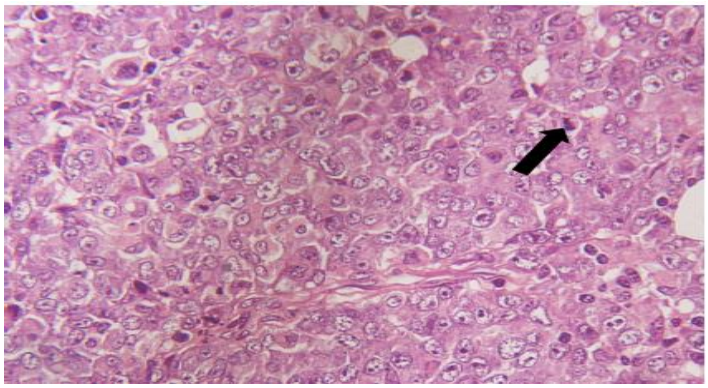

Figure 4. *Photomicrograph shows poorly differentiated Endometroid adenocarcinoma under H&E stain (X400).*

The above photomicrograph shows poorly formed neoplastic glands, with abnormal mitosis (arrow).

3.3. Prevalence of p53 Expression in Epithelial Ovarian Cancer

Of the 104 analyzed samples, 71 (68.3%) exhibited positive p53 protein expression, while 33 (31.7%) were negative, as detailed in Table 3. Representative images of positive and negative p53 staining are shown in Figures 5 and 6, respectively.

Table 3. *Prevalence of p53 in epithelial ovarian cancer*

p53 expression in EOC		
	Frequency	**Proportion (%)**
Positive	71	68.3
Negative	33	31.7
Total	104	100

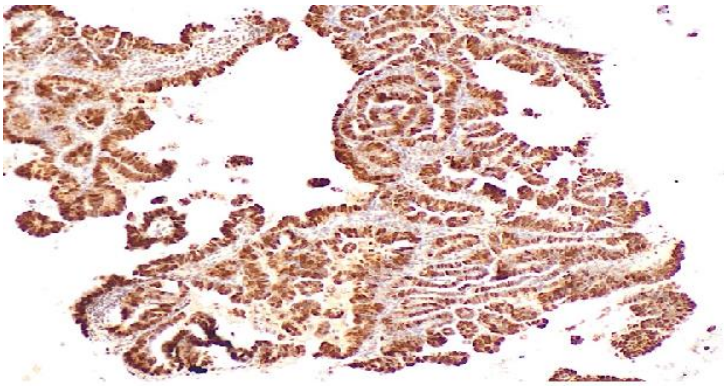

Figure 5. *photomicrograph showing p53 positive (IHC stain X400).*

The above photomicrograph Shows strong brown nucleus staining of the serous subtype about 100%.

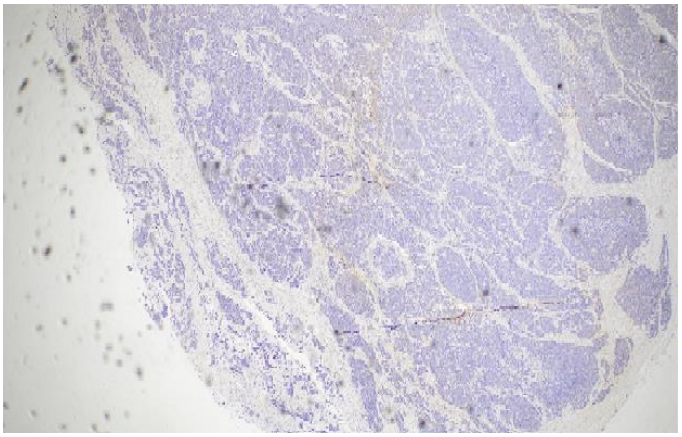

Figure 6. *Photomicrograph showing p53 negative score 0 (IHC stain X200)*

3.4. Association Between p53 Expression and Age in Epithelial Ovarian Cancer

P53 expression was more frequent in patients aged 50 years or older (72.2%, 39/54) compared to those younger than 50 years (64.0%, 32/50), as shown in Table 4. However, this difference was not statistically significant (p = 0.368, Chi-square = 0.81

Table 4. *Association between p53 expression and age in epithelial ovarian Cancer*

Age	Positive n (%)	Negative n (%)	P-value
<50	32 (64)	18 (36)	0.368
≥50	39 (72.2)	15 (27.8)	
Chi-square value		0.81	

3.5. p53 Expression and Association with Histological Type of Epithelial Ovarian Cancer

p53 positivity was highest in mucinous (100%, 2/2) and endometrioid (100%, 1/1) adenocarcinomas, followed by serous (67.7%, 63/93) and Brenner (62.5%, 5/8) subtypes, as presented in Table 5.

No statistically significant association was observed between p53 expression and WHO histological types (p = 0.676, Chi-square = 0.092).

Table 5. *P53 expression and histology type*

Histologic type	Positive n (%)	Negative n (%)	P-value
Serous type	63 (67.7)	30 (32.3)	0.676
Mucinous type	2	0 (0.0)	
Malignant Brenner type (Transitional type)	5 (62.5)	3 (37.5)	
Endometroid type	1	0 (0)	
Chi-square value		0.092	

3.6. p53 Expression and Association with Tumor Grade of Epithelial Ovarian Cancer

p53 expression was most prevalent in poorly differentiated tumors (75.8%, 25/33), followed by moderately differentiated (71.4%, 20/28) and well-differentiated tumors (60.0%, 21/35), as shown in Table 6.

No statistically significant association was found between p53 expression and tumor grade (p = 0.351, Chi-square = 2.1)

Table 6. *Correlation between p53 protein expression and grade of epithelial ovarian cancer***:**

Histologic grade	Positive n (%)	Negative n (%)	P-value
Well-differentiated	21 (60)	14 (40)	
Moderately differentiated	20 (71.4)	8 (28.6)	0.351
Poorly differentiated	25 (75.8)	8 (24.2)	
Chi-square value		2.1	

4. DISCUSSION

The prevalence of p53 protein expression in epithelial ovarian cancer (EOC) was 68.3%, aligning closely with studies from the United States, Greece, and Finland, which reported rates of 65% to 70% (15–17). In contrast, a Chinese study found a lower prevalence of 54.2% (18), while a Tanzanian study reported a significantly lower rate of 18% (19). These differences may arise from variations in study design, sample size, or tumor heterogeneity. Additionally, the use of different primary antibody clones for p53 detection in immunohistochemistry (IHC) likely contributes to the variability, as antibody specificity and sensitivity vary by manufacturer. Differences in IHC scoring systems across studies further complicate comparisons, as varying thresholds for positivity can significantly influence reported prevalence. The high prevalence observed here underscores p53's potential as a key biomarker in EOC, emphasizing the need for standardized IHC protocols to ensure consistency across global studies.

EOC is typically diagnosed in women in their fifth decade or later, with malignant surface epithelial tumors being rare in younger adults (20). The mean age at diagnosis in this study was

49 years, with a peak at 50 years, consistent with findings from Turkey and the United States (21,22). No statistically significant association was found between p53 expression and age at diagnosis, aligning with studies from Turkey, the United States, and Nigeria (21,23,24). This suggests that age may not strongly influence p53 expression in EOC, though the sample size (n=104) may limit the detection of subtle associations. Larger cohorts could further clarify this relationship.

The serous subtype of EOC exhibited the highest p53 positivity rate at 67.7%, consistent with a U.S. study (25). Mucinous and endometrioid subtypes showed 100% positivity, though their small sample sizes (2 and 1 cases, respectively) limit generalizability. Brenner tumors had a 62.5% positivity rate. No statistically significant association was observed between p53 expression and histological type (p=0.676), consistent with some studies (26) but contrasting with reports from Germany and Egypt that found significant associations (27,28). These discrepancies may reflect differences in IHC methodologies, sample sizes, or population-specific genetic variations.

Poorly differentiated EOC tumors showed the highest p53 expression at 75.8%, followed by moderately differentiated (71.4%) and well-differentiated tumors (60.0%), aligning with a Finnish study (29). However, no statistically significant association was found between p53 expression and tumor grade (p=0.351), contrasting with U.S. studies reporting higher p53 positivity in moderately and poorly differentiated tumors or an association with higher-grade tumors (23,30). These differences may stem from variations in grading criteria, IHC techniques, or biological differences in the populations studied.

5. Limitations

This study faced limitations that may impact its findings. Incomplete or inadequately filled request forms led to missing data, such as prior chemotherapy or radiotherapy history, potentially affecting the accuracy of clinicopathological correlations. Inappropriate tissue fixation could have influenced antigen retrieval during immunohistochemistry, potentially altering p53 expression results. The small sample size (n=104), particularly for mucinous and endometrioid subtypes, limited the generalizability of findings. Additionally, reliance on immunohistochemistry alone without molecular analysis may restrict the depth of p53 mutation insights.

6. Conclusion

This study revealed a 68.3% prevalence of p53 expression in epithelial ovarian cancer in Uganda, with no significant associations with age, histological type, or grade. Findings highlight the need for standardized immunohistochemistry protocols and larger studies to elucidate p53's role and therapeutic potential in low-resource settings.

List of Abbreviations

EOC:	Epithelial Ovarian Cancer
FFPE:	Formalin Fixed Paraffin Embedded
FIGO:	International Federation of Gynecology and Obstetric
H&E:	Hematoxylin and Eosin
HPF:	High Power Field
IHC:	Immunohistochemistry
Mab:	Monoclonal Antibody
MMR:	Mismatch Repair System
WHO	World Health Organization

Declarations

Ethics approval and consent to participate

Permission to conduct the study was granted by the School of Biomedical Sciences Research and Ethics Committee (SBSREC). The committee also approved a waiver of informed consent for the use of biopsy specimens. To ensure patient confidentiality, no personal identifiers, such as names or biopsy numbers, were used; instead, a unique approval number, SBS-2022-230, was assigned to the study.

Availability of data and materials

The data supporting the findings of this study are available upon request from the corresponding author.

Competing interests

The authors declare that they have no competing interests.

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Authors' Contributions

R.A.M. conceptualized and designed the study, gathered and organized data, performed the analysis, and drafted and revised the manuscript. H.N., M.A., B.M., E.D.M, L.R.., and K.S.

contributed to the study's conceptualization, design, data collection, analysis, and manuscript revisions. B.M. conducted an extensive review and edited the final manuscript. H.N. and K.S. provided project oversight. All authors critically reviewed and approved the final manuscript for submission.

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