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SUDAN JOURNAL OF HEALTH SCIENCES

How Sudan's Conflict Drives Child Homelessness

Awareness and Use of Online Medical Resources among Medical Practitioners

Quality of Life among Sudanese Diabetic Amputees

Students' Satisfaction with Electronic vs Paper Exam

Differentiating Benign and Malignant Prostatic Lesions using Mucin and DNA Stains

VOLUME 3, ISSUE 3, SEP – DEC 2025
ISSN: 2948-3026
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SUDAN JOURNAL OF HEALTH SCIENCES

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The Sudan Journal of Health Sciences has been licensed by the National Council for Press and Journalistic Publications, identified by the number:/م ص ق م1 /ص /36 /ع أ

Dated Oct 13, 2021

The **ISSN** for the print publication "Sudan Journal of Health Sciences" is identified as **2948-3026** by the International Standard Serial Number International Centre on Feb 20, 2023.
The confirmation record is at the ISSN Portal:
https://portal.issn.org/resource/ISSN/2948-3026

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Overview

The Sudan Journal of Health Sciences (SJHS) is an open-access, peer-reviewed journal (ISSN 2948-3026) dedicated to advancing health sciences through the dissemination of high-quality research articles. The journal accepts various manuscript types, including original articles, case reports, review articles, and meta-analyses. Authors must follow specific guidelines to ensure the quality and consistency of submissions.

Rules and Conditions for Publication

Authors are warmly invited to submit their manuscripts to the Sudan Journal of Health Sciences (SJHS). Each submission will be evaluated by an editor to ensure alignment with the journal's aims and scope, with suitable manuscripts progressing to peer review.

Before submission, authors must obtain permission for any materials included in their manuscript, such as photographs and datasets, and ensure all authors consent to their inclusion. Research involving human or animal subjects must receive approval from the appropriate ethics committee, in accordance with legal requirements.

While editors provide constructive feedback, some submissions may not meet the journal's publication standards. Authors are encouraged to refine their work and resubmit. It is crucial that the study design and arguments are clearly articulated, with a concise title and an independent abstract. Authors should refer to the provided checklist to prepare their submissions effectively.

Publication Steps

1. **Submission:** The author has to submit an electronic copy (Microsoft Word) of the manuscript via the official website: sjhs.fajr.edu.sd. Alternatively, submissions can be made to the academic secretary of the Journal via email:
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2. **Initial Evaluation:** The manuscript will be evaluated, and the author will be informed of the results of the initial evaluation within a week of working days.

3. **Arbitration Process:** In the event that the manuscript is initially accepted, it will be sent to the assigned arbitration committee for amendments and notes (the arbitration period takes from one to three weeks at a maximum).
4. **Revisions:** The comments and observations of the arbitration committee will be sent to the author to make the amendments, and then the author re-sends the modified version.
5. **Final Approval:** The modified version is presented again to the arbitration committee. If the manuscript is finally accepted for publication, it will be sent to the author for approval in an official, signed, and stamped form.
6. **Publication:** The author will be provided an electronic copy of the issue containing their paper when the issue is published. In the event that the author desires to obtain printed copies, they must contact the academic secretary of the Journal.

Publication Terms

The manuscript must not have been previously published or be under consideration elsewhere.

Manuscript Preparation Guidelines

1. Layout Requirements

First Page:

- **Title:** Size 16, accurate and expressive of the content of the manuscript.
- **Author(s):** Full names; abbreviate middle names (e.g., Mohamed Elnour Ali Elamin → Mohamed E. A. Elamin).
- **Affiliation:** Include the institution (e.g., Alfajr College for Science and Technology, Khartoum, Sudan).

Second Page:

- **Abstract:** In both languages (Arabic and English), max 250 words, with subheadings: background, methods, results, conclusion.
- **Keywords:** Up to six keywords in both languages, organized by importance.

2. Content Structure

- **Introduction:** Background information, including the study's aim.
- **Materials and Methods:** Study design, population, data collection, ethical considerations.
- **Results:** Findings presented with tables, figures, and graphs.

- **Discussion:** Interpretation of results and comparison with existing research.
- **Conclusion:** Summary of main points and future directions.
- **Limitations:** State any limitations.
- **Conflict of Interests:** Disclose any conflicts.
- **Acknowledgments:** Recog nize contributions or support.
- **References:** Follow Vancouver guidelines.

3. Additional Requirements

- **Size:** Manuscripts (original research) should be 3,000-6,000 words and not exceed 10 pages.
- **Font Size and Style:** Acceptable font size is 12, font style is Times New Roman.
- **Figures and Tables:** Numbered according to appearance, with font size 10 for text and 12 for titles.

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Submission Preparation Checklist

All submissions must meet the following requirements.

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- All tables and figures have been numbered and labeled.
- Permission has been obtained to publish all photos, datasets and other material provided with this submission.

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Forward and Acknowledgement

Mohammed E. A. Elameen

In the final issue of the third year of the *Sudan Journal of Health Sciences*, I am pleased, on my own behalf and on behalf of the administration of Al-Fajr College, to extend my sincere thanks, appreciation, and respect to all those who have contributed to the success and continuity of this peer-reviewed scientific *Journal*, including the esteemed reviewers listed in Table 1. The *Journal* has become, by the grace of Allah and through dedicated efforts, a reputable platform serving scientific research in Sudan and the region.

I would like to express my special appreciation to **Professor Hasan Abuaisha**, Editor-in-Chief, who has led the *Journal* with wisdom and professionalism, overseeing every detail with a high sense of responsibility, sincerity, and selflessness. His tireless dedication and commitment have been instrumental in ensuring that each issue is published to a standard befitting the *Journal's* academic standing.

DOI: https://doi.org/10.69993/2025.3.3.en1

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I also extend my profound gratitude to **Dr Egbal Ahmed Bashir Abukaraig,** the Executive Editor, for her perseverance, patience, and outstanding efforts in coordinating with authors, reviewers, and members of the editorial board. Her dedication and organizational skills have had a clear and positive impact on the smooth functioning of the editorial process and the quality of the *Journal's* output.

My appreciation also extends to the journal's young and dedicated editorial team, particularly the newly appointed assistant editors, led by **Dr Ali Adam Ali Hamad**, who have devoted their time and energy to follow-up, editing, revision, and production. Special thanks are due to **Dr. Ali**, in recognition of his diligence, collaborative spirit, and sincere commitment to advancing the *Journal*, issue after issue.

As we enter the third year of the *Journal*, we take a moment to reflect on the remarkable journey that has brought us to this end. Over the course of nine issues, the *Journal* has showcased an impressive breadth of scholarship, highlighting the rich diversity of topics across the health and science fields. Further details about the published articles are provided at the end of this editorial.

The *Journal's* continued growth would not be possible without the tremendous dedication of our reviewers, whose expertise, thoughtful evaluations, and commitment to maintaining the quality and integrity of every issue. Their careful guidance strengthens each manuscript and ensures that the *Journal* remains a trusted platform for meaningful scientific exchange. We extend our deepest appreciation for their invaluable contributions and the vital role they play in shaping the *Journal's* success. Table 2 displays the names and affiliations of those who contributed their efforts during the year 2025.

Table 2: Names of the Expert Reviewers who contributed to the production of the *Journal* issues for the year 2025

Name	Speciality	Affiliation
Prof. Abdalla Abdelrahman	Professor of Child, Adolescent and Adult Psychiatry	University of Khartoum, Sudan
Prof. Yasir Hassan Abdalla Elhassan	Professor of Clinical Anatomy and Medical Education	College of Medicine, Madinah, KSA
Prof. Imad Eldin Mohamed Taj Eldin	Professor of Pharmacology	University of Gezira, Sudan
Prof. Ahmed M. Makeen	Professor of Internal Medicine & Endocrinology	The International University of Africa, Sudan
Prof. Kamal Alzaki	Professor of Surgery	University of Khartoum, Sudan
Prof. Hassan Essa	Professor of Microbiology	Bahrain College, Sudan
Prof. Wadie Mohamed Yasin Elmadhoun	Professor of Pathology	University of Science and Technology, Aden, Yemen; University of Medical Science and Technology, Sudan
Dr. Mohamed Alamein Salih	Associate Professor of General and Colorectal Surgery and Medical Education	University of Umm Alqura, AlQunfudah, KSA
Dr. Rashida Abdelfatah Mohamed Eltayeb	Associate Professor of Nursing	University of Khartoum, Sudan
Dr. Bahaeldin Hassan	Associate Professor of Obstetrics and Gynaecology and Medical Education	College of Medicine, King Khalid University, Abha, KSA

Dr. Jalal Ali Bilal	Associate Professor of Pediatrics and Medical Education	Shaqra University, KSA
Dr. Fatima Alzahra Abdu Rahman Mustafa Galgam	Assistant Professor of Paediatric Nursing	International University of Africa, Sudan
Dr. Sharfeldin Mohammed Shuib	Assistant Professor of Surgical Nursing	Najran University, KSA
Dr. Imad Eddin Rahamtalla Musa	Consultant in Internal Medicine & Endocrinology	Royal Commission Hospital, AlJubail Industrial City, Eastern Region, KSA
Dr Lina Faisal Mohammed Altayeb	Lecturer in Clinical and Pharmacy Practice	Omdurman Islamic University, Sudan
Dr Ali Awadallah Saeed	Researcher / Lecturer in Pharmacology	Mycetoma Research Centre, University of Khartoum, Sudan

We pray that Allah blesses these endeavors and grants everyone continued success and further contributions to sound scientific research, in the service of knowledge and its community, and in the advancement of our academic institutions.

Over the past three years, the *Journal* has evolved into a multidisciplinary platform publishing editorials, original articles, and case reports that link clinical research, public health, and medical education within the Sudanese and regional context. Early issues introduced core themes in medical training and community health, while 2024 saw broader coverage of infectious diseases, nursing, maternal mental health, and health economics. By 2025, the *Journal* was featuring more advanced and timely topics—including artificial intelligence in healthcare, health system resilience during the Sudan war, child homelessness, and the psychological impact of displacement—reflecting both academic maturity and a growing commitment to addressing complex health and social challenges in the region. Table 2 displays the titles and links of each published paper since the launch of the *Journal*.

Table 2: Titles and Links of the Papers Published in the *Journal 2023-25*

	Title	Link
Volume 1, Issue 1- 2023		
1	Editorial 1 The Sudan Journal of Health Sciences	https://www.sjhsfajr.org/2023/04/editorial-1-sudan-journal-of-health.html
2	Editorial 2: Team-Based learning	https://www.sjhsfajr.org/2023/04/editorial-2-team-based-learning.html
3	Medical Students' Perception and Satisfaction towards Team-Based Learning at Alfajr College for Science and Technology, Sudan, 2022	https://www.sjhsfajr.org/2023/04/Medical-Students-Perception-and-Satisfaction.html
4	Premarital Counselling and Screening Awareness and Perception among Alfajr College for Science and Technology Medical Students, Khartoum, Sudan, 2021	https://www.sjhsfajr.org/2023/04/premarital-counseling-and-screening.html
5	First Aid Awareness and Practice of Highway Traffic Police Officers from Three States in Sudan, 2021	https://www.sjhsfajr.org/2023/04/first-aid-awareness-and-practice.html
6	Support for Distal Extension Denture Base Using Corrected Cast Technique; Case Report	https://www.sjhsfajr.org/2023/04/support-for-distal-extension-base.html
7	The Creation of Man in the Holly Qur'an "The Phenotype and the Genotype", 2023	https://www.sjhsfajr.org/2023/04/the-creation-of-man-in-quran.html
Volume 1, Issue 2- 2023		
8	Editorial 1- SJHS, the Second Issue and the Internecine Khartoum War	https://www.sjhsfajr.org/2023/08/editorial-1-second-issue-and-war.html
9	Editorial 2 - Alfajr College and Khartoum War	https://www.sjhsfajr.org/2023/08/editorial-2-alfajr-college-and-war.html
10	Editorial 3 - Analgesics and Anti-inflammatory Drugs Prescription during Pregnancy	https://www.sjhsfajr.org/2023/08/editorial-3-analgesics-and-pregnancy.html
11	Analgesics and Anti-inflammatory Prescription for Pregnant Women, Military and Khartoum Teaching Hospitals, Khartoum, Sudan, 2016	https://www.sjhsfajr.org/2023/08/analgesics-anti-inflammatory-pregnant.html
12	Validity of Rapid Diagnostic Test compared to Light Microscopy for Malaria Diagnosis at Amana Clinic in Khartoum State, 2020	https://www.sjhsfajr.org/2023/08/validity-of-rdt-compared-to-microscopy.html
13	Testicular Self-examination: Knowledge, Attitude and Practice of Male Medical Students in Alfajr College for Science and Technology, Khartoum, Sudan, 2022.	https://www.sjhsfajr.org/2023/08/testicular-self-examination-kap-of-male.html
14	Molecular Identification of Sudanese Females' Vaginal Microbiota and Microbiota associated with Bacterial Vaginosis, Khartoum, Sudan, 2018	https://www.sjhsfajr.org/2024/01/molecular-identification-of-vaginal-Microbiota.html
Volume 1, Issue 3- 2023		
15	Editorial, Social Phobia	https://www.sjhsfajr.org/2023/12/editorial-social-phobia.html
16	Research Activities and University Ranking: Academic Staff Opinion from a Sudanese University, with Roadmap for Improvement	https://www.sjhsfajr.org/2023/12/research-activities-university-ranking.html
17	Social Phobia and Academic Achievement among Alfajr College for Science and Technology Medical Students, Khartoum, 2022	https://www.sjhsfajr.org/2023/12/social-phobia-and-academic-achievement.html
18	Use of High and Low Powers Diode Laser (980nm) in the Treatment of Dentine Hypersensitivity: an in Vivo Comparative Study	https://www.sjhsfajr.org/2023/12/use-of-diode-laser-in-treatment.html
19	Expenditure on Health Sector and its Effect on improving Health Indicators in Sudan. A study of Live Births and Neonatal Mortality Indicators, 2002 - 2020	https://www.sjhsfajr.org/2023/12/expenditure-on-health-sector-in-sudan.html

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20	Editorial - Lesson of the Year 2023	https://www.sjhsfajr.org/2024/04/lesson-learned-2023.html
21	Editorial - Recognizing Anatomical Variations: A Necessity for Optimal Patient Care	https://www.sjhsfajr.org/2024/04/editorial-anatomical-variations.html
22	Antibacterial and Anticandidal Activity of Ethanolic Extracts of Pomegranate (Punica granatum Linn) Peel, Sudan	https://www.sjhsfajr.org/2024/04/pomegranate-peel.html
23	Seroprevalence of Salmonella Typhi among School Children in Marawe Area in Northern Sudan	https://www.sjhsfajr.org/2024/04/seroprevalence-of-salmonella-typhi.html
24	Anatomical Variations in the Extensor Digiti Minimi Tendon: A Case Study and Significance	https://www.sjhsfajr.org/2024/04/extensor-digiti-minimi-tendon-variations.html
25	Rapunzel Syndrome: A Case Report from Al-Dabba Hospital, Northern State, Sudan	https://www.sjhsfajr.org/2024/04/trichobezoar-rapunzel-syndrome.html

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26	Editorial Breast Cancer: A Global and National Perspective	https://www.sjhsfajr.org/2024/08/editorial-breast-cancer.html
27	The Effect of Training Health Care Providers in Early Detection of Breast Cancer at Family Health Centers in Khartoum State, Sudan	https://www.sjhsfajr.org/2024/08/early-detection-of-breast-cancer.html
28	Proliferative Index in Different Grades of Invasive Breast Cancers using Argyrophilic Nucleolar Organizer Region Expression in Sudanese Patients, 2018-2020	https://www.sjhsfajr.org/2024/08/proliferative-index-of-breast-cancers.html
29	Fraser Syndrome; Case report and Literature Review	https://www.sjhsfajr.org/2024/08/fraser-syndrome-case-report-.html
30	The Impact of Health Outcome on Human Development Index in Sudan during the Period 2001-2021	https://www.sjhsfajr.org/2024/08/Health-Outcome-and-Human-Development.html

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32	Bloom's Classification and Psychometric Analysis of Multiple-Choice Questions as Quality Indicators for Medicine Clerkship Examinations	https://www.sjhsfajr.org/2024/12/blooms-classification-and-analysis-mcqs.html
33	Nurses' Practice regarding Bedside Shift Reports in Critical Care Units at Governmental Hospitals – Khartoum State	https://www.sjhsfajr.org/2024/12/nurses-practice-bedside-shift-reports.html
34	Assessment of Depression and Anxiety Levels among Postpartum Women in Najran City	https://www.sjhsfajr.org/2024/12/depression-and-anxiety-postpartum-women.html
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41	Quality of Life Assessment Among Type-2 Diabetic Patients Attending Health Care Centers, Wad Medani, Sudan	https://sjhs.fajr.edu.sd/index.php/sjhs/article/view/Quality-of-Life-Diabetes-Sudan

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50	**Quality of Life among Amputees with Diabetes Mellitus Attending Two Tertiary Healthcare Centres in Khartoum, Sudan**	**https://sjhs.fajr.edu.sd/index.php/sjhs/article/view/quality-of-life-diabetic-amputees**
51	**Differentiating Benign and Malignant Prostatic Lesions using Mucin and DNA Histochemical Staining, Samples from Omdurman Teaching Hospital, Sudan**	**https://sjhs.fajr.edu.sd/index.php/sjhs/article/view/benign-malignant-prostatic-lesions-mucin**
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Growing Up in Crisis: How Sudan's Conflict is driving Streetism and Homelessness among Children

Sumaia M. Alfadil[1*], Mona A. Bashir[2]

Street, homeless, street connected, of the street, street involved, street working, from street families, or in street situation, etc..all are terms applied in a way or another to children who are dependently connected to streets, whether for permanent or temporal living; all share the fact of staying for long durations away from families and un-supervised by responsible careers. [(1)] These phenomena can be described as streetism, which will be referred to frequently in this paper.

Streetism refers to a situation where children are strongly and frequently linked with streets for living and/or working without access to basic needs, including education and parental supervision. It commonly indicates a weak family bond (some live on the street and go back to their families at night), inadequate child protection mechanisms, caused by several unequal socioeconomic predictors, including poverty, family breakdown, displacement, weak holistic national social protection systems, etc. [(2,3)]

DOI: https://doi.org/10.69993/2025.3.3.en2

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Two major issues that impede focused interventions to prevent and control streetism worldwide are the wide scope of defining "street/homeless children" and availability of accurate data on the numbers of this group of children. Definitions and estimates are crucial for sound planning for each category, as they have different characteristics and so require different contextualized interventions. [(1)] Sudan is not different, where estimates of children suffering streetism are scarce and vary significantly from an earlier count of 70,000 in 2008, [(4)] to 600,000 in March 2025. [(5)] The latter higher rates can be attributed to the long history of recurrent conflicts and displacement.

Besides being scarce, studies of homeless children in Sudan are limited to Khartoum state. Studies show that more than two-thirds of children are from states other than Khartoum (the majority had conflict crises) and almost a quarter or more are from neighboring countries, namely Chad, Ethiopia and South Sudan. [(6,7)] Despite over one-third of children being illiterate, about half received a basic education, which could facilitate their reintegration, perhaps in technical education. Close to two-thirds left home because of poverty and family issues like divorce, violence, neglect, death of either of parents or both, displacement, etc; however, one third return home and some are

accompanied by families on the streets. [6,7] Children on the street are commonly engaged in begging, violence and abuse, consumption of substances, namely glue-sniffing, tobacco use, street gangs and other offending practices. [7]

Like other countries, streetism in Sudan is amplified by the chronic economic deterioration, leading to poverty and social inequity and the recurrent conflicts in different parts of the country, the latest of which is the worst of them. More than five million children in Sudan were estimated to have fled their homes, searching for safety, and hundreds lost the company of families during the war chaos, abandoned in a place to call home. [8] Save the Children International estimates that 7,600 children are fleeing homes daily as a result of the war. [9] Schools that were a place of learning and joy are now shelters for the larger displaced communities. As a result, more than 17 million of the 19 million school-aged children are out of school. [8]

During this conflict, children suffered grave violations, including killings, sexual violence, and forced recruitment into armed groups. [10] Family breakdown, migration, and displacement are all interconnected drivers, being a cause and a consequence of large-scale child homelessness.

Sudan's economy and poverty landscape, as predictors of streetism, were high before the 2023 conflict. National poverty rates (61.1%) ranged between 48.8% in urban settings compared to 67.6% in rural areas. The devastating economic crisis arising from several factors and extensively triggered by the war has led to a 48% contraction of the GDP in 2023, which is expected to have pushed over 1.8 million people into poverty if the war continued to 2025. [11] The economic crisis, by amplifying poverty, injustice, unemployment, and inequalities, is one of the key factors pushing children and young adolescents to the streets. Family factors, whether underpinned by poverty or social breakdowns, equally result in streetism, especially in view of the rapid transformations in cultural values, discriminatory beliefs and general societal attitudes towards children. [12] Many homeless and displaced children engage in informal work or street labour out of necessity, sacrificing their education and health to support themselves or their families. This cycle both perpetuates and deepens their vulnerability. [6,12]

Including children and adolescents, Sudanese faced violent attacks, inadequate access to food and healthcare, leading to hunger, undernutrition, and ill-health, impacting their mental health and safety, with children being particularly affected. As a result, an estimated 15.7 million children and their families affected by the crisis in Sudan are at risk of mental health disorders, caused by the combined challenges of hunger and conflict. [10,13]

In Ethiopia, a study assessed the nutritional status of children and adolescents aged 12-19 years, found that 44% and 56% of them were respectively thin and stunted. Length of stay on the street, being sick during the last three months, using unimproved sources of water and drinking alcohol were claimed as predictors of undernutrition. [14]

Undernutrition is highly prevalent among homeless children, posing grave threats to their physical and cognitive development, requiring urgent nutritional and health outreach interventions. In Sudan, a significantly high proportion (80%) of street children were food insecure, with a higher percentage of moderate and severe food insecurity as revealed in a study in Khartoum, 2025. [6]

Mental health disorders are among the grave consequences of wars and insecurity. Research reveals that trauma resulting from disasters, coupled with frequent and different kinds of losses and subsequent helplessness, is perceived to be the root cause of homelessness. [15] Similarly, poverty heightens the risk of developing mental illnesses as a result of the physical and psychosocial impact of lower socioeconomic status, leading to greater disease burden and the lack of access to healthcare. People with poor mental health are more susceptible to key factors such as loss of productivity, disaffiliation, social stigmata and negative stereotyping, exacerbating deprivation that can lead to more impoverishment and homelessness. [15]

In view of the above, comprehensive and coordinated responses, a spanning policy reform, protection services, community-based interventions, and restoration of basic health and educational support are needed to address both immediate and structural factors underlying the problem of streetism in all its forms. Research shows that despite the great challenges; yet focused approaches through personal and emotional support, cultural and religious beliefs, supportive peer relationships, and participation in sports activities are protective and resilient strategies that should be strengthened in health promotion interventions with a focus on mental health, the prevention of violence, substance use, and daily physical activities that seem to provide meaning and hope. [16]

Interventionists should follow a rights-based approach that involves partnership and active engagement with street children, rather than a charitable one. This approach helps empower children in various forms of streetism to support their well-being and productive participation in their communities. An example is that interventions targeting working street children who are living with or frequently visit their parents are different from interventions for lone street children. [17] More efforts shall be exerted to enhance the social protective systems by the government and civil society

References:

1. Julien G. Traits of street children [Internet]. 2022 [cited 2025 Dec 3]. Available from: https://www.researchgate.net/publication/361080505_Traits_of_street_children
2. Ewusie E. Child streetism in Ghana: safeguarding human rights and ensuring child welfare amidst urban challenges [Internet]. 2024 [cited 2025 Dec 3]. Available from: https://www.researchgate.net/publication/380586099_Child_Streetism_in_Ghana_Safeguarding_Human_Rights_and_Ensuring_Child_Welfare_Amidst_Urban_Challenges
3. Sayidah I, Syarmila H. Child 'streetism' through kinaesthetics. ARTEKS J Teknik Arsitektur. 2023;8(3):377–86. Available from: https://www.researchgate.net/publication/377337500_Child_'streetism'_through_Kinaesthetics
4. Plummer ML, Kudrati M, Yousif NDEH. Beginning street life: factors contributing to children working and living on the streets of Khartoum, Sudan. Child Youth Serv Rev. 2007;29(12):1520–36. Available from: https://www.sciencedirect.com/science/article/abs/pii/S0190740907001545
5. Forgotten future: the struggle of street children for their rights [Internet]. Street Children in Africa; 2025 Mar 4 [cited 2025 Dec 3]. Available from: https://rightforeducation.org/2025/03/04/forgotten-future-the-struggle-of-street-children-for-their-rights/
6. Osman AH, Magzoub MA, Ibrahim GM, et al. Determinants of homeless children in Khartoum City, Sudan. Sudan J Health Sci [Internet]. 2025;3(1):15–27 [cited 2025 Dec 3]. Available from: https://sjhs.fajr.edu.sd/index.php/sjhs/article/view/Determinants-Homeless-Children-Sudan
7. Elhassan Ali Hassan SM, Ahmed AA, Elhassan YA, et al. Reasons for leaving home and pattern of child abuse and substance misuse among street children in Khartoum, Sudan: a cross-sectional survey. Pan Afr Med J [Internet]. 2023;46:36 [cited 2025 Dec 3]. Available from: https://www.panafrican-med-journal.com/content/article/46/36/full/
8. UNICEF. Trapped in conflict [Internet]. 2025 [cited 2025 Dec 3]. Available from: https://www.unicef.org/sudan/trapped-conflict
9. Save the Children. Sudan: about 7,600 children fleeing homes daily in world's largest child displacement crisis [Internet]. 2025 [cited 2025 Dec 3]. Available from: https://www.savethechildren.net/news/sudan-about-7600-children-fleeing-homes-daily-world-s-largest-child-displacement-crisis

10. European Commission. Sudan's children are suffering – this is how conflict is destroying their future [Internet]. 2025 Aug 15 [cited 2025 Dec 3]. Available from: https://civil-protection-humanitarian-aid.ec.europa.eu/news-stories/stories/sudans-children-are-suffering-how-conflict-destroying-their-future_en
11. Ahmed M, Raouf M, Siddig K. What are the economic and poverty implications for Sudan if the conflict continues through 2025? J Dev Stud. 2025;1–22. doi:10.1080/00220388.2025.2510642
12. Namli K. Situational analysis of street living and street working children in OIC countries [Internet]. Ankara: SESRIC; 2019 [cited 2025 Dec 3]. Available from: https://www.researchgate.net/publication/342591484_Situational_Analysis_of_Street_Living_and_Street_Working_Children_in_OIC_Countries
13. Mohammed FEA, Altamih RAA, Elgailani USA, Khalid RFE, Alhassan FEA, Ibrahim RAY, et al. Sudan's forgotten generation: confronting the mental health crisis. BMJ Glob Health. 2025;10(6):e017518.doi:10.1136/bmjgh-2024-017518
14. Nigatu A, Abdureshid N, Abate S, Dagne I, Oumer A. Undernutrition and determinants among adolescent street children in Dire Dawa City, eastern Ethiopia: vulnerability assessment. Nutrition. 2024;119:112307. doi:10.1016/j.nut.2023.112307
15. Pumariega AJ, Gogineni RR, Benton T. Poverty, homelessness, hunger in children and adolescents: psychosocial perspectives [Internet]. World Soc Psychiatry. 2022;4(2):54–62 [cited 2025 Dec 3]. Available from: https://www.researchgate.net/publication/378294332_Poverty_Homelessness_Hunger_in_Children_and_Adolescents_Psychosocial_Perspectives
16. Hills F, Meyer-Weitz A, Oppong Asante K. The lived experiences of street children in Durban, South Africa: violence, substance use, and resilience. Int J Qual Stud Health Well-being. 2016;11:30302. doi:10.3402/qhw.v11.30302
17. Dutta N. Street children in India: a study on their access to health and education. Int J Child Youth Fam Stud. 2018;9(1):69–82. doi:10.18357/ijcyfs91201818120

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Awareness and Utilization of Online Medical Resources among Medical Practitioners at Port Sudan Teaching Hospital, Sudan, 2025

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Abstract

Background: Online medical resources (OMRs) constitute a critical component of global clinical decision-making. However, their utilization and awareness in low-resource settings have not been adequately studied.

Methods: This descriptive cross-sectional study was conducted in July 2025 among 174 healthcare professionals at Port Sudan Teaching Hospital. A structured questionnaire was used for data collection. Descriptive statistics summarized awareness and utilization patterns. Associations were tested using Chi-square, and logistic regression calculated predictors of awareness with odds ratios (OR) and 95% confidence intervals (CI)

Results: Overall awareness was high (90%), with Medscape (70%) and UpToDate (40%) being the most recognized tools. Free sources like PubMed (30%) and Google Scholar (20%) were most frequently used. The frequency of use was distributed as follows: 19% daily, 35% weekly, 17% monthly, 19% seldom, and 10% never. Poor internet connection (55%), no training (78%), and subscription fees (22%) were the obstacles. Logistic regression showed that awareness was significantly associated with professional role (OR = 2.1, 95% CI: 1.3-3.5) and department (OR= 1.8, 95% CI: 1.1-3.0).

Conclusion: Awareness of online resources among practitioners was high, with junior doctors demonstrating greater usage. However, the actual utilization was moderate. Systemic barriers including limited connectivity and inadequate training, were major impediments. Strengthening Institutional support and capacity-building initiatives could enhance the integration of OMRs into routine clinical practice.

Keywords: online resources, awareness, utilization, medical practitioners, Sudan

DOI: https://doi.org/10.69993/2025.3.3.en3

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Introduction:

Online medical resources (OMRs) such as Medscape and UpToDate play a vital role in supporting evidence-based medical practice by giving clinicians rapid and accurate access to current scientific evidence. They are significant in enhancing diagnostic accuracy, informing clinical decision-making, and keeping healthcare workers up-to-date with the latest advances in medicine and healthcare delivery.(1)

In high-income countries, OMRs are deeply integrated into medical education, hospital systems, and routine patient care. Their presence has enhanced the quality of clinical services by filling the information gaps, enabling continuous professional development, and refining standard evidence-based interventions.(2)

In low- and middle-income countries (LMICs), however, adoption and effective utilization of OMRs remain low. Barriers such as poor internet connections, high subscription costs, limited institutional access, and poor digital literacy among health professionals are considerable deterrents.(3-6) Organizational and cultural problems, such as insufficient institutional backing and low levels of awareness about accessible databases, also contribute to underutilization. Research conducted in Ethiopia and Iran has shown the differential level of awareness and usage among physicians, nurses, and medical students, where usage patterns significantly depend on the availability of infrastructure, technical proficiency, and organizational policy. (6.7)

In the Sudanese context, no studies have been conducted on this topic, though an increasing number of hospitals and medical schools are becoming more aware of digital health tools.

However, no empirical data exist describing how Sudanese physicians view, access, and implement OMRs in everyday clinical work. To our knowledge, no study published todate has comprehensively assessed OMR awareness, utilization patterns, and barriers among healthcare workers in Sudan.

This study aims to assess the level of awareness, utilization patterns and perceived barriers concerning OMRs among medical practitioners at Port Sudan Teaching Hospital. It explores the predictors influencing OMR use and hence provides insights that could enhance digital resource adoption into practice in Sudan.

Materials and Methods:

Study Design and Area:

A descriptive cross-sectional survey design was conducted in July 2025 at the Port Sudan Teaching Hospital. The Hospital is one of the main tertiary hospitals in the eastern region of Sudan, located in the Red Sea State. It is an important location for studying such trends, considering its heterogeneous workforce and status as a centre of medical education.

Sample Design:

The study population included medical doctors (interns, medical officers, residents, and consultants) working in the hospital during the study period. All doctors actively engaged in clinical duties were eligible to participate. The sample size was calculated using the single population proportion formula (8)

$n = N/ (1+N*d2)$

Where n is the sample size, N is the finite study population (N=315); d = margin of error (d=0.05). This yielded a required sample size of 176

The participants were selected using a convenience sampling technique, as the questionnaire was distributed electronically to all eligible medical doctors via hospital communication platforms (Google form), and participation was voluntary.

Data collection tools and procedures:

Data were initially collected using a structured questionnaire adapted by the study team from previously published tools. (6,7) To ensure content validity, the draft questionnaire was reviewed by two experts in medical education and clinical research. Their feedback was used to refine the wording, clarity, and relevance of the items before finalization.

The questionnaire was then pilot-tested among 20 healthcare professionals not included in the main study to assess clarity, comprehension, and estimated completion time. Necessary modifications were made before the final distribution. Data from the pretest were not included in the final analysis.

The questionnaire included four domains: (1) demographic information, (2) awareness of online medical resources, (3) utilization patterns, and (4) perceived barriers.

Duplicate-prevention measures included one-response-per-device restriction, IP-based response monitoring, and manual review for identical timestamps or demographic duplication, with measures in place to prevent duplicate responses.

The questionnaire remained open from 2 July to 27 July 2025. Participation was voluntary, and submission of a completed questionnaire

was considered as implied consent to participate.

Data analysis:

Data were analyzed using SPSS version 25. Descriptive statistics (frequencies and percentages) were used to summarize awareness and utilization patterns, perceptions, and perceived barriers. Associations between categorical variables were examined with the chi-square test.

Binary Logistic regression was applied to identify predictors of awareness and utilization of OMRs, Independent variables included gender, professional role, department, and years of professional experience. Odds ratios (OR) with 95% confidence intervals (CI). Statistical significance was set at $p < 0.05$

Ethical approval:

Ethical approval was obtained from the Institutional Review Board (IRB) of Port Sudan Teaching Hospital, Reference Number: PSTH-IRB-2025-07-OMR-12. No personal identifiers were collected, and confidentiality was maintained throughout the study, based on voluntary participation and electronic informed consent.

Results:

A total of 174 medical doctors participated in the study with 99%response rate. The majority were female (64.6%), and most of the respondents were from the 20–30 years age group (70.3%). In terms of professional level, medical officers comprised more than half of the sample (51.7%). Representation by speciality was extensive, with the largest being from internal medicine (28.0%). As displayed in Table 1.

Table 1: Participants' Demographic Characteristics

Variable	Category	n (%)
Gender	Male	62 (35.6)
	Female	112 (64.4)
Age group	years 20 - 30	122 (70.3)
	years 31 - 40	39 (22.4)
	> 40 years	13 (7.3)
Professional role	Intern (House officer)	25 (14.4)
	Medical officer	90 (51.7)
	Resident (Registrar)	41 (23.6)
	Specialist/Consultant	18 (10.3)
Speciality	Internal medicine	49 (28.0)
	Surgery	33 (18.9)
	Pediatrics	27 (15.4)
	Obstetrics/Gyne.	27 (15.4)
	Emergency medicine	31 (17.7)
	Others	7 (4.0)

Awareness of online medical resources

Overall, 90% of respondents reported awareness of at least one OMR. Medscape was the most commonly recognized platform (70%), while DynaMed was the least known (6%). (figure 1)

The most frequently cited barrier was lack of training (78%), and the least was the reliability concerns (17%), as shown in Table 2.

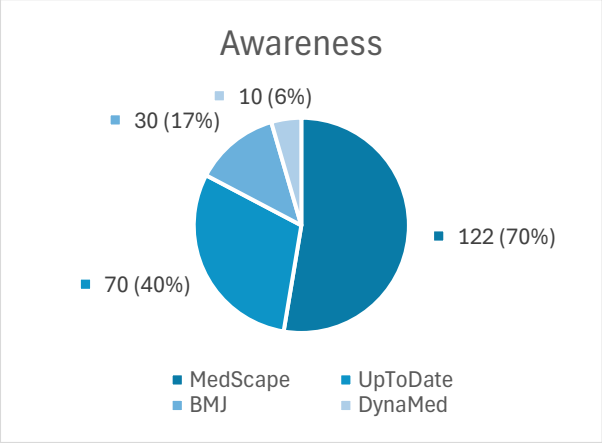

Figure 1: Awareness to Online Medical Resources

Table 2: Barriers to Utilization of Online Medical Resources

Variable	Category	n (%)
Barriers	Lack of training	136 (78.0)
	Poor internet access	96 (55.0)
	Subscription cost	38 (22.0)
	Reliability concerns	30 (17.0)
	Concern about clinical judgement*	40 (23.0)

***Clinical judgment: is defined in Methods/Results as the concern that reliance on OMRs might reduce physicians' independent reasoning.**

Patterns of utilization

The frequency of OMRs use ranged between daily used accounting for (19%) and never used (9%).

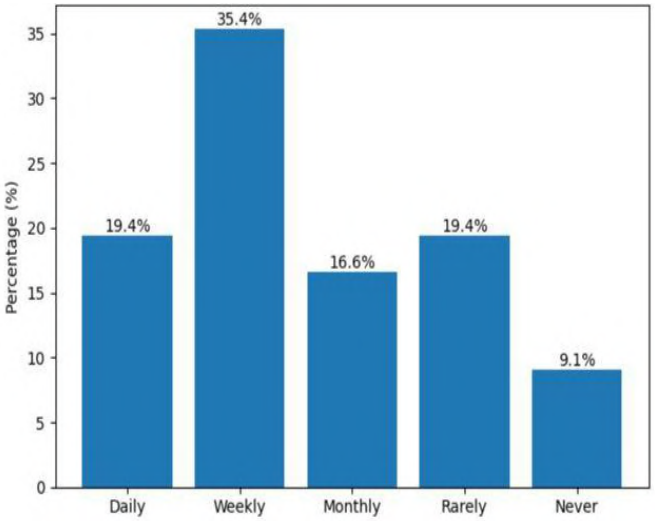

Figure 2: Frequency of Online Medical Resources Use (n=174)

Frequency of Use of Free-access websites

PubMed (30%), local clinical guidelines (23%), Google Scholar (20%), and WHO databases (19%). These were more commonly used than the subscription-based or paid databases.

Perceptions and Clinical Impact

There was a positive perception toward online medical resources in general among respondents, where 85% of them believed that OMRs provided quicker and easier access to information compared to textbooks.

Table 3 shows the clinical impact on OMRs as perceived by the respondents. improved diagnostic accuracy (65%), reduced clinical errors (54%), saved clinical time (51%), and improved patient outcomes (38%). Only a small minority (7%) was of the view that OMRs did not influence practice.

Table 3: Perceptions Toward Online Medical Resources

Perception	n (%)
Faster/easier than textbooks	148 (85.0)
Improve diagnostic accuracy	113 (65.0)
Reduce clinical errors	94 (54.0)
Save clinical time	89 (51.0)
Improve patient outcomes	66 (38.0)
No significant impact on practice	12 (7.0)

Predictors of use and awareness

Multivariable logistic regression analysis showed that professional role and clinical department were significantly associated with awareness of online medical resources. Professional role was a significant predictor of awareness (OR = 2.1; 95% CI: 1.3–3.5), with higher awareness observed among non-consultant physicians compared with consultants P-value = 0,018. Departmental affiliation was also significantly associated with awareness (OR = 1.8; 95% CI: 1.1–3.0; p = 0.026) In contrast, gender (p = 0.585) and years of professional experience (p = 0.394) were not significantly associated with awareness of online medical resources.

Table 4: Multivariate Logistic Regression of Predictors of Awareness

Variable	OR	CI %95	**p-value**
Professional role	2.1	3.5 – 1.3	**0.018**
Department	1.8	3.0- 1.1	**0.026**
Gender	1.1	1.6 – 0.7	**0.585**
Years of experience	0.9	1.4 – 0.6	**0.394**

Discussion:

This study assessed the awareness and utilization of online medical resources (OMRs) among medical practitioners at Port Sudan Teaching Hospital. The findings indicate that overall awareness of OMRs was high (90%), with most respondents familiar with at least one platform. This aligns with previous research showing widespread awareness among healthcare providers around the world. (3-5)

Medscape and UpToDate were the most recognized tools, accounting for 70% and 40% respectively, while subscription-based platforms like DynaMed were less known. For example, Ethiopian physicians often use medical applicationslike UpToDate and Medscape for clinical decisions. Ref Awareness was greater among younger and junior doctors. This mirrors findings from studies in Canada, which reported higher online medical resource use among residents compared to senior consultants. (11) This may reflect differences in Digital literacy and the need for rapid access to evidence.

This study reflects a higher weekly frequency of use (35%) than daily (19%) and monthly (17%), showing moderate integration into clinical practice. Similar trends have been noted in resource-limited areas, where free-access databases like PubMed and Google Scholar are frequently used.(12) In contrast, Iranian studies showed moderate awareness but limited use due to a lack of institutional support (6,7). These findings highlight that infrastructure and access significantly shape usage patterns.

Barriers identified in this study included poor internet connectivity (55%), lack of training (78%) and subscription costs (22%). These issues align with challenges found in other LMICs. Jahanshir et al. in Iran noted that the lack of formal training limited proper online medical resource use. (7) In Ecuador, Cherrez-Ojeda et al. identified additional barriers, such as legal risks and questions about content reliability.(10)These results indicate that barriers exist at various levels: structural, institutional, and individual, where systemic solutions are needed.

Overall, perceptions towards online medical resources were mostly positive. Eighty-five per cent of participants viewed them as faster and easier to access than textbooks. Many respondents attributed benefits like improved diagnostic accuracy, reduced errors, and time savings to their use. This aligns with studies in Canada and Ethiopia, which found that online resources boost clinician confidence and efficiency in decision-making. (6-13) However some respondents (23%) expressed concerns that frequent reliance on OMRs could compromise clinical judgment. This reflects a perceived conflict between relying on online tools and

maintaining professional reasoning. Previous studies have also warned against overreliance on unverified digital sources. (4)

In this study, professional role and department were significant predictors of awareness of online medical resources ($p = 0.018$ and $p < 0.05$, respectively), whereas gender and years of experience were not ($P = 0.585$ and $p > 0.05$).

These findings align with previous research published inBMJ Open (2022), which demonstrated that clinical settings and professional responsibilities strongly influence the adoption of digital tools (12). Notably, younger clinicians appeared more comfortable integrating online medical resources into their daily practice, suggesting that digital proficiency and role-specific expectations shshape usage patterns.

Conclusion:

This study demonstrated that while awareness of online medical resources among doctors at Port Sudan Teaching Hospital was high, particularly among junior practitioners, the actual utilization of these tools remains suboptimal. Most respondents depended on freely available platforms such as PubMed and Google Scholar, with limited use of subscription-based resources due to barriers including poor internet connectivity, insufficient formal training, and the high cost of subscriptions.

Despite these limitations, participants expressed positive perceptions toward online resources, recognizing their value in improving diagnostic accuracy, reducing clinical errors and enhancing efficiency. Addressing systemic challenges through strengthened internet infrastructure, targeted capacity-building programs, and subsidized or institutional access to high-quality subscription resources may substantially enhance effective utilization.

Future research should assess the impact of improved access and training on clinical decision-making and patient outcomes. Furthermore, research is needed to explore strategies to promote greater adoption of digital evidence-based tools among senior clinicians.

Study Limitations:

This study has several limitations, namely, the use of a convenience sampling technique may limit the generalizability of the findings beyond the study population. The reliance on self-reported data introduces the possibility of recall and social desirability bias. In addition, the single-centre design restricts the applicability of results to other healthcare settings in Sudan. Finally, the cross-sectional nature of the study limits causal interpretation of the observed associations

Conflict of Interest:

The authors declare no conflict of interest.

Funding:

No external funding for this study was received.

Acknowledgement:

We wish to express our special appreciation and thanks to Ms. Rania Ibrahim Abdelbasit for willing to join our team for data analysis of the research, and the medical staff of Port Sudan Teaching Hospital for their participation

References:

1- Karatza AA, Tsintoni A, Kapnisis D, et al. Evidence-based medicine and good clinical practice in research in pediatric and adolescent medicine. Children Available from .1309:(10)12;2025 https://doi.org/10.3390/children12101309

2- ,Maggio LA, Aakre CA, Del Fiol G Shellum J, Cook DA. Impact of clinicians' use of electronic knowledge .resources. J Med Internet Res e13315:(7)21;2019 https://doi.org/10.2196/13315

3- Castaneda C, Nalley K, Mannion C, et al. Clinical decision support systems for improving diagnostic accuracy. J Clin Bioinform. 2015;5:4 https://doi.org/10.1186/s13336-015-3-0019

4- UpToDate. Improving patient outcomes using evidence-based clinical decision .support at the point of care. White Paper Waltham, MA: Wolters Kluwer; 2016. :Available from https://www.uptodate.com

5- Naik HS, Padmamma S. Usage of electronic resources by faculty members of medical colleges: a study. Int J Libr Inf Stud. 2017;7(2):223–226. Available from: https://www.ijlis.org/articles/usage-of-electronic-resources-by-faculty-members-of-medical-colleges-a-study.pdf

6- ,Baxter SL, Lander L, Clay B, Bell J Hansen K, Walker A, et al. Comparing UpToDate and DynaMed Plus as medical knowledge resources for clinical decision support: cross-over randomized trial (Preprint). Journal of .Medical Internet Research [Internet] Feb 28 2020 :Available from https://doi.org/10.2196/preprints.18475

7- Akula V, Dick K. Challenges in remaining "UpToDate." Health Science Inquiry [Internet]. 2020 Aug :Available from .92–88:(1)11;10 https://doi.org/10.29173/hsi302

8- Naing NN. Determination of sample size. Malays J Med Sci. 2003 ;Jul;10(2):84-6. PMID: 23386802 PMCID: PMC3561892

9- Haileye G, Tilahun B, Guide HA, Debre Markos University, University of .Gondar, Bahir Dar University Smartphone medical app use and associated factors among physicians at ,referral hospitals in Amhara region North Ethiopia, in 2019: cross-sectional study [Internet]. JMIR Mhealth and Uhealth. 2021 Mar. Available from: https://www.researchgate.net/publication/350431324

10- Jahanshir A, Karimialavijeh E, Sheikh .Motahar Vahedi H, Momeni M Smartphones and medical applications in the emergency department daily .practice [Internet]. Emergency. 2017 :Available from https://pmc.ncbi.nlm.nih.gov/articles/PMC5325882/pdf/emerg-5-e14

11- Fournier, K. (2022). Mobile app use by medical students and residents in the .clinical setting: an exploratory study Journal of the Canadian Health Libraries Association / Journal De L'Association De Bibliothèques De La Santé Du .Canada, 43(1) https://doi.org/10.29173/jchla29562

12- ,Cherrez-Ojeda, I., Vanegas, E., Felix ,.M., Mata, V. L., Jiménez, F. M ,.Sanchez, M., Simancas-Racines, D ,.Cherrez, S., Gavilanes, A. W .Escherichia, J., & Chedraoui, P. (2018) Preferences, perceptions and barriers of health among ecuador physicians: an Ecuadorian cross-sectional study .(Preprint). JMIR https://doi.org/10.2196/preprints.12862

13- BMJ Open. Barriers and facilitators to use of a digital clinical decision support tool: a cohort study combining .clickstream and survey data e064952:12;2022 https://bmjopen.bmj.com/content/12/11/e064952

Quality of Life among Amputees with Diabetes Mellitus Attending Two Tertiary Healthcare Centres in Khartoum, Sudan

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Abstract

Background: Diabetes Mellitus is a leading global cause of morbidity and mortality. Diabetic Foot Ulcers, a severe complication of diabetes, often lead to Lower Extremity Amputation, significantly reducing patients' Quality of Life (QoL). This study assessed the QoL of Sudanese diabetic amputees and diabetic non-amputees using the validated Short-Form-36 questionnaire.

Methods: A cross-sectional hospital-based study was conducted between April and August 2019, involving 200 amputees and 200 non-amputees from Ribat University Hospital and Jabir Abu-Ezz Diabetic Centre in Khartoum. Physical and mental health components were analysed alongside demographic and clinical characteristics to determine their impact on QoL between the two study groups.

Results: Amputees had significantly lower QoL scores than non-amputees, with physical health scores of 64.6±15.3 vs. 81.6±10.3 and mental health scores of 56.3±19.4 vs. 86.2±12.4, respectively. Males had better QoL than females, and below-knee amputees fared better than above-knee amputees. In general, QoL scores were 60.5±17.4 in amputees compared with 83.9±11.3 in non-amputees.

Conclusion: Diabetic amputees experience a significant decline in QoL, necessitating a multidisciplinary care approach addressing both physical and psychological needs. Specialised rehabilitation centres, including diabetes specialists, educators and dietitians, are needed to manage the physical as well as the psychological sequelae of diabetic amputations.

Keywords: Diabetes mellitus, Diabetic foot ulcers, Amputation, Quality of life, Sudan

DOI: https://doi.org/10.69993/2025.3.3.en4

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Introduction:

Diabetes mellitus (DM) is a chronic condition that affects millions worldwide, leading to various complications, including diabetic foot ulcers (DFUs) and lower extremity amputations (LEAs). (1) DFUs are among the most serious complications of DM as they increase the risk of infection and the inevitable need for amputations. (2)

Research has shown that up to 85% of all LEAs in diabetic patients are preceded by DFUs, and once a patient undergoes an amputation, their Quality of Life (QoL) is drastically affected. (3, 4) Kizillkurt et al found that the impact of amputations on the QoL is not simply due to the loss of function but is strongly linked to social and psychological factors. (5)

According to the International Diabetes Federation, Sudan's country report, there were 3.9 million people with diabetes in 2024. (6) This figure is expected to rise to 8.7 million by 2050. The Sudanese Diabetes Association reports the prevalence of diabetes as 19% based on a total population of 24,192,200 and a total number of cases of 3'860'600. (7)

The World Health Organization (WHO) defines QoL as an individual's perception of their position in life within the context of the culture and value systems in which they live.(8) Migou et al highlighted that diabetic amputees will often lose their circle of friends and family following the loss of mobility and independence in activities of daily living; moreover, Phantom limb pain, new infections, and inability to perform daily tasks exacerbate the issue.(9) Once the diabetic complications lead to amputation, it is often associated with other chronic conditions such as cardiovascular disease and hypertension, further hampering rehabilitation efforts and general well-being.(10)

The International Committee of the Red Cross indicates that healthcare resources are scarce in Sudan. This forces the country to focus on emergency care, diabetic care and rehabilitation are inevitably knocked down the priority list. (11) Apart from Abdelgadir et al's (12) pilot study that used a pre-tested questionnaire to assess the psychological impact of DFU in Sudanese patients living in rural areas; no other studies were looking at the overall QoL in Sudanese diabetic amputees using a pre-validated questionnaire. Highlighting this gap is highly needed, allowing for tailored interventions that can enhance both physical and mental well-being.

The current study aimed to fill this gap by evaluating the QoL of Sudanese diabetic amputees, focusing on both physical and mental health components. The aim is to provide insights to develop targeted interventions to improve QoL among amputees.

Materials and Methods:

Study Design and Study Area

This research is an analytical, cross-sectional, hospital-based study to evaluate the QoL among diabetic amputees. The study was conducted in two large tertiary healthcare centres in Khartoum, Ribat University Hospital and Jabir Abu-Ezz Diabetic Centre (JADC).

The diabetic centres and hospitals provide specialized diabetic care, including those with advanced complications such as DFUs and amputations. These facilities were selected based on the high number of diabetic patients they serve, ensuring a sufficient sample size for the study.

Study Population

The study population consisted of Sudanese diabetic patients attending Ribat University Hospital and JADC during the study period. The population was divided into two groups: a test group from the diabetic patients who had undergone lower extremity amputations (amputees) and a control group from diabetic patients who did not have amputations (non-amputees).

In addition to the amputation status, the inclusion criteria for the study were that Sudanese participants, of both genders, aged 18 years or older. Patients with psychiatric disorders, or those who were critically ill and unable to participate in the interview, were excluded from the study.

Study Duration

The research was conducted over five months, from April to August 2019. This time frame allowed for the enrolment of the intended sample size.

Sample Size

According to the hospital records, it was estimated that each hospital would treat around eighty diabetic patients per month, which provided, over the five months, a pool of 800 participants. The sample size was calculated using the Raosoft® sample size calculator (http://www.raosoft.com/samplesize.html) with the following parameters: 5% margin of error, 95% confidence level, 50% response rate. The minimum recommended sample size, as per the calculator, was 260 participants.

Four hundred participants were chosen as it offered a reasonable sample size for statistical analysis, allowing for meaningful comparisons between the two groups. The 200 diabetic amputees and 200 non-amputees were selected by convenience sampling over the study period.

Data Collection Tools and Process

The study examined the QoL of diabetic amputees and diabetic non-amputees using the Short Form-36 (SF-36) questionnaire. (13) The SF-36 is a validated tool used to assess both the mental and physical QoL. According to Zhang et al (14)the Cronbach's alpha for this questionnaire falls between 0.76 and 0.9, indicating good to excellent internal consistency reliability.

The SF-36 questionnaire comprises 36 items assessing eight key dimensions of health: physical functioning, limitations due to physical problems, limitations due to emotional problems, social functioning, mental health, energy and vitality, pain, and general health perception. The short survey is translated into numerous languages to facilitate its use; the study used Arabic versions. This tool was selected for its comprehensive scope in evaluating both physical and mental health among diabetic patients, particularly those who had undergone amputations. The printed format of the survey was filled manually during the patient's interview and then entered onto an online version that calculated percentages for each of the eight domains. The scores ranged from 0 to 100, with higher scores indicating better quality of life. (15, 16)

Alongside the SF-36 questionnaire, a structured form was used to collect demographic and clinical data, including variables such as age, gender, educational level, occupation, and place of residence. Clinical data focused on the duration of diabetes, type of treatment (insulin or oral hypoglycaemic agents), presence of comorbidities (e.g., hypertension or renal disease), and, in the case of amputees, the cause (neuropathy or ischaemia) and level of amputation (below-knee or above-knee). The causes of diabetic ulcers were based on the available medical notes and the surgeon's clinical assessment of each case. There was no clear classification or assessment documented in the notes to indicate how the cause of the ulcers was determined. Most of the records indicate the cause as either ischemia or neuropathy. The level of amputation was documented and analysed.

The validity of the tool was ensured through expert review, during which subject matter specialists evaluated the questionnaire for relevance and clarity. Their feedback was carefully considered, and suggested revisions were incorporated to enhance the content validity of the instrument, ensuring that it accurately reflected the constructs it was intended to measure. The data collection process was conducted through face-to-face interviews administered by trained healthcare professionals, thereby ensuring accuracy, consistency, and appropriate interpretation of responses.

Study Variables

The study's independent variables included demographic characteristics such as age, gender, occupation, educational level, socioeconomic status, and body mass index (BMI). Clinical variables such as the duration of diabetes, treatment type and regimen, presence of comorbidities, and the level and cause of amputation were also considered. The primary dependent variable was the QoL score, as measured by the SF-36 tool.(17) The QoL score was divided into the Physical Health Composite (PHC), Mental Health Composite (MHC), and the overall QoL score.

Data Analysis

The collected data were analysed using the Statistical Package for the Social Sciences (SPSS) software, version 21.0. Descriptive statistics were employed to summarise the demographic and clinical characteristics of the study population. Continuous variables were described using means and standard deviations, while categorical variables were presented as frequencies and percentages, providing a clear overview of the sample composition.

To examine the relationships between demographic and clinical characteristics and QoL scores, various comparative statistical analyses were performed. Chi-square tests were used to assess associations between categorical variables—such as gender, occupation, and socioeconomic status. For continuous variables like age and BMI, Analysis of Variance (ANOVA) was conducted to evaluate differences between amputees and non-amputees. Additionally, independent t-tests were applied to compare mean QoL scores between these two groups. A p-value of <0.05 was considered statistically significant, denoting a meaningful relationship between the variables under investigation.

Ethical Considerations

Ethical approval for the study was obtained from the Sudan Medical Specialization Board (SMSB). Written informed consent was obtained from all participants after explaining the purpose of the study, the procedures involved, and their right to withdraw at any time without any consequences. Confidentiality was maintained by assigning each participant an identification number, and no personally identifiable data was included in the report. All data were stored securely in an encrypted format to protect participants' privacy, and the study adhered to the highest ethical standards in line with international research guidelines.

Results:

Demographic and Socioeconomic Characteristics

The study included 400 diabetic patients, comprising 200 amputees and 200 non-amputees. Demographic and socioeconomic characteristics are presented in Table 1. The majority of participants in both groups were male (amputees: 78%, non-amputees: 75%). The amputee group was predominantly aged 40–60 years (57.5%), with 38% over 60 years old. In contrast, a larger proportion (70%) of non-amputees were in the 40–60-year age group, with only 21% over 60. There were no statistically significant differences between the two groups in the various demographic and socioeconomic characteristics of the study population.

Table 1: Demographic and socioeconomic characteristics of the study population

		Amputee (N= 200)	Non-amputee (N= 200)	P. value
Gender	Male	156 (78%)	150 (75%)	0.479
	Female	44 (22%)	50 (25%)	
(Age) years	<40	9 (4.5%)	18 (9%)	0.072
	40-60	115 (57.5%)	140 (70%)	
	>60	76 (38%)	42 (21%)	
Education	Illiterate	9 (45%)	15 (7.5%)	0.399
	Primary	74 (37%)	65 (32.5%)	
	Secondary	114 (57%)	109 (54.5%)	
	University	3 (1.5%)	11 (5.5%)	
Occupation	Not work	133 (66.5%)	115 (57.5%)	0.095
	Worker	52 (26%)	48 (24%)	
	Employee	15 (7.5%)	37 (18.5%)	
Residence	Rural	76 (38%)	91 (45.5%)	0.215
	Urban	124 (62%)	109 (54.5%)	
Socioeconomic status	High	3 (1.5%)	20 (10%)	0.12
	Moderate	39 (19.5%)	56 (28%)	
	Low	158 (79%)	124 (62%)	

Table 2 summarizes clinical features and comorbidities in both groups. Duration of diabetes was longer among amputees: 96% had diabetes for more than five years compared to 86% of non-amputees. With respect to treatment, insulin use and Combination therapy with oral hypoglycemic agents were used in both groups. Comorbidities included hypertension, renal disease, and cardiovascular disease in both groups. However, the differences were not statistically significant in all these aspects.

Table 2: Clinical Features and Comorbidities

		Amputee (N= 200)	Non-amputee (N= 200)	P. value
Body Mass Index (BMI)	Normal	141 (70.5%)	160 (80%)	0.253
	Overweight	15 (7.5%)	16 (8%)	
	Obese	6 (3%)	24 (12%)	
	Underweight	38 (19%)	0 (0%)	
Diabetes duration (years)	<1	0 (0%)	10 (5%)	0.067
	1-5	8 (4%)	18 (9%)	
	>5	192 (96%)	172 (86%)	
DM treatment	Insulin	115 (57.5%)	96 (48%)	0.153
	OHA*	34 (17%)	56 (28%)	
	Combined	51 (25.5%)	48 (24%)	
Co-morbidities	None	69 (34.5%)	100 (50%)	0.221
	Hypertension	52 (26%)	45 (22.5%)	
	Renal diseases	38 (19%)	33 (16.5%)	
	CVD	32 (16%)	15 (7.5%)	
	Thyroid diseases	9 (4.5%)	7 (3.5%)	

***OHA = Oral Hypoglycemic Agents**

Clinical Features and Amputation Profile

Table 3 shows the QoL scores by demographic and clinical variables among the amputee group. Gender analysis showed higher QoL scores among male amputees (62.2±14.4) than female amputees (51.8±8.6; p=0.021). Patients with below-knee amputations (BKA) had higher QoL (65.8±17.6) compared to those with above-knee amputations (AKA) (58.9±17.6; p=0.03). However, other factors such as age, level of education, type of occupation, being rural or urban in residence or BMI had no significant effect on QoL scores.

Table 3: Mean and SD of QoL Scores by Demographic and Clinical Variables Among the Amputee Group

		Mean	SD	P. value
Gender	Male	62.2	14.4	**0.021***
	Females	51.8	8.6	
Age (years)	<40	59.8	9.1	0.47
	40-60	57.6	11.3	
	>60	52.8	7.9	
Education	Illiterate	52	15.1	0.533
	Primary	55.2	19.9	
	Secondary	57.2	16.5	
	University	61.3	13	
Occupation	Not work	57.7	18.5	0.063
	Worker	59.2	13.2	
	Employee	60.5	20	
Residence	Rural	60.1	19.3	0.432
	Urban	54	17.4	
Socioeconomic status	High	68	14.9	0.178
	Moderate	61.2	19.4	
	Low	60	17.8	
BMI	Normal	60.4	17.8	0.391
	Overweight	57.7	15.9	
	Obese	62.8	15.1	
	Underweight	60.7	19.5	
DM duration (Years)	1 – 5	60.4	14.4	0.785
	>5	59.5	18.3	
Amputation cause	Neuropathy	61.3	18.4	0.839
	Ischemia	60.5	15.6	
Amputation levels	Above knee	58.9	17.6	**0.030***
	Below knee	65.8	19.4	

Quality of Life Outcomes

QoL scores were significantly lower in amputees. The mean physical health component score was 64.6±15.3 in amputees vs. 81.6±10.3 in non-amputees (p<0.001). The mean mental health component score was 56.3±19.4 in amputees vs. 86.2±12.4 in non-amputees (p<0.001). Overall QoL scores were 60.5±17.4 in amputees compared with 83.9±11.3 in non-amputees (p<0.001) (Table 4)

Table 4: Comparison of Total Scores and the Sub-scales of the SF-36 among Amputees and Non-amputees

	Amputee	Non-amputee	P. value
	(N= 200)	(N= 200)	
	Mean±SD	Mean±SD	
Physical Health Composite (PHC)	64.6±15.3	81.6±10.3	<0.001
Mental Health Composite (MHC)	56.3±19.4	86.2±12.4	<0.001
Overall SF-36 QoL score	60.5±17.4	83.9±11.3	<0.001

Discussion:

The findings of this study showed that diabetics who undergo LEA, have a significant reduction in their QoL. Amputations do not only have profound physical implications, but they also substantially impact mental health and overall well-being, as reflected by the lower SF-36 scores among amputees.

In light of previous studies on DFU and its significant global burden, where prevalence ranges from 11.4% to 29.7%, the risk of LEA increases from 2% to 16%, depending on the study design and population examined (18).

In this study, age did not have a significant effect on the quality of life among diabetic amputees and non-amputees. Results show that approximately 95.5% of the amputees were over the age of 40. In a similar context, Al-Rubeaan et al. (19), in their retrospective cohort study, reported that "age ⩾45 years was a risk factor for developing DFU and amputation in a Saudi population." More recently, Musa et al. (20), in their study of factors associated with amputation among patients with DFU in the same population, highlighted the "global metabolic syndrome epidemic." In general, older patients are more susceptible to risk factors for amputation, such as peripheral arterial disease, infection, chronic hyperglycaemia, and a history of previous DFU .(21)

Physical Health Decline

The physical health component of the SF-36 showed a significant decline in amputees compared to non-amputees. This is expected, as amputees experience reduced mobility, phantom limb pain, and difficulty performing daily activities. Additionally, the majority of amputees in this study were unemployed, which may further affect their ability to find work, and so they are effectively sentenced to lifelong unemployment. Studies by Atinga et al (22) and Ngwane (23) have shown that regular physical activity and employment are associated with better QoL, as they provide individuals with a sense of purpose and independence. The lack of employment among amputees in this study underscores the need for vocational rehabilitation programs to help reintegrate amputees into the workforce and improve their physical functioning.

Mental Health Implications

The mental health component of the SF-36 revealed a significant decline in amputees, with mental health scores being lower than those of non-amputees. This reflects the psychological toll of amputation, which often leads to depression, anxiety, and social isolation.(24) The loss of a limb can be a traumatic event, leading to feelings of helplessness and dependency, particularly in a culture where mobility and independence are highly valued. Moreover, amputees may experience a loss of social identity, especially if they are no longer able to fulfil their traditional roles within the family or community Kizilkurt et al. (25) Psychological support and counselling should be routinely offered for people following amputations. This may help patients navigate their disabilities and the associated challenges they face. It may also improve their mental health outcomes.

Gender Differences

One of the key findings offered by this study is the gender disparity in QoL among amputees, with male amputees reporting higher scores than females. In other words, male amputees had better QoL than female amputees. A study by Soomro et al (26) and Corey et al (27), demonstrated that the most significant predictors of lower limb amputations in people with and without diabetes were gender. Their findings indicate that males may have better coping mechanisms or greater physical and emotional resilience following amputations. On the contrary, female patients may face additional social and psychological challenges, possibly due to societal expectations and differences in social support systems. A review on diabetes in Sudan by Ahmed and Ahmed (28) showed that being a female with diabetes is associated with poor diabetic control. In the Sudanese culture, females often manage the household budget, where they tend to place their healthcare expenditure at the bottom of

the list. This reflects on their dietary choices and expenditure on medication. Another study, by Hamid et al (24), looking at the same QoL of DFU in Sudan, showed the same finding. Moreover, A study by Sana et al. (29) conducted in Saudi Arabia shares the same findings that females had significantly lower QoL scores compared to males, which might be attributable to cultural factors where females become more dependent on family members for daily activities. This is likely to make them feel like a burden and exacerbate their sense of loss following the amputation. However, contrasting studies by Cox et al.(30) reported that female amputees had better QoL scores, suggesting that these gender differences may be context-specific, varying by region, culture, and healthcare access. The lived experience of women amputees by Nayak showed that women are often independent and hold an important role in society in their capacity as housewives or working ladies.(31) In view of that, any loss of function will have detrimental effects on their roles and instead of being productive to society that will feel like a burden. Equally, young, and unmarried women will feel less able to get married because of their disability, which will lead to feelings of helplessness and depression. Regardless of which gender has the lowest QoL, there is a call for more efforts to be made to help educate patients about the consequences of diabetes and to offer good rehabilitation services post-amputation.

Impact of Amputation Level

The level of amputation played a significant role in determining QoL outcomes. Patients with BKA had significantly better QoL scores compared to those with AKA. This finding is in keeping with a study by Dominsiano and Visagie that looked at the quality of life experienced by South Sudanese lower limb prosthetic users.(32) It suggests that BKAs allow for easier mobility with prosthetics, leading to better physical functioning and overall independence. Cox et al. found similar results, where patients with BKA recorded higher functional independence and QoL scores compared to those with AKA. Above-knee amputations require more complex rehabilitation, and prosthetic fitting is more challenging, contributing to a lower QoL. This is more so in a deprived country like Sudan, where rehabilitation services are scarce.

From the author's experience of working in underdeveloped countries, surgeons and indeed other health professionals often take into account other considerations, apart from the clinical condition, when determining clinical procedures. In other words, if a patient would not be able to financially afford a revised procedure or has other comorbidities that make them unable to stand multiple operations, they

may be offered an above-knee amputation regardless of the clinical indication.

Role of Diabetes Duration and Management

The study found that most amputees had been living with diabetes for over five years, and insulin use was more prevalent among amputees compared to non-amputees. The usage of insulin suggests poor diabetic control and possibly a more advanced stage of diabetes among amputees. This supports the well-documented association between longer diabetes duration and the risk of complications, including DFUs and amputations. (33) Poor glycaemic control leads to peripheral neuropathy, which is the underlying cause of DFUs, as observed in 79.5% of the amputees in this study. Effective diabetes management, including strict glycaemic control, is essential for preventing complications. As per Swaminathan et al, the role of patient education and health promotion is fundamental in preventing early macrovascular and microvascular complications of diabetes. It follows that early interventions can prevent DFUs and the need for amputation.(34)

Comorbidities and Socioeconomic Factors

Although hypertension, renal disease, and cardiovascular disease were common comorbidities among both amputees and non-amputees, these did not significantly affect QoL scores in the amputee group. This suggests that the impact shown is primarily due to the physical and psychological effects of the amputations.

Conclusion & Recommendations

Diabetic amputees in Sudan experience significant declines in QoL, particularly in physical and mental health. It follows that early interventions and targeted rehabilitation could improve patient well-being. Recommendations include implementing psychological support programs for amputees, promoting diabetic foot care, and establishing diabetic foot clinics in different regions of Sudan to prevent DFUs and subsequent amputations. Given the financial limitations of the health services in Sudan, these clinics could be run by trained diabetic nurses who would refer urgent cases for further assessment and follow up. This relatively low-cost intervention could potentially save a lot of amputations and its subsequent devastating consequences.

Study Limitations:

The study's limitations include its cross-sectional design, which does not allow for establishing causal relationships. Additionally, the sample size was relatively small and limited to the patients in the two medical centres, which may not represent the general population. Furthermore, potential recall bias could have affected the accuracy of self-reported data. The duration of the study did not allow for long-term assessment of the effect of the disease on the quality of life over a longer period. Future

research can be improved by exploring the patient's clinical images and investigations to better determine the cause of the diabetic foot and whether this was the first amputation. The research can be expanded further to include the other major diabetic centres in Sudan. More variables can be included, such as the glycated haemoglobin, physical exercise, diet, smoking and alcohol consumption, which are all important elements that may affect the result. These details will act as a database upon which more research and correlations can be extracted. This will enhance the generalisability and validity of the current findings.

Conflict of Interest

The authors declare that there are no conflicts of interest related to this study.

Funding:

This study received no specific grant from any funding agency.

Acknowledgments:

The authors sincerely thank all participants for their valuable contribution to this study. We are also grateful to the medical and administrative staff of Ribat University Hospital and JADC in Khartoum, Sudan, for their cooperation and support during data collection. The authors further acknowledge the dedication of the research team and data collectors, whose efforts were instrumental in the successful completion of this work. All data relevant to this study are available from the corresponding author upon request

References:

1. Zhang H, Huang C, Bai J, Wang J. Effect of diabetic foot ulcers and other risk factors on the prevalence of lower extremity amputation: a meta-analysis. Int Wound J. 2023;20(8):3035–47. https://doi.org/10.1111/iwj.14179

2. Wukich DK, Raspovic KM, Jupiter DC, Heineman N, Ahn J, Johnson MJ, et al. Amputation and infection are the greatest fears in patients with diabetes foot complications. J Diabetes Complications. 2022;36(7):108222.

https://doi.org/10.1016/j.jdiacomp.2022.108222

3. Piaggesi A, Apelqvist J. The diabetic foot syndrome. Basel: Karger Medical and Scientific Publishers; 2017.

4. Setacci C, De Donato G, Setacci F, Chisci E. Diabetic patients: epidemiology and global impact. J Cardiovasc Surg (Torino). 2009;50(3):263–73.

5. Kizilkurt OK, Kizilkurt T, Gulec MY,

Giynas FE, Polat G, Kilicoglu OI, et al. Quality of life after lower extremity amputation due to diabetic foot ulcer: the role of prosthesis-related factors, body image, self-esteem, and coping styles. Dusunen Adam J Psychiatry Neurol Sci. 2020;33(2):125–34.

https://doi.org/10.14744/DAJPNS.2020.00026

6. International Diabetes Federation. Diabetes in Sudan. 2024. [Internet]. 2025 [cited 2025 Jul 27].

https://idf.org/our-network/regions-and-members/middle-east-and-north-africa/members/sudan/

7. International Diabetes Federation. Sudan diabetes country report 2000–2050. [Internet]. 2025 [cited 2025 Jul 26].

https://diabetesatlas.org/data-by-location/country/sudan/

8. The WHOQOL Group. The World Health Organization quality of life assessment (WHOQOL): position paper from the World Health Organization. Soc Sci Med. 1995;41(10):1403–9.

9. Migaou H, Kalai A, Hassine YH, Jellad A, Boudokhane S, Frih ZBS. Quality of life associated factors in a North African sample of lower limbs amputees. Ann Rehabil Med. 2019;43(3):321–7.

https://doi.org/10.5535/arm.2019.43.3.321

10. Okesina A, Nsubuga I, Omoola O, Okesina H. Understanding lower limb amputation: a review of the strategies for healthcare improvement, prevention, and management. Risk. 2016;16:18. https://dx.doi.org/10.4314/rmj.v81i1.13

11. Sudan faces health crisis as conflict devastates medical infrastructure. [Internet]. International Committee of the Red Cross; 2025 [cited 2025 Jul 30].

https://www.icrc.org/en/news-release/sudan-faces-health-crisis-conflict-devastates-medical-infrastructure

12. Abdelgadir M, Shebeika W, Eltom M, Berne C, Wikblad K. Health related quality of life and sense of coherence in Sudanese diabetic subjects with lower limb amputation. Tohoku J Exp Med. 2009;217(1):45–50.

https://doi.org/10.1620/tjem.217.45

13. Alwahbany SAM, Ahmed TO, Hussien AD. Radiological assessment of closure time of around elbow secondary ossification centers in Khartoum, Sudan (December 2009–2010). Int J Orthop. 2017;3(2):806–12.

14. Zhang Y, Bo Q, Lun SS, Guo Y, Liu J. The 36-item short form health survey: reliability and validity in Chinese medical students. Int J Med Sci. 2012;9(7):521–6.

https://doi.org/10.7150/ijms.4210

15. Martinez JE. Avaliação da qualidade de vida de pacientes com fibromialgia através do Medical Outcome Survey 36 Item Short-form Study. Rev Bras Reumatol. 1999;39(6):312–6. https://doi.org/10.1590/S1413-35552010005000015

16. Nogueira R, Franca M, Lobato MG, Belfort R, Souza CB, Gomes JÁP. Qualidade de vida dos pacientes portadores de síndrome de Stevens-Johnson. Arq Bras Oftalmol. 2003;66:67–70.

17. Saris WE, Gallhofer IN. Design, evaluation, and analysis of questionnaires for survey research. Hoboken (NJ): John Wiley & Sons; 2014.

18. Frykberg RG, Zgonis T, Armstrong DG, Driver VR, Giurini JM, Kravitz SR, et al. Diabetic foot disorders: a clinical practice guideline (2006 revision). J Foot Ankle Surg. 2006;45(5 Suppl):S1–66.

https://doi.org/10.1016/S1067-2516(07)60001-5

19. Al-Rubeaan K, Al Derwish M, Ouizi S, Youssef AM, Subhani SN, Ibrahim HM, et al. Diabetic foot complications and their risk factors from a large retrospective cohort study. PLoS One. 2015;10(5):e0124446.

https://doi.org/10.1371/journal.pone.0124446

20. Musa IR, Ahmed MO, Sabir EI, Alsheneber IF, Ibrahim EM, Mohamed GB, et al. Factors associated with amputation among patients with diabetic foot ulcers in a Saudi population. BMC Res Notes. 2018;11(1):260.

https://doi.org/10.1186/s13104-018-3372-z

21. Rayman G, Krishnan ST, Baker NR, Wareham AM, Rayman A. Are we underestimating diabetes-related lower-extremity amputation rates? Results and benefits of the first prospective study. Diabetes Care. 2004;27(8):1892–6.

https://doi.org/10.2337/diacare.27.8.1892

22. Atinga B-E, Henyo A, Addah G, Ayamga CA, Perekuu T, Addah WGG. Lifestyle adjustments in diabetic individuals following lower extremity amputations: a qualitative study. Cureus. 2024;16(12):e77414.

https://doi.org/10.7759/cureus.76188

23. Atinga B et.al, Lifestyle adjustments in diabetic individuals following lower extremity amputations: a qualitative study. Cureus. 2024;16(12):e77414.

24. Ngwane EL. Examining the psychological impacts of a traumatic lower limb amputation among young adults in Cameroon. 2024.

25. Hamid YH, Mohammed M, Hamid S, Mohamedahmed W, Ahmed O, Nugud F, et al. Impact of diabetic foot ulcer on the health-related quality of life of diabetic patients in Khartoum state. Cureus. 2024;16(1):e52202.

https://doi.org/10.7759/cureus.52813

26. Soomro N, Khan M, Ahmed SI, Minhas MA. Determinants of lower extremity amputations: an institutional experience. J Coll Physicians Surg Pak. 2013;23(7):491–4.

27. Corey MR, Julien JS, Miller C, Fisher B, Cederstrand SL, Nylander WA, et al. Patient education level affects functionality and long-term mortality after major lower extremity amputation. Am J Surg. 2012;204(5):626–30.

https://doi.org/10.1016/j.amjsurg.2012.03.011

28. Mohamed Ahmed A, Hassan Ahmed N. Diabetes mellitus in Sudan: the size of the problem and the possibilities of efficient care. Pract Diabetes Int. 2001;18(9):324–7.[1]

https://doi.org/10.1002/pdi.292

29. AlSadrah SA. Impaired quality of life and diabetic foot disease in Saudi patients with type 2 diabetes: a cross-sectional analysis. SAGE Open Med. 2019;7:2050312119832092.

https://doi.org/10.1177/2050312119832092

30. Cox PSL, Williams SKP, Weaver SR. Life after lower extremity amputation in diabetics. West Indian Med J. 2011;60(5):536–40.

31. Nayak SS. The lived experience of women amputees in Odisha. Int J Sci Res (IJSR). 2022;11(6):943–50. DOI: https://doi.org/10.52403/ijhsr.20220601

32. Dominsiano LCP, Visagie S. Quality of life experienced by South Sudanese lower limb prosthetic users after rehabilitation. Afr J Disabil. 2025;14:1671.[8]

https://doi.org/10.4102/ajod.v14i0.1671

33. Yu J, Kim J-H, Kim B, Han K, Lee SH, Kim MK. The severity of diabetes and the risk of diabetic foot amputation: a national cohort study. Endocrinol Metab (Seoul). 2025 (forthcoming).
DOI: https://doi.org/10.3803/EnM.2024.2266

34. Swaminathan N, Awuah WA, Bharadwaj HR, Roy S, Ferreira T, Adebusoye FT, et al. Early intervention and care for diabetic foot ulcers in low- and middle-income countries: addressing challenges and exploring future strategies: a narrative review. Health Sci Rep. 2024;7(5):e2075.

https://doi.org/10.1002/hsr2.2075

Students' Satisfaction with Electronic Versus Traditional Paper-Based Examinations, AlNeelain University, Sudan

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Abstract

Background:

The rapid integration of technology in higher education has led to increased use of electronic examinations as an assessment tool. This study aimed to compare students' satisfaction with electronic and traditional paper-based examinations at AlNeelain University and to identify factors influencing their preferences.

Methods:

A descriptive cross-sectional study was conducted among 378 students from six faculties at AlNeelain University: Nursing, Physiotherapy, Insurance, Law, Engineering, and Statistics. Data were collected using a researcher-developed questionnaire and analyzed using the Statistical Package for the Social Sciences (SPSS) version 16. Results were presented in tables and figures.

Results:

The majority of participants (97.3%) were aged 22–25 years. Electronic examinations were reported as more stressful by 59.3% of students, while 60% perceived paper-based examinations as more difficult. High satisfaction with electronic examinations as a true reflection of academic performance was reported by 44% of students, whereas 43.1% were satisfied with the time allocated for electronic examinations. Additionally, 59.1% felt that examination formats were not well aligned with their academic specialties, and 48.9% expressed dissatisfaction with the influence of socioeconomic factors on electronic examination experiences. No significant association was found between academic specialty and examination preference (paper pen or electronic) ($p = 0.800$).

Conclusion:

Students showed mixed satisfaction with electronic and paper-based examinations. Enhancing electronic examination systems through appropriate support and training may improve students' confidence and overall satisfaction.

Keywords: Students' satisfaction, electronic examination, paper-based examination.

DOI: https://doi.org/10.69993/2025.3.3.en5

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Introduction:

An examination (Exam) can be defined as a structured process that is taken to show knowledge and professional competence in a particular subject or to obtain a qualification.(1) The Exam process is considered to be one of the most important means of performance measurement and assessment, and it is an essential part of the educational process to clarify the extent to which educational goals are achieved. In general, assessments vary considerably in their reliability and level of detail, and no single assessment can provide educators with all the information they need to know. (2)

Online learning is gaining popularity in formal educational settings and for personal development. One specific form of information and communication technology for assessment is an electronic Exam or computer-based testing. (2)

An electronic Exam is performed on a computer where questions and answers are presented on screen rather than sheets of paper. (3)

Computer-based testing results are generated more quickly than those from paper-based tests, and they can make admission decisions more quickly. Individuals can take computer-based testing even with minimal or no previous computer experience.(2)

Online Exams are being recognized as one of the more efficient assessment methods. They are effective in both blended and traditional forms of learning, and when used appropriately, bring benefits to both learners and the learning process. (4) There has been a growing interest in improving and utilizing computer-based testing educational systems instead of traditional paper-and-pen Exams. (4) While traditional Exams, using paper and pen, result in a heavy burden on learners and instructors, online Exams provide solutions for such issues. (5) Instructors can save time in grading and mark compilation, resulting in lower administrative costs, while students can receive immediate and detailed feedback, take their Exams at a time and in a place that works best for them, and access self-assessment opportunities. (1) However, online Exams present several challenges, including increased work in the preparation stage, the possibility of technical failures, security issues, and cheating. (1)

In this study, the researcher discussed two types of tests: paper-and-pen tests and electronic tests. The traditional Exam refers to a general group of assessment tools in which candidates read questions and respond in writing. This test can be used to assess subject or course-related knowledge, ability or skills qualifications. Because many candidates are assessed at the same time with a paper-and-pen test, such tests are an efficient method of assessment.(1)

Online education and online assessment were implemented before the COVID-19 pandemic. However, it was conducted in a limited number of lessons and had limited hours. With the COVID pandemic, online education started to be implemented in almost all courses and at all grade levels. Depending on the quarantine, online education is now carried out everywhere. This situation obliged universities to review their previous infrastructure and facilities and to make necessary changes.[6]

Despite the increasing adoption of electronic Exams in higher education institutions due to technological advancements and expanded educational demands, student satisfaction with these digital assessment methods remains uncertain. The transition from traditional paper-based Exams to electronic formats raises concerns about stress levels, perceived difficulty, and alignment with academic needs across various disciplines. Learners' perceptions of online Exams in developing countries have not been widely studied despite the potential of such research for contributing to more effective use of online Exams in these countries. [4]

The current study aims to address the level of student satisfaction with electronic Exams compared to traditional paper-based Exams.

Materials and Methods:

Study design and Study Area:

A descriptive cross-sectional study was conducted in AlNeelain University at six faculties. AlNeelain University is located in Khartoum State, Sudan, and was established following the Sudanization of Cairo University, Khartoum Branch, in 1993. The university includes different faculties in the areas of medical and health sciences, humanitarian studies, and technical sciences.

Sample Design:

The researchers divided the faculties, according to subject areas, into three groups. The first group was the medical and health sciences faculties, which consist of the faculties of Pharmacy, Medicine, Nursing, Physiotherapy, Dentistry, Optometry, Visual Sciences, and medical laboratory sciences. The second group was the humanitarian studies faculties, which consist of the faculties of Arts, Law, Commerce, Economy, Social Studies, Education, and Community Development. The third group was technical sciences, consisting of the Faculty of Petroleum and Mining, Agricultural Technology, Fisheries Science, Math and Statistics, Computer Science, Information Technology and Engineering, and Science and Technology.[18] Since each group was regarded as a cluster, the sample Faculties were selected from each group using the cluster sampling technique.

Within each of these clusters, the researchers purposely selected two faculties based on their use of the electronic Exams. The selected faculties included Nursing Sciences, Physiotherapy, Law, Insurance, Engineering, and Statistics. This approach allowed for a more structured and comprehensive selection of the targeted faculties.

The sample size for the students was calculated using the formula according to Glenn D.

$$n = N/ [1+N (e)^2]$$

Where:

n =sample size.

N=total population=6883

e^2=Degree of precision (0.05)

$n=6883/(1+6883*0.05^2) = 378$

The sample size was divided proportionally according to the weight of students in each faculty, as shown in Table 1. The study enrolled students at level four who were exposed to the two types of Exams.

Table 1: Distribution of the Sample Size by Faculties n (378)

Faculty	Number of students	Proportion for each	Size
Nursing	95	95/892*378	40
Physiotherapy	58	58/892*378	25
Insurance	318	318/892*378	135
Law	200	200/892*378	85
Engineering	103	103/892*378	43
Statistics	118	118/892*378	50
Total	**892**		**378**

Data Collection Method and Tools:

Data was collected using a self-administered interview by a questionnaire designed by the researchers after a constructive review of the literature. The questionnaire consisted of two parts: **part one** about students' characteristics (age, faculty, gender, previous courses, socioeconomic status, computer use background), **part two** about satisfaction (environment, control, process of Exam, grading).

To ensure the validity and reliability of the study tool, face and content validity were ensured by an experienced associate professor in nursing, along with a medical education expert, through a pilot test that was conducted in a similar study population that met the criteria of the study. Feedback from the participants was collected to evaluate the tool's effectiveness in measuring the intended constructs. In addition, the reliability of the study tool was evaluated using Cronbach's alpha to determine the internal consistency of the items within the tool. Cronbach's alpha value was found to be 0.80.

Data Analysis:

Data were analyzed using the Statistical Package for the Social Sciences, version 16. Descriptive statistics were applied to summarize the data and calculate frequencies, while bivariate analysis was conducted to examine the significance of associations

between variables. A p-value of ≤ 0.05 was considered the threshold for statistical significance. Results were presented using frequency tables and cross-tabulations.

Ethical Consideration:

The study was approved by the Institutional Review Board of the Postgraduate Faculty at AlNeelain University (Registration NO: **NU-IRB-18-12-12-98)**. Permission was obtained from the deans of the participating faculties. Verbal consent was obtained from all study participants. All participants were ensured anonymity, confidentiality, and their privacy and dignity were protected. Participants had the right to refuse to answer any question.

Results:

The vast majority (97.36%) of respondents were between 20 and 25 years old, and there were more males (55%) than females. Table 2 shows the demographic characteristics of the students.

Table 2: Demographic characteristics of the students (n=378)

Variables		Frequency	Percentage
Age group	20 – 25 years	368	97.36%
	26- 30 years	6	1.59%
	Above 31	4	1.06%
Type of study	Medical studies	65	17.20%
	Human studies	220	58.20%
	Technical studies	93	24.60%
Gender	Male	208	55.03%
	Female	170	44.97%

Analysis of students' satisfaction with electronic Exams revealed generally positive perceptions in key areas, as shown in Table 3. Grading accuracy and fairness received the highest approval, with 84.7% of students expressing satisfaction. A majority were also highly satisfied with the Exam structure (53.2%) and learning opportunities (49.2%), though 20.9% felt electronic Exams lacked sufficient educational value. Time efficiency yielded mixed responses, with 24.6% expressing dissatisfaction, indicating some concern over Exam duration or pacing.

Table 3: level of satisfaction regarding electronic Exam. n=378

Response	Dissatisfied		Satisfied		highly satisfied		Total	
	No	%	No	%	No	%	No	%
1. Provide true grading.	58	15.3%	154	40.7%	166	44%	378	**100%**
2. Do not need more time comparing with traditional Exam.	93	24.6%	163	43.1%	122	32.3%	378	**%100**
3. Exam is well structured.	47	12.4%	130	34.4%	201	53.2%	378	**100%**
4. Provide opportunity to learn.	79	20.9%	113	29.9%	186	49.2%	378	**100%**
5. Suitable for all faculties and materials	258	68.2%	77	20.4%	43	11.4%	378	**100%**

The most notable area of dissatisfaction was the suitability of electronic Exams across different faculties and academic content, with 68.2% reporting discontent.

Table 4 highlights students' satisfaction levels with traditional Exams. A majority (57.7%) were dissatisfied with grading accuracy, raising concerns about fairness and transparency. While 51.3% found the allocated time sufficient, 39.1% were dissatisfied, suggesting time constraints for some students.

The Exam structure received moderate approval, with 54.8% satisfied but 37.3% dissatisfied, indicating areas for improvement. However, traditional Exams were viewed as relatively suitable across faculties and subjects, with 57.4% satisfaction, though 15.9% expressed dissatisfaction

Table 4: level of satisfaction regarding traditional Exam. n=378

Response	Dissatisfied		Satisfied		Highly satisfied		Total	
	No	%	No	%	No	%	No	%
1. Provide true grading.	218	57.7%	127	33.6%	33	8.7%	378	**100%**
2. The time is enough for finishing	148	39.1%	194	51.3%	36	9.6%	378	**100%**
3. Exam well structured.	141	37.3%	207	54.8%	30	7.9%	378	**100%**
4. Suitable for all faculties and materials	60	15.9%	217	57.4%	101	26.7%	378	**100%**

Table 5 presents students' satisfaction levels regarding the organization and environment of electronic and traditional Exams. Overall, electronic Exams received a more positive perception. A majority (48.9%) were satisfied with their structure, with 30.2% highly satisfied, while traditional Exams had a slightly higher satisfaction rate (53.7%) but lower high satisfaction (16.9%). The Exam environment was rated favorably for both formats, with electronic Exams receiving 51.8% satisfaction and 35.8% high satisfaction. In contrast, traditional Exams had slightly lower satisfaction (46.8%) but comparable high satisfaction (31%). A key distinction was in control and minimizing cheating, where 72.8% of students were highly satisfied with electronic Exams, whereas 70.6% were dissatisfied with traditional Exam security, indicating a major concern about cheating in traditional settings.

Overall, students expressed greater satisfaction with the organization, environment, and security of electronic Exams compared to traditional Exams, with notable concerns about minimizing cheating in traditional Exams.

There was a statistically significant difference in satisfaction between electronic and traditional Exams. Students reported higher satisfaction with electronic Exams compared to traditional paper-based Exams.

Table 5: Satisfaction level regarding the organization and environment of the Exam n=378

Response	Dissatisfied		Satisfied		highly satisfied		Total	
	No	%	No	%	No	%	No	%
1. The electronic Exam is well structured.	79	20.9%	185	48.9%	114	30.2%	378	**100%**
2. The traditional Exam is well structured	111	29.4%	203	53.7%	64	16.9%	378	**%100**
3. There was a good environment in the exam room for the electronic Exam.	47	12.4%	196	51.8%	135	35.8%	378	**%100**
4. There was a good environment in the room in the traditional Exam.	84	22.2%	177	46.8%	117	31%	378	**%100**
5. Good control and minimize the chance of cheating in the electronic Exam.	35	9.2%	68	18%	275	72.8%	378	**%100**
6. Good control and minimize the chance of cheating in a traditional Exam.	267	70.6%	85	22.5%	26	6.9%	378	**%100**

Table 6 illustrates the relationship between students' Exam preferences and their field of study. Medical students showed a lower preference for electronic Exams (14.3%) compared to human studies (36.8%) and technical studies (19.84%), though traditional Exams were even less favored across all groups. Human studies students exhibited the highest preference for electronic Exams, while technical students also leaned toward electronic assessments, with only 4.8% favoring traditional Exams. Overall, electronic Exams were the preferred choice across all fields, though traditional Exams retained some support in each academic discipline

Table 6: The association between students' preference of Exam types and their speciality, gender and age n=378

Type of study	Electronic Exam		Traditional Exam		Total		p-value
	No	%	No	%	No	%	
Medical studies	54	14.3%	11	2.91%	65	17.2%	**.8**
Human studies	139	36.8%	81	21.43%	220	58.2%	
Technical studies	75	19.84%	18	4.8%	93	24.6%	
Total	268	70.9%	110	29.1%	378	100%	
Male	130	34.4%	78	20.63%	208	55%	**0.001**
Female	138	36.51%	32	8.5%	170	45%	
Total	268	70.9%	110	29.1%	378	100%	
20 -25 Years	258	68.2%	110	29.10%	368	97.3%	
26 -30 Years	6	1.6%	0	0%	6	1.59%	**.05**
Above 31	4	1.06%	0	0%	4	1.06%	
Total	268	70.9%	110	29.1%	378	100%	

Discussion:

Online assessment research has shown varying focuses. Some studies emphasize online assessment [7.8.9], while others compare online and traditional assessment methods. [10] Additionally, some studies investigate security concerns in online Exams. [11]

A study conducted in Saudi Arabia comparing student performance in online and paper-based Exams concluded that Exam type and question format did not significantly affect performance. Instead, students' preparation and study habits were the major determinants of success. High-achieving students performed well in both Exam formats, while low-achieving students struggled regardless of the format. Students expressed a preference for certain features of online Exams, such as automatic results and immediate feedback, which could enhance learning when incorporated into practice Exams. The authors recommended expanding the study to include larger, more diverse samples across different faculties, majors, and genders to strengthen the generalizability of the findings. [7]

Numerous studies have been conducted on various aspects of online assessment and paper-based assessment methods. While some studies focused on the comparison of learners' academic performance in online or computer-based tests as opposed to paper-based tests. [8]

Others also examined students' attitudes and perceptions toward the same. For instance, Jaap et al. compared the mean scores of students who took an online test on one hand, to the mean scores of their counterparts who took the same test in a traditional paper-based mode on the other hand. Their findings indicated a non-significant difference between the mean scores of the two groups. Similarly, Yu and Iwashita reported that they found comparable scores between students who took a computer-based test and those who took a paper-based test. In contrast, Domínguez-Figaredo et al. reported an increase in academic performance of students when a university in Spain adopted online assessment for its 28 bachelor's degree programs during the COVID-19 pandemic. [8,9]

A study conducted in Egypt aimed to assess the opinions and satisfaction of critical care nursing students and staff regarding electronic Exams and their barriers found that more than half of the students demonstrated a high level of satisfaction with electronic Exams and reported generally positive perceptions and high satisfaction rates among both students and staff. [12]

Regarding stress levels, the study revealed that electronic Exams were perceived as more stressful than traditional Exams by 59% of respondents. This finding aligns with a similar study conducted in Rzeszow, where 63% of participants reported experiencing higher stress

levels during electronic Exams compared to traditional paper-and-pen assessments. [13] The increased stress associated with electronic Exams may be attributed to factors such as technical issues, time constraints, and unfamiliarity with the digital format.

Adanir, investigated and compared students' perceptions of online Exams at state universities in Turkey and Kyrgyzstan via a mixed study research design. Results of the quantitative analysis revealed that Turkish learners found online Exams less stressful and more reliable than the traditional mode of taking Exams while Kyrgyz learners perceived it otherwise [14]

Regarding the perceived difficulty level of Exams, the study found that 60% of respondents considered traditional Exams more challenging than electronic Exams. Similarly, a study conducted in Rzeszow, Pland, reported that only 18% of students found electronic Exams more difficult than traditional ones, while 41% believed both formats had a comparable level of difficulty. [15]. The preference for traditional Exams being more difficult could be attributed to factors such as the need for manual writing, time management challenges, and the absence of digital tools that might aid in answering questions more efficiently. [15]

The present study demonstrated that students expressed mixed satisfaction with electronic Exams. While a considerable proportion valued their accuracy, fairness, and structured organization, as shown by higher satisfaction mean scores compared to traditional Exams (M = 2.09 vs. 1.88, $p < 0.001$), concerns persisted regarding their adaptability across different faculties and subjects. Nearly half of the respondents appreciated the time efficiency and exposure to new technology**,** yet dissatisfaction remained notable regarding their suitability for diverse academic disciplines.

These findings align with prior research in Saudi Arabia, which concluded that Exam type (online or paper) did not significantly influence students' performance**,** but that students appreciated unique features of online Exams such as automatic feedback and instant grading. [16] Similarly, our results confirm that electronic Exams are generally perceived as more structured and fairer, but challenges remain in terms of disciplinary adaptability and inclusiveness**.**

Unlike the Saudi study, which emphasized that student preparation was the main determinant of success**,** the current study highlights the importance of structural and organizational features of electronic Exams in shaping satisfaction. This indicates that while performance outcomes may not differ substantially**,** students' perceptions of fairness, efficiency, and usability play a critical role in their acceptance of electronic assessments. [16]

Regarding satisfaction with traditional Exams, the study found that 57.7% of respondents were

dissatisfied with their ability to provide accurate grading. However, 51.3% were satisfied with the time required to complete traditional Exams, while 54.8% found them to be well-structured. Additionally, 57.4% of respondents believed that traditional Exams were more suitable for all faculties and university subjects. A study conducted to assess the Comparative Analysis of Students' Satisfaction Regarding Online vs. Traditional Exam at the Postgraduate Level in the University of Agriculture Faisalabad, Pakistan, concluded that students were more satisfied with the traditional Exam setup, as it was perceived to promote greater learning. In contrast, satisfaction with online Exams was lower. However, since online Exams are also a necessity of the present time, further developments are needed to make this system more familiar and easier for all students to understand and adopt. [13]

In terms of satisfaction with the organization and environment of both electronic and traditional Exams, approximately half of the respondents were satisfied with the structured format of both methods (49% for electronic Exams and 54% for traditional Exams). Compared to the study in Assiut, Egypt, where 53.9% of critical care nursing students reported satisfaction with electronic Exams [12], our result (49% satisfaction with the structure for electronic Exams) is somewhat lower but comparable. Similarly, in Alexandria, the increase in learning satisfaction in virtual classroom settings was more pronounced than our finding, indicating that settings which include broader online learning experiences may support greater satisfaction than isolated Exam-structure alone[17]., studies involving mobile-technology tools for evaluation in critical care nursing have shown positive structural satisfaction when tool design is thoughtful (layout, instruction clarity), suggesting that enhancements in the design and delivery of electronic Exams could raise satisfaction in our context to match or surpass those previous studies[18]

Regarding Exam preferences, the study found that a majority (70.9%) of respondents favored electronic Exams. This finding is consistent with a similar study conducted in sub-Saharan Africa. With regard to learner attitudes and preferences between computer-based and paper-based assessment, various studies have similarly reported mixed feelings. Whereas some students express a positive attitude and preference toward online assessment [15,19]

The study revealed that there was no statistically significant relationship between the type of study program and students' Exam preferences, as indicated by a p-value of 0.840. This suggests that students' choices between electronic and traditional Exams were not influenced by their specific field of study. However, the study found a highly significant statistical association between gender and

students' Exam preferences, with a p-value of 0.001. Furthermore, other studies investigated the influence of demographic factors of learners on their scores in computer-based tests. For instance, McClelland and Cuevas analyzed the influence of gender and computer familiarity on students' scores in computer-based tests and concluded that there was no statistically significant relationship between such factors. Their findings were reportedly consistent with some earlier studies.[20,21]

Limitations of the Study

Despite the significance of the findings, several limitations must be acknowledged. First, the study's cross-sectional design provides a snapshot of perceptions at a single point in time, which precludes the ability to establish definitive causal relationships or monitor longitudinal changes in student satisfaction and awareness. Second, the reliance on self-reported data through questionnaires introduces potential subjective biases, such as social desirability or recall bias, which may impact the precision of the results. Furthermore, the study was conducted exclusively at AlNeelain University, and while it included various faculties, the findings may have limited generalizability to other Sudanese or international institutions with differing technological infrastructures and examination protocols. Future research should consider longitudinal approaches and multi-institutional samples to provide a broader understanding of online assessment dynamics.

Acknowledgement

The researchers extend their profound gratitude to the final-year students of the Faculties of Medical and Health Sciences (Departments of Nursing and Physiotherapy), Humanitarian Studies (Departments of Law, Economics, and Social Studies), and Technical Sciences (Departments of Mathematical Sciences, Statistics, and Engineering) for their invaluable participation and contribution to this study. Their engagement significantly enriched the research process and outcomes

Conflict of Interests: The authors declare that they have no competing interests.

Funding: The author(s) received no financial support for the research, authorship, and/or publication of this article.

References:

1. Mammadova T. Grading and feedback. In: Academic writing and information literacy instruction in digital environments. Cham: Palgrave Macmillan; 2022. p. 121–35. https://doi.org/10.1007/978-3-031-19160-2

2. Schildkamp K. Data-based decision-making for school improvement: research insights and gaps. Educ Res. 2019;61(3):257–73. https://doi.org/10.1037/edu0000530

3. Malik MA, Kumar P. Information and communication technology (ICT): a critical analysis in context of cognitive styles. 1st ed. [Place unknown]: [publisher unknown]; 2023.

4. Afacan AG, İsmailova R, Omuraliev A, Muhametjanova G. Learners' perceptions of online exams: a comparative study in Turkey and Kyrgyzstan. Int Rev Res Open Distrib Learn. 2020;21(3):212–30.

5. Sletten SR. Rethinking assessment: replacing traditional exams with paper reviews. J Microbiol Biol Educ. 2021;22(2):e00109-21. https://doi.org/10.1128/jmbe.00109-21

6. Gopika JS, Rekha RV. Awareness and use of digital learning before and during COVID-19. Int J Educ Reform. 2023;32(4):10567879231173389. https://doi.org/10.1177/10567879231173389

7. Al-Qdah M, Ababneh I. Comparing online and paper exams: performances and perceptions of Saudi students. Int J Inf Educ Technol. 2017;7(2):106–9. https://doi.org/10.18178/ijiet.2017.7.2.850

8. Yang BW, Razo J, Persky AM. Using testing as a learning tool. Am J Pharm Educ. 2019;83(9):7324. https://doi.org/10.5688/ajpe7324

9. Yeboah D. Undergraduate students' preference between online test and paper-based test in Sub-Saharan Africa. Cogent Educ. 2023;10(2):2281190. https://doi.org/10.1080/2331186X.2023.2281190

10. Luecht RM, Hadadi A, Swanson DB, Case SM. A comparative study of online and traditional assessment methods. J Educ Meas. 1998;35(3):245–60.

11. Cluskey GM Jr, Ehlen CR, Raiborn MH. Ensuring integrity in online exams: a review of security measures. J Acad Ethics. 2011;9(2):127–36.

12. Mohamed A, Abdelhafez N, Ahmed N. Opinion and satisfaction of critical care nursing students and staff regarding electronic exams and their barriers. Assiut Sci Nurs J. 2023;11(40):355–67. https://doi.org/10.21608/asnj.2024.250335.1720

13. Ali IL, Iftikhar M. Comparative analysis of students' satisfaction regarding online vs traditional examination at postgraduate level in University of Agriculture Faisalabad. Int J Soc Sci. 2025; https://doi.org/10.55627/ijss.01.1.0111

14. Abood H, Abu Maizer M. Strategies to address cheating in online exams. Int J Technol Educ. 2022;5(4):608–20.
https://doi.org/10.46328/ijte.256

15. Karaoğlan-Yilmaz FG, Üstün AB, Yilmaz R. Investigation of pre-service teachers' opinions on advantages and disadvantages of online formative assessment: an example of online multiple-choice exam. J Teach Educ Lifelong Learn. 2020;2(1):10–19.

16. Alqabbani S, AlMuqbil N, AlHayyan W, Alfaris E, Alqahtani N. Readiness towards online learning among medical students during COVID-19 lockdown. Int J Med Educ. 2020;11:177–83.
https://doi.org/10.1177/2042753020981651

17. Arafa Hassan E, Abd Elrazek Baraka A. Effect of virtual classroom on critical care and emergency nursing students' achievement and learning satisfaction. Egypt J Health Care. 2021;12(2):545–54.
https://doi.org/10.21608/ejhc.2021.164789

18. Ghafari S, Yazdannik A, Mohamadirizi S. Education promotion based on "mobile technology" in the critical care nursing department: four-phase intervention. J Educ Health Promot. 2020;9:325.
https://doi.org/10.4103/jehp.jehp_34_20

19. Domínguez-Figaredo D, Gil-Jaurena I, Morentin-Encina J. The impact of rapid adoption of online assessment on students' performance and perceptions: evidence from a distance learning university. Electron J E-Learn. 2022;20(3):224–41.
https://doi.org/10.34190/ejel.20.3.2399

20. McClelland T, Cuevas J. A comparison of computer-based testing and paper-and-pencil testing in mathematics assessment. Online J New Horiz Educ. 2020;10(2):78–89.

21. Bennett RE, Persky H, Weiss AR, Jenkins F. Problem solving in technology-rich environments: a report from the NAEP Technology-Based Assessment Project. Washington (DC): National Center for Education Statistics; 2007. Report No.: NCES 2007–466.
Government report.

Differentiating Benign and Malignant Prostatic Lesions using Mucin and DNA Histochemical Staining, Omdurman Teaching Hospital, Sudan

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Abstract

Background: Benign prostatic hyperplasia (BPH) and prostate cancer (PCa) are the most common prostatic diseases in elderly men. Cost-effective methods are required to accurately differentiate benign hyperplasia from prostatic adenocarcinoma.

Methods: This is an analytical, cross-sectional study conducted on 109 archival paraffin-embedded prostate tissue samples obtained from Omdurman Teaching Hospital. Data collected included histopathological diagnosis, lesion type, patient age, and Gleason score for malignant cases. Three sections were prepared from each sample and stained using Periodic Acid–Schiff, Alcian blue (pH 2.5), and Feulgen reaction to assess mucin types and DNA intensity. The diagnostic value of these histochemical stains in differentiating benign and malignant prostatic lesions and their association with Gleason grading were evaluated.

Results: All 53 BPH cases showed positive staining for neutral mucins with complete absence of acidic mucins. In contrast, PCa samples demonstrated acidic mucin positivity in 22 cases (39.21%), neutral mucin positivity in 2 cases (3.5%), positivity for both mucin types in 17 cases (30.35%), and negativity for all mucins in 15 cases (26.78%). Statistically significant differences were observed between benign and malignant groups regarding mucin type and DNA staining intensity ($p < 0.001$). Additionally, Gleason score showed a significant association with both mucin type and DNA intensity in malignant cases ($p < 0.001$).

Conclusion: Mucin histochemical stain can be used as a useful biomarker in differentiating BPH from PCa. The intensity of DNA expression using Feulgen reaction may provide valuable prognostic information in prostate cancer.

Keywords: Prostate Adenocarcinoma, Benign Prostatic Hyperplasia, Mucin, DNA, Gleason

DOI: https://doi.org/10.69993/2025.3.3.en6

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Introduction:

Globally, prostate diseases are a major cause of morbidity and mortality in men. (1) Prostate cancer remains the second most frequent type of cancer among men globally (2), with 1.5 million new cases and 400,000 annual deaths in 2022, as reported by the latest global cancer statistics. (3) In many sub-Saharan African countries, prostate cancer represents a major health burden among men, with African American men showing significantly higher incidence and mortality rates compared to men of other ethnicities, particularly among younger age groups. (4)

Prostate cancer is the most common malignancy in Sudanese men and has an increasing incidence among the younger population. (5) Benign Prostatic Hyperplasia (BPH) is the most prevalent prostatic condition and typically poses a diagnostic dilemma due to its histological similarity with well-differentiated adenocarcinoma, (6,7) which could lead to misdiagnosis and negatively impact treatment options and prognostic evaluation. (8)

Even though numerous studies have described the histopathological features of prostatic adenocarcinoma (PCa) and BPH, very few attempts have been made, particularly in low-resource settings like Sudan, on the application of histochemical techniques for differentiation. Most available information is from developed countries, where advanced immunohistochemical and molecular facilities are readily provided. (9) Such techniques are, however, not available or unaffordable for utilization in the majority of pathology laboratories in most of the African region. (10) It is important to address this gap towards improving diagnostic accuracy, guiding appropriate management, and making the best use of available resources in such settings.

The expression of neutral and acidic mucins was found to show differences between nodular hyperplasia and adenocarcinoma, according to previous histochemical analyses. (11) This suggests that special stains similar to Periodic Acid Schiff (PAS) and Alcian blue may provide diagnostic support in situations where immunohistochemistry is limited.

This study aims to evaluate the diagnostic utility of histochemical demonstration, specifically mucin and Deoxyribonucleic Acid (DNA) staining, in distinguishing between benign and malignant prostatic lesions and to assess the potential of these markers in providing prognostic information. (8)

Materials and Methods:

Study Design and Area:

This is an analytical, cross-sectional study of prostatic lesions collected from the histopathology lab of Omdurman Teaching Hospital, a major public hospital in Omdurman, Sudan, serving as a key healthcare facility.

Sample Design:

The sample size included all archival paraffin-embedded tissue blocks of prostate gland lesions available at the study site during the study period. Samples were included from the stored Formalin -Fixed Paraffin -Embedded prostate tissue blocks from the Histopathology Lab of Omdurman Teaching Hospital. They included specimens with a definite histopathological diagnosis of either BPH or PCa. Those with insufficient tissue, which precludes reliable staining, and cases lacking essential clinicopathological details were excluded.

Data Collection Methods and Tools:

Data was collected using a data collection form that covered histopathological diagnosis, type of lesion, patient age, and Gleason score (for malignant cases).

paraffin-embedded tissue blocks were sectioned using a rotary microtome (Leica Ltd). With thickness adjusted to 5µm.

Three sections were prepared from each sample and dewaxed in xylene for four minutes, and hydrated through gradual concentrations of ethyl alcohol: 100%, 90%,70% taking two minutes in each concentration and then applied to distilled water for two minutes.

PAS and Alcian blue technique (2.5 pH) were applied to demonstrate neutral and acidic mucin, respectively, and for DNA demonstration, the Feulgen reaction was applied.

Alcian Blue staining technique for acid mucin:

Hydrated sections were treated with Alcian blue solution at room temperature for 30 minutes. Then they washed in running water for 2 minutes and rinsed in distilled water. Then stained with nuclear-fast red for 5 minutes, washed in tap water, then Dehydrated, cleared, and cover-slipped. (12,13)

Periodic Acid Schiff reaction (PAS) for neutral mucin:

Hydrated sections were treated with periodic acid for 5 minutes, rinsed in distilled water, and covered with Schiff's reagent for 15 minutes, then washed in running tap water for 10 minutes. Harris hematoxylin was used as a counterstain for 15 seconds and blued with ammoniacal water, then rinsed in tap water. The sections were then subjected to gradual concentration of alcohol for dehydration (70, 80, 95, and 100%), followed by clearing in xylene, and a mounted coverslip was applied

with Distyrene Plasticizer Xylene (DPX) (14,15)

Feulgen method for DNA:

5 M Hcl was used for hydrolysis at room temperature for one hour. Then Schiff reagent was applied for 45 minutes. Washed in running water for five minutes, rinsed in distilled water, and stained with one per cent Light green for two minutes, washed, dehydrated and cleared with xylene, and a coverslip was applied with DPX. (13,16)

Ethical consideration:

Ethical approval was granted by the Scientific Research Committee of Al-Neelain University, Medical Laboratory Sciences Faculty. Permission for using the archived, anonymized histopathology samples and associated clinical information was obtained from the Histopathology laboratory of Omdurman Teaching Hospital. The Committee waived informed consent in compliance with institutional and national guidelines for research using archived specimens because there was no direct patient contact and no identifiable personal information.

Results:

A total of 109 samples of prostatic lesion biopsies prepared as paraffin-embedded blocks were enrolled in this study. Fifty-three (48.7%) were diagnosed with BPH, and 56 (51.3%) were PCas.

Using the Gleason scoring, among the 56 samples diagnosed with prostatic adenocarcinoma, 24 (42.9%) were high-grade, 22 (39.3 %) moderate, and 10 (17.9%) were low-grade.

Histochemical demonstration of mucin showed acid mucin in 22 samples (20.2 %) and neutral mucin expressed in 55 samples (50.5 %), 17 samples (15.6 %) were positive for both acid and neutral mucin, and 15 (13.8 %) revealed absence of mucin expression.

DNA staining intensity for the 109 samples showed a weak reaction in 14 (12.8%), a moderate reaction in 48 (44.0%), and a strong reaction in 47 (43.1%).

All samples of benign hyperplasia were positive for neutral mucin with complete absence of acidic mucin expression, whereas the PCa group were positive for acidic mucin in 22 samples (39.2%) and neutral mucin in two samples (3.5 %),17 samples (30.3%) revealed positive expression for both types of mucins, and 15 samples (13.8%) were negative for mucin expression (Figure 1 and 2). Regarding the staining intensity of DNA. The group of benign prostatic hyperplasia showed weak intensity of DNA expression by Feulgen

Table 1: Distribution of Mucin Staining Pattern by Histochemical Methods

Diagnosis	Neutral mucin only	Acidic mucin only	Both types	Negative	Total
BPH (n = 53)	53 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	53
PCa (n = 56)	2 (3.5%)	22 (39.2%)	17 (30.3%)	15 (26.8%)	56
Total	55 (50.5%)	22 (20.2%)	17 (15.6%)	15 (13.8%)	109

The difference between BPH and PCa is significant at **(p < 0.001)** (Chi-square test).

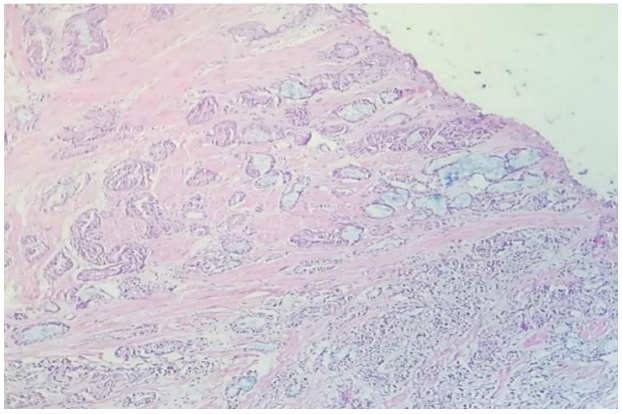

Figure 1: Positive Alcian Blue staining in prostate cancer

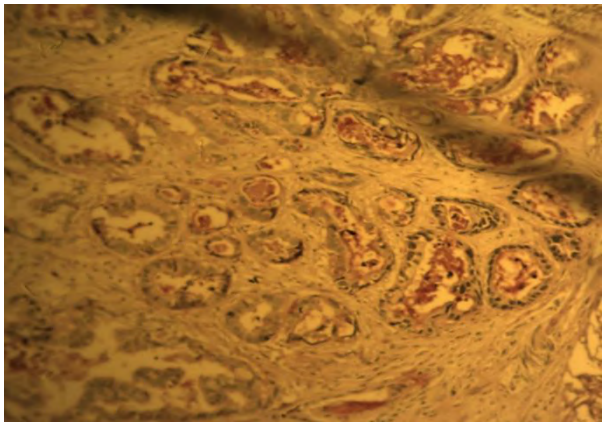

Figure 2: Positive PAS for neutral mucin in BPH

reaction in 11samples (10.09%), moderate in 42 samples (38.53%), no samples showed strong expression, while the PCa group revealed weak expression in 3 (2.75%), moderate in 6 samples (5.50%) and strong intensity reaction in 47 samples (43.11%) (Figure 3 and 4).

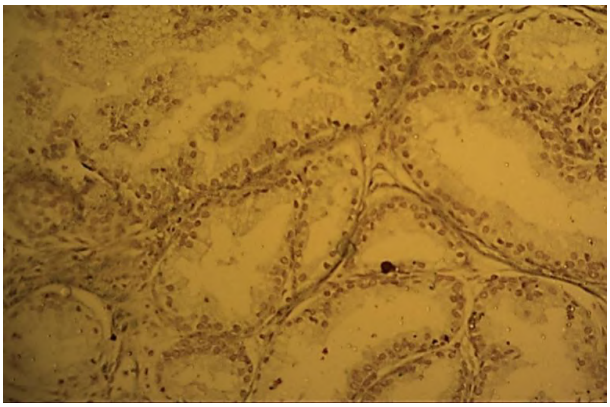

Figure 3: DNA staining in moderate grade (PCa).

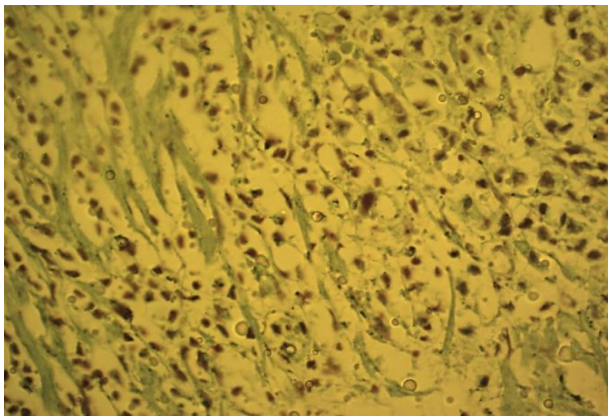

Figure 4: DNA staining in high-grade (PCa).

Table 2. DNA Staining Intensity by Feulgen Reaction.

Diagnosis	Weak (+)	Moderate (++)	Strong (+++)	Total
BPH (n = 53)	11 (20.8%)	42 (79.2%)	0 (0.0%)	53
PCa (n = 56)	3 (5.4%)	6 (10.7%)	47 (83.9%)	56
Total	14 (12.8%)	48 (44.0%)	47 (43.1%)	109

Discussion:

PCas exhibit a wide spectrum of appearances, ranging from anaplastic tumors to highly differentiated neoplasms that are distinguished from non-neoplastic glands with great difficulty due to their reliance on histomorphological appearance(18)

This study examined the mucin expression patterns and DNA staining intensity to compare between benign and malignant prostatic lesions, and to investigate the association between these markers and Gleason grading in adenocarcinomas.

The study finding demonstrates a significant difference in mucin expression within the type of lesions, with a complete absence of acid mucin among the prostatic hyperplasia group; the tendency towards the acidic type of mucin in malignant tissue proves the existing precepts that the mucin composition alteration indicates malignancy (8, 19, 20).

Acidic mucins, either sialomucins or sulfomucins, could be involved in the adhesion, invasion, or immune escape of tumor cells, potentially conferring aggressive tumor behavior (21). While neutral mucin is prevalent in benign lesions, supporting its role in mucin characterization as a method for malignancy assessment beyond conventional morphology.

The observation that there is a strong correlation between mucin subtype and Gleason grade in our population is in accordance with the finding that particular patterns of mucin expression are associated with the degree of tumor differentiation and aggressiveness, and underlines its potential use as a biomarker for both diagnosis and prognosis (22).

The Feulgen technique used for histochemical demonstration of DNA, characterized by its usefulness in archival formalin-fixed paraffin-embedded sections, giving a permanent result suitable for semiquantitative evaluation of DNA (23).

In our study, DNA intensity showed a significant relation with the type of prostatic lesion and with the Gleason score among the adenocarcinoma group. This finding supports the hypothesis that malignant cells typically exhibit increased DNA content due to genomic instability, such as aneuploidy or polyploidy, which is a hallmark of cancer. (24, 25)) And that is supported in previous studies that similarly reported that higher Feulgen reactivity correlates with more aggressive tumor behavior and higher histological grade. (23)

Taking all these factors into consideration, the changes in the expression of mucin and the intensity of DNA staining suggest the biological aggressiveness of PCa in the current study. This is also reflected in the clinicopathological features of the patients.

The prevalence of prostate cancer increases with age, with the highest rates being among men over 70 years of age. In Sudan, cancer patients come to hospitals at advanced stages of disease. (17) This may be attributed to the limited availability of specialized oncology and pathology services in rural regions, leading patients to seek care only at major referral centers in Khartoum, such as Omdurman Teaching Hospital. In the current study, there was a high proportion (42%) of adenocarcinomas that were initially presented as high grade, confirming that there is a high rate of late diagnosis in this setting.

Our findings confirm the value of the histochemical staining technique of mucin and DNA for differential diagnosis between prostatic hyperplasia and PCa, and that it may add value to the diagnosis.

Conclusions:

The present study confirms the utility of histochemical mucin staining and intensity of DNA staining as a tool for low-cost settings to differentiate between benign and malignant prostatic lesions, providing diagnostic and prognostic information about prostatic lesions.

Study Limitations:

The sample size was relatively small and restricted to a single institution, which may limit the generalizability of the findings.

Conflict of Interest:

The authors declare that they have no conflict of interest.

Funding:

This research received no external funding.

Acknowledgments:

The authors acknowledge the staff at Omdurman Teaching Hospital-Histopathology lab and the Faculty of Medical Laboratory Sciences, Al-Neelain University, for their assistance and technical support during this study.

References:

1. Seraphin TP, Joko-Fru WY, Kamaté B, Chokunonga E, Wabinga H, Somdyala NIM, et al. Rising prostate cancer incidence in sub-Saharan Africa: a trend analysis of data from the African Cancer Registry Network. Cancer Epidemiol Biomarkers Prev. 2021 Jan;30(1):158–65.

https://doi.org/10.1158/1055-9965.EPI-20-1005

2. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2021 May;71(3):209–49.

https://doi.org/10.3322/caac.21660

3. International Agency for Research on Cancer. GLOBOCAN 2022: prostate cancer fact sheet [Internet]. Lyon: IARC; [cited 2025]. Available from: https://gco.iarc.who.int/media/globocan/factsheets/cancers/27-prostate-fact-sheet.pdf

4. Leung DKW, Wong CHM, Ko ICH, Siu BWH, Liu AQY, Meng HYH, et al. Global trends in the incidence, mortality, and risk-attributable deaths for prostate, bladder, and kidney cancers: a systematic analysis from the Global Burden of Disease Study 2021. Eur Urol Oncol. 2025;8(6):1533–43.

https://doi.org/10.1016/j.euo.2025.05.007

5. Taha SM, Weng HY, Mohammed MEI, Osman YM, N'dri N, Mohammed SI, et al. Prostate cancer clinical characteristics and outcomes in Central Sudan. Ecancermedicalscience. 2020;14:1116.

https://doi.org/10.3332/ecancer.2020.1116

6. Humphrey PA. Diagnosis of adenocarcinoma in prostate needle biopsy tissue. J Clin Pathol. 2007 Jan;60(1):35–42.

https://doi.org/10.1136/jcp.2005.036442

7. Srigley JR. Benign mimickers of prostatic adenocarcinoma. Mod Pathol. 2004 Mar;17(3):328–48.

https://doi.org/10.1038/modpathol.3800055

8. Agrawal D, Zawar M, Deshpande N, Sudhamani S. The study of mucin histochemistry in benign and malignant lesions of prostate. J Sci Soc. 2014;41(1):38–40. https://doi.org/10.4103/0974-5009.126751

9. Signoretti S, Waltregny D, Dilks J, Isaac B, Lin D, Garraway L, et al. p63 is a prostate basal cell marker and is required for prostate development. Am J Pathol. 2000 Dec;157(6):1769–75. https://doi.org/10.1016/S0002-9440(10)64814-6

10. Sweety RA, Sultana S, Islam MA, Dewan MRK, Zhumur M, Jeba R, et al. Evaluation of mucin histochemistry in relation to p63 expression in nodular hyperplasia and adenocarcinoma of prostate. Int J Res Med Sci. 2023;11(3):824–8.

https://doi.org/10.18203/2320-6012.ijrms20230302

11. Role of Neutral Mucin in Differentiating Prostatic Adenocarcinoma from Nodular Hyperplasia of Prostate. TAJ J Teach Assoc. 2024;37(2).

https://doi.org/10.70818/taj.v37i2.0141

12. Sheehan DC, Hrapchak BB. Theory and practice of histotechnology. Columbus (OH): Battelle; 1980. p. 189–190.

13. Bancroft JD, Gamble M. Theory and practice of histological techniques. 6th ed.

London: Churchill Livingstone; 2008. p. 163–167.

14. Giri D. Basic histopathological techniques. 2nd ed. New Delhi: Jaypee Brothers Medical Publishers; 2015. p. 120–124.

15. McManus JFA. Histological and histochemical uses of periodic acid. Stain Technol. 1948;23(3):99–108.

16. Chieco P, Derenzini M. The Feulgen reaction 75 years on. Histochem Cell Biol. 1999;111(5):345–58.

https://doi.org/10.1007/s0041800503765

17. Elamin A, Ibrahim ME, Abuidris D, Mohamed KEH, Mohammed SI. Part I: cancer in Sudan—burden, distribution, and trends breast, gynecological, and prostate cancers. Cancer Med. 2015 Mar;4(3):447–56.

https://doi.org/10.1002/cam4.387.

18. Sweety RA, Sultana S, Islam MA, Dewan MRK, Zhumur M, Jeba R, et al. Evaluation of mucin histochemistry in relation to p63 expression in nodular hyperplasia and adenocarcinoma of prostate. Int J Res Med Sci. 2023;11(3):824–8.

https://doi.org/10.18203/2320-6012.ijrms20230338

19. Srikanth K, Raj VD, Suresh N, Vimal M. Mucin profile of prostatic lesions: a histochemical approach for differentiation in a tertiary care center. SJH Res. 2025.

https://sjhresearchafrica.org/index.php/public-html/article/view/1713https://doi.org/10.51168/sjhrafrica.v6i3.1713

20. Mathur SK, Gupta S, Marwah N, Narula A, Singh S, Arora B. Significance of mucin stain in differentiating benign and malignant lesions of prostate. Indian J Pathol Microbiol. 2003 Oct;46(4):593–5

21. Chen C, Patel A, Demirkhanyan L, Gondi CS. The role of mucins in cancer and cancer progression: a comprehensive review. Curr Issues Mol Biol. 2025 May 29;47(6):406.

https://doi.org/10.3390/cimb47060406

22. Zedan EM, Morgan NM, El-Sawi R, Youssef SA. The study of mucin stains and cyclin D1 expression in benign prostatic hyperplasia and prostatic adenocarcinoma (immunohistochemical study). Benha Med J. 2024.https://doi.org/10.21608/bmfj.2024.267338.2011

23. Salih MM, Elsheikh LA. Feulgen reaction as a marker for identifying prostatic hyperplasia and prostate cancer. Andrology. 2019;8(201):2167-0250.2110.
https://doi.org/10.24015/2167-0250.10.201

24. Van Neste L, Herman JG, Otto G, Bigley JW, Epstein JI, Van Criekinge W. The epigenetic promise for prostate cancer diagnosis. Prostate. 2012 Aug;72(11):1248–61.

https://doi.org/10.1002/pros.22459

25. Dumke C, Gemoll T, Oberländer M, Freitag-Wolf S, Thorns C, Glaessgen A, et al. SATB1, genomic instability and Gleason grading constitute a novel risk score for prostate cancer. (Journal details and year not specified in source text; please complete when available.)

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