

ACCESSIBILITY GAPS IN OMANI HOSPITAL WEBSITES: A WCAG 2.1 COMPLIANCE STUDY

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ABSTRACT

In the digital age, ensuring web accessibility in the healthcare sector is critical for inclusivity, especially for individuals with disabilities. This study evaluates the accessibility compliance of top-ranked hospital websites in Oman against the Web Content Accessibility Guidelines (WCAG) 2.1 standards. Through the use of automated tools (e.g. WAVE, TAW and EIII) accessibility metrics were analyzed to find common accessibility problems such as: missing alternative text, low contrast ratios between background and foreground, and operability issues. Public and private sector websites of the top six hospitals formed the sample. Results show significant differences, with private hospitals being more prone to accessibility violations than public hospitals. Common categories of accessibility mistakes included information and relationships, non-text content, labels or instructions, headings and labels and keyboard accessibility. The study concludes that most hospital websites in Oman generally fail to meet web accessibility standards, restricting the functionality available to many users. This study highlights the need for an organized web accessibility criteria framework for the healthcare sector in Oman and contributes valuable perspectives toward a more digitally inclusive future as a part of the Vision 2040 goal.

Keywords: *Web Accessibility, WCAG 2.1, Healthcare Websites, Digital Inclusivity, Accessibility Compliance, Vision 2040*

1. INTRODUCTION

In the digital era, web accessibility is essential for healthcare inclusivity, yet hospital websites globally struggle to meet standards like WCAG 2.1, as evidenced by recent studies [1]. In Oman, where e-health initiatives are expanding under Vision 2040, inaccessible hospital websites pose significant barriers for individuals with disabilities, exacerbating health inequities. This gap, underscored by the increased reliance on digital health platforms during the COVID-19 pandemic (Smith & Jones, 2021), demands urgent evaluation to ensure equitable access to critical information and services.

The internationally recognized WCAG standards produced by the W3C are the benchmark for accessibility compliance online. According to the [2], these detailed technical guidelines ensure web content allows for easier navigation and is designed to be accessible. They stress the importance of perceivable, operable, understandable and robust content, and the necessity to cater the users with varying needs. Feature that ease accessibility such as

text alternatives for non-text content, keyboard navigability, clear design structures, etc.

The healthcare industry in Oman has made great strides in the last few decades. Innovative technologies have been embraced considerably by the Ministry of Health and private healthcare providers to improve the delivery of services [3]. However in the modern-day world of pandemic, the websites of hospitals have become one of the main tools for communicating patient-relevant information, having virtual consultations, scheduling visits, as well as awareness for maintaining health. Yet we have not sufficiently explored the accessibility of these digital platforms. It is still unclear as to exactly how accessible these websites are, despite the advancements in technology.

For persons with disabilities, website accessibility barriers create some really large challenges. For example, visually impaired users face challenges on websites that are not compatible with screen readers, and users who have motor impairments may find it difficult to navigate on platforms that are not accessible through a keyboard [4]. Studies on other

geographical areas such as the European Union and North America show that minimum accessibility levels are still not met even on the "best" hospital websites [5]. This raises concerns as to whether hospitals in Oman, a member of the Gulf Cooperation Council (GCC) faces similar challenges.

It is important to note that accessible websites are not just important at an individual level; they have far-reaching consequences on healthcare access equity and outcomes. In the absence of adequate information, communications may be less readable, health literacy may suffer, and use of digital health services may fall, especially in vulnerable populations [6]. Moreover, it can also have legal consequences in areas where such specifications are obligatory for conformity with accessibility benchmarks.

This study aims to assess the accessibility of websites of top-ranked hospitals in Oman against WCAG 2.1 standards, using automated tools (WAVE, TAW, EIII) to measure compliance levels and identify prevalent accessibility barriers. Outcome measures include the number and type of accessibility violations, pass scores, and comparative performance between public and private hospitals. This research is novel as it provides the first comprehensive analysis of Omani hospital website accessibility, addressing a critical gap in the Gulf Cooperation Council (GCC) region and contributing to Oman's Vision 2040 digital inclusivity goals, where prior studies have focused on other regions like Saudi Arabia or India.

This study focuses on evaluating the accessibility of the homepages of six top-ranked public and private hospital websites in Oman, using automated tools aligned with WCAG 2.1 Level AA standards. The scope is limited to these homepages due to their role as primary entry points for users seeking healthcare information. Assumptions include that these homepages represent the overall accessibility of the hospital websites and that automated tools provide a reliable initial assessment, though manual testing and user feedback are acknowledged as valuable complements beyond this study's scope. Limitations include the exclusion of deeper site pages, Arabic content, and real-world user testing with individuals with disabilities, which could offer additional insights.

2. RELATED WORK

Improving accessibility of healthcare platforms and hospital websites to information for users has emerged as an area of research, with studies related

to improving inclusivity through implementing better standards, scalable tools and user-centered approaches to enhancing accessibility. [7] found high non-compliance with WCAG 2.1 among Indian hospital websites owing to poor interface-design and absence of assistive technology. Similarly, [8] focused on the accessibility of ophthalmology hospital websites in the U.S. and highlighted the need for improvement to assist people with visual impairment. [9] show that even organizations compliant with WCAG must consider ongoing accessibility testing due to the evolving nature of accessibility needs within the healthcare sector. [10], [11] shares methods for large-scale evaluations, with a 20% sampling approach to millions of pages using automatic validation tools, extending the ability and efficiency of access assessments. [12] highlight the needs for services addressed to users on Greek hospital websites, emphasizing the need to make changes rather than just updating to the technical compliance. [13] develop metrics to quantify accessibility barriers and calculate scores, providing a systematic foundation for targeted improvements. Together, this research underlines the importance of a comprehensive approach: that considers not only technical standards or modern tools, but also the specific conditions and needs of users when aiming to provide defined digital healthcare services.

Hospital websites are vital for public health communication, yet accessibility remains a global challenge. [14] found only 20% of Saudi hospital websites fully complied with WCAG 2.0, a study limited by its focus on a single compliance level without exploring user impact. In similar fashion, [15] identified widespread errors globally but lacked regional specificity, weakening its applicability to Oman. These studies highlight a persistent digital divide for people with disabilities, yet their reliance on automated tools alone overlooks usability nuances, a gap this study aims to address with a focused Omani context.

However, such services and information might be out of reach especially for people with disability due to the non-availability of these information and services in the hospital websites [14]. This digital divide is also a major challenge for persons with disabilities already facing barriers when it comes to obtaining health care [16] which can aggravate health inequalities. Especially, Islanders are facing issues in getting access to health-related information and the insight of health information is very crucial for the disabled citizens [17]

A number of studies have assessed hospital website accessibility by different methodologies. For

instance, [18] created a framework to assess hospital websites based on the Web Content Accessibility Guidelines. Similarly, [19] assessed Indian hospital websites for their accessibility, usability, and security. These studies shed light on hospital websites in other regions and demonstrate the importance of continuous evaluation and improvement across such important public access information.

The websites of educational institutions are also not free from the accessibility challenges. Research [20], [21] on 302 homepages found common violations, including missing alternative text, insufficient page number levels, and navigational issues. Despite noted improvements in some regions, universal accessibility is one of the major challenges that educational institutions will have to deal with worldwide. Now, we know by instincts that education has gone a long way from traditional classrooms filled with blackboards, known teachers and student, reading, writing and memorizing of facts.

This past year of the COVID-19 pandemic has highlighted the necessity of having health information available online [22]. The internet, providing information about COVID-19 symptoms and vaccination, among others, has relied heavily during the pandemic. For this reason, hospital websites and other health-related sites must be available to everyone, including those with disabilities.

There have been some studies that assessed the accessibility of health websites in the time of COVID-19. [22], [23], for example, evaluated the accessibility of COVID-19 pandemic websites to the disabled users. Similarly, [24] automated tools used to evaluate accessibility of healthcare sites. These studies give us critical insight into how we were able to access health information online during the course of the pandemic.

Efforts can be made to adopt and implement accessibility guidelines like the Web Content Accessibility Guidelines to improve the accessibility of hospital websites [25]. The WCAG guidelines provide a standard for making web content accessible to people with disabilities. In addition, facilities are also encouraged to conduct regular accessibility audits of their websites to identify and rectify accessibility mistakes [26]. Furthermore, hospitals should include users with disabilities in their website design and testing processes to ensure that the resulting sites are usable by all [17].

In the sultanate of Oman, with the growing e-health initiatives, it is very important to ensure that

hospital websites adhere to WCAG 2.1 guidelines so that every citizen including citizens with disabilities have equal access. Understanding accessibility status of Omani hospital websites will also provide evidence based information to the policy makers and will be a step towards narrowing down the accessibility gap in the health sector.

2.1 Web Content Accessibility Guidelines

The Web Content Accessibility Guidelines (WCAG) 2.1, developed by the World Wide Web Consortium [2]. Web Content Accessibility Guidelines (WCAG) 2.1 describe how to make Web content more accessible to people with disabilities. The disabilities that relate to accessibility fall into a wider spectrum that includes visual, auditory, physical, speech, cognitive, language, learning and neurological disabilities. Though these guidelines address a broad range of concerns, they cannot meet the needs of people with all types, levels and combinations of disability. These guidelines also enhance the usability of Web content for older people with changing abilities due to aging, often making them more usable for all users. The Web Content Accessibility Guidelines (WCAG) 2.1 outline four key principles of web accessibility as mentioned below [2] Perceivable, Operable, Understandable and Robust.

Perceivable: Information and user interface components are presented to the user in such a way that the user can perceive them, with a requirement for providing text alternatives for non-text content.

Operable: The user interface must be navigable ensuring that all functionality is accessible with a keyboard and is free from time limits that may disadvantage some users.

Understandable: Users should be able to understand the information and use the interface without confusion.

Robust: Content must be robust enough to be reliably interpreted by a wide variety of user agents, including assistive technologies.

The key aspect of accessibility is demand that can include that of levels of conformity related to the effect of accessibility, and all the guidelines contain success criteria. In order to adapt to the needs of different situations and different users, the guidelines have three levels of compliance [2]:

- 1) A: Lowest level
- 2) AA: Middle level
- 3) AAA: Highest level.

Most websites which implement WCAG 2.1 use the 'AA level'. Problems in website accessibility are detectable using a combination of automatic tools and criteria defined by an expert in web accessibility. However, this process can take time and is a subjective one, as an expert can't necessarily tell how "good" a website is. Software tools can detect errors in HTML code and CSS structure, assess browser compatibility, check links and performance of the website, and generate warnings [27].

In Oman, while there are no specific legal mandates on website accessibility, aligning with international standards such as WCAG 2.1 is vital for healthcare institutions aiming to provide inclusive services. Globally, countries such as the United States have implemented legislation like the Americans with Disabilities Act (ADA), which enforces web accessibility for organizations, including healthcare providers.

2.2 The Research Questions

A recent study conducted on Saudi Arabian hospitals found widespread accessibility challenges, with only 20% of evaluated websites fully complying with WCAG 2.1 standards. Similar issues have been reported in India, where accessibility errors limit user engagement and inclusivity. However, no comprehensive studies have examined the accessibility of hospital websites in Oman. This

RQ 3: What accessibility issues can be most frequently found in Oman hospital websites?

We will describe the evaluation process in the next section. It describes the site selection process and the evaluation method used to determine if certain hospitals' websites were accessible.

3. METHODOLOGY

3.1 Selection of Hospitals

This study focuses on evaluating the websites of the top-ranked public and private sector hospitals in Oman based on their reputation, the range of medical services provided, and their digital presence. The below six hospitals selected for evaluation include:

1. Royal Hospital
2. Sultan Qaboos University Hospital
3. Khoula Hospital
4. Muscat Private Hospital (Private)
5. Aster Royal Al Raffah Hospital (Private)
6. Burjeel Hospital (Private)

3.2 Evaluation Tool

To assess web accessibility, we utilized the Wave, TAW, and EIII tools, each designed to evaluate compliance with the Web Content Accessibility Guidelines (WCAG) 2.1, focusing on Level AA standards. These tools were selected for their comprehensive analysis and ability to identify accessibility issues effectively. Figure 1 shows an example of evaluation process in Evaluation Tool.

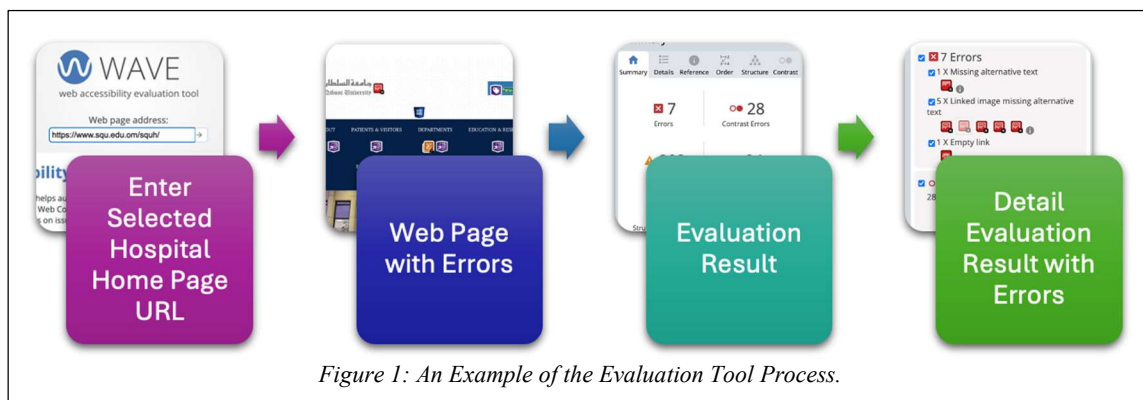


Figure 1: An Example of the Evaluation Tool Process.

research seeks to address this gap, providing an analysis and comparison to similar studies in other countries. The study aimed to cover the following three research questions which analyzed Oman's best public and private hospitals.

RQ 1: How accessible are hospitals' websites in the Sultanate of Oman?

RQ 2: Are the public and private hospitals websites in Oman has any significant difference on accessibility compliance?

Wave: This tool [28] visually evaluates websites for WCAG compliance by marking errors directly on the page. It categorizes findings using symbols: red symbols for critical errors, green symbols for areas of improvement, and other symbols for items requiring manual review. Each hospital's website was analyzed using Wave, focusing on its Arabic homepage to accommodate the primary language of most users in Oman.

TAW: This tool [29] provided an automated and interactive assessment of each hospital's Arabic

homepage, highlighting WCAG violations and offering actionable feedback. TAW categorized issues based on severity and impact, ensuring the identification of critical areas for improvement in the accessibility of the websites.

EIII: In addition to the WCAG 2.1 standards, this tool [30] also provided a detailed assessment based on regional accessibility guidelines. It highlighted the user experience and offered recommendations on improving accessibility on the hospital websites' Arabic homepages in Oman.

Using these tools, we made sure that accessibility problems were being assessed holistically, catering to the main userbase language to get meaningful and reliable outcomes.

3.3 Evaluation Process

Three main steps were taken in the accessibility evaluation process:

1. **Website Selection:** The URL of each hospital homepage was inputted into the Wave, TAW, and EIII tools.
2. **Accessibility Testing:** We used Wave, TAW, and EIII tools to scan each page, and then generated reports on how many and what type of accessibility issues were found.
3. **Data Analysis:** Errors were assigned codes and analyzed for trends in accessibility issues amongst both public and private hospitals.

Such methodology enables comparisons between the public and private hospital websites, thus, revealing possible differences in accessibility between them in the hospital industry in Oman.

4. RESULTS AND ANALYSIS

Here, we perform a comprehensive assessment of hospital web sites in Oman using accessibility metrics as evaluated from WAVE, TAW and EIII tools. The report hit on the accessibility status, the disparity between public and private facilities, and notable mistakes plaguing these sites. We go right to the heart of each research question for clarity and actionable insights.

4.1 Accessibility Status (RQ1)

In Oman, availability of hospital websites is variable among both public and private institutions. Public hospitals (eg Sultan Qaboos University Hospital, Royal Hospital) performed relatively better in some metrics (eg structural elements and ARIA compliance). By contrast, the main violations at private hospitals like Muscat Private Hospital are concentrated regarding contrast errors and operable issues.

Key Metrics:

1. WAVE Tool:

- Alerts and Structural Elements emerged as the most frequent violations across all hospitals.
- Royal Hospital recorded the highest alerts (101), while Muscat Private Hospital had the most contrast errors (66).
- ARIA violations were highest in Khoula Hospital (79 issues).

2. TAW Tool:

- Perceivable content and Operable issues were dominant challenges.
- Khoula Hospital had the most Perceivable violations (27), and Muscat Private Hospital reported the highest Operable violations (49).

3. EIII Tool:

- Total violations ranged from 299 (Khoulia Hospital) to 1,046 (Muscat Private Hospital).
- Pass scores varied from 91.41% (Royal Hospital) to 97.52% (Muscat Private Hospital), indicating room for improvement.

Figures 2, 3, and 4 summarize the distribution of violations across tools, metrics, and hospitals.

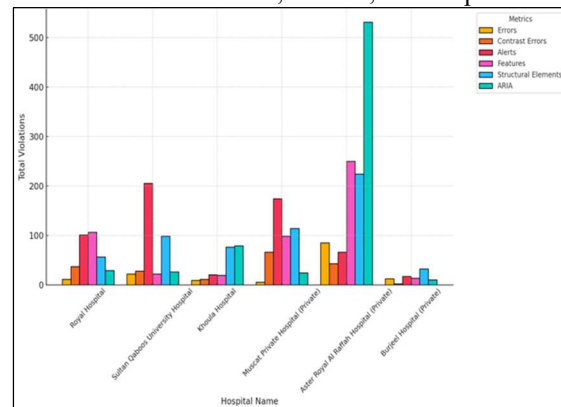


Figure 2: WAVE Tool - Violations per Hospital

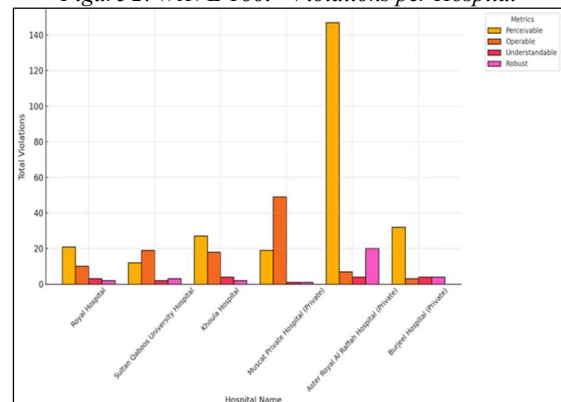


Figure 3: TAW Tool - Violations per Hospital

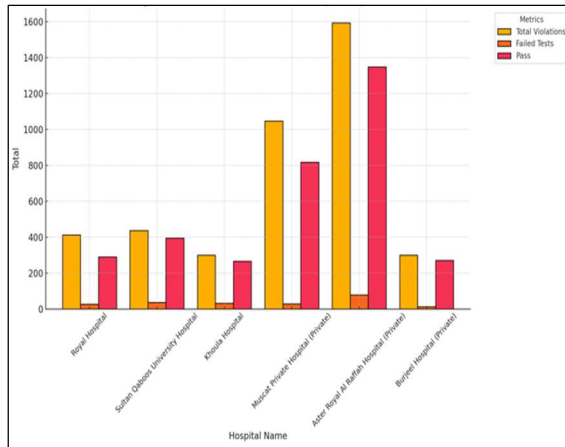


Figure 4: EIII Tool - Violations and Scores per Hospital

4.2 Public vs. Private Hospital Accessibility (RQ2)

The analysis reveals clear disparities in accessibility compliance between public and private hospital websites.

Public Hospitals:

- Generally performed better in structural integrity and overall ARIA compliance.
- Common challenges included missing alternative text and redundant links.

Private Hospitals:

- Struggled with contrast errors, operable issues, and total violations.
- Muscat Private Hospital showed the highest number of violations across all tools, particularly in contrast errors and navigation-related issues.

Private hospitals demonstrated significantly more accessibility challenges compared to public hospitals, particularly in operability and contrast compliance. Addressing these disparities requires targeted interventions.

4.3 Common Accessibility Errors (RQ3)

The most prevalent accessibility issues affecting hospital websites were consistent across tools and hospitals, as summarized below:

I. Missing Alternative Text:

- A universal issue flagged by both WAVE and EIII tools.
- Images, multimedia elements, and form fields often lacked descriptive labels.

II. Low Contrast Ratios:

- A major barrier for visually impaired users, with Muscat Private Hospital recording the highest number of violations (66).

III. Structural Issues:

- Improper nesting of elements and hidden content were frequently reported, especially in Khoulia Hospital.

IV. Operability Challenges:

- Navigation-related issues such as improper focus order, lack of keyboard accessibility, and missing labels were identified in multiple hospitals.

Figures 2 to 4 highlight these errors, providing a comprehensive overview of their distribution across hospitals.

4.4 Comparative Analysis and PMIs

Compared to prior studies, such as those in Saudi Arabia (20% WCAG compliance) and India (high non-compliance), Omani hospital websites show similar accessibility gaps but with unique regional nuances.

Plus: Public hospitals like Royal Hospital outperform private ones in structural integrity, aligning with global trends where public entities often prioritize compliance. Automated tools effectively identified universal issues (e.g., missing alt text), consistent with large-scale evaluations elsewhere.

Minus: Private hospitals like Muscat Private Hospital lag significantly in contrast and operability, a weakness more pronounced than in Saudi studies, possibly due to less regulatory oversight in Oman. The lack of manual testing limits depth compared to user-centric studies in the U.S.

Interesting Facts: Khoulia Hospital's high ARIA violations (79) suggest a focus on advanced features that are poorly implemented, a pattern less noted in other GCC studies. The high pass scores (91-97%) despite violations indicate a superficial compliance that masks usability issues.

4.5 RECOMMENDATIONS

Based on the results, the following recommendations are made to improve the accessibility of hospital websites in Oman:

Implement Alternative Text for All Images:

Ensure that all visual elements, including images, videos, and icons, have descriptive alternative text to assist users with visual impairments.

Improve Keyboard Navigability: Ensure that all interactive elements, including dropdown menus, form fields, and buttons, can be accessed via keyboard. Conduct regular testing to identify and fix keyboard navigability issues.

Enhance Content Clarity and Simplicity: Use plain language and provide input assistance for forms. Hospitals should aim to present information

in a clear and understandable manner, especially for users with cognitive impairments.

Ensure Compatibility with Assistive Technologies: Regularly conduct tests of websites with screen readers, and different assistive tools to ensure that all content is accessible. Following best coding practices will help with keeping compatibility.

Regular Accessibility Audits: Ensure that periodic accessibility checks are performed using both manual testing and automated solutions. Testing with users with disabilities provides valuable real-world insights into usability issues.

This analysis highlights critical accessibility gaps in Oman's hospital websites, emphasizing the need for targeted improvements in compliance with WCAG standards. Addressing these gaps will ensure a more inclusive and user-friendly digital presence.

5. CONCLUSION AND FUTURE WORK

This study reveals substantial accessibility deficiencies in Omani hospital websites, with no evaluated site fully adhering to WCAG 2.1 Level AA standards, a novel finding for Oman and the GCC region. By identifying prevalent issues like missing alt text and low contrast ratios, it contributes the first empirical baseline for healthcare web accessibility in Oman, advancing the Vision 2040 inclusivity agenda. The impact is significant in today's context, where digital health access is vital post-COVID-19, highlighting urgent needs for policy and design improvements to ensure equitable access for individuals with disabilities. Future work could expand to deeper site pages, incorporate user testing with disabled individuals, and track longitudinal progress toward WCAG compliance.

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