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Research on Inclusive Analysis and Accessibility Optimization of Healthcare Service Websites Based on the Needs of Elderly Users

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Abstract. As society ages, the need for online resources for older adults is becoming increasingly significant. However, because older adults are characterized by declining cognitive responses and delayed operating behaviors, they face many challenges in their access experience on healthcare service websites. Taking several domestic healthcare service websites as samples, this study analyzes the inclusiveness of website pages and detects accessibility from the perspective of inclusiveness by comparing the standards of Web Content Accessibility Guidelines (WCAG) and using an open source automated detection tool. The study aims to reveal the barriers faced by elderly users in accessing healthcare service websites from multiple dimensions such as perceivability, operability, comprehensibility and stability. At the same time, the web operating behavior, subjective feelings, and actual access barriers of elderly users were explored in depth through observation and in-depth interview methods. Based on the obtained data, accessibility optimization strategies for medical service websites are proposed to enable older users to access medical information and services more easily and conveniently.

Keywords. Medical service websites, accessibility optimization, inclusive design

1. Introduction

According to the survey, 91.8% of the elderly in Shanghai own cell phones, of which only 4.7% do not use Internet terminal devices, 16.2% own tablet computers (PADs), 14.2% own desktop computers, and 10.0% own laptops. For older adults who already own smartphones, the top three Internet applications that require assistance from friends, relatives or volunteers to use are: online government services (37.0%), online medical care (34.8%), and online socializing/chatting (31.8%)[1].The increase in the new generation of older persons and the rise in educational attainment have led to significant structural changes in the aging population[2].

Accessibility refers to the provision of flexible facilities and environments, whether virtual or physical, to meet the needs and preferences of each user. This can be any place, space, program or service that is easy to approach, reach, enter, interact with, understand or otherwise use[3]. Accessibility guidelines for website accessibility also

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make Web content easier to use for older adults whose abilities have changed due to age, and generally improve usability for the average user[4].Inclusive design is one of the main design theories for dealing with an aging population, and its practice is guided by an engineering approach that looks at a diversity of user abilities, often by reducing the ability requirements of a product to accommodate as many users as possible[5].Therefore, the inclusiveness of websites is important in mitigating the phenomenon of "digital exclusion" among older users.

In order to address these issues, this study will adopt a mixed research methodology, combining quantitative and qualitative research, referring to the indicators of WCAG, and selecting representative medical service websites in China as samples to analyze the barrier factors that elderly users may encounter when accessing medical service websites. At the same time, the qualitative research method of observation and in-depth interviews will be used to analyze the accessibility characteristics of medical service websites based on the usage needs of elderly users.

2. Research status

Based on the needs of older users, international research has focused more on web accessibility design standards and specifications, the development of assistive technologies, and the practical application of accessibility design on websites. For example, the World Wide Web Consortium (W3C) released the Web Content Accessibility Guidelines (WCAG), a set of international standards for ensuring the accessibility of websites and applications, which has quickly become a global benchmark for web accessibility and at the same time can be better adapted to older users.

In recent years, based on the needs of elderly users, China has successively promulgated a series of relevant policies and laws and regulations aimed at promoting and strengthening the construction of information accessibility. For example, in 2006, the Shanghai Society of Gerontology and the Geriatric Information Technology Professional Committee issued the "Geriatric Accessibility Web Page/Website Construction Norms (for Trial Implementation)"[6], and in order to address the challenges faced by special groups in the use of smart technologies, such as broadband and Internet poverty, the Ministry of Industry and Information Technology (MIIT) recently issued the "Special Action Program for Ageing and Accessibility Reconstruction of Internet Applications," which focuses on the adaptation and accessibility transformation of Internet websites and mobile applications. The program focuses on seven specific elements, including ageing and accessibility transformation of Internet websites and mobile applications, inclusion of the level of ageing and accessibility transformation in "enterprise credit evaluation," and issuance and public announcement of information accessibility symbols[7].

With the popularization of medical Internet service platforms, the expectations of older persons for convenient and fast medical services are increasing. However, despite the abundance of online platform resources, older adults still face multiple challenges in information access and learning; therefore, relevant governmental departments should attach great importance to the accessibility of medical service websites and actively enhance the implementation of accessibility standards. Currently, international insights and research results on the inclusiveness analysis of healthcare websites are richer than those in China. Therefore, the aim of this study is to analyze the available

data and website testing results, and to propose accessibility optimization strategies for healthcare websites, so that elderly users in China can access healthcare information more easily and conveniently.

AChecker supports a variety of accessibility standards and guidelines, including WCAG and Section 508 (U.S. Federal Accessibility Act). Users can select specific criteria, and then AChecker checks against the selected criteria and generates a detailed report showing accessibility issues and non-compliant items on the page. Therefore, AChecker based on AChecker was chosen as a tool for digital website evaluation in this study. International scholars used AChecker and Access Monitor based on WCAG standards to check the accessibility of COVID19 websites in Asian countries[8], Chinese scholars used tools such as AChecker and A-prompt based on WCAG 2.0 to evaluate the accessibility of websites for the elderly[9].

3. Research design

3.1. Research target

Fifteen relatively healthy elderly users aged 60 years or older were selected as respondents for this study. These elderly users will participate in field observations and in-depth interviews to fully understand the situations they face and the barriers they encounter when accessing medical service websites. By observing the experiences, reactions and needs of elderly users in practice, it is possible to more accurately hypothesize the degree of accessibility of online resources for healthcare services among elderly users in general.

In addition, some national, provincial and municipal medical service websites will be selected from the whole country to be tested in this study. These websites cover 15 provinces and cities including Hunan, Guangxi, Shandong, Fujian, Zhejiang, Jiangsu, Shanghai, Wenzhou, Tianjin, Changchun and Guangzhou. The research team will conduct accessibility testing and inclusiveness analysis of these medical service websites. Through studying the problems of these websites, the research team will propose optimization strategies for medical service websites based on the needs of elderly users.

3.2. Research Methods and Tools

Web Accessibility Automated Detection Tool: WCAG is the internationally recognized Web Content Accessibility Guidelines (WCAG), including WCAG 2.0, WCAG 2.1, and WCAG 2.2. The WCAG 2.0 standard has 12-13 guidelines, which are categorized into 4 principles: Perceptibility, Actionability, Understandability, and Stability. Each guideline has testable criteria, and the criteria are categorized into three levels: A, AA, and AAA[4].WCAG 2.1 extends WCAG 2.0 by adding new elements to take into account a wider range of disabilities, including people with blindness and low vision, deafness and hearing loss, limited mobility, speech impairment, photosensitivity, and learning disabilities and handicaps[10].The WCAG 2.2 Proposed Recommendations, the most recent update released on July 20, 2023, was initiated with the goal of continuing the work of WCAG 2.1, which incrementally advanced the guidelines for web content accessibility in all of these areas, but emphasized that these guidelines do not meet all user needs[11]. WCAG 2.0 was used as the standard since 15 relatively

healthy elderly users aged 60 years or older were selected for this study. In this study, AChecker (Accessibility Checker), which is based on the WCAG 2.0 standard, was chosen as a tool for digital website evaluation. This tool quickly scans website pages and provides feedback on technical accessibility issues and errors. By uploading the website's HTML code, we were able to obtain a detailed accessibility report. Given the multi-layered structure of different types of healthcare service websites, we selected the homepage of the website from which to test.

Field Observation and Interview Scale for User Experience: In-depth interviews and observation methods were used for data collection in this study to ensure comprehensibility and operationalization of the study. Prior to the implementation of the experiment, five older users were consulted in order to make appropriate adjustments to the interview questions, sequencing and methodology, thus ensuring the validity of the interview questions. The data collection process consisted of observations and interviews with older users during their visits to healthcare service websites. The description of the observation points of the healthcare services website and the interview questions for the older users are shown in Table 1.

Table 1. User Observation Points and Interview Question Items for Elderly Users of Healthcare Services Web Sites

dimension	Description of interview questions
perceivability	Are you able to easily recognize different text, images and other elements when navigating a website?
	Does it feel like the site has enough contrasting colors to help you properly understand the content of the page?
	Do you find enough descriptive labels on your website to understand the function of links and buttons?
	Can you easily recognize and understand charts, images and multimedia content on a website?
operability	When using the site, are you able to easily find and click on buttons, links, and other interactive elements?
	Do you feel that the navigation structure of the website is clear and helps you to find the information you need quickly?
	Have you encountered complicated or difficult to understand steps when using the website?
	Are you comfortable scrolling, zooming in and out of pages?
comprehensibility	When navigating the content of the site, are you able to clearly understand the information and instructions on the page?
	Do find the language and wording of the website easy to understand and not confusing?
	Have you encountered jargon or abbreviations that are difficult to understand when using the website?
	Is it easy to understand the error messages and alerts on the website?
stability	Are you able to access and use the website properly on different devices?
	Are you experiencing slow page loads or crashes while using the site?
	Have you tried visiting websites on different browsers? Are you able to get the same experience on all of them?
	Does it feel like the site maintains a stable layout and functionality across different screen sizes and resolutions?

4. Analysis of research data and results

4.1. Accessibility Testing and Inclusive Analysis of Healthcare Service Websites

The WCAG 2.0 standard pays full attention to the accessibility challenges that may be encountered by various types of users, such as elderly users and users with disabilities, when browsing the web, and has formulated corresponding technical guidelines. These guidelines provide detailed accessibility requirements for website designers based on specific provisions for different contexts and possible accessibility issues.The WCAG 2.0 standard pays full attention to the accessibility challenges that may be encountered by various types of users, such as elderly users and users with disabilities, when browsing the web, and has formulated corresponding technical guidelines. These guidelines provide detailed accessibility requirements for website designers based on specific provisions for different contexts and possible accessibility issues.

Table 2. Statistics on the types of errors at all levels for the 20 sample websites

Rank	WCAG2.0	Typology	Number of error instances	Sample website error rate
Grade A	Providing alternative text for non-textual content	perceivability	15	75%
	Preserve information and relationships implicit in visual or auditory formats when making changes	perceivability	12	60%
	Functions can be operated via the keyboard interface	perability	4	20%
	Controllable motion, flashing, scrolling, automatic update of information in web pages, etc	operability	6	30%
	Web pages containing headings that describe their subject matter or purpose	comprehensibility	3	15%
	Links point clearly	operability	13	65%
	The default language for web pages can be programmed	comprehensibility	17	85%
	Predict the effect when entering data or selecting form controls	comprehensibility	11	55%
	Elements of markup language-implemented content need to have full start and end tags, compliant nesting, non-duplicated attributes, and unique IDs, except as noted in the specification	stability	4	20%
Grade AA	Text can be enlarged up to 200% without assistive technology and without loss of content or functionality	perceivability	7	35%
	Titles and labels that describe the subject or purpose	operability	1	5%
Grade AAA	Visual contrast ratio of text,images not 7:1	perceivability	2	10%

Based on the WCAG 2.0 standard, the homepage and learning pages of 20 selected sample websites were tested, and the statistical results include the number of instance errors and the proportion of the websites with errors to the total number of tested

websites. As shown in Table 2, for example, if there is no text describing the subject or title of a web page, the test report will point out the error of "no subject or title".

Of all the sample websites tested for Level A errors, the test point that the default language of a web page can be determined programmatically had the highest number of error instances, with 17 sample websites failing to comply with the principle of comprehensibility. This criterion is set to ensure that web page content is correctly presented to the user according to the user's language preference. The purpose of this standard is to provide a better user experience, especially for those who use screen readers or other assistive technologies, which can help them understand and access the content of web pages more accurately. By setting the default language of a web page correctly, it is possible to ensure that web pages are presented in the correct language and pronunciation with the support of speech synthesis and other assistive features, thus improving the accessibility and usability of web pages.

The high number of false instances for the test point Provide alternative text for non-textual content and the test point Preserve information and relationships implied by visual or auditory formatting when changing violates the principle of perceptibility. The purpose of these two guidelines is to ensure that non-textual content (e.g., images, charts, multimedia, etc.) included on web pages can be understood and communicated to users by assistive technologies, such as screen readers, that information related to such content can be accessed by visually impaired users, and that information on a web site retains its original information and relationships when converted between different visual or auditory formats. For example, when charts are converted to audio for presentation, the data and relationships in the charts should be able to be communicated effectively to maintain the accuracy and coherence of the content. This helps to maintain the comprehensibility of the site and allows users to have a consistent information experience regardless of the method used.

The test point of link pointing clarity also had a high number of error instances and did not comply with the principle of operability. The purpose is to ensure that users are able to understand exactly what the link is intended to do and what it does, thereby improving the comprehensibility and operability of the site. By setting this guideline with clear link text, users can better predict what will happen when they click on a link and avoid misunderstanding or confusion. This helps users to navigate more easily through and around web content, especially for those using assistive technologies, such as screen reader users. This standard aims to ensure that all users can easily understand and manipulate links, providing a more user-friendly experience.

4.2. Observation and interview analysis of older users

Observation and semi-structured interviews were conducted based on the observation points and interview questions listed in Table 1. The form and order of the questions were flexibly adjusted according to the actual responses of the interviewees. During the interviews, shorthand was used to record the content of the interviews; after the interviews, the shorthand content was organized and summarized.

Analysis of barriers and attribution of accessing medical service websites: Through interviews and observation of the process of accessing medical service websites by elderly users, we found that elderly users face some barriers in terms of aesthetic experience, functional experience, resource experience and technical experience. These barriers mainly stem from the fact that website design does not fully consider the sensory abilities of elderly users, especially the actual situation of vision deterioration, short-term memory impairment, limited attention span, interest preferences, and insufficient computer operation ability. The barriers and attribution of older users' access to websites are analyzed in Table 3.

Table 3. Statistics on the types of errors at all levels for the 20 sample websites

Rank	Barriers to online browsing for older users	attributional analysis
perceivability	100% of elderly users report that the font size is too small, making it difficult to read.	Considering the vision loss needs of elderly users, the presentation of the website interface needs to be adjusted accordingly, including text style, magnification, color contrast, line spacing and layout, and content density. Most older adults cannot find accessible reading features on the interface.
	25.6% of older users cited the presence of ads on websites	Redundant information increases the cognitive load of older users, and sources of interference should be reduced and unnecessary advertising plug-ins eliminated.
operability	38.75% of older users can't distinguish the target interface portal	Some older users are not aware of the source of regular target pages; for example, search engines such as Baidu have a fancy interface design and many advertisements. Regular websites should be placed at the top of the page so that older users can quickly find the entry point.
	53.57% of older users experienced difficulties with enrollment	Older users are less proficient with computers and have a higher external cognitive load. The design can streamline the information.
	54.3% of the elderly users reported that when returning to the previous page, they would easily close all the pages by mistake.	The layers of the web page are too deep, resulting in an increased likelihood of operational errors for older users. A step-by-step display strategy can be adopted to simplify the operation process. Functions that are more complex and less frequently used can be collapsed and hidden, while similar functions can be categorized and displayed so that older users can find what they need more easily.
	27.5% of older users reported difficulty in clicking on the appropriate location, requiring multiple attempts to succeed.	The small response area of the control bar may be a nuisance to older users, making mouse clicking operations difficult. Consideration could be given to designing a keyboard instead of a mouse for easier operation by older users.
	21.5% of seniors need help from others to operate the page	Human-computer interaction can be used to assist older people to understand the logic of the website more clearly and provide them with operational support and guidance. It is also important to enhance interactivity and feedback mechanisms, which can help develop self-confidence in learning among older users.
comprehensibility	34.2% of older users can't fathom the meaning of some of the content on the website	Some of the titles are too specialized, making it difficult to meet the needs of older users at different levels. Considering the prior knowledge of older users and hierarchical resource design when designing titles

		can effectively reduce the complexity of learning content on websites.
stability	20.4% of the elderly users think that the compatibility of the website is not good, and many contents cannot be presented normally after changing to other electronic devices.	Website design and development must be carried out in accordance with the standards

5. Accessibility Optimization Strategies for Healthcare Websites

Accessibility optimization of healthcare service websites is based on the WCAG connotation, which embodies the idea of inclusive design, i.e., website presentation should be adapted as much as possible to users with different characteristics, covering age, gender, culture, and ability, in order to enable them to access web content without barriers. This study discusses the previous findings from the perspective of inclusive design and proposes an accessibility optimization strategy for healthcare service websites.

5.1. Popularizing the concept of barrier-free design

Analyzing the results in Table 2, we observe that the sample websites mainly have A-level technical errors, which are mostly concentrated in the most basic and high-impact levels. This suggests that the overall accessibility level of healthcare service websites in China is low. Although the technical implementation of Level A errors is not difficult, these errors could have been avoided. It also shows that some designers and developers lack the necessary awareness of accessibility in the process of website design and development.

5.2. Popularizing the concept of barrier-free design

If the philosophy of the designers of a health service website is limited to targeting only users who are physically and mentally normal and have some computer skills, the website may result in barriers to access by older users with reduced sensory, memory and mobility skills, especially those who are less information literate. This defeats the goal of including older users' abilities and excludes them to some extent. To address this issue, healthcare service websites should follow the WCAG 2.0 standard to ensure that web content is perceptible, understandable, operable, and compatible, i.e., presenting content that is well presented, easy to understand, clear to navigate, and device compatible. At the early stage of design, website designers should incorporate the ideas and norms of information accessibility, fitting the concept of inclusive design. Inclusive design can reduce the ability requirement for web access, realize multiple ways to meet the diverse needs of different elderly users with declining sensory abilities, adapt to the decline of cognitive rules and memory ability of elderly users through concise presentation design, and design simple and easy-to-use operation methods to adapt to the decline of mobility ability of elderly users.

5.3. Popularizing the concept of barrier-free design

By analyzing Table 3, we found that elderly users raised questions and demands in terms of website page layout, content, human-computer interaction, operation guidance and compatibility. Elderly users expect medical service websites to be "accessible" and "have access needs". "Accessible" means that the website should be able to accommodate older users so that they can easily access information and communicate with each other. "Demand for access" means that the website should provide content that appeals to older users and meets their diverse needs.

In order to meet the needs of older users, medical service websites must strictly follow the WCAG standards and design interfaces that take into account features such as large fonts, large icons, and high-contrast text to simplify interactions and minimize advertising interference. At the same time, it should be compatible with features such as screen-reading software, hearing aids and even smart devices, in order to meet the diverse needs of older users' senses, memory and mobility.

6. Conclusions

Through this study, we have combined quantitative and qualitative research methods to reveal the barriers, forms and causes that older users face when accessing the Web, and to analyze in depth the characteristics that should characterize an online resource based on the needs of older users to use it. The needs of older users dictate that the design and development of healthcare service websites must follow inclusive design in order to meet and respond to their multilevel and diverse needs. The beneficiary group of an accessible environment is all members of society, an environment that can be enjoyed by people with functional disabilities on an equal basis with others, essentially the basis on which all people can participate in society on an equal basis, ultimately benefiting the entire population[12].Therefore, the design of healthcare service websites should also take into account the needs of older users, while meeting the individual needs of regular users. Through inclusive design, we can provide equal access to resources and information and provide an accessible online experience for older users. This is exactly the significance of studying and applying inclusive design concepts to design online resources for older users.

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