User-centered web accessibility: recommendations for ensuring access to government information for older adults

Accesibilidad web centrada en el usuario: recomendaciones para garantizar el acceso a la información gubernamental para los adultos mayores

Acessibilidade na Web centrada no usuário: recomendações para garantir acesso a informações governamentais para idosos

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Abstract

Introduction: This article is the result of the research project "User-Centered Web Accessibility: Recommendations for Ensuring Access to Governmental Information for Older Adults", developed at the University of Cauca-Colombia in 2023.

Problem: Despite the importance of web accessibility, web pages are not adapting to the evolution of web accessibility proposed by the international consortium, which can limit access for users with physical and/or cognitive limitations.

Objective: This article presents a set of recommendations for the design and development of government websites specifically for older adults, to ensure access to government information and take into account their health, physical, and mental condition.

Methodology: A relationship is established between the limitations of older adults and the recommendations of the Web Content Accessibility Guidelines (WCAG) 2.2, with the aim of proposing specific design and development guidelines for government websites to counteract a specific limitation.

Results: The implementation of these recommendations will allow government portals to have greater acceptance among older adult users. In addition, a case study was conducted in which these recommendations were validated and adjusted, which allowed for access to government information as a means of protecting fundamental rights.

Conclusion: This article highlights the importance of web accessibility and proposes specific recommendations for the design and development of accessible government websites for older adults.

Originality: This article presents a specific approach to web accessibility for older adults and proposes recommendations that differ from WCAG guidelines.

Limitations: The proposed recommendations focus on web accessibility for older adults and do not address the limitations of other groups with physical and/or cognitive limitations. In addition, they were validated and adjusted in a specific case study and may require additional adjustments in other contexts.

Keywords: Web accessibility, government websites, older adults, limitations.

Resumen

Introducción: El artículo es producto de la investigación "Accesibilidad web centrada en el usuario: recomendaciones para garantizar el acceso a la información gubernamental para adultos mayores", desarrollada en la Universidad del Cauca-Colombia en el año 2023.

Problema: A pesar de la importancia de la accesibilidad web, las páginas web no se están adaptando a la evolución de la accesibilidad web propuesta por el consorcio internacional, que puede limitar el acceso para usuarios con limitaciones físicas y/o cognitivas.

Objetivo: Este artículo presenta un conjunto de recomendaciones para el diseño y desarrollo de sitios web gubernamentales específicamente para adultos mayores, para garantizar el acceso a la información gubernamental y tener en cuenta su estado de salud, físico y mental.

Metodología: Se establece una relación entre las limitaciones de los adultos mayores y las recomendaciones de las Pautas de Accesibilidad al Contenido Web (WCAG) 2.2, con el objetivo de proponer pautas específicas de diseño y desarrollo para sitios web gubernamentales para contrarrestar una limitación específica.

Resultados: La implementación de estas recomendaciones permitirá que los portales gubernamentales tengan una mayor aceptación entre los usuarios adultos mayores. Además, se realizó un estudio de caso en el que se validaron y ajustaron estas recomendaciones, lo que permitió el acceso a la información gubernamental como medio para proteger los derechos fundamentales.

Conclusión: Este artículo destaca la importancia de la accesibilidad web y propone recomendaciones específicas para el diseño y desarrollo de sitios web gubernamentales accesibles para adultos mayores.

Originalidad: Este artículo presenta un enfoque específico de la accesibilidad web para adultos mayores y propone recomendaciones que difieren de las pautas WCAG.

Limitaciones: Las recomendaciones propuestas se centran en la accesibilidad web para adultos mayores y no abordan las limitaciones de otros grupos con limitaciones físicas y/o cognitivas. Además, fueron validados y ajustados en un estudio de caso específico y pueden requerir ajustes adicionales en otros contextos.

Palabras clave: Accesibilidad web, sitios web gubernamentales, adultos mayores, limitaciones.

Resumo

Introdução: O artigo é produto da pesquisa "Acessibilidade web centrada no usuário: recomendações para garantir o acesso à informação governamental para idosos", desenvolvida na Universidade de Cauca-Colômbia em 2023.

Problema: Apesar da importância da acessibilidade web, as páginas web não estão a adaptar-se à evolução da acessibilidade web proposta pelo consórcio internacional, o que pode limitar o acesso a utilizadores com limitações físicas e/ou cognitivas.

Objetivo: Este artigo apresenta um conjunto de recomendações para a concepção e desenvolvimento de websites governamentais específicos para idosos, para garantir o acesso à informação governamental e ter em conta o seu estado de saúde física e mental.

Metodologia: Estabelece-se uma relação entre as limitações dos idosos e as recomendações das Diretrizes de Acessibilidade para Conteúdo da Web (WCAG) 2.2, com o objetivo de propor diretrizes específicas de design e desenvolvimento de sites governamentais para neutralizar uma limitação específica.

Resultados: A implementação destas recomendações permitirá que os portais governamentais tenham maior aceitação entre os usuários idosos. Adicionalmente, foi realizado um estudo de caso no qual estas recomendações foram validadas e ajustadas, permitindo o acesso à informação governamental como forma de proteger os direitos fundamentais.

Conclusão: Este artigo destaca a importância da acessibilidade na web e propõe recomendações específicas para a concepção e desenvolvimento de websites governamentais acessíveis para idosos.

Originalidade: Este artigo apresenta uma abordagem específica à acessibilidade web para idosos e propõe recomendações que diferem das diretrizes WCAG.

Limitações: As recomendações propostas centram-se na acessibilidade da web para adultos mais velhos e não abordam as limitações de outros grupos com limitações físicas e/ou cognitivas. Além disso, foram validados e ajustados em um estudo de caso específico e podem necessitar de ajustes adicionais em outros contextos.

Palavras-chave: Acessibilidade na web, sites governamentais, idosos, limitações.

1. INTRODUCTION

The aging of the population is currently one of the most important social phenomena of this century. According to the World Health Organization (WHO) [1], the 20th century saw a revolution in terms of longevity, as the average life expectancy increased

by 20 years since 1950 and reached 66 years [2]. It is expected that by 2050, life expectancy will increase by another 10 years. This increase will be especially notable and rapid in developing countries, where the elderly population is expected to quadruple in the next 50 years [3]. This type of demographic transformation has profound consequences in all aspects of life, both individual and community, national and international. Every facet of humanity, whether social, economic, political, cultural, psychological or spiritual, will experience an evolution. At the same time, older people are valuable resources that are often unrecognized, but that make an important contribution to the structure of our societies [4].

The aging process is an innate reality in human life that many people have difficulty accepting. However, we are currently experiencing a demographic transition worldwide that is expected to significantly increase the number of people over 60 years old, especially in developing countries. It is important to note that at the age of 65, half of the population will have some type of disability, regardless of its severity, and for a quarter of those seniors, the disability will be severe. These problems affect certain aspects of their interactions with computers. Therefore, it is essential to link aging with the development of technologies to improve the quality of life of seniors. Despite these problems, seniors are excited about every small advancement and appreciate finding places where they can easily interact.

Currently, designing web pages or multimedia content with older people in mind is important and relevant due to their population size. In this sense, many older people may be using the web for the first time and, due to their advanced age, are not familiar with computers and the Internet. Unlike other generations, technological learning can be slower. In addition, search engine optimization for websites could be relevant to the topic of user-centered web accessibility, as while it is important to improve the visibility and ranking of a website in search results, it is also crucial to ensure that the website is accessible and usable for all users, including older adults [5]. As mentioned in Pernett's article, older people may have difficulty accessing information online due to their lack of knowledge in the field of computers or health problems and functional diversity. Therefore, it is important to consider web accessibility for older adults when optimizing a website for search engines [6].

Older adults may face various limitations or challenges when interacting with a computer or accessing a website due to the physical, cognitive, and perceptual changes they experience with aging. Some of the most common limitations are: a) Vision problems: Older adults may have difficulty reading small texts, distinguishing colors, perceiving objects on the screen, among others; b) Hearing problems: They may have difficulty hearing sounds, videos, or audios from websites; c) Motor difficulties: Older

adults may have difficulty moving the mouse or cursor on the screen, and using the keyboard or touchpad; d) Cognitive difficulties: They may have difficulty understanding complex information or performing multiple tasks at the same time [7]. Additionally, some older adults may have little experience with technology and may feel intimidated by the use of computers and mobile devices.

These limitations can affect the accessibility and usability of websites for older adults, which can make it difficult for them to access information and services online. Therefore, it is important that website designers and developers take these limitations into account and design interfaces and content that are accessible and easy to use for seniors.

In Colombia, there are initiatives and regulations aimed at guaranteeing access to information and accessibility to government websites for all people, including those with disabilities and older adults. For example, Law 1712 of 2014 [8], establishes the rules and principles for access to information and transparency, and Resolution 667 of 2018 [9], establishes the requirements for web accessibility in the public sector.

However, according to a report [10] from the Ministry of Information and Communications Technology of Colombia, published in 2020, web accessibility on government sites still presents significant challenges. The report found that only 12% of the evaluated websites met basic web accessibility criteria, while 88% presented problems in areas such as navigation, readability, and compatibility with assistive technologies.

This suggests that, although there are regulations and policies in place to guarantee access to information and web accessibility in Colombia, more effort is still needed to effectively implement these initiatives and ensure that all people can access government services online easily and efficiently.

This work presents a set of recommendations/guidelines that render the design and development of accessible government websites suitable for addressing the physical and mental limitations of the older adult population. The rest of the article is organized as follows: Section 2 presents a set of concepts that were considered for the generation of this article. In Section 3, related works on web accessibility in older adults are presented. In Section 4, relevant age-related diseases are presented, in Section 5, recommendations abstracted from WCAG 2.2 are presented. Finally, in Section 6, conclusions and future work derived from this research are presented.

1.1 Literature review or research background

In Patsoule [11], the importance of this work lies in the identification and evaluation of the accessibility of Spanish-language websites with health information for older adults. The results obtained show that there is a great variability in the degree of adequacy of each website to accessibility standards, highlighting the need to improve accessibility in websites targeted to this population group. The findings of the study also provide valuable information for web designers and developers so that they can improve the accessibility of their websites and ensure that older adults can effectively access online information and services. Furthermore, this work underscores the importance of ensuring accessibility to available online resources to address the needs of older adults and leverage the potential that the Internet offers to improve their quality of life.

In Blat [12], the importance of considering accessibility in web design is emphasized, not only for people with physical disabilities, but also for those who may have difficulties accessing websites due to different situations. By doing so, the user experience can be improved and everyone can have access to information and resources online. Specifically, older adults are identified as an important group to consider in web accessibility, as they often face specific challenges when learning and using ICT and the web. Furthermore, emphasis is placed on the importance of not stigmatizing older adults, which is crucial in any accessibility initiative.

In Neil [13], it is suggested that older adults can benefit from the opportunities provided by computers and the Internet. However, the lack of adaptation in website design to address physical and cognitive problems related to aging can create accessibility barriers. It is essential to consider web accessibility so that all people can interact with the Web and contribute content, especially when searching for health information. Therefore, the importance of considering web accessibility in the design of websites for older adults is emphasized, which could significantly improve their quality of life.

Based on the methodology proposed by the World Wide Web Consortium (W3C) to assess the level of compliance with web design recommendations[1], special emphasis was placed on a specific demographic group, namely, older people. Although there are review methodologies with more detailed heuristics [14] [15], other studies opted for a more condensed model [16]. This methodology is based on the 25 guidelines of the NIA [13] divided into four sections: Readability, Information presentation, Other media, and Navigation. The results of this work allow web designers to evaluate the degree of compliance with design recommendations for older people and, consequently,

1 For more information about the Consortium, see w3.org

improve the accessibility and usability of their websites. Additionally, this methodology can be useful for web developers who want to create user-friendly websites for older people. A positive critical comment on this work is that it provides a clear and concise guide for web designers on how to create accessible and easy-to-use websites for older people. The proposed methodology is based on existing recommendations and is presented in an easy-to-understand and applicable way. The inclusion of practical tips on readability, information presentation, other media, and navigation makes this work highly relevant to the web design community.

In Chadwick-Dias [17], it is indicated that the main contribution of the work is to offer concrete recommendations to improve the organization and navigation of websites, based on a previous study conducted by Chadwick-Dias et al. [17]. These recommendations focus on the simplicity of content organization, the consistent use of designs throughout the site, and the inclusion of large buttons with text and site maps. Implementing these recommendations can significantly improve the user experience on websites, facilitating navigation and information location. A highlight is that the work provides a practical list of useful recommendations for web designers and developers, supported by a previous study and with the potential to improve the user experience. The inclusion of practical tips such as the use of large buttons with text and site maps makes this work highly relevant to the web design and development community.

Elderly and age-related functional limitations

Limitation refers to any physical or mental condition that impedes or hinders access to certain resources or activities. In the realm of technology and communication, accessibility refers to the ability of digital products and services to be used by people with different types of limitations [18]. Web accessibility is a crucial aspect today, as the use of the internet has become a basic necessity for many people worldwide. However, it is often forgotten that web accessibility is not limited to people with physical or mental disabilities. It also includes older people, people with slow internet connections or outdated equipment, and people in noisy or visually distracting environments. In this context, it is essential to pay attention to web accessibility to ensure that all people can enjoy digital resources equitably.

MATERIALS AND METHODS

For this work, an elderly person is considered someone who has reached an advanced age, but there is no clear consensus on the exact age at which a person becomes an elderly person. In some studies, the reference age is considered from 50 years old [19], while in others, it is established from 60 or 65 years old [20]. It is important to consider this age group in the design and development of web projects, as their needs and abilities may be different from those of other age groups.

Relevant diseases of the elderly

Vision is one of the most important senses for human beings, as it allows us to interact with our environment effectively and safely. However, over time, visual capabilities may decrease, especially in the elderly population [21]. It is therefore crucial to know the most common visual diseases or problems in this age group to provide appropriate care and attention. In this regard, a study has been carried out on the prevalence of visual diseases in the elderly population, which revealed that the most frequent problem is astigmatism, which causes difficulties in reading small or extensive texts. The following image shows the complete prevalence of visual diseases detected in this age group, with the aim of raising awareness about the importance of visual health in the elderly population.

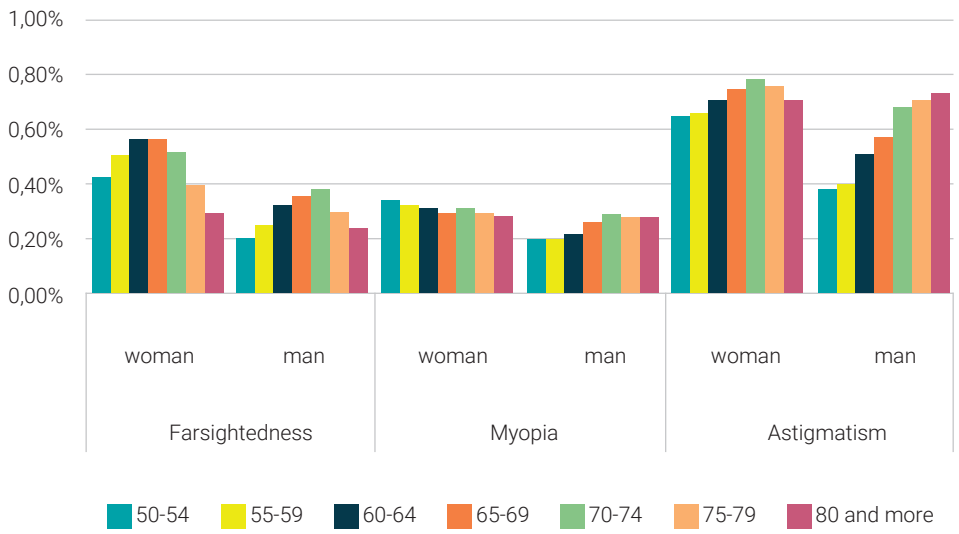

Fig. 1 Prevalence of diseases by age groups and sex
Source: own work

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Methodology

The research that will be carried out will use the Design Patterns for Research Methods: Iterative Field Research methodology [22], which consists of four stages: observation, identification, development, and evaluation. In the first stage, field observations are carried out to identify the needs related to the selected task. Field observations evolve throughout the project lifecycle. In the second stage, field observations are used to identify the specific research problem or question. In the third stage, development work is carried out, the nature of which depends on the application and type of research. Finally, in the fourth stage, the original configuration is revisited and the new work is tested. This cycle of observation, identification, development, and testing is shown in the following figure.

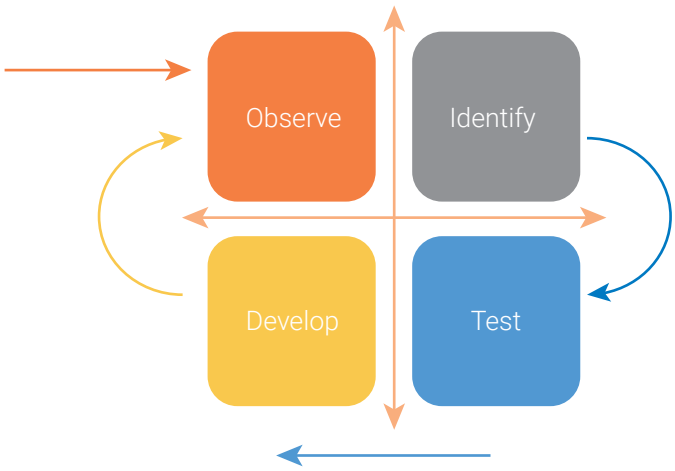

Fig. 2 The proposed stages by Design Patterns for Research Methods: Iterative Field Research. Adapted from Pratt.
Source: own work

Phase 1 Observe: This initial phase provides an empathetic understanding of the problem to be solved. It characterizes government web applications and limitations of access to information for the elderly population.

Phase 2 Identify: During this phase, after collecting information and synthesizing observations, an exploration of different accessibility principles and guidelines was carried out. Guidelines generated on web pages targeted towards the elderly population were identified, and a set of recommendations for designing websites for the elderly were obtained.

Phase 3 Develop: In this third experimental phase, the objective is to identify the best possible solution for each of the problems identified during the first two phases.

In this regard, it was necessary to address the success criteria of each of the four principles of the accessibility guide provided by W3C, which would guide the process of constructing and evaluating websites focused on this type of population.

Phase 4 Test: This is the final step of the 4-step model. Results generated in the testing phase are often used to redefine one or more problems and inform the understanding of user, usage conditions, thinking, behaviour, feeling, and empathy. Even during this phase, modifications and improvements are made to discard problem solutions and obtain as deep an understanding of the product and its users as possible. In this final phase, the case study was rigorously tested on a web portal of the Municipal Mayor's government in Popayán, Cauca, evaluating each of the proposed recommendations for the elderly.

Characterization of government web applications.

As part of the implementation of the Online Government strategy of the Ministry of Information and Communications Technologies [10], the National Government presents 'My Digital Colombia', an initiative that aims to modernize, redesign, and improve the websites of public entities at the territorial level. Over the past 10 years, MinTic has delivered 2,270 websites to entities throughout the country. The emergence of new mobile digital devices, which demand more intuitive functionalities and friendlier environments for users, obliges the State to evolve its relationship with citizens through the strategic use of ICTs. This new model of state platforms is governed by the Transparency and Access to Public Information Law, Resolution 3564 of 2015 [23].

The national and dimensional results of the accessibility evaluation are presented in Table 2 through graphic representation, in compliance with the four principles of WCAG 2.2. The websites that had the highest number of accessibility successes were the RUNT portal and the IGAC portal. Of the 10 government websites, a high number of failures and errors were found in accessibility criteria, such as the FNA (National Savings Fund) portal and the Cauca Governor's portal.

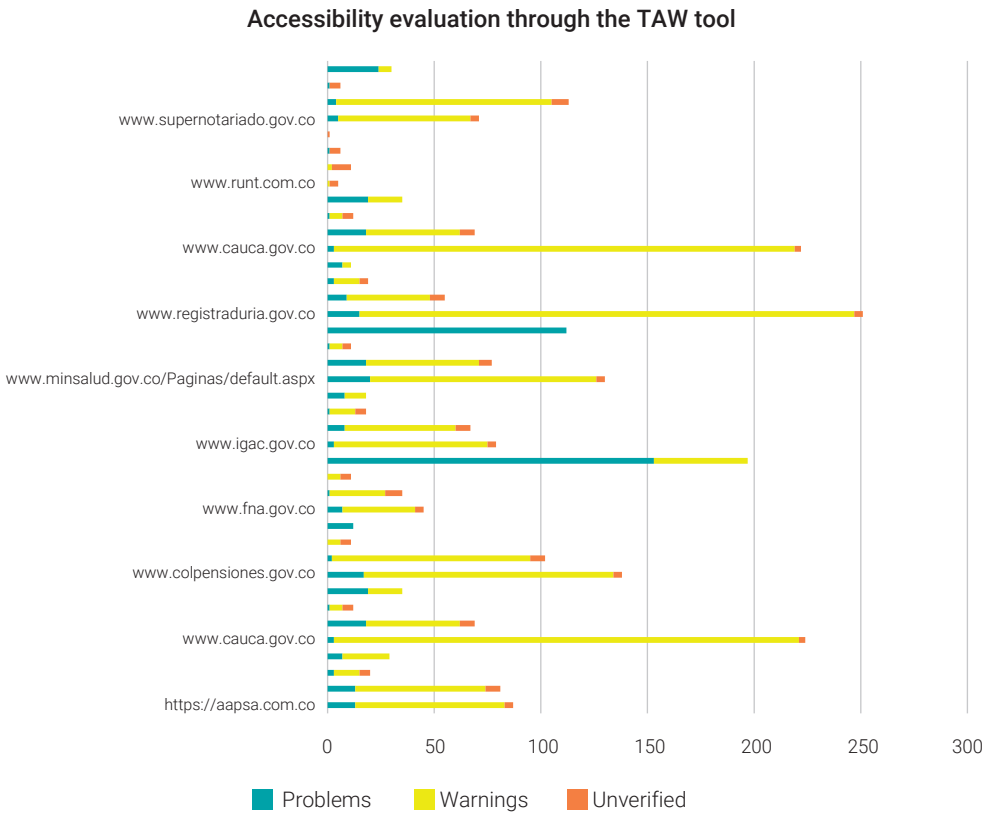

Fig. 3 Summary of accessibility evaluation through the TAW tool.
Source: own work

Accessibility recommendations

Accessibility recommendations refer to a set of technical guidelines and standards aimed at making websites and applications more accessible to all people, including those with disabilities or physical and cognitive limitations [24]. Online accessibility is becoming increasingly important in our digital society, and it is especially relevant for older adults, who may have difficulties accessing and using digital tools.

However, it is important to note that accessibility recommendations have certain limitations in their scope and application. For example, these recommendations generally apply to government websites and applications specifically designed for older adults. Additionally, there are often technical and design limitations that can make it difficult to fully implement these recommendations in all cases. Therefore, although accessibility recommendations are an important step towards a more inclusive web, it is necessary to continue working to overcome technical limitations and expand their scope to other areas of the web.

Table 1. Major Adult Diseases

Type	Limitation	Description	
Cognitive	Alzheimer's or Senile Dementia	It is a disease that is based on the progressive loss of your memory and mental abilities	
		Insomnia	Difficulty falling asleep or maintaining night-time sleep. Irritability, lack of concentration, memory loss, excessive tiredness and anxiety are the most common symptoms during the day.
		Senile depression	It is a mood disorder in which feelings of sadness, anger, loss, or frustration interfere with an older adult's daily life.
	Mild Cognitive Impairment (DCL)	It is an intermediate state between expected cognitive decline due to aging	
	Chronic Fatigue	A neurological disease. It is characterized by extreme and intense exhaustion, physical and mental. It is not recovered with rest and can have devastating effects on the patient's personal life.	
Drive	Arthritis	Joint inflammation is a disease that is based on inflammation in the joints that usually causes joint swelling.	
	Arthrosis	It is a disease that is based on the degeneration of joint cartilage due to age, causing movement pain and motor difficulties.	
	Lateral Sclerosis Amyotrophy (ELA)	It is a rare neurodegenerative disease, affecting the motor neurons of the brain and spinal cord. The latter stops sending messages to the muscles causing inability to move in certain joints and muscle weakness.	
	Fibromyalgia	It is a disease that is based on chronic body pain and extreme, physical and mental exhaustion.	
	Stroke	It is a cerebrovascular disease that occurs when blood flow from the brain is interrupted.	
	Osteoporosis	Osteoporosis occurs as a result of decreased amounts of minerals in the bones.	
	Parkinson	It is a neurodegenerative disease usually; Parkinson's is recognized by a movement disorder.	
	Fragility syndrome	The phenotype of fragility represents a complex relationship between sarcopenia, decreased physical activity, weakness with objective lack of strength (less than 17 kg of force in the hand), decreased gait speed (less than 0.8 mts/sec) and low physical activity.	
		Sarcopenia	Is an age-related musculoskeletal disease with loss of muscle mass and function. It is a pathology of high prevalence in the eldest adult population. Its ethology is multifactorial where nutrition, lifestyle and hormonal factors influence.
		Heart failure	Chronic condition that causes the heart not to pump blood as effectively as necessary
Visual problems	Tired view	With age, the eye loses the ability to accommodate as a result of the lens (the lens inside the eye) becomes less elastic, making it difficult to see clearly over short distances. This leads to the individual trying to focus the objects by separating them from the face until they can see the details sufficiently.	
	Glaucoma	It is an optic nerve disease that is usually associated with high eye pressure and has risk factors such as family history of glaucoma, black race, elevated myopia, diabetes and vascular diseases produces a restriction of the visual field, so that it becomes smaller, even being able to reach blindness.	

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Type	Limitation	Description	
Visual problems	Refractive defects	Myopia	A condition in which nearby objects are clearly visible, but not so far away.
		Hyperopia	An eye condition in which nearby objects look blurry.
		Astigmatism	Common imperfection in the curvature of the eyes.
	Falls	It is a condition, characterized by a decrease in slow and progressive vision. It consists of opacity, more or less large and dense, of the lens that hinders vision, by restricting the passage of light through it.	
	Amd	Age-related macular degeneration	It is an injury of the retina, the close vision will be greatly affected, limiting, and even making impossible, all the activities that have to do with reading or recognizing objects or faces.
Hearing Problems	Deafness	Sudden deafness	Hearing loss is a sudden, unexplained hearing loss that usually affects only one ear.
		Cofosis	It is a hearing impairment, also known as anacusia, that involves complete hearing loss.
		Phonophobia	It is an anxiety disorder, and manifests itself as an uncontrollable fear of loud sounds.
		Hyperacusis	It is an amplification of sounds, an extreme sensitivity to certain noises, which often generates acute headaches and inability to withstand especially noisy environments.
		Misofony	It is a neurological disease that causes the misinterpretation of auditory stimuli.
		Hipoacusia	Despite listening, they may not understand a few words, especially in places with ambient sound or a lot of noise. In addition to losing hearing, they become more sensitive to certain high-pitched sounds.
	Presbycusis	It is the generic form in which progressive hearing loss is known in older adults and is due to the deterioration of the inner ear caused by age	
	Perforated eardrum	Symptoms, when a perforation or similar eardrum injury occurs, are: secretions, hums, ear pain, hearing loss, and vertigo in some cases.	

Source: own work

The relationship between limitations and the principles of the WCAG 2.2 standard

A set of website recommendations based on WCAG 2.2 are presented, classified by principle, with a summary of each sub-guideline, a recommendation on the problem, and the limitation that is affected. Although the recommendations presented in this section are aimed at the specific audience mentioned above, the general public who can benefit from the application of this recommendation on a website has also been indicated.

Table 2. Accessibility Issues for Older Adults and Recommendations Guide

Id	Beginning	Summary	Recommendation	Limitation
1	Perceptible	Textual alternatives to multimedia content	The multimedia contents of the website (audio and/or video recorded or live), must have a textual alternative that contains equivalent information.	People with hearing limitations
2	Perceptible	Hearing alternatives to video content	The video media contents of the portal must contain an audio track with equivalent information.	Visually limited people
3	Perceptible	Multimedia content with subtitles	The multimedia contents of the website (audio and/or video recorded or live) must have subtitles, which include the sound effects and identification of the interlocutors within the content.	People with hearing limitations
4	Perceptible	Presentations with subtitles	The multimedia presentations of the web portal must have subtitles, which include the sound effects and identification of the interlocutors in the case of a dialogue between two or more people.	People with hearing and/or cognitive limitations
5	Perceptible	Presentation with descriptions	Web portal media presentations must have a description of the actions, characters, scene changes that are important and not indicated in the content.	People with hearing and/or cognitive limitations
6	Perceptible	Control in multimedia presentations	Web portal media presentations should provide pause and resume mechanisms, in case the reading time is very short.	People with reading deficits
7	Perceptible	Sign language	The video contents of the web portal must have sign language interpretation.	People with hearing limitations
8	Perceptible	High contrast ratio	Between the background and the text of the web portal there must be a high contrast ratio, except when the text is part of a logo or icon.	Visually limited people
9	Perceptible	Increasing the size of the content	The web portal must allow the size to increase by up to 200% in images, texts and subtitles, so that the content and functionality of the same are not lost.	Visually limited people
10	Perceptible	Alternative texts in images	The web portal must have alternate texts associated with each of the images on the site.	People with visual and/or cognitive limitations
11	Perceptible	Control of background sound	The web portal must allow for the suspension and resumption of the background sound of the site, so as not to disperse attention to the playback of multimedia content.	People with attention deficits
12	Perceptible	Use of color	It is recommended that the color of the components of the website is not the only means to indicate actions or request responses from the user.	Visually limited people
13	Perceptible	Using text images	Within the portal you should avoid the use of text images, except if it is a logo.	Visually limited people
14	Perceptible	Conservation in the relationship of components	The web portal must allow the information and relationships of the different components to be preserved by changing the format of the presentation (reading from different devices).	Visually limited people

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Id	Beginning	Summary	Recommendation	Limitation
15	Perceptible	Sequential presentation of content	The web portal should enable the presentation of content (paragraphs, columns) in a sequential and logical order, benefiting people who rely on reading techniques aloud.	People with reading deficits
16	Operable	Using the keyboard	The functionalities of the content of the web portal must be able to be operated through the keyboard or from devices that emulate the operation of the same.	People with visual limitation and/ or hand motor problems.
17	Operable	Focus movement	The web portal should allow for the movement and positioning of the focus on the different elements of the site, such as: forms, menus, among others.	Visually limited people
18	Operable	Keyboard navigation	The web portal must allow navigation through the portal by using the keyboard or through a device that emulates the operation of the same.	People with visual limitation and/ or hand motor problems.
19	Operable	Operating time	The web portal must ensure the appropriate time for the user to interact with the contents of the site (at least 20 seconds).	People with physical, cognitive and/or sensory limitations
20	Operable	Mobile content functionality	The contents of the web portal should have the option to pause, resume and / or hide, in such a way that the attention of the user is not distracted.	People with attention deficits
21	Operable	Reducing mobile content	As far as possible, use within the content portal that requires interactions with a time limit should be reduced.	People with physical, visual and/or hearing impairments
22	Operable	Stop pop-up messages	The web portal should allow users to stop pop-ups or site advertising, except in emergencies (connection loss).	People with visual limitations and/or attention deficits
23	Operable	Loss of connection	The web portal must allow the completion of authenticated transactions in circumstances such as compliance with the inactivity limit or loss of the connection.	Access to the site through unstable connections
24	Operable	Contents with flashes	The web portal should avoid the use of content that flashes more than 3 times per second or that are below the general flash and red threshold.	People with photosensitive epilepsy
25	Operable	Direct access to content	The web portal should allow users direct access to portal content, through links grouped into lists avoiding blocks that are difficult to track visually.	People with cognitive limitations
26	Operable	Titles in the different views	The web portal must have titles in the different views that describe the purpose of the content and allow to guide the user in terms of browsing the site.	People with visual and/or cognitive limitations
27	Operable	Order in focus	It should be ensured that users can navigate sequentially through the keyboard focus while preserving the reading order, without affecting their meaning and operation of the components.	People with visual limitations and/or attention deficits

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Id	Beginning	Summary	Recommendation	Limitation
28	Operable	Purpose of links	The web portal must allow an understanding of the purpose of the links available on the site (preview), so that users can decide whether or not to follow the link.	People with visual and/or cognitive limitations
29	Operable	Multiple navigation routes	The web portal must enable the use of different forms or ways of browsing.	People with visual and/or cognitive limitations
30	Operable	Focus visibility	The web portal must ensure that the focus indicator can be easily displayed on the site forms.	People with visual limitation, attention deficit and/or short-term memory
31	Operable	User location	The web portal must provide user location information within the set of web pages (bread crumb trace)	People with attention deficits
32	Operable	Section headers	If the web portal is organized by sections, headers must be provided for each of these sections.	People with cognitive impairments
33	Understandable	Unusual terms	The web portal must have a glossary for unknown or unusual terms.	People with cognitive impairments and/or children
34	Understandable	Meaning of words	The web portal must display the meaning or expanded form of abbreviations.	People with literacy-writing deficits and/or children
35	Understandable	Reading level	The web portal must provide supplemental content when a text requires a more advanced reading level than the secondary minimum.	People with literacy-writing deficits and/or children
36	Understandable	Pronunciation of words	The web portal must provide a mechanism for understanding the pronunciation of words whose meaning is ambiguous.	People with literacy-writing deficits and/or children
37	Understandable	Order in the receipt of data	The web portal must maintain the order in which it receives the data within the forms.	People with visual and/or cognitive limitations
38	Understandable	Consistent navigation	The web portal must allow consistent navigation across the different views of the site.	People with visual and/or cognitive limitations
39	Understandable	Consistent components	The web portal must enable consistent identification of components that have the same functionality within the site.	People with visual and/or cognitive limitations
40	Understandable	Identifying errors	The web portal must ensure that users notice the occurrence of an error and the explanation of it within the site.	People with visual and/or cognitive limitations
41	Understandable	Data types	The web portal must provide tags or instructions in the data entry form, indicating the type of data received.	People with visual and/or cognitive limitations
42	Understandable	Suggestion in case of error	The web portal must provide attendance or suggestion boxes when detecting any errors in a form's data entry.	People with visual and/or cognitive limitations
43	Robust	Well-formed HTML tags	The web portal must contain well-formed HTML tags, i.e., with full opening and closing.	Doesn't apply

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Id	Beginning	Summary	Recommendation	Limitation
44	Robust	Installing additional components	The web portal must enable access to the contents of the web portal without the need to download and install additional software components.	Access from different browser versions
45	Robust	Different devices	The web portal is adaptable (size, font, layout of the elements) in terms of access from different devices (Smartphone, Tablet, pc, etc.).	Access from different devices and/or browsers
46	Robust	Weight of the different elements of the site	The web portal has control over the weight of the different elements of the site (images, videos, text), which guarantees adequate access from different devices and from different types of connection.	Access from different devices and/or browsers
47	Robust	Printing site content	The web portal must make it possible to print the content of the site without any difficulty.	Access from different devices and/or browsers
48	Robust	Navigation control	The web portal must allow the user to have control of navigation from different access devices (Smartphone, Tablet, pc, etc.).	Access from different devices and/or browsers
49	Robust	Agent support	The web portal must allow compatibility with current and future user agents (user agents understand the browsers from which the content is accessed).	Access from different browser versions
50	Robust	Playing multimedia content	The web portal must allow multimedia content to be played or consumed from different devices (Smartphone, Tablet, pc, etc.).	Access from different devices and/or browsers

Source: own work

2. RESULTS

Web accessibility is an essential component in ensuring equal access to information and online services for all users, particularly those with disabilities and older adults. In order to achieve this equitable access, accessibility guidelines have been established to guide web developers and designers in creating accessible websites. However, for these recommendations to be truly effective, it is crucial to validate and adapt them according to the specific needs and characteristics of end users, taking physical, motor, and sensory limitations of older individuals into consideration.

Furthermore, bioengineering [25], with its technological advancements, will play a significant role in the evolution of web accessibility, particularly for older adults. Understanding the physical, motor, and sensory conditions of this demographic group will enable the development of more empathetic and tailored solutions for their browsing experience on web portals. Advances in bioengineering, such as data analysis

and the application of specialized technologies, can provide valuable insights for designing interfaces and functionalities that optimize usability and web accessibility for older adults, offering them a more satisfying and enriching experience in the digital environment.

In this study, accessibility recommendations for government web applications and for older adults were evaluated using a website from the Municipality of Popayán as a case study. The aim of the study was to validate and adjust these recommendations according to the needs and characteristics of end users.

The Municipality of Popayán website was evaluated by a group of carefully selected participants to represent end users of the application. The study was conducted on December 12, 2022, with the participation of twenty-five (25) older adults, twelve of whom had low levels of vision and required the use of prescription glasses by an ophthalmologist, five older adults had decreased mobility in their dominant hand, three older adults were in good physical condition, one older adult had cognitive limitations, and four older adults experienced physical limitations, such as partial hearing loss or minor pain in their limbs.

The evaluation was carried out using the accessibility recommendations presented in Table 2, which were adjusted and calibrated based on the results of the case study. As a result of the evaluation, several problems were identified in adapting the old page of the website of the Municipality of Popayán. Table 3 shows the proposed changes for each of these problems, which were validated by the participants in the study.

In summary, the aim of this study is to validate and adjust accessibility recommendations for government web applications and for older adults through the evaluation of a website of the Municipality of Popayán as a case study. The results of this study can be used to improve the accessibility of government websites and other websites for older adults. The website of the Municipality of Popayán can be found at the following URL: https://www.popayan.gov.co/Paginas/default.aspx

Table 3. Government websites case study

Level	Problem	Suggestion
A	Non-text content	If the textual content intends to create a specific sensory experience, then the text alternatives provide at least a description of the non-text content.
A	Keyboard traps	If it is possible to move focus to a component of the page using a keyboard interface, then focus can be removed from that component using only the keyboard and, if anything other than the arrow keys or any other method is required, it informs the user about the appropriate method to move focus.
A	Color usage	Color is not used as the only way to convey information indicate an action request a response or distinguish a visual element.
A	Three flashes or less	Web page does not contain anything that flashes more than three times, but to the extent that any content does not meet this criterion, detail and measure the time of page on/off.
AA	Adjustable time	For each time limit imposed by the content, at least one of the following is true: turn off, when the user can stop the time before encountering it or adjust, when the user can adjust the time limit before encountering it in a range that is at least 10 times greater than the originally fixed time.
AA	AA Text resizing	Except for captions and text images, all text can be resized without assistive technology up to 200% without loss of content or functionality.

Source: own work

3. DISCUSSION AND CONCLUSIONS

This study presents a detailed proposal of a set of accessibility recommendations for the design of government websites focused on the elderly population. The recommendations are designed to serve as a guide for developers in the process of building and designing web applications for older people with physical and cognitive limitations typical of their age range, from the perspective of web accessibility.

In addition, an inspection of the website of the municipal government of Popayán-Cauca was carried out, in which some basic problems were identified regarding the adaptation of web pages for older adults. As a result of this evaluation, a comparison of the identified problems on the website was made, and a suggestion for change was associated with each one of them.

As a future work, the intention is to design a heuristic test based on the heuristics proposed in this research. This test aims to assist in the evaluation processes of websites aimed at the elderly population. With this test, the effectiveness of government websites in terms of accessibility and usability for the elderly population can be measured, which will allow for the improvement of the design and functionality of these sites in the future.

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