PEER REVIEW, Vol. 6, Nº 10, 2024
DOI: 10.53660/PRW-2151-4005
ISSN: 1541-1389

Impact of reduced contrast sensitivity function in the elderly

Impacto da redução da função de sensibilidade ao contraste na pessoa idosa

Diva Bernardes Vargas
https://orcid.org/0000-0003-4510-8907
UniCEPLAC – University Center of Planalto Central Apparecido dos Santos, Gama, Brasilia, Brazil
bernardesvargas@gmail.com
Clarissa Vargas Araújo
https://orcid.org/0000-0002-9686-6196
Higher School of Health Sciences, Brasilia, Brazil
clarissavaraujo@gmail.com
Isadora Vargas Cunha
https://orcid.org/0009-0004-2828-7899
The Federal District Health Department, Brasilia, Brazil
ivcunha.prep@gmail.com
Julia Vargas Araújo
https://orcid.org/0009-0005-7133-6091
University Center of Brasília – UniCeub, Brasilia, Brazil,
ju.vargas2000@hotmail.com
Marco Antônio V. Matos
https://orcid.org/0009-0008-3564-3942
University Center of Planalto Central Apparecido dos Santos., Gama, Brasilia, Brazil
marcodevargas@hotmail.com

ABSTRACT

Contrast sensitivity is a visual function associated with recognizing objects in low light. **Objective**: to review the contrast sensitivity function (CSF) in the elderly, the changes related to it with aging and the impact of its decline on daily activities. **Methods**: Search in PubMed/MEDLINE and SciELO, using the descriptors "contrast sensitivity" AND "seniors" OR "Elder*" OR "older adults" OR aged. Inclusion criteria: age ≥ 60 years or "elderly" and reference to CSF assessment. **Results**: elderly people have reduced CSF, leading to the risk of falls. CSF is useful for balance, performance on digital tasks, movement processing and quality of life, as well as it is important in cognitive and neuropsychological tests. Impairment of CSF is associated with loss of driving performance of motor vehicles, especially at low luminance. Elderly people who have a decrease in CSF have less social interaction and a lower quality of life. **Conclusion**: the reduction in CSF occurs with aging and is associated with postural imbalance, in addition to an increase in fall rates and impact on the activities of daily living of the elderly, influencing mobility and social interaction.

Keywords: contrast sensitivity; elderly; visual function.

Recebido: 03/04/2024 | Aceito: 05/05/2024 | Publicado: 10/05/2024

RESUMO

A sensibilidade ao contraste é uma função visual associada ao reconhecimento de objetos em baixa luminosidade. **Objetivo**: revisar a função de sensibilidade ao contraste (FSC) no idoso, suas alterações no envelhecimento e o impacto do seu declínio nas atividades diárias. **Métodos**: Busca no PubMed/MEDLINE e SciELO, usando os descritores "*contrast sensitivity*" AND "*seniors*" OR "*Elder**" OR "*older adults*" OR *aged*. Critérios de inclusão: idade ≥ 60 anos ou "idosos" e referência à avaliação da FSC. **Resultados**: os idosos apresentam FSC reduzida, levando ao risco de quedas. A FSC é útil no equilíbrio, desempenho em tarefas digitais, processamento de movimento e qualidade de vida, além de importante em testes cognitivos e neuropsicológicos. O comprometimento da FSC está associado à perda de desempenho de condução de veículos automotores, principalmente em baixa luminância. Os idosos que apresentam diminuição da FSC têm menor interação social e menor qualidade de vida. **Conclusão:** a redução da FSC ocorre com o envelhecimento e associa-se ao desequilíbrio postural, além de aumento das taxas de quedas e impacto nas atividades da vida diária dos idosos, influenciando a mobilidade e interação social.

Palavras-chave: sensibilidade ao contraste; idoso; função visual.

INTRODUÇÃO

Senility is not always about getting sick, however, as the population ages, health problems arise, placing demands on health systems and social security. Unless it is associated with a limiting illness, aging is related to good health. Furthermore, improvements associated with health and innovations in technological tools have allowed the population with access to public or private services to have a better quality of life at this stage. As a result, it has become possible investing more optimally in lifelong care projects, increasing the speed of resolving today's challenges and, increasingly, those to come (Kalache, 2008).

With senility, however, the processing of the visual image by humans becomes less clear. Large, close objects can generally be seen clearly, however, elderly people tend to have difficulty seeing smaller elements (Liutkevičiene *et al.*, 2013). The visual system is influenced by several factors such as gender, geographic location, eating habits, as well as climatic aspects. Socioeconomic factors also have an important impact on the eye health of the elderly (Taylor, 1980).

Over time, the elements comprising the ocular system undergo various metabolic insults, stemming from genetic predispositions, endogenous reactions, and environmental influences (Amir et al., 2021).

Consequently, the elderly is more susceptible to frequent and debilitating eye conditions. Among the myriad facets of visual function, contrast sensitivity stands out, crucial for discerning objects in low-light conditions. Some researchers posit that this ability begins to diminish after the age of 20 (Hirvela, Koskela, and Laatikainen, 1995).

The Contrast Sensitivity Function (CSF) gauges the lowest discernible contrast for each tested spatial frequency. As individuals age, degenerative changes associated with senescence emerge. Elderly individuals experience miosis, where the pupil constricts less in darkness, lens clarity diminishes, and accommodation reserves along with convergence decrease (Ward, 2018). These alterations impede light access to the retina. Literature suggests that contrast sensitivity begins to decline post-20 years of age (Owsley *et al.*, 2001). Detecting low-contrast objects is pivotal for daily visual tasks like driving, reading, walking, and facial recognition. Recent research indicates that assessing CSF aids in detecting and monitoring conditions such as glaucoma, cataracts, keratoconus, macular degeneration, diabetic retinopathy, and optic neuropathy (Sieiro *et al.*, 2016).

For many years, the assessment of human visual function has relied heavily on measuring visual acuity (VA), defined as the ability to distinguish letters or symbols of different sizes within a standardized framework, typically with high contrast. However, VA alone doesn't provide a complete picture of someone's visual abilities. Other aspects of vision are closely tied to overall quality of life. Among these is contrast sensitivity, which is vital, especially in low-light or glare conditions where the difference in contrast between an object and its background diminishes. Even if someone has normal VA but reduced contrast sensitivity, they may still face significant visual challenges. Occasionally, an individual may achieve 20/20 (6/6) vision, considered normal visual acuity, yet struggle with poor night vision. Tasks related to mobility and social interactions have been observed to be constrained by contrast sensitivity. While contrast sensitivity isn't typically evaluated in clinical settings, research has linked low contrast sensitivity to reduced walking speed, mobility issues, and an increased risk of falls in various studies (Swenor *et al*., 2015; Thompson *et al*., 2023a). However, it's worth noting that in these studies, many participants also had poor visual acuity. This research aimed to explore how contrast sensitivity changes as people age and examine how declines in contrast sensitivity affect daily activities among older adults.

Visual function encompasses several components, with visual acuity (VA) being the most commonly evaluated. However, it also encompasses contrast sensitivity, peripheral and central visual fields, object shape and movement perception, as well as color vision (Lopes, Henrique and Lobo, 2020). As the population ages rapidly, there's a growing need to understand age-related visual impairments and how they affect daily activities among the elderly (Owsley, 2012). The optical system has the capacity to detect stimuli of varying sizes and contrasts, transmitting them to the brain for processing. Contrast sensitivity plays a crucial role in perceiving shapes, facilitating object recognition. It's quantified as the minimum contrast required to detect a specific visual pattern or spatial frequency (Cornsweet, 1970).

As individuals age, their Contrast Sensitivity Function (CSF), which plays a vital role in visual function and the performance of daily tasks (Woods and Wood, 1995), tends to decrease. Due to its effectiveness in evaluating visual health, CSF is extensively utilized in guiding recommendations and predicting the outcomes of surgeries and other ocular treatments, additionally, it serves as a valuable tool in examining patients with visual impairments (Thayaparan, 2007).

Since the 1970s, when contrast sensitivity measurements were first introduced, numerous tests have been developed for routine use (Hirvela, Koskela and Laatikainen, 1995). While visual acuity (VA) remains one of the most commonly used assessments in ophthalmology, it's important to recognize that it's just one aspect of the visual system. VA aims to determine the smallest optotype that can be seen on a high-contrast background, representing optimal visual acuity. On the other hand, contrast sensitivity testing evaluates vision in everyday contexts, reflecting the ability to recognize objects of various sizes and contrasts within the environment (Banks and Salapatek, 1976). This functional approach provides insights into vision under real-world conditions (Parede *et al.*, 2013)

Visual acuity (VA) primarily assesses the ability to utilize visual details at high spatial frequencies, but it may not detect impairments at low or intermediate spatial frequencies, known as "hidden visual loss" (Regan, Silver and Murray, 1977). Contrast sensitivity measurements, however, can provide insights into information regarding low and intermediate spatial frequencies. They have the potential to uncover "hidden vision" in instances where visual acuity is diminished (Hyvärinen, Laurinen, and Rovamo, 1983).

According to Snellen, VA can be expressed in spatial frequencies; however, higher spatial frequencies are assessed by standard VA testing only under conditions of maximum contrast. Therefore, contrast sensitivity is partially assessed (Liutkevičiene *et al*., 2013).

The Functional Acuity Contrast Test (FACT) is recognized as a highly informative and precise tool for assessing visual functions. It's a particularly sensitive method that can effectively evaluate the visual system and identify early signs of disease, even when visual acuity remains relatively intact (Liutkevičiene *et al*., 2013).

Research indicates that relying solely on the conventional Snellen chart to assess visual acuity, particularly with Landolt rings (C optotypes), is inadequate for comprehensive visual function testing. This method offers limited insights into central vision. Thus, it's essential to evaluate not only visual acuity but also contrast sensitivity to obtain a more comprehensive understanding of visual capabilities (Ginsburg, 2006).

Radhakrishnan *et al*. (2004) conducted a study involving both younger and older participants, revealing a decline in contrast sensitivity associated with aging. Similarly, Hohberger *et al*. (2007) affirmed a notable correlation between age and reduced contrast sensitivity.

Additionally, Hohberger *et al.* (2007) explored the impact of cataracts on contrast sensitivity, finding a significant association between decreased contrast sensitivity and age. They also observed that cataracts played a role in this decline. These findings align with the conclusions drawn by Hirvelä *et al.* (1995), who suggested that reduced brightness contributes to diminished contrast sensitivity in older individuals, particularly those with cataracts. Concomitant to this, Yan *et al.* showed that there is a decrease in the efficiency of central processing of visual images with age (Yan *et al*., 2020). The study of older normal subjects presents a number of difficulties for the researcher and a definition of 'normal' becomes more difficult with increasing age (Liutkevičiene *et al*., 2013).

The decline in contrast sensitivity with age can be attributed to various factors, including neurological changes such as reduced light entry into the retina due to smaller pupil size caused by age-related difficulties in dilation, decreased retinal neuron count, or optical factors such as increased higher-order aberrations (Artal *et al*., 2003).

As individuals age, they may experience senile miosis, where the lenses become less transparent and more rigid, leading to diminished accommodation and convergence reserves (Sekuler and Sekuler, 2004). These alterations ultimately result in decreased light reaching the retina. Consequently, older individuals exhibit reduced contrast sensitivity across all spatial frequencies compared to younger individuals (Ross, Clarke, and Bron, 1985).

METHOD

Search strategy

To gather relevant studies on issues concerning contrast sensitivity in the elderly, a search strategy was devised. MeSH terms and free text terms were employed in databases such as PubMed/MEDLINE and SciELO. Additionally, a manual search of the bibliographic references of selected articles was conducted to uncover any pertinent studies missed by the initial algorithm. The search criteria aimed to identify research focusing on contrast sensitivity and its implications for older individuals. The search terms included "contrast sensitivity" AND "seniors" OR "Elder*" OR "older adults" OR "aged". Table 1 lists the keywords included in the search strategy, which were as follows:

Table 1 – Keywords Utilized in the Search Strategy

Elderly	**Contrast Sensitivity**
Seniors	Contrast sensitivity
Elder*	
Older adults	
Aged	

Source: Vargas, 2024

To qualify for inclusion in the review, articles or books must meet the following criteria: they must be published in English or Portuguese, involve participants aged 60 years or older or be described as pertaining to "elderly" or "older adults", encompassing both healthy individuals and those with comorbidities. Additionally, they should focus on the evaluation of contrast sensitivity, without any restriction on publication date. The terms "elderly" or "older adults" were chosen to ensure the inclusion of articles from international literature that commonly use these terms to refer to older individuals instead of specifying numerical age ranges.

Only original research was considered, encompassing various study designs such as randomized controlled trials, prospective and retrospective observational studies, review articles, and epidemiological studies to ensure a comprehensive exploration of the topic.

The exclusion criteria encompassed publications in the format of theses, dissertations, monographs, reviews, and articles centered on the authors' hypotheses. Additionally, studies where the elderly were not the primary focus were omitted. Subsequently, the reference lists of the chosen publications were scrutinized. The research was conducted between 2022 and 2023.

RESULTS

Ross *et al.* (1985) conducted a study measuring contrast sensitivity in individuals without ocular impairments, dividing them into a group aged ≥ 50 years and a younger group. They compared these groups to assess differences between older and younger individuals and to examine data specifically within the older age group. The findings revealed that older individuals exhibited reduced contrast sensitivity across all spatial frequencies compared to their younger counterparts. Moreover, within the ≥ 50 years age group, there was a unidimensional decline in contrast sensitivity with age for medium and high spatial frequencies.

Another study, by Elliott, McGwin, and Owsley (2013) aimed to analyze rates of visual impairment among individuals aged > 60 years residing in assisted living facilities. This study evaluated visual acuity, cognitive status, and the presence of ocular diseases. Among the participants, 89.3% failed the contrast sensitivity screening, 40.4% were found to have cognitive impairment, and 89% had at least one diagnosed ocular condition. Visual acuities did not differ significantly between groups with varying degrees of cognitive impairment or differing numbers of ocular problems. Among those screened, 70% had visual acuity worse than 20/40 for distance or near vision, and 90% had impaired contrast sensitivity. Cognitive impairment played a minor role in changes in near vision and contrast sensitivity. In their study, Hirvelä *et al*. (1995) found no discernible gender differences among individuals aged ≥ 70 years when comparing visual acuity and contrast sensitivity. They observed a robust correlation between visual acuity and contrast sensitivity in healthy eyes, which diminished notably in subgroups with cataracts or macular diseases. Healthy eyes exhibited significantly better contrast sensitivity than eyes affected by diseases. While there was generally a strong correlation between visual acuity and contrast sensitivity tests across groups, this correlation notably weakened in the cortical cataract group. Despite a generally high correlation, instances of low visual acuity with good contrast sensitivity, and vice versa, were noted. The authors suggested that contrast sensitivity tests should not be routinely administered in cases involving cortical or nuclear cataracts or macular diseases in the elderly. However, they emphasized the value of these tests in individual cases where visual acuity alone fails to address visual complaints.

Liutkevičienė *et al.* (2013) discovered that contrast sensitivity at low and medium spatial frequencies was superior in younger patients compared to older ones. Specifically, lower spatial frequencies exhibited poorer results in the older age group, particularly under conditions inducing blur such as night and daylight assessments. The authors proposed that the decline in contrast sensitivity at medium spatial frequencies could be attributed to advanced age-related lens opacities, with cataracts (cortical or posterior subcapsular) likely contributing to reduced contrast sensitivity in individuals with otherwise good visual acuity. Additionally, glare was identified as a factor reducing contrast sensitivity in the elderly, particularly those with cataracts. The study concluded that contrast sensitivity diminishes with age due to age-related changes in the optical system.

In their examination of eye diseases and their impact on fear of falls, Wang *et al.* (2012) identified reduced contrast sensitivity in elderly patients as a risk factor, along with depression, decreased muscle strength in the lower limbs, and diminished visual acuity. McGwin *et al.* (2003) discovered that elderly patients with cataracts who underwent surgery experienced improved visual acuity (VA) and CSF, encountered less difficulty in daily visual tasks, had a lower involvement in traffic accidents compared to those who did not undergo surgery, and reported an enhanced quality of life.

Datta (2008) conducted a study investigating the influence of visual factors on the quality of life of elderly women with bilateral cataracts. The study revealed that VA, stereopsis and CSF contributed to their quality of life. While VA was associated with quality of life before surgery, the study emphasized that stereopsis and CSF were more significant than VA, especially considering many cataract patients have relatively good baseline acuity. The importance of CSF on acuity was highlighted, given that the environment typically comprises more low-contrast than high-contrast visual stimuli. Furthermore, stereopsis, VA and CSF were linked to mobility, with only VA being associated with depression.

Owsley, Ball and Keeton (1995) investigated adults aged 59-88 with various degrees of visual field loss to understand how visual sensitivity and target location in specific areas of the visual field correlate with finding objects. The study aimed to determine whether target localization issues in the elderly stem from deficiencies in peripheral visual sensitivity or if deficits in higher-order visual processing also contribute. The findings revealed that older adults with severe visual field loss struggled to locate targets. Even among individuals with normal or almost normal visual fields, about half experienced severe localization difficulties, despite having good visual field sensitivity. Contrast sensitivity explained only 36% of the variance in localization performance across individuals, with a weaker relationship observed when the target was surrounded by distracting stimuli. This suggests that impaired attentional abilities also contribute to localization issues in the elderly. Thus, many elderly individuals face challenges in locating points of interest in visual search tasks, despite adequate visual field sensitivity, and good VA and contrast sensitivity in central vision.

A study by Popescu *et al*. (2011) aimed to ascertain measures of visual function, including visual acuity (VA), CSF and visual field, and their connection with mobility. They found that contrast sensitivity and visual field play a crucial role in maintaining balance, aiding in detecting subtle movements and facilitating rapid postural responses, particularly beneficial for challenging balance tasks like standing on one leg.

Allen *et al*. (2010) investigated age-related differences in perceiving global movement patterns. They discovered an age-related decline in adults' ability to discern movement direction, especially when the moving pattern was less distinct. This decline in motion perception was attributed mainly to deficits in contrast sensitivity, suggesting its greater impact on motion perception than previously acknowledged.

Duggan *et al*. (2017) explored the relationship between visual function (VA and CSF) and fall risk factors in community-dwelling older adults. They found no significant association between VA and various gait variables. Their findings indicated that detailed, high-contrast vision measured by VA may not be critical for basic straight-line walking, suggesting that contrast sensitivity is a better indicator of fall risk than VA.

Lord *et al*. (1991) examined visual function in the elderly and its association with falls. They observed a significant decrease in visual function with age and noted a disparity in contrast sensitivity between individuals who experienced falls and those who didn't. Reduced vision was proposed as a predisposing factor for falls, particularly in situations where peripheral sensation is diminished.

Leonard *et al*. (2005) investigated the performance of older adults with visual impairments on desktop computer tasks. They found that changes in contrast sensitivity significantly impacted task efficiency in individuals with visual impairments, extending from traditional desktops to mobile devices. Contrast sensitivity emerged as a crucial determinant of performance across various computer tasks.

In a study by Caballe-Fontanet *et al*. (2022), anxiety and quality of life related to vision in patients with Age-related Macular Degeneration were evaluated. Visual acuity (VA), CSF and age were correlated with quality of life. The study revealed correlations between CSF, VA, anxiety and quality of life. The authors emphasized the significant impact of Age-related Macular Degeneration on anxiety and quality of life, with decreased CSF and VA worsening with age being notable factors contributing to reduced quality of life in Age-related Macular Degeneration patients.

Research conducted on drivers aged 70 and older revealed a notable correlation between impaired contrast sensitivity and decreased driving proficiency. These findings align with previous observations linking diminished driving capabilities in the elderly to deficits in contrast sensitivity. Drivers experiencing impaired contrast sensitivity demonstrated reduced annual mileage and fewer weekly trips, even after accounting for various influencing factors. Interestingly, visual acuity deficits did not impact changes in driving behavior, nor did cognitive status influence the relationship between vision impairment and driving habits. The study further highlighted that older adults with cataracts and impaired contrast sensitivity faced a heightened risk of accidents and driving difficulties, emphasizing the importance of addressing contrast sensitivity issues to mitigate crash risks and enhance driving safety (Sandlin, Mcgwin and Owsley, 2014).

Another study underscored the significance of contrast sensitivity in risk perception among older drivers, irrespective of other factors. The research indicated that road markings enhancing image contrast can improve risk perception, particularly for nighttime driving among elderly individuals. The authors suggested that hazard perception relies on effective processing of visual stimuli, implicating factors like visual acuity and field of view in mediating older drivers' ability to perceive potential risks on the road (Horswill *et al.*, 2008).

Lord *et al*. (2006) highlighted a significant decline in contrast sensitivity in older individuals, particularly in those experiencing senility, with this decline being influenced by lighting conditions and posing a risk factor for falls among the elderly. Anstey *et al.* (2006) delved into the relationship between vision and memory, investigating how reduced contrast sensitivity and exposure to low-contrast stimuli impact information processing in older adults. Their findings suggested that diminished contrast sensitivity was associated with slower processing speed and revealed a notable link between visual contrast sensitivity and cognitive performance, indicating that visual aging may involve slower encoding of information at a more central level than previously understood.

Similarly, Santos *et al.* (2006) observed lower contrast sensitivity across all spatial frequencies in elderly individuals compared to young adults. Ward *et al.* (2018) explored the association between visual contrast sensitivity and cognitive decline or dementia risk in a population-based cohort of elderly women. Their longitudinal study found that reduced contrast sensitivity was independently associated with a higher risk of developing mild cognitive impairment or dementia within a decade. These associations remained significant even after adjusting for known risk factors like age, education, and ocular conditions such as glaucoma, age-related macular degeneration, or cataracts. The authors advocated for the inclusion of contrast sensitivity tests in comprehensive assessments to identify older adults at heightened risk of dementia, suggesting that dysfunction in the visual system may precede or parallel cortical or subcortical degeneration associated with clinical dementia.

In their research, Santos *et al.* (2004) explored the relationship between aging and contrast sensitivity function across various angular frequencies, comparing older individuals to their younger counterparts. Interestingly, their findings revealed that sensitivity at low and very low angular frequencies was superior in the older group compared to younger individuals. The authors suggested that this improvement in sensitivity at lower angular frequencies among the elderly might be attributed to differences in the mechanisms involved in processing these frequencies. They speculated that different visual cortical areas likely process distinct angular frequencies, and aging may impact these underlying mechanisms differently, especially at lower angular frequencies. Some evidence in the literature supports the notion that aging can influence both neural and optical pathways involved in spatial and angular frequency processing, shedding light on the complex interplay between aging and visual perception (Yan et al., 2020).

In contrast to some expectations, Oshika, Okamoto, Samejima *et al.* (2006) discovered a notable link between best spectacle-corrected high-contrast visual acuity (VA) and age, but no such correlation between contrast sensitivity function (CSF) and age. This finding challenged the conventional belief that high-contrast VA aligns with measures of retinal image quality. Through their multiple regression analysis, they determined that age did not significantly influence contrast sensitivity. However, they did observe a significant correlation between CSF and ocular aberrations of a higher order, rather than with the age of the subjects. These findings led them to suggest that the apparent association between age and contrast sensitivity might actually be an indirect correlation mediated by higher-order ocular aberrations, acting as a concealed causal variable.

Rubin *et al.* (1994) delved into the connection between visual function and automobile accidents, finding that the loss of binocular field and sensitivity to brightness were predictors of such accidents. Surprisingly, stereoacuity, CSF and visual acuity were not found to be significant predictors. Meanwhile, Schieber *et al*. (1992) aimed to gauge the real-world visual challenges accompanying normal adult aging by assessing visual problems during daily tasks and driving, including an assessment of CSF. Their study unveiled a correlation between aging and increased visual problems while driving, with these age-related issues significantly linked to losses in contrast sensitivity at intermediate and high spatial frequencies.

Similarly, Henderson and Donderi (2005) explored the link between peripheral motion contrast sensitivity and elderly drivers' ability to detect accident risks. They noted that while movement enhances contrast sensitivity, stationary contrast sensitivity begins to decline after approximately 60 years of age. Their findings suggested that reduced motion sensitivity in visual periphery could contribute to age-related driving performance deficits, potentially indicating drivers who may struggle to perceive accident risks.

Thompson *et al*. (2023) studies underscored that elderly individuals lacking cognitive impairment or substantial visual deficits impaired visual acuity may have mild preclinical deficiencies in contrast sensitivity and physical ability, which puts them at risk of facing mobility and balance challenges.

DeLoss *et al*. (2015) highlighted a significant issue affecting elderly individuals aged 65 and above: the decline in visual function with age, which correlates with an increased risk of falls and vehicle collisions. They emphasized that this heightened risk is linked to deteriorating contrast sensitivity and visual acuity, with contrast sensitivity decline being particularly pronounced. The authors pointed out that reduced contrast sensitivity impacts the ability to perceive and discern details, crucial for maintaining balance and safe driving, thus increasing the likelihood of falls among the elderly.

Ivers et *al.* (1998) further emphasized the strong association between visual impairment and falls in the elderly. Their study revealed that various visual function tests, including visual acuity (VA), CSF and reduced supra threshold visual field, were significantly associated with a higher risk of experiencing two or more falls. CSF, in particular, showed a significant association across all spatial frequencies and emerged as the most influential risk factor for falls. They suggested that elderly individuals may experience deficits in low spatial frequency CSF, which is closely linked to posture and stability.

Bjelica *et al*. (2021) addressed the prevalence of vision loss among individuals over the age of sixty-five, with cataracts affecting approximately one-third of this population, resulting in impaired contrast sensitivity due to lens cloudiness. Their research demonstrated how such visual impairment can lead to challenges in perceiving step edges and limits, thereby increasing the risk of serious falls. To mitigate this risk, many public staircases incorporate tread edge markers to aid individuals with visual impairment in detecting step edges. Additionally, prior studies have indicated that decreased contrast sensitivity function, rather than visual acuity dysfunction, mediates the association between cataracts and recent automobile accidents (Owsley *et al*., 2001).

Donoghue *et al.* (2014) conducted a study examining the link between visual function, fear of falling, and activity restriction due to fear among adults aged 50 and above. They found that participants' perceptions of their visual function were independently linked to their fear of falling and the restriction of related activities. Interestingly, this association was not explained by other measured visual factors such as visual acuity (VA) and CSF. However, worse VA and CSF did influence the relationship between fear-related activity restriction and mobility. This underscores the importance of a comprehensive vision assessment, especially for individuals experiencing fear of falling. While participants' perceptions of visual function were related to fear of falling and activity restriction, other visual and non-visual factors like stereopsis, visual perimetry, eye disease, and cognitive processing also played significant roles. As age advances, visual functions like VA and CSF tend to decline, along with cognitive processes such as executive function, processing speed, and visual attention.

Owsley *et al.* (2002) investigated the impact of cataract surgery on the driving behavior of elderly individuals aged 65 and above. They compared the involvement in car accidents of patients who underwent cataract surgery with those who did not opt for surgery. The findings after a 10-year follow-up revealed overwhelmingly positive effects from cataract surgery and intraocular lens implantation among elderly patients. These benefits included improved visual acuity and contrast sensitivity. Moreover, elderly patients who underwent cataract surgery had approximately half the rate of involvement in automobile accidents compared to those who did not undergo surgery.

Freeman *et al.* (2006) explored the relationship between visual function and driving behavior changes in older adults. They discovered that reduced contrast sensitivity and visual field were associated with decreased mileage and cessation of night driving, suggesting that these visual functions play a crucial role in routine driving activities. Interestingly, contrast sensitivity and visual fields were not linked to stopping driving in unfamiliar areas. The authors suggested that individuals with poor contrast sensitivity or visual field scores but good acuity scores might find it less challenging to drive in unfamiliar areas than in familiar ones.

Kimlin *et al.* (2017) highlighted that older drivers with impaired mesopic vision face challenges when driving in nighttime conditions due to age-related declines in vision. These declines are particularly pronounced under low-contrast and low-luminance conditions, which are common in nighttime driving scenarios. The study suggested that tests measuring low-contrast, low-luminance vision better reflect the functional vision of older adults for driving at night.

A study investigating visual predictors of gait adaptations in Age-Related Macular Degeneration found that contrast sensitivity was significantly associated with gait adaptations, indicating postural instability, slower walking speed, wider steps, and shorter stride length. These adaptations suggest a more cautious walking pattern adopted by individuals with impaired contrast sensitivity. This progressive loss of contrast sensitivity and visual fields in Age-related Macular Degeneration patients may contribute to difficulties with balance and mobility (Wood *et al.*, 2009).

Wood *et al.* (2011) discovered a significant association between increased visual impairment in elderly Age-related Macular Degeneration patients and a higher incidence of falls and other injuries. Reduced CSF and visual acuity were linked to an increased fall rate, even after adjusting for various factors such as age, sex, cognitive function, and cataract severity. Reduced contrast sensitivity emerged as a significant predictor of non-fall injuries and was associated with higher rates of both falls and other injuries.

In terms of cognition, Wood *et al*. (2010) noted that contrast sensitivity, affected by aging, plays a crucial role in cognitive testing. Their study, which manipulated visual acuity and contrast sensitivity using simulation filters, found that differences in contrast sensitivity significantly influenced performance on neuropsychological tests, even after accounting for age effects. The research suggested that changes in contrast sensitivity, rather than visual acuity, better predict cognitive test performance in older adults.

Rubin *et al*. (1994) investigated how various aspects of visual impairment, beyond just reduced visual acuity (VA), impact functional independence in older adults aged 65 or over. They conducted vision tests and administered a questionnaire to assess self-reported difficulty with activities of daily living (ADLs), instrumental activities of daily living (IADLs), and mobility activities. The findings revealed that reduced VA was linked to challenges in tasks requiring clear vision and adaptation to changing light conditions, while full spatial contrast (CSF) was associated with difficulties in tasks involving depth perception, nighttime driving, and mobility. However, brightness and stereoacuity did not show associations with self-reported disability. The study concluded that both reduced VA and FSC are significant contributors to self-reported disability.

Lord (2006) emphasized the crucial role of vision in maintaining balance, highlighting its impact on postural stability. Impaired vision was identified as an independent risk factor for falls and fractures among the elderly. Lord's research examined the effects of multifocal glasses on vision and falls in older adults. Participants performed poorly on depth perception and FSC tests when viewing targets through the lower segments of multifocal glasses. This impairment is particularly concerning during activities such as navigating stairs and unfamiliar environments outside the home. The study suggested that multifocal glasses may elevate fall risk by compromising distance FSC and depth perception in the lower visual field, thereby impeding the detection of environmental hazards.

DISCUSSION

In discussing the implications of these findings, it's crucial to consider the significant impact of contrast sensitivity on visual quality and function. This review underscores the progressive decline in contrast sensitivity as individuals age. Owsley *et al*. (2001) propose that this decline in contrast sensitivity may begin as early as 20 years of age. Moreover, this reduction occurs even in the absence of apparent eye diseases. However, various eye conditions, whether age-related or not, can further exacerbate the decline in contrast sensitivity, including cataracts, Age-related Macular Degeneration, and glaucoma. It is a consolidated fact that a decrease in CSF has an impact on the activities of daily living of elderly patients, influencing, among others, mobility, driving ability, social interaction and falls.

The sole study that examined genders separately did not discover statistically significant differences between men and women concerning reduced CSF (Hirvela, Koskela and Laatikainen, 1995).

Studies have consistently found that CSF remains diminished even after adjusting for various factors such as cognition and the presence of multiple eye diseases, which theoretically could influence CSF. Interestingly, cognitive impairment appears to have minimal impact on changes in contrast sensitivity (Elliott, McGwin, and Owsley, 2013).

An intriguing observation from several studies is that while most show a strong correlation between visual acuity (VA) and CSF, some do not demonstrate a consistently high correlation between VA values and contrast sensitivity. In some cases, individuals may have low visual acuity but good contrast sensitivity and vice versa.

Numerous studies have highlighted that elderly individuals with cataracts, who exhibit reduced CSF, experience improvements following cataract surgery and intraocular lens placement. Moreover, glare, often encountered during activities such as driving in daylight, further diminishes CSF, especially in individuals with cataracts (Liutkevičiene *et al.*, 2013; Owsley, Ball and Keeton, 1995). Additionally, research has indicated that elderly individuals with reduced CSF often experience decreased mobility, social interaction, and overall quality of life due to fear of falls (Wang *et al.*, 2012; Donoghue *et al.*, 2014).

Consistent with previous findings, numerous studies reviewed here have linked lower CSF to postural instability, impaired stability, and increased fall risk among the elderly. Regarding driving ability, impairments in contrast sensitivity have been independently associated with reduced driving performance (Sandlin, McGwin, and Owsley, 2014). Furthermore, age-related deficits in driving performance have been linked to reduced motion sensitivity in the visual periphery, suggesting that peripheral motion contrast sensitivity can help identify drivers at higher risk of failing to detect accident risks (Henderson and Donderi, 2005). Similarly, Kimlin *et al.* (2017) reported that older drivers experience functional declines in driving performance, particularly challenging under low-luminance and low-contrast conditions, such as nighttime driving.

In the context of Age-related Macular Degeneration, studies have indicated that the loss of CSF is more pronounced compared to other eye diseases. This change in CSF has been identified as an independent risk factor for anxiety and decreased quality of life in individuals with Age-related Macular Degeneration (Caballe-Fontanet *et al.*, 2022).

CONCLUSION

Visual acuity (VA) is frequently assessed in clinical vision exams, but it might not provide a comprehensive measure of functional vision. These exams typically focus on high-contrast visual acuity, often under well-lit conditions, which may not fully capture the range of visual abilities required for various lighting conditions, such as low luminance and glare encountered at night. Contrast Sensitivity Function (CSF) is known to be influenced by age, a widely acknowledged phenomenon. However, its implications are still not fully explored. The relationship between ocular diseases and mobility appears to be largely influenced by CSF.

This review highlights that CSF tends to decline with age, especially in individuals affected by visual system disorders like cataracts, glaucoma, and age-related macular disease. Elderly individuals frequently report mobility issues, including falls and vehicle collisions, which are often linked to visual impairments, particularly reduced CSF. Lower CSF has also been associated with decreased postural stability and an elevated risk of falls. Additionally, it contributes to the fear of falling, which further limits mobility, reduces social interaction, and diminishes overall quality of life.

The significance of assessing CSF alongside visual acuity is emphasized in this review. Given that the environment presents more low-contrast visual stimuli than high-contrast ones, evaluating CSF in the elderly is crucial. This underscores the importance of identifying diseases associated with additional impairment related to CSF, highlighting the need for comprehensive vision assessments in aging populations.

REFERENCES

ALLEN, H. A. et al. The role of contrast sensitivity in global motion processing deficits in the elderly. **Journal of Vision**, v. 10, n. 10, p. 1–10, 2010.

ANSTEY, K. J. et al. Between- and within-individual effects of visual contrast sensitivity on perceptual matching, processing speed, and associative memory in older adults. **Gerontology**, v. 52, n. 2, p. 124–130, 2006.

ARTAL, P. et al. Optical Aberrations and the Aging Eye. **Int Opht Clinics**, v. 43, n. 2, p. 63–77, 2003.

BANKS, M. S.; SALAPATEK, P. Contrast sensitivity function of the infant visual system. **Vision Research**, v. 16, n. 8, 1976.

BJELICA, M.; LEVINE, I. C.; NOVAK, A. C. Increasing the contrast of tread edge highlighters improves stair descent safety in older adults with simulated visual impairment. **Applied Ergonomics**, v. 97, n. June, p. 103525, 2021.

CABALLE-FONTANET, D. et al. Quality of Life and Anxiety in Age Macular Degeneration Patients: A Cross-Sectional Study. **International Journal of Environmental Research and Public Health**, v. 19, n. 2, 2022.

DATTA, S. et al. The importance of acuity, stereopsis, and contrast sensitivity for health-related quality of life in elderly women with cataracts. **Investigative Ophthalmology and Visual Science**, v. 49, n. 1, p. 1–6, 2008.

DELOSS, D. J.; WATANABE, T.; ANDERSEN, G. J. Improving Vision Among Older Adults: Behavioral Training to Improve Sight. **Psychological Science**, v. 26, n. 4, p. 456–466, 2015.

DONOGHUE, O. A. et al. Relationship between fear of falling and mobility varies with visual function among older adults. **Geriatrics and Gerontology International**, v. 14, n. 4, p. 827–836, 2014.

DUGGAN, E. et al. Time to Refocus Assessment of Vision in Older Adults? Contrast Sensitivity but Not Visual Acuity Is Associated with Gait in Older Adults. **Journals of Gero - Series A Biological Sci and Med Sciences**, v. 72, n. 12, p. 1663–1668, 2017.

ELLIOTT, A. F.; MCGWIN, G.; OWSLEY, C. Vision impairment among older adults residing in assisted living. **Journal of Aging and Health**, v. 25, n. 2, p. 364–378, 2013.

FREEMAN, E. E. et al. Measures of visual function and their association with driving modification in older adults. **Invest Oph and Visual Sci**, v. 47, n. 2, p. 514–520, 2006.

FREEMAN, E. E. et al. Visual field loss increases the risk of falls in older adults: The salisbury eye evaluation. **Invest Oph and Visual Sci**, v. 48, n. 10, p. 4445–4450, 2007.

GINSBURG, A. P. Contrast sensitivity: Determining the visual quality and function of cataract, intraocular lenses and refractive surgery. **Current Opinion in Oph**, v. 17, n. 1, p. 19–26, 2006.

HENDERSON, S.; DONDERI, D. C. Peripheral Motion Contrast Sensitivity and Older Drivers' Detection Failure Accident Risk. p. 41–50, 2005.

HIRVELA, H.; KOSKELA, P.; LAATIKAINEN, L. Contrast sensitivity in the elderly I : j '. 1995.

HOHBERGER, B. et al. Measuring contrast sensitivity in normal subjects with OPTEC® 6500: Influence of age and glare. **Graefe's Archive for Clinical and Experimental Ophthalmology**, v. 245, n. 12, p. 1805–1814, 2007.

HORSWILL, M. S. et al. The hazard perception ability of older drivers. **J of Geron - Series B Psychological Sciences and Social Sciences**, v. 63, n. 4, p. 212–218, 2008.

HYVÄRINEN, L.; LAURINEN, P.; ROVAMO, J. Contrast Sensitivity in Evaluation of Visual Impairment Due To Diabetes. **Acta Ophth**, v. 61, n. 1, p. 94–101, 1983.

IVERS, R. Q. et al. Visual impairment and falls in older adults: The blue mountains eye study. **Journal of the American Geriatrics Society**, v. 46, n. 1, p. 58–64, 1998.

KALACHE, A. O mundo envelhece: É imperativo criar um pacto de solidariedade social. **Ciencia e Saude Coletiva**, v. 13, n. 4, p. 1115–1117, 2008.

KIMLIN, J. A.; BLACK, A. A.; WOOD, J. M. Nighttime driving in older adults: Effects of glare and association with mesopic visual function. **Investigative Ophthalmology and Visual Science**, v. 58, n. 5, p. 2796–2803, 2017.

LEONARD, V. K.; JACKO, J. A.; PIZZIMENTI, J. J. An exploratory investigation of handheld computer interaction for older adults with visual impairments. **ASSETS 2005 - The Seventh Int ACM SIGACCESS Conf on Computers and Accessibility**, p. 12–19, 2005.

LIUTKEVIČIENE, R. et al. Associations between contrast sensitivity and aging. **Medicina (Lithuania)**, v. 49, n. 6, p. 273–277, 2013.

LOPES, A. A.; HENRIQUE, M.; LOBO, S. Avaliação das funções visuais e sua relação com a visão funcional e quedas em idosos ativos da comunidade 237. v. 79, n. 4, p. 236–241, 2020.

LORD., S. R.; MENZ, H. B. Visual contributions to postural stability in older adults. **Gerontology**, v. 46, n. 6, p. 306–310, 2000.

LORD, S. R. Visual risk factors for falls in older people. **Age and Ageing**, v. 35, n. SUPPL.2, p. 42–45, 2006.

LORD, S. R.; CLARK, R. D.; WEBSTER, I. W. Visual acuity and contrast sensitivity in relation to falls in an elderly population. **Age and Ageing**, v. 20, n. 3, p. 175–181, 1991.

MCGWIN, G. et al. The impact of cataract surgery on depression among older adults. **Ophthalmic Epidemiology**, v. 10, n. 5, p. 303–313, 2003.

OSHIKA, T. et al. Contrast Sensitivity Function and Ocular Higher-Order Wavefront Aberrations in Normal Human Eyes. **Ophth**, v. 113, n. 10, p. 1807–1812, 2006.

OWSLEY, C. et al. Visual risk factors for crash involvement in older drivers with cataract. **Archives of Ophthalmology**, v. 119, n. 6, p. 881–887, 2001.

OWSLEY, C. et al. Impact of cataract surgery on motor vehicle crash involvement by older adults. **Journal of the Am Medical Association**, v. 288, n. 7, p. 841–849, 2002.

OWSLEY, C. Owsley 2011 Aging and vision. v. 51, n. 13, p. 1610–1622, 2012.

OWSLEY, C.; BALL, K.; KEETON, D. M. Relationship between visual sensitivity and target localization in older adults. **Vision Research**, v. 35, n. 4, p. 579–587, 1995.

PAREDE, T. R. R. et al. Quality of vision in refractive and cataract surgery, indirect measurers: Review article. **Arq Bras de Oftalmologia**, v. 76, n. 6, p. 386–390, 2013.

POPESCU, M. L. et al. Age-related eye disease and mobility limitations in older adults. **Investigative Ophthalmology and Visual Science**, v. 52, n. 10, p. 7168–7174, 2011.

RADHAKRISHNAN, H. et al. Effect of positive and negative defocus on contrast sensitivity in myopes and non-myopes. **Vision Research**, v. 44, n. 16, p. 1869–1878, 2004.

REGAN, D.; SILVER, R.; MURRAY, T. J. Visual acuity and contrast sensitivity in multiple sclerosis-hidden visual loss: An auxiliary diagnostic test. **Brain**, v. 100, n. 3, p. 563–579, 1977.

ROSS, J. E.; CLARKE, D. D.; BRON, A. J. Effect of age on contrast sensitivity function: Uniocular and binocular findings. **Brit J of Oph**, v. 69, n. 1, p. 51–56, 1985.

RUBIN, G. S. et al. Visual impairment and disability in older adults. **Optometry and Vision Science**, 1994.

SANDLIN, D.; MCGWIN, G.; OWSLEY, C. Association between vision impairment and driving exposure in older adults aged 70 years and over: A population-based examination. **Acta Ophthalmologica**, v. 92, n. 3, 2014.

SANTOS, N. A. et al. Mesopic radial frequency contrast sensitivity function for young and older adults. **Braz J of Med and Bio Research**, v. 39, n. 6, p. 791–794, 2006.

SANTOS, N. A.; SIMAS, M. L. B.; NOGUEIRA, R. M. T. B. L. Comparison of angular frequency contrast sensitivity in young and older adults. **Braz J of Med and Bio Research**, v. 37, n. 3, p. 375–378, 2004.

SCHIEBER, F. et al. **The relationship between contrast sensitivity and the visual problems of older drivers. SAE Technical Papers**, 1992.

SEKULER, R.; SEKULER, A. B. Age-related changes, optical factors, and neural processes. **Encyclopedia of psychology, Vol. 8.**, v. 8, p. 180–183, 2004.

SIEIRO, R. DE O. et al. Contrast sensitivity assessment in different age group in medium and high spatial frequency. **Rev Bras de Oft**, v. 75, n. 4, p. 296–299, 2016.

SWENOR, B. K. et al. Visual impairment and incident mobility limitations: The health, aging and body composition study. **J of the Am Geriat Soc**, v. 63, n. 1, p. 46–54, 2015.

TAYLOR, H. R. Prevalence and causes of blindness in Australian Aborigines. **Medical Journal of Australia**, v. 1, n. 2, p. 71–76, 1980.

THAYAPARAN, K.; CROSSLAND, M. D.; RUBIN, G. S. Clinical assessment of two new contrast sensitivity charts. **British Journal of Oph**, v. 91, n. 6, p. 749–752, 2007.

THOMPSON, A. C. et al. Association Between Contrast Sensitivity and Physical Function in Cognitively Healthy Older Adults: The Brain Networks and Mobility Function Study. **The J of Geront. Series A, Bio Sci and Med sci** v. 78, n. 8, p. 1513–1521, 2023a.

THOMPSON, A. C. et al. Relationship of Self-reported and Performance-based Visual Function With Performance-based Measures of Physical Function: The Health ABC

Study. **The J of gerontology. Series A, Biological sciences and Medical sciences**, v. 78, n. 11, p. 2060–2069, 2023b.

WANG, M. Y. et al. Activity limitation due to a fear of falling in older adults with eye disease. **Investigative Oph and Visual Science**, v. 53, n. 13, p. 7967–7972, 2012.

WARD, M. E. et al. Reduced contrast sensitivity among older women is associated with increased risk of cognitive impairment. **Annals of Neuro**, v. 83, n. 4, p. 730–738, 2018.

WOOD, J. et al. Simulated visual impairment leads to cognitive slowing in older adults. **Optometry and Vision Science**, v. 87, n. 12, p. 1037–1043, 2010.

WOOD, J. M. et al. Postural stability and gait among older adults with age-related maculopathy. **Investigative Oph and Visual Science**, v. 50, n. 1, p. 482–487, 2009.

WOOD, J. M. et al. Risk of falls, injurious falls, and other injuries resulting from visual impairment among older adults with age-related macular degeneration. **Investigative Ophthalmology and Visual Science**, v. 52, n. 8, p. 5088–5092, 2011.

WOODS, R. L.; WOOD, J. M. The role of contrast sensitivity charts and contrast letter charts in clinical practice. **Cl and Exp Optometry**, v. 78, n. 2, p. 43–57, 1995.

YAN, F. F. et al. Aging affects gain and internal noise in the visual system. **Scientific Reports**, v. 10, n. 1, p. 1–10, 2020.