

Journal Optometry

www.journalofoptometry.org



### ORIGINAL ARTICLE

# Prevalence of dry eye disease in the low vision population at the University of Colorado



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Received 14 April 2023; accepted 11 October 2023 Available online 7 November 2023

#### **KEYWORDS**

Low vision; Visual impairment; Dryness; Dry eye syndrome; Ocular surface disease; Meibomian gland dysfunction; Blepharitis

#### Abstract

*Purpose*: To evaluate the prevalence of diagnosed dry eye syndrome, meibomian gland dysfunction, and blepharitis amongst the low vision population.

*Methods*: A retrospective analysis was conducted on patients seen in the University of Colorado Low Vision Rehabilitation Service between the dates of 12/1/2017 and 12/1/2022. 74 ICD-10 codes were used to identify patients as having dry eye syndrome or not having dry eye syndrome. Data was further analyzed to determine the prevalence of blepharitis and meibomian gland dysfunction using 29 blepharitis and 9 meibomian gland dysfunction ICD-10 codes. Data were also analyzed to determine the age and sex of the patients with diagnosed dry eye syndrome.

*Results:* The percentage of patients with a diagnosis of dry eye syndrome by an eyecare provider was 38.02 %. The prevalence of dry eye syndrome by age group was 3.57 % for 0-19 years, 14.35 % for 20-39 years, 29.07 % for 40-59 years, 43.79 % for 60-79 years, and 46.21 % for 80 and above. The prevalence of meibornian gland dysfunction and blepharitis was 11.90 % and 9.1 % respectively. Dry eye syndrome prevalence amongst males was 31.59 % and 42.47 % for females.

*Conclusion:* This study demonstrates that dry eye syndrome in the low vision population is a significant co-morbidity occurring in over a third of patients in the University of Colorado Low Vision Rehabilitation Service. These findings are meaningful as ocular comfort should not be overlooked while managing complex visual needs.

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# Introduction

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#### https://doi.org/10.1016/j.optom.2023.100501

In the United States, visual impairment is one of the leading causes of disability.<sup>1-3</sup> The prevalence of visual impairment and blindness is increasing the United States largely due to an aging population and shifting demographics.<sup>4,5</sup> Data from 2017 estimated the prevalence of low vision amongst adults

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45 years and older to be 3 % based on a best-corrected visual acuity (BCVA) of less than 20/40, 1.1 % based on a BCVA of less than 20/60, and 0.8 % based on a BCVA of less than 20/ 200.<sup>6</sup> The leading causes of visual impairment in the United States includes macular degeneration, cataracts, glaucoma, and diabetic retinopathy.<sup>4</sup> The overall prevalence of visual impairment increases with age, and the predominant underlying causes vary by race and ethnicity.<sup>4,7</sup> In Colorado. according to the Vision Eve Health Surveillance System data from the Behavior Risk Factors Surveillance System, the percentage of people who are blind or have serious difficulty seeing, even when wearing glasses, was 2.91 % in 2018.<sup>8</sup> Similarly, in 2019 the Vision Eye Health Surveillance System data from the American Community Survey reports the percentage of Coloradans who are blind or have serious difficulty seeing, even when wearing glasses, was 1.94 %.8

Visual impairment is known to reduce quality of life through decreasing independence, negatively impacting mobility and orientation, impacting enjoyment from leisure activities, <sup>9-11</sup> and is also associated with cognitive decline.<sup>12</sup> Healthcare practitioner attention and effort is primarily spent on the visual diagnosis, management of ocular disease, management of associated systemic disease, methods to maximize visual potential, and therapies to assist with vocation, independence, and transportation needs. Given the considerable clinical management, challenging visual accommodations, and extensive lifestyle modifications it is not only plausible, but likely, that the ocular comfort in patients with low vision may be neglected or at least overshadowed.

One of the primary causes of ocular discomfort is dry eye syndrome (DES)<sup>13</sup> which was estimated by a recent metaanalysis to occur in approximately 8.1 % of the population in the United States.<sup>14</sup> Symptoms of DES commonly include dryness, grittiness, burning, stinging, sharp pain, dull pain, foreign body sensation, tearing, photophobia, and blurred vision.<sup>15</sup> People with DES are three times more likely to report difficulty with activities of daily life such as driving, reading, computer work, and watching television<sup>16</sup> and have a worse quality of life compared to an age-matched normative data.<sup>17</sup> Survey assessments have demonstrated that mild dry disease is as burdensome as mild psoriasis, while severe DES has a similar effect on quality of life as moderate to severe angina.<sup>18</sup> DES also is known to affect visual function by worsening visual acuity, visual fluctuations, higher order light aberrations, irregular astigmatism, contrast sensitivity, and overall visual quality.<sup>19-22</sup>

Therefore, it is in the best interest of patients suffering from vision loss to mitigate ocular discomfort originating from DES to ensure quality of life is not unnecessarily diminished. Furthermore, treatment of DES may allow patients to fully utilize their remaining vision through stabilization of the tear film and corneal surface.

To our knowledge, only one manuscript has ever been published on the topic of low vision and dry eye. Researchers from Montreal, Quebec, Canada randomly selected 201 charts from their vision rehabilitation clinics and investigated symptoms of DES, systemic medications with an ocular surface dry effect, artificial tear usage, and corneal assessment (only performed in 8.95 % of patients).<sup>23</sup> Our investigation differs as it is larger in scale and relies on a formal diagnosis of DES.

#### Methods

A records review was conducted on all patients seen in the University of Colorado Low Vision Rehabilitation Service between the dates of 12/1/2017 and 12/1/2022. A list of 74 ICD-10 codes consistent with DES (Tables 1a) or drynessrelated ocular surface disease (Table 1b, 1c) were used to identify DES and patients were grouped into two categories as having DES or not having DES. A positive hit was determined whenever a unique patient seen in the Low Vision Rehabilitation Service had a formal diagnosis of DES with any of the 74 dryness related ICD-10 codes at any encounter in the University of Colorado Department of Ophthalmology during this five-year period. Data was further analyzed to determine the prevalence of blepharitis and meibomian gland dysfunction specifically using a list of 29 blepharitis ICD-10 codes (Table 1b) and a list of 9 meibomian gland dysfunction ICD-10 codes (Table 1c). Over 84,000 records were reviewed and there were 5164 unique patient encounters where a patient was seen in low vision who had an ICD-10 diagnosis code matching one of the 74 diagnosis codes and a total of 2572 unique patients amongst these encounters. Data were also analyzed to determine the age and sex of the patients with diagnosed DES seen in the Low Vision Rehabilitation Service.

#### Results

The total number of individual patients seen in the Low Vision Rehabilitation Service at the University of Colorado during this timeframe was 2572 (n<sup>1051</sup>=male, n<sup>1521</sup>=female). Of these patients, the number of patients with a formal diagnosis of DES by an eye care professional was 978 ( $n^{332}$ =male, n<sup>646</sup>=female). Table 2 demonstrates the number of patients with diagnosed DES by age range and sex. In the Low Vision Rehabilitation Service at the University of Colorado, the overall prevalence of diagnosed DES was 38.02 %. The prevalence of DES amongst this population varied by low vision provider and ranged from 33.37 % to 41.70 %. The prevalence of meibomian gland dysfunction was 11.90 % and the prevalence of blepharitis was 9.1 %. The distribution of DES amongst the low vision population by age range is depicted in Graph 1. The youngest patient was 17 years old while the oldest patient was 107 years old. 66.05 % of the patients with DES were female while 33.95 % were male. The prevalence of DES by age group is demonstrated in Table 3. The prevalence of DES amongst males was 31.59 % and 42.47 % for females. All patients identified as either male or female.

#### Discussion

This study demonstrates that DES in the low vision population is a significant co-morbidity occurring in over a third of low vision patients at the University of Colorado Low Vision Rehabilitation Service. While this may be partially attributable to the climate of Colorado these numbers are significantly higher than national averages thus demonstrating that DES may be a co-morbidity affecting persons with low vision at higher rates than the general public.<sup>14</sup> A systemic review and meta-analysis published in 2022 by McCann et al. estimated the prevalence of DES to be only 8.1 % while the prevalence was

#### Table 1a List of ICD10 codes related to dry eye syndrome but not related to meibomian gland dysfunction nor blepharitis.

Diagnosis	ICD-10 Code
Keratoconjunctivitis sicca, non-Sjögren's syndrome, right eye	H16.221
Keratoconjunctivitis sicca, non-Sjögren's syndrome, left eye	H16.222
Keratoconjunctivitis sicca, non-Sjögren's syndrome, bilateral	H16.223
Keratoconjunctivitis sicca, non-Sjögren's syndrome, unspecified eye	H16.229
Conjunctival Xerosis, unspecified eye	H11.149
Conjunctival Xerosis, bilateral	H11.143
Dry eye syndrome of right lacrimal gland	H04.121
Dry eye syndrome of left lacrimal gland	H04.122
Dry eye syndrome of bilateral lacrimal glands	H04.123
Dry eye syndrome of unspecified lacrimal gland	H04.129
Exposure Keratoconjunctivitis, right eye	H16.211
Exposure Keratoconjunctivitis, left eye	H16.212
Exposure Keratoconjunctivitis, bilateral	H16.213
Exposure Keratoconjunctivitis, unspecified eye	H16.219
Sicca syndrome (Sjögren) with keratoconjunctivitis	M35.01
Sicca syndrome (Sjögren), unspecified	M35.00
Superficial Keratitis, unspecified, right eye	H16.101
Superficial Keratitis, unspecified, left eye	H16.102
Superficial Keratitis, unspecified, bilateral	H16.103
Superficial Keratitis, unspecified, unspecified eye	H16.109
Filamentary Keratitis, right eye	H16.121
Filamentary Keratitis, left eye	H16.122
Filamentary Keratitis, bilateral	H16.123
Filamentary Keratitis, unspecified eye	H16.129
Punctate Keratitis, right eye	H16.141
Punctate Keratitis, left eye	H16.142
Punctate Keratitis, bilateral	H16.143
Punctate Keratitis, unspecified eye	H16.149
Neurotrophic keratoconjunctivitis, right eye	H16.231
Neurotrophic keratoconjunctivitis, left eye	H16.232
Neurotrophic keratoconjunctivitis, bilateral	H16.233
Neurotrophic keratoconjunctivitis, unspecified eye	H16.239
Recurrent Erosion of Cornea, right eye	H18.831

38.02 % in our cohort.<sup>14</sup> McCann et al. found a meibomian gland dysfunction prevalence of 21.2 % compared to our 11.9 % prevalence. One potential explanation for this discrepancy is that low vision specialists may be more likely to diagnose DES based on symptoms consistent with dry eye rather than identifying the cause of these symptoms to be meibomian gland dysfunction. This is entirely plausible as these providers are generally more focused on visual concerns rather than diagnosing ocular surface disease. Low vision specialists are also less likely to have meibography technology available to assess meibomian gland atrophy as this is not particularly relevant to their area of eye care. Interestingly, of the only two manuscripts pertaining to low vision and DES, both investigations demonstrate evidence of a higher DES prevalence compared to the general population. Bitton et al. found 25 % of low vision patients have DES symptoms with 36.8 % regularly using artificial tears.<sup>23</sup> Although our prevalence was determined through formal diagnosis of DES, our results more closely align with these numbers than the general population.

There are many plausible explanations as to why this population may be more susceptible to DES. Glaucoma, the leading cause of blindness worldwide,<sup>24</sup> oftentimes requires long-term use of topical medications known to cause DES.<sup>25</sup>

Table 1b	List of ICD10 codes related to	dry eye sy	ndrome and ble	pharitis but not related to	meibomian gland dysfunction.

Diagnosis	ICD-10 Code
Unspecified blepharitis, right upper lid	H01.001
Unspecified blepharitis, right lower lid	H01.002
Unspecified blepharitis, right eye, unspecified	H01.003
Unspecified blepharitis, left upper lid	H01.004
Unspecified blepharitis, left lower lid	H01.005
Unspecified blepharitis, left eye unspecified	H01.006
Unspecified blepharitis, unspecified eye, unspecified lid	H01.009
Unspecified blepharitis, right upper and lower lids	H01.00A
Unspecified blepharitis, left upper and lower lids	H01.00B
Ulcerative blepharitis, right upper lid	H01.011
Ulcerative blepharitis, right lower lid	H01.012
Ulcerative blepharitis, right eye, unspecified	H01.013
Ulcerative blepharitis, left upper lid	H01.014
Ulcerative blepharitis, left lower lid	H01.015
Ulcerative blepharitis, left eye, unspecified	H01.016
Ulcerative blepharitis, unspecified eye, unspecified lid	H01.019
Ulcerative blepharitis, right upper and lower lids	H01.01A
Ulcerative blepharitis, left upper and lower lids	H01.01B
Squamous blepharitis, right upper lid	H01.021
Squamous blepharitis, right lower lid	H01.022
Squamous blepharitis, right eye, unspecified	H01.023
Squamous blepharitis, left upper lid	H01.024
Squamous blepharitis, left lower lid	H01.025
Squamous blepharitis, left eye, unspecified	H01.026
Squamous blepharitis, unspecified eye, unspecified lid	H01.029
Squamous blepharitis, right upper and lower lids	H01.02A
Squamous blepharitis, left upper and lower lids	H01.02B
Other specified inflammations of the eyelid	H01.8

Individuals with visual impairment are more likely to have had prior ocular surgery, especially cataract surgery,<sup>26</sup> which may alter ocular surface anatomy resulting in DES.<sup>27</sup> Another cause of visual impairment includes injury to the cornea,<sup>28,29</sup> which may result in corneal nerve dysfunction thereby impairing blink rate and lacrimal gland secretions.<sup>30</sup> Furthermore, visual impairment is associated with increased mental health burden and other systemic conditions (ex. hypertension),<sup>31</sup> where the systemic treatments utilized commonly cause or worsen DES through reduced tear secretions.<sup>27</sup> In their low vision cohort, Bitton et al. reported 30.3 % of their patients using systemic medications known to cause DES, 49.2 % having a systemic condition associated with DES, and 72.1 % with a history of ocular surgery.<sup>23</sup>

In our retrospective analysis, the prevalence of dryness increased with age which is consistent with other studies.<sup>32-34</sup> This study also aligns with prior studies when it demonstrated that DES was also more commonly found in women as compared with men.<sup>32,35</sup>

These findings are meaningful as the ocular comfort of low vision patients should not be overlooked while managing their visual needs. Both visual impairment and DES are Table 1c List of ICD10 codes related to dry eye syndrome and meibomian gland dysfunction but not related to blepharitis.

Diagnosis	ICD-10 Code
Meibomian gland dysfunction right upper eyelid	H02.881
Meibomian gland dysfunction right lower eyelid	H02.882
Meibomian gland dysfunction of right eye, unspecified eyelid	H02.883
Meibomian gland dysfunction left upper eyelid	H02.884
Meibomian gland dysfunction left lower eyelid	H02.885
Meibomian gland dysfunction of left eye, unspecified eyelid	H02.886
Meibomian gland dysfunction of unspecified eye, unspecified eyelid	H02.889
Meibomian gland dysfunction right eye, upper and lower eyelids	H02.88A
Meibomian gland dysfunction left eye, upper and lower eyelids	H02.88B

Table 2Number of patients with diagnosed dry eye syndrome by age range and sex in the University of Colorado Low VisionRehabilitation Service.

	Male			Female		
Age Range	n	Mean age	SD	n	Mean age	SD
0-19	2	18	1	2	19	1
20-39	11	31	5	17	31	6
40-59	37	52	6	67	50	6
60-79	123	71	5	239	71	6
80 and older	159	87	5	321	89	6

associated with a significant reduction in quality of life, and it is conceivable that the effect of living with both conditions may compound the reduction in quality of life.<sup>16,36</sup> Furthermore, while visual impairment is oftentimes irreversible,<sup>37</sup> DES is oftentimes treatable and appropriate intervention may result in improved quality of life.<sup>38</sup>



Distribution of Dry Eye Syndrome by Age

**Graph 1** The distribution of diagnosed dry eye syndrome by age in the University of Colorado Low Vision Rehabilitation Service.

It is imperative for all professionals working with the low vision population to recognize the potential for DES and to coordinate DES management for these individuals when appropriate. Ocular comfort assessment should be performed in adjunct with typical visual function assessment to better screen for DES which may go overlooked if not specifically assessed. Questions assessing the degree of ocular discomfort may be quick and efficient methods to gain valuable insight on the level of ocular comfort in low vision patients. Additionally, short questionnaires such as the SPEED or the DEQ-5 may be utilized to formally grade the level of dry eye symptoms being experienced by a patient.<sup>39</sup>

Table 3	Prevalence of diagnosed dry eye syndrome by age
group in t	he University of Colorado Low Vision Rehabilitation
Service.	

Age Group	Prevalence of Dry Eye Syndrome
0–19	3.57 %
20–39	14.35 %
40–59	29.07 %
60–79	43.79 %
80 and above	46.21 %

The most obvious limitation of this study is the narrow sample of patients from only within the University of Colorado Low Vision Rehabilitation Service. One future goal is to carry forth a similar investigation with other departments of optometry and ophthalmology in the United States to compare prevalence of DES by condition as well as geographical location. We believe that this retrospective analysis is a key step in better understanding the prevalence and significance of DES within the visually impaired population at large.

#### **Conflicts of interest**

The authors have no proprietary or commercial interest in any materials discussed in this article.

#### Human subjects

Human subjects were included in this study. A retrospective chart review was performed on all patients seen within the University of Colorado Department of Ophthalmology Low Vision Rehabilitation Service between December 1, 2017 and December 1, 2022. The study received approval from the Colorado Multiple Institutional Review Board, and all research conformed to the tenets of the Declaration of Helsinki. No animal subjects were used in this study.

#### Author contributions

Conception and design: Abbott, Hanson, Data collection: Abbott, Lally, Analysis and interpretation: Abbott, Obtained funding: Study was performed as part of regular employment duties at the University of Colorado Anschutz School of Medicine. No additional funding was provided. Overall responsibility: Abbott, Hanson, Lally

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