IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 6, March 2026
Impact Factor: 8.2

# A Review of the Prevalence of Dry Eye Disease among Contact Lens Wearers Using Silicone Hydrogel Lenses

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**Abstract:** *Dry Eye Disease is a multifactorial disorder of the ocular surface characterized by tear film instability, hyperosmolarity, inflammation, and neurosensory abnormalities. Contact lens wear remains one of the most significant risk factors associated with ocular discomfort and dry eye symptoms. Silicone hydrogel (SiHy) lenses were introduced to improve oxygen permeability and reduce hypoxic complications associated with traditional hydrogel lenses. Despite these advancements, a considerable proportion of silicone hydrogel lens wearers continue to experience symptoms of dry eye disease.*
*This review examines the prevalence of DED among silicone hydrogel contact lens users, explores contributing risk factors, and evaluates current evidence regarding lens materials and ocular surface health. Findings indicate that while silicone hydrogel lenses improve corneal physiology, they do not completely eliminate contact lens-related dry eye. The prevalence of dry eye symptoms among contact lens wearers ranges from 30% to 70%, depending on study population, diagnostic criteria, and duration of lens wear. Factors such as reduced tear film stability, meibomian gland dysfunction, environmental conditions, and prolonged digital screen exposure contribute significantly to symptom development. Understanding these factors is essential for improving patient comfort and long-term lens tolerance*

**Keywords:** Dry Eye Disease, Silicone Hydrogel Lenses, Contact Lens Wear, Tear Film Stability, Ocular Surface Disease, Contact Lens Discomfort

## I. INTRODUCTION

Dry Eye Disease (DED) is a common ocular condition affecting millions of individuals worldwide. The Tear Film and Ocular Surface Society (TFOS) Dry Eye Workshop II defines DED as a multifactorial disease characterized by loss of tear film homeostasis accompanied by ocular symptoms (Craig , 2017). Contact lens wear is recognized as one of the leading contributors to dry eye symptoms and discomfort.

The introduction of silicone hydrogel lenses revolutionized contact lens technology by providing substantially higher oxygen transmissibility compared to conventional hydrogel lenses. Increased oxygen permeability reduces corneal hypoxia, neovascularization, and corneal edema (Dumbleton, 2013). However, despite these advantages, many wearers continue to report dryness, discomfort, and reduced wearing time.

Studies indicate that contact lens discomfort remains the primary reason for discontinuation of lens wear, with dry eye symptoms accounting for approximately 50% of contact lens dropouts (Nichols, 2013). Consequently, understanding the prevalence and determinants of DED among silicone hydrogel lens users remains an important area of ophthalmic research.

## DRY EYE DISEASE AND CONTACT LENS WEAR

Contact lenses interact directly with the tear film and ocular surface. This interaction can disrupt tear film stability, increase evaporation, and induce inflammatory changes. The presence of a contact lens divides the tear film into pre-lens and post-lens layers, altering its normal dynamics (Nichols, 2019).

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Common symptoms include:
Ocular dryness
Burning sensation
Foreign body sensation
Blurred vision
Eye fatigue
Redness
These symptoms may worsen with prolonged lens wear, low humidity environments, and increased digital device use.

## SILICONE HYDROGEL LENSES: CHARACTERISTICS AND ADVANTAGES

Silicone hydrogel lenses represent one of the most significant advancements in contact lens technology and have transformed the field of vision correction since their introduction in the late 1990s. These lenses were developed to overcome the limitations associated with conventional hydrogel lenses, particularly inadequate oxygen transmission to the cornea during extended periods of wear. Traditional hydrogel lenses rely primarily on water content to facilitate oxygen transport, meaning that higher water content generally results in increased oxygen permeability. However, this relationship imposes limitations on lens design because highly hydrated lenses may be more fragile and susceptible to dehydration. Silicone hydrogel lenses address this challenge by incorporating silicone into the lens matrix, enabling oxygen to pass directly through the material at much higher rates than conventional hydrogels. As a result, silicone hydrogel lenses provide superior oxygen transmissibility while maintaining adequate moisture and comfort, making them a preferred choice for many eye care practitioners and contact lens wearers worldwide (Dumbleton 2013).

One of the most important characteristics of silicone hydrogel lenses is their exceptionally high oxygen permeability. Oxygen transmission is commonly expressed as Dk/t, where Dk represents the oxygen permeability of the material and t represents lens thickness. The cornea is an avascular tissue that depends on atmospheric oxygen for its metabolic needs. Insufficient oxygen supply can lead to hypoxic complications such as corneal swelling, neovascularization, endothelial changes, and decreased corneal sensitivity. Silicone hydrogel lenses exhibit oxygen permeability values several times greater than those of traditional hydrogel lenses, significantly reducing the risk of hypoxia-related complications. This enhanced oxygen delivery promotes healthier corneal physiology and allows for safer daily and extended wear schedules (Jones 2013).

Another notable characteristic of silicone hydrogel lenses is their ability to support extended wear. Due to their superior oxygen transmissibility, many silicone hydrogel lenses are approved for overnight or continuous wear under professional supervision. Continuous wear lenses provide convenience for individuals with demanding lifestyles, shift workers, military personnel, and others who may find daily lens removal impractical. Studies have shown that silicone hydrogel lenses substantially reduce corneal edema associated with overnight lens wear when compared with traditional hydrogel materials. Consequently, these lenses have become the standard choice for extended wear applications, although proper patient selection and monitoring remain essential to minimize the risk of complications such as microbial keratitis (Stapleton 2017).

Silicone hydrogel lenses are also characterized by improved corneal health outcomes. By maintaining near-physiological oxygen levels at the corneal surface, these lenses help preserve normal cellular metabolism and tissue integrity. Clinical studies have demonstrated reductions in limbal redness, corneal swelling, and neovascularization among wearers of silicone hydrogel lenses compared with users of conventional hydrogels. The preservation of corneal health is particularly important for individuals requiring long-term contact lens wear, as chronic hypoxia can lead to structural and functional changes in the cornea over time. The ability of silicone hydrogel lenses to maintain corneal homeostasis contributes significantly to their widespread adoption in modern optometric practice (Craig 2017).

A further characteristic of silicone hydrogel lenses is their enhanced mechanical strength and durability. The incorporation of silicone into the lens material generally increases tensile strength and resistance to tearing. As a result, these lenses are often easier to handle during insertion, removal, and cleaning procedures. Improved durability contributes to longer lens lifespan in reusable lens modalities and reduces the likelihood of accidental damage. For many patients, the robustness of silicone hydrogel lenses improves overall satisfaction and convenience by facilitating daily handling and maintenance.

Despite their many advantages, early generations of silicone hydrogel lenses faced challenges related to surface wettability. Silicone is inherently hydrophobic, meaning it repels water and may contribute to reduced surface lubrication and discomfort. To address this issue, manufacturers developed advanced surface treatments, internal wetting agents, and plasma coating technologies that enhance moisture retention and lens wettability. Modern silicone hydrogel lenses incorporate sophisticated material engineering approaches designed to improve comfort while maintaining high oxygen permeability. These innovations have led to substantial improvements in wearer experience and have expanded the suitability of silicone hydrogel lenses for a broader range of patients (Nichols 2013).

One of the major advantages of silicone hydrogel lenses is the reduction in contact lens-related complications associated with hypoxia. Before the introduction of silicone hydrogel materials, corneal oxygen deprivation represented a major concern for contact lens wearers, particularly those using thick lenses or extended wear modalities. Hypoxic stress could lead to corneal edema, endothelial polymegethism, limbal hyperemia, and vascularization. By dramatically increasing oxygen delivery to the cornea, silicone hydrogel lenses have significantly reduced the incidence of these complications. This advancement has improved both the safety profile and clinical outcomes associated with contact lens wear.

Another significant advantage is improved wearing comfort for many users. Although comfort depends on numerous factors, including tear film quality, lens fit, and ocular surface health, silicone hydrogel lenses often provide superior comfort due to their ability to maintain corneal health and minimize hypoxia-induced symptoms. Many patients report reduced redness, less ocular fatigue, and greater tolerance during prolonged wear. Newer-generation silicone hydrogel lenses with enhanced moisture retention technologies have further improved comfort by reducing lens dehydration and maintaining a stable tear film throughout the day.

Silicone hydrogel lenses also offer advantages in terms of visual performance. Adequate oxygenation helps maintain corneal transparency and regularity, both of which are essential for optimal vision. By minimizing corneal swelling and physiological disturbances, these lenses contribute to stable visual acuity and consistent optical quality. In addition, many silicone hydrogel lenses are available in advanced optical designs that address refractive errors such as myopia, hyperopia, astigmatism, and presbyopia. The combination of high oxygen permeability and sophisticated optical engineering enhances visual outcomes across diverse patient populations.

The versatility of silicone hydrogel materials represents another important advantage. These lenses are available in daily disposable, biweekly, monthly replacement, toric, multifocal, and specialty designs. Such diversity enables practitioners to tailor lens selection according to individual patient needs, lifestyle requirements, and ocular characteristics. Daily disposable silicone hydrogel lenses, in particular, have gained popularity because they combine the physiological benefits of high oxygen transmission with the hygiene advantages of single-use wear. This modality reduces the accumulation of deposits and minimizes risks associated with improper lens care.

From a public health perspective, silicone hydrogel lenses contribute to improved long-term ocular health and patient satisfaction. The reduction in hypoxia-related complications has lowered the burden of contact lens-associated adverse events and enhanced the sustainability of contact lens wear. Furthermore, their compatibility with modern lifestyles characterized by prolonged digital device use and extended working hours has made them an increasingly valuable vision correction option. Ongoing innovations continue to improve material properties, wettability, antimicrobial resistance, and comfort, ensuring that silicone hydrogel lenses remain at the forefront of contact lens technology.

Silicone hydrogel lenses combine high oxygen permeability, excellent corneal compatibility, enhanced durability, and improved wearing comfort, making them a landmark development in contact lens science. Their ability to provide superior oxygen transmission while maintaining visual performance and ocular health has revolutionized contact lens practice and significantly improved the experience of millions of wearers worldwide. Although challenges such as dry eye symptoms and lens discomfort may still occur in some individuals, continued advances in material design and surface technology are further enhancing the benefits of silicone hydrogel lenses. Consequently, these lenses remain the preferred choice for many practitioners and patients seeking safe, effective, and comfortable contact lens wear.

Silicone hydrogel lenses combine silicone materials with hydrogel polymers, resulting in:

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High oxygen permeability (Dk/t)
Reduced hypoxic stress
Improved corneal metabolism
Extended wear capability
Enhanced corneal health
Despite these benefits, silicone materials may increase surface hydrophobicity, potentially contributing to tear film instability and discomfort if surface treatments are inadequate (Jones, 2013).

## PREVALENCE OF DRY EYE DISEASE AMONG SILICONE HYDROGEL LENS WEARERS

Numerous epidemiological studies have investigated the occurrence of dry eye symptoms among contact lens users.

**Table 1: Selected Studies on Dry Eye Prevalence in Contact Lens Wearers**

| Author | Year | Study Population | Key Findings |
|---|---|---|---|
| Nichols | 2002 | Contact lens wearers | Approximately 50% reported dry eye symptoms |
| Chalmers | 2009 | Silicone hydrogel lens users | Dry eye remained a leading complaint despite improved oxygen transmission |
| Dumbleton | 2013 | Silicone hydrogel wearers | Significant proportion experienced end-of-day dryness |
| Jones | 2013 | Review of SiHy lenses | Dryness and discomfort continued despite material advances |
| Stapleton | 2017 | International contact lens users | Contact lens wear identified as major DED risk factor |
| Nichols | 2019 | Ocular surface studies | Tear film disruption linked to contact lens discomfort |

Research suggests that the prevalence of dry eye symptoms among silicone hydrogel lens wearers ranges between 30% and 70%, depending upon diagnostic criteria and patient demographics (Stapleton, 2017).

## RISK FACTORS ASSOCIATED WITH DRY EYE IN SILICONE HYDROGEL LENS USERS

### 1. Tear Film Instability

Contact lenses alter tear film distribution and increase evaporation rates. Tear breakup time (TBUT) is often significantly reduced in symptomatic lens wearers.

### 2. Meibomian Gland Dysfunction

Meibomian gland dysfunction (MGD) is frequently observed among contact lens users. Reduced lipid secretion increases tear evaporation and contributes to ocular dryness (Arita , 2017).

### 3. Duration of Lens Wear

Longer daily wearing times correlate with greater symptom severity. Many patients experience worsening dryness toward the end of the day.

### 4. Digital Screen Exposure

Increased use of computers, smartphones, and tablets decreases blink rate and increases tear evaporation. Modern lifestyles therefore amplify dry eye symptoms among lens wearers.

### 5. Environmental Conditions

Air conditioning, low humidity, pollution, and prolonged exposure to wind contribute to tear film instability and ocular surface stress.

### 6. Age and Gender

Women, particularly postmenopausal women, exhibit a higher prevalence of DED due to hormonal influences affecting tear production and ocular surface integrity (Craig , 2017).

## MECHANISMS UNDERLYING CONTACT LENS-RELATED DRY EYE

Several physiological mechanisms have been proposed:

**1. Mechanical Friction**

Repeated interaction between lens surfaces and ocular tissues may induce epithelial stress and inflammation.

**2. Inflammatory Response**

Contact lens wear can trigger inflammatory mediator release, leading to ocular surface irritation.

**3. Altered Tear Composition**

Lens wear affects tear proteins, lipids, and mucins, thereby compromising tear film stability.

**4. Neural Sensitivity Changes**

Long-term contact lens wear may alter corneal nerve function and sensory perception, contributing to discomfort.

## CLINICAL MANAGEMENT STRATEGIES

To reduce dry eye symptoms among silicone hydrogel lens wearers, clinicians may recommend:

**1. Lens Material Optimization**

Selection of newer-generation silicone hydrogel lenses with enhanced wettability.

**2. Lubricating Eye Drops**

Preservative-free artificial tears can improve tear film stability.

**3. Improved Lens Hygiene**

Proper cleaning and replacement schedules reduce inflammatory complications.

**4. Treatment of Meibomian Gland Dysfunction**

Warm compresses and lid hygiene improve lipid layer function.

**5. Environmental Modifications**

Use of humidifiers and regular blinking during screen use may alleviate symptoms.

**6. Daily Disposable Lenses**

Several studies report improved comfort with daily disposable silicone hydrogel lenses compared to reusable modalities.

## II. CONCLUSION

Silicone hydrogel lenses have substantially improved ocular health by increasing oxygen permeability and reducing hypoxic complications associated with contact lens wear. However, dry eye disease remains a prevalent concern among silicone hydrogel lens users. Current evidence suggests that between one-third and two-thirds of wearers experience dry eye symptoms during lens use. Multiple factors, including tear film instability, meibomian gland dysfunction, environmental conditions, prolonged screen exposure, and individual susceptibility, contribute to symptom development. Continued innovation in lens materials and personalized management strategies is essential for enhancing comfort, maintaining ocular surface health, and improving long-term contact lens success.

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ISSN: 2581-9429
Volume 6, Issue 6, March 2026
Impact Factor: 8.2

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