Volume 4, Issue 11, November 2026 ISSN (E): 2938-3765

# CHANGES IN TEAR FILM STABILITY DEPENDING ON THE DURATION OF SMARTPHONE USE

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**Abstract**

**Background**: Smartphones have become an integral part of communication, education and work. Sustained viewing of small digital displays may alter blinking behaviour and increase ocular surface exposure, potentially destabilising the tear film. However, published findings are not entirely consistent, and the effects appear to depend on exposure duration, task characteristics and individual susceptibility.

**Objective**: To analyse current evidence on changes in tear film stability in relation to the duration of smartphone use and to identify clinically relevant mechanisms, assessment methods and preventive measures.

**Keywords**: Smartphone use; screen time; tear film stability; tear break-up time; blink rate; incomplete blinking; digital eye strain; dry eye disease; ocular surface.

## Introduction

The rapid expansion of smartphone technology has changed the way people read, communicate, study and perform professional tasks. Unlike many conventional visual activities, smartphone use frequently involves sustained near fixation, a relatively small visual target, reduced viewing distance and continuous interaction with rapidly changing information. These characteristics can increase visual and cognitive demand and may influence the normal protective mechanisms of the ocular surface.The tear film is a dynamic structure that lubricates the cornea and conjunctiva, protects the epithelium, contributes to optical quality and supports ocular surface homeostasis. Its stability depends on an appropriate balance among aqueous secretion, mucin-associated wettability, the lipid layer produced by meibomian glands, and regular, complete blinking. When the tear film breaks up prematurely, the exposed ocular surface becomes vulnerable to desiccation, friction and hyperosmolar stress. The TFOS DEWS II consensus defines dry eye disease as a multifactorial ocular surface disease characterised by loss of tear film homeostasis and accompanied by ocular symptoms; tear instability, hyperosmolarity, inflammation, damage and neurosensory abnormalities all contribute to its pathophysiology [1,2].

## LITERATURE REVIEW

The TFOS Lifestyle report on the digital environment describes several pathways through which screen viewing can affect the ocular surface. The most consistently discussed mechanism is a reduction in blink frequency and completeness during visually demanding tasks. Reduced blinking lengthens the interblink interval, while incomplete eyelid closure may fail to redistribute the tear film



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adequately across the exposed cornea. The resulting increase in evaporation can promote local tear break-up and discomfort [3].

Experimental research provides evidence of duration-related changes, although the magnitude and timing differ. In a controlled study of smartphone exposure, symptoms such as dryness, burning and fatigue increased after one and four hours of use. Fluorescein and non-invasive tear break-up times were significantly reduced after four hours in the smartphone group, while tear secretion and tear meniscus measurements did not show comparable changes [4]. This pattern supports the possibility that prolonged use may affect tear quality or distribution before producing a clear reduction in tear volume. Other studies have reported more nuanced findings. A 60-minute smartphone reading experiment found an increase in incomplete blinks and ocular symptoms, but no significant change in non-invasive tear break-up time, lipid layer appearance or tear meniscus height [5]. Similarly, a study of children playing smartphone games for one hour found a substantial reduction in blink rate and worsening symptoms, while measured tear parameters remained unchanged immediately after the task [6]. These results suggest that altered blinking and subjective discomfort may precede detectable changes in conventional tear tests.

## MATERIALS AND METHODS

This article was prepared as a narrative review of published evidence rather than as a report of a new clinical trial. Relevant literature was identified through searches of PubMed/MEDLINE, PubMed Central, scientific journal platforms and the official Tear Film and Ocular Surface Society (TFOS) reports. Search concepts included combinations of the terms “smartphone”, “screen time”, “digital eye strain”, “tear film stability”, “tear break-up time”, “blink rate”, “incomplete blinking” and “dry eye disease”.Priority was given to peer-reviewed human studies that evaluated smartphone or digital-device exposure and reported at least one relevant outcome: fluorescein tear break-up time (FBUT), non-invasive tear break-up time (NIBUT), blink rate, incomplete blinking, tear meniscus height, Schirmer test, ocular surface staining or validated symptom scores. Consensus reports and foundational dry-eye publications were included to provide diagnostic and pathophysiological context. Studies involving other digital displays were considered where their findings informed mechanisms applicable to smartphone viewing.

## RESULTS AND DISCUSSION

### Biological mechanisms linking smartphone use with tear film instability

The principal proposed mechanism is altered blinking. Under ordinary conditions, complete blinks spread the tear film, support lipid layer distribution and help maintain a smooth optical surface. During concentrated screen viewing, blink rate may decline and the proportion of incomplete blinks may increase. An incomplete blink leaves part of the cornea insufficiently covered, particularly in the inferior region, and can contribute to localised evaporation and earlier tear break-up. The effect is influenced not only by the number of blinks but also by their amplitude and completeness.

### Changes according to exposure duration

Short exposure periods may primarily produce functional changes in blinking and symptoms. Studies involving approximately one hour of smartphone reading or gaming have documented increased



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discomfort and altered blink behaviour, although conventional tear stability measures have not always changed significantly [5,6]. This discrepancy should not be interpreted as evidence that short exposure has no ocular effect. Rather, symptom generation and objective tear film changes do not necessarily occur simultaneously, and some clinical tests may be insufficiently sensitive to brief or localised changes.

With longer exposure, the probability of measurable tear film disturbance may increase. The study by Wang and colleagues reported significantly reduced FBUT and NIBUT after four hours of smartphone use, together with increased ocular symptoms and changes in oxidative stress markers [4]. The findings indicate that prolonged continuous viewing can affect both subjective comfort and objective tear film parameters. However, the results of a single controlled study cannot define a universal threshold, because individual baseline status and task conditions may differ.

The available evidence therefore supports a graded, but not necessarily linear, relationship. A person using a smartphone for two hours with frequent breaks and complete blinking may experience a different ocular response from someone using the same device continuously for two hours while gaming at close range. Total daily screen time should be distinguished from uninterrupted exposure, and smartphone use should be assessed alongside computer and tablet use rather than in isolation.

## CONCLUSION

The available scientific evidence indicates that smartphone use can influence tear film stability, particularly when exposure is prolonged, uninterrupted or associated with high cognitive demand. The most plausible pathway involves reduced blink frequency and completeness, resulting in less effective tear film redistribution and increased evaporation. Experimental studies have reported worsening ocular symptoms after relatively short tasks and reductions in FBUT or NIBUT after longer exposure, although findings are not uniform.

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