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Prolonged Digital Screen Exposure and Dry Eye Disease in Adults: A Systematic Review of Subjective Symptoms and Objective Ocular Surface Findings

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Abstract

Prolonged digital screen use has increasingly been associated with dry eye disease (DED); however, its relationships with subjective symptoms, objective ocular surface findings, and clinically meaningful exposure thresholds remain uncertain. This systematic review examined observational studies involving adults with reported digital screen exposure and subjective or objective dry eye outcomes. Electronic databases were systematically searched, followed by study selection, data extraction, critical appraisal using the Joanna Briggs Institute (JBI) tools, and narrative synthesis. Nine studies involving 2,445 participants met the inclusion criteria, comprising eight cross-sectional studies and one prospective comparative study. Associations between digital screen exposure and subjective dry eye symptoms varied in direction and magnitude across studies. The most consistent objective finding was reduced tear film break-up time (TBUT) during screen exposure, indicating increased tear film instability, whereas findings from the Schirmer test were inconsistent. Heterogeneity in exposure definitions, outcome measurements, and reporting methods precluded meta-analysis, and no reliable threshold for daily screen exposure associated with DED could be established. The overall evidence was limited by predominantly cross-sectional study designs, reliance on self-reported screen exposure, inconsistent outcome definitions, selected study populations, incomplete reporting, and insufficient adjustment for potential confounding factors. Prolonged digital screen exposure was associated with greater dry eye symptom burden in certain adult populations and short-term reductions in tear film stability. However, the available evidence remained inconclusive regarding causality and clinically meaningful exposure thresholds. Further prospective studies incorporating standardized ocular surface assessments, objective screen exposure measurements, and appropriate confounder adjustment are warranted to clarify these associations.

INTRODUCTION

Dry eye disease (DED) is a prevalent, multifactorial ocular surface disorder characterized by a loss of tear film homeostasis and associated ocular symptoms that may adversely affect visual function, quality of life, and daily productivity (Craig et al., 2017).

The widespread use of smartphones, computers, tablets, and other digital devices for occupational, educational, and recreational purposes has made prolonged digital screen exposure an increasingly important potential risk factor for ocular surface symptoms among adults (Wolffsohn JS, 2023).

Sustained visual attention during digital device use may reduce blink frequency and increase the proportion of incomplete blinks, thereby promoting tear film evaporation, impairing tear film lipid layer distribution, and compromising tear film stability (Bron et al., 2017).

Previous observational studies and systematic reviews have suggested that greater digital screen exposure may be associated with increased dry eye symptom severity, higher scores on validated symptom questionnaires, and shorter tear film break-up time (TBUT). However, the magnitude and direction of these associations have varied across studies (Al-Mohtaseb Z, 2021).

Interpretation of the available evidence is complicated by inconsistencies in outcome definitions and measurement methods. Digital eye strain, self-reported ocular discomfort, questionnaire-defined symptomatic dry eye, abnormal tear function test results, and clinically diagnosed DED represent related but distinct clinical constructs that should not be considered interchangeable (Wolffsohn et al., 2017).

Comparisons across studies are further complicated by variations in screen exposure thresholds, device types, exposure assessment methods, and study populations. Additional methodological limitations include the predominance of cross-sectional designs, reliance on selected student or occupational populations, and inadequate adjustment for ocular, behavioral, demographic, and environmental confounding factors (Al-Marri K, 2021).

Consequently, uncertainty remains regarding whether prolonged daily digital screen exposure is consistently associated with subjective dry eye symptoms and objective ocular surface abnormalities in adults. Moreover, the existence of a dose–response relationship and the identification of clinically meaningful daily screen time thresholds have not been conclusively established (Al-Mohtaseb Z, 2021).

To address these uncertainties, this systematic review aimed to synthesize the available evidence on the association between prolonged digital screen exposure and DED in adults, separately evaluate subjective symptom outcomes and objective ocular surface findings, and examine potential exposure–response relationships and clinically meaningful screen time thresholds. By distinguishing subjective symptoms from objective clinical measurements and critically appraising the methodological quality of the included studies, this review sought to clarify the relationship between digital screen exposure and ocular surface health, identify limitations in the existing evidence, and inform future research and evidence-based clinical practice.

METHOD

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 reporting guidelines. Any deviations from the predefined review protocol were documented and justified.

The review examined the association between digital screen exposure duration and dry eye disease (DED) among working-age adults. Study eligibility criteria were established using the Population, Exposure, Comparator, and Outcome (PECO) framework, as presented in Table 1.

Table 1. PECO framework and eligibility criteria

Domain	Inclusion criteria	Exclusion criteria
Population	Adults aged 18–50 years, including university students, office workers, and other working-age populations	Participants younger than 18 years; studies exclusively involving adults older than 50 years; paediatric populations
Exposure	Daily use of smartphones, computers, laptops, tablets, or other digital-screen devices, with screen duration reported quantitatively or categorically	Studies that did not quantify digital-screen exposure or examined non-screen-related near work alone
Comparator	Participants with lower or no digital-screen exposure, or comparisons across categories of screen-use duration	Studies without an exposure comparison or analysable relationship between screen duration and outcomes
Outcomes	Dry eye symptoms or disease measured using validated questionnaires or objective ocular-surface tests	Studies reporting only nonspecific visual symptoms without a dry-eye-related outcome
Study design	Observational cross-sectional, case-control, and cohort studies; eligible interventional studies reporting baseline exposure–outcome data	Reviews, meta-analyses, case reports, case series, editorials, letters, conference abstracts, protocols, animal studies, and in vitro studies

Data extraction based on subjective and objective examinations. Subjective data included the Ocular Surface Disease Index, Computer Vision Syndrome Questionnaire (Segui M del M, 2015), Dry Eye Questionnaire-5 (Chalmers RL, 2010), National Eye Institute Visual Function Questionnaire-25 (Mangione CM, 2001), or other validated dry-eye symptom instruments. Objective data included tear-film break-up time or non-invasive tear break-up time, Schirmer testing, corneal or conjunctival staining, blink rate or incomplete blinking, anterior-segment examination, and other established ocular-surface measures. The details were as follows: (1) Population: Adults aged 18–50 years, including university students, office workers, and other working-age populations; (2) Exposure : daily use of smartphones, computers, laptops, tablets, or other digital-screen devices, with screen duration reported quantitatively or categorically; (3) Comparison : participants with lower or no digital-screen exposure, or comparisons across categories of screen-use duration; (4) Outcome : dry eye symptoms or disease measured using validated questionnaires or objective ocular-surface tests; (5) Study design : observational cross-sectional, case-control, and cohort studies.

PubMed/MEDLINE and Scopus were searched from January 2021 to August 2026. The reference lists of eligible articles and relevant reviews were additionally screened to identify studies not retrieved through the database searches. The search combined controlled vocabulary, where available, with free-text terms describing digital-screen exposure and dry

eye disease. The principal concepts included “dry eye,” “dry eye disease,” “ocular surface,” “digital screen,” “screen time,” “smartphone,” “computer,” “laptop,” “tablet,” “visual display terminal,” “OSDI,” “Schirmer test,” and “tear break-up time.” A representative search structure was: (“dry eye” OR “dry eye disease” OR “ocular surface disease”) AND (“screen time” OR “digital screen” OR smartphone OR computer OR laptop OR tablet OR “visual display terminal”).

Two reviewers independently assessed methodological quality using the Joanna Briggs Institute critical appraisal checklist appropriate to each study design. Cross-sectional, case-control, and cohort studies were evaluated using their corresponding design-specific instruments. Particular attention was given to participant selection, exposure measurement, validity of dry-eye assessment, identification and control of confounding variables, completeness of outcome data, and appropriateness of statistical analysis. Disagreements were resolved through consensus (Aromataris E, 2024).

RESULTS AND DISCUSSION

The database searches identified 125 records. After the removal of 35 duplicates, 90 records underwent title and abstract screening, of which 71 were excluded because they did not address digital-device exposure and dry eye (n = 42), were narrative or non-primary publications (n = 18), or involved an ineligible population or publication type (n = 11). There are 19 full-text articles were assessed for eligibility. Ten articles were excluded because they used non-standard outcome instruments (n = 4), employed an interventional or randomized clinical design outside the review scope (n = 3), or did not provide sufficiently extractable numerical data (n = 3). Nine observational studies were included in the final review, comprising 8 for cross-sectional studies and 1 for prospective comparative study (Figure 1) (Page MJ, 2021).

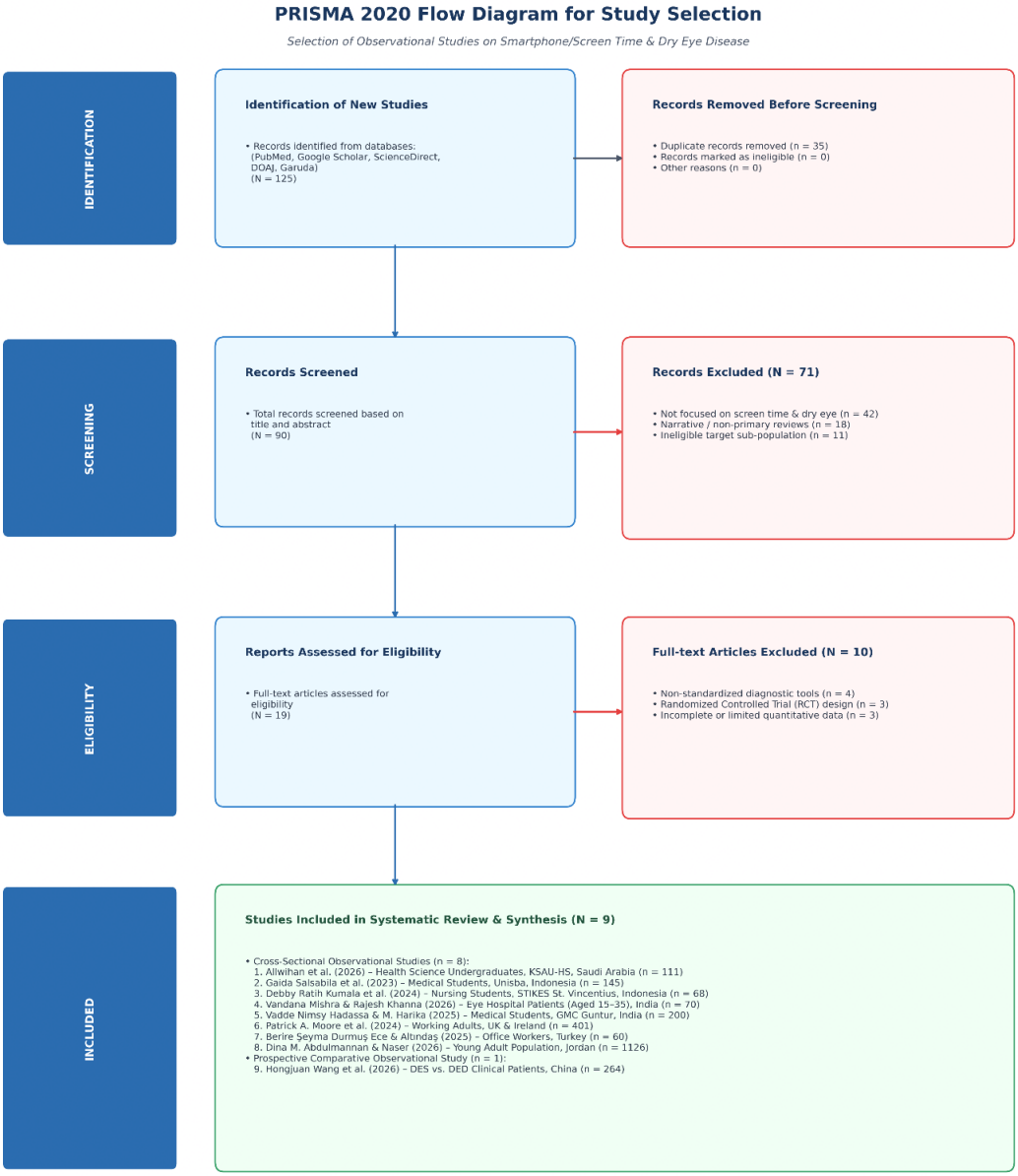


Figure 1 Prisma 2020

The nine studies were published between 2023 and 2026 and included 2,445 participants from Saudi Arabia, Indonesia, India, China, the United Kingdom and Ireland, Türkiye, and Jordan. Study populations comprised university students, healthcare students, office workers, young adults, and patients classified as having digital eye strain or dry eye disease. Sample sizes ranged from 60 to 1,126 participants (Page MJ M. D., 2021).

Digital exposure was predominantly assessed through self-reported daily device use; only Salsabila et al. used smartphone-recorded screen-time data (Salsabila G, 2023). Outcomes varied substantially and included the Ocular Surface Disease Index (OSDI), Computer Vision Syndrome Questionnaire (CVS-Q), Dry Eye Questionnaire-5, tear-film break-up time (TBUT), Schirmer testing, ocular-surface staining, and self-reported dry eye (Wolffsohn JS, 2023).

Five studies were assigned to the primary narrative synthesis of screen duration and dry-eye-related outcomes, whereas four provided contextual evidence concerning symptom

prevalence, measurement agreement, clinical-group comparisons, or treatment response (Page MJ M. D., 2021).

Subjective Dry Eye Outcomes

Evidence from symptom-based outcomes was inconsistent. Kumala et al. reported a strong positive correlation between device-use duration and OSDI severity (Kumala DR, 2024). In contrast, the grouped data from Salsabila et al. showed a higher proportion of symptoms among participants with shorter rather than longer smartphone exposure, despite a statistically significant between-group association. Because the chi-square test did not establish the direction or magnitude of an adjusted association, these findings did not provide consistent evidence of a positive dose-response relationship (Salsabila G, 2023).

Mishra and Khanna reported a significant relationship between screen exposure and symptoms but did not provide a sufficiently detailed effect estimate. In addition, their sample included participants aged 15–17 years without separate adult results (Mishra V, 2026). High symptom frequencies were also reported by Nimsy Hadassa and Harika (Hadassa VN, 2025), Moore et al. (Moore PA, 2024), and Allwihan et al. (Allwihan R, 2026); however, these estimates represented different constructs and could not be combined as a single dry eye outcome.

Objective Ocular Surface Outcomes

Durmuş Ece and Altındaş provided the clearest objective evidence of short-term tear-film instability. TBUT decreased significantly over a single workday, and the magnitude of change correlated moderately with screen-exposure duration. Schirmer I values did not change significantly, suggesting that short-term screen exposure may affect tear-film stability more consistently than aqueous tear production (Durmus Ece BS, 2025).

Nimsy Hadassa and Harika reported Schirmer values ≤10 mm in 96 of 200 participants, but did not report results across screen-duration categories. The remaining studies used heterogeneous clinical definitions or did not provide extractable exposure-specific objective outcomes. Accordingly, the available findings did not support a definitive duration threshold for persistent dry eye disease (Hadassa VN, 2025).

Summarizes nine included studies, almost all cross-sectional, drawn from populations dominated by healthcare students and office workers across several countries. Five studies were treated as contextual evidence. Allwihan (2026) examined 111 Saudi healthcare students, most of whom reported more than 5 hours of daily device use, but symptom classifications (CVS-Q) and Schirmer test results were not equivalent. Moore (2024) surveyed 401 workers in the UK and Ireland and found a digital eye strain prevalence of 62.6% with mean screen use of 9.7 hours per day. Abdulmannan (2026) studied 1,126 young Jordanian adults and reported a self-reported dry eye prevalence of 32.4%, although no direct estimate of screen duration was available and case counts were internally inconsistent. Wang (2026), a prospective comparative study of 264 Chinese patients, found a TBUT of 6.3 s in the digital eye strain group versus 5.1 s in the dry eye group ($p = 0.005$), and longer screen duration predicted poorer treatment response (OR 1.17, 95% CI 1.02–1.35).

Four studies contributed to the primary synthesis. Salsabila (2023) studied 145 Indonesian medical students using device-recorded smartphone duration and the OSDI, and symptoms occurred in 45 of 49 participants using screens for less than 6 hours and in 74 of 96 using screens for more than 7 hours (91.8% vs 77.1%; $p = 0.04$). Kumala (2024), in 68 final-

year Indonesian students, reported a correlation between self-reported screen duration and OSDI severity ($r = 0.751$; $p < 0.001$), although the report contained an inconsistent coefficient elsewhere. Mishra (2026) examined 70 Indian screen users aged 15–35 years and stated a significant association, but no verifiable effect estimate was reported, so this study entered the synthesis with applicability concerns. Durmus Ece (2025) used a repeated-measures design in 60 female Turkish office workers, in whom TBUT decreased from 8.62 ± 2.73 to 6.38 ± 2.70 s over one workday ($p < 0.001$). This change correlated with exposure duration ($r = 0.463$; $p = 0.001$), whereas Schirmer I values did not change significantly.

The Joanna Briggs Institute appraisal identified substantial variation in methodological quality. Participant characteristics and study settings were generally well described, but screen exposure was objectively recorded in only one study. Confounding factors were identified in most reports, although only four clearly described methods for controlling them. Outcome measurement was considered valid and reliable in six studies, while the appropriateness of the statistical analysis was clear in only one. Recurrent concerns included self-reported exposure, inconsistent dry eye definitions, insufficient confounder adjustment, incomplete reporting of exposure-stratified results, and internal statistical inconsistencies.

Table 2. Critical Appraisal of the Methodological Quality of the Included Studies Using the Joanna Briggs Institute (JBI) Checklist

Penelitian	K1	K2	K3	K4	K5	K6	K7	K8
Allwihan dkk., mahasiswa kesehatan	Y	Y	U	U	Y	N	Y	U
Salsabila dkk., durasi smartphone	Y	Y	Y	Y	Y	Y	Y	U
Kumala dkk., durasi gadget	Y	Y	U	Y	U	N	Y	N
Mishra & Khanna, penggunaan layar	Y	Y	U	U	Y	U	U	U
Wang dkk., perbandingan DES dan DED	Y	Y	U	Y	Y	Y	Y	U
Moore dkk., pekerja UK–Irlandia	Y	Y	U	Y	Y	N	Y	U
Ece & Altındaş, screen use dan TBUT	Y	Y	U	Y	Y	Y	Y	Y
Hadassa & Harika, pengguna smartphone	U	Y	U	U	U	N	U	N
Abdulmannan & Naser, populasi Yordania	Y	Y	NA	N	Y	Y	N	NA

K1 = clear inclusion criteria; K2 = participants and setting described; K3 = screen exposure measured validly and reliably; K4 = dry eye condition determined using standard criteria; K5 = confounding factors identified; K6 = method of handling confounders described; K7 = outcomes measured validly and reliably; K8 = statistical analysis appropriate.

Y = Yes, **N** = No, **U** = Unclear, **TA** = Not Applicable.

Main Findings

This systematic review suggests that longer digital-screen exposure may be associated with greater dry-eye symptom burden and reduced tear-film stability in adults, although the direction and magnitude of the findings were inconsistent across the nine included studies (Salsabila G, 2023) (Kumala DR, 2024) (Mishra V, 2026) (Durmus Ece BS, 2025) (Hadassa VN, 2025) (Allwihan R, 2026) (Moore PA, 2024) (Wang H, 2026) (Abdulmannan DM, 2026).

The findings further indicate that symptom-defined dry eye, digital eye strain, abnormal tear-test results, and clinically diagnosed dry eye disease should not be interpreted as interchangeable outcomes because they represent different dimensions of ocular-surface health (Wolffshon JS, 2017) (Wolffsohn JS, 2023) (Craig JP, 2017).

Evidence based on subjective outcomes was conflicting, as the positive correlation reported by Kumala et al. contrasted with the inverse distribution of symptoms across exposure categories in Salsabila et al., while Mishra and Khanna did not provide a sufficiently verifiable effect estimate (Salsabila G, 2023) (Kumala DR, 2024) (Mishra V, 2026).

Although several studies reported a high frequency of ocular symptoms among intensive screen users, differences among OSDI, DEQ-5, CVS-Q, and self-reported dry-eye definitions limit direct comparison of their prevalence estimates (Chalmers RL, 2010) (Segui M del M, 2015).

The clearest objective finding was the intra-day reduction in TBUT reported by Durmuş Ece and Altındaş, in which greater screen exposure was associated with a larger decline in tear-film stability but not with a significant change in Schirmer I values (Durmus Ece BS, 2025).

Other studies provided less conclusive objective evidence because abnormal Schirmer or TBUT findings were not consistently reported according to screen-exposure categories, and comparisons between preselected clinical groups could not estimate the risk of developing dry eye from screen use (Allwihan R, 2026) (Hadassa VN, 2025)(Wang H, 2026).

A screen-associated decline in tear-film stability is biologically plausible because sustained visual concentration may reduce blink frequency and completeness, increase ocular-surface exposure, and accelerate tear evaporation (Wolffsohn JS, 2023) (Patel S, 1991).

The absence of consistent Schirmer changes may be compatible with a predominantly evaporative mechanism, although environmental humidity, air conditioning, viewing distance, screen position, cognitive demand, and break behaviour may modify this response (Wolffsohn JS, 2023) (Craig JP, 2017).

Interpretation of the observed associations requires caution because demographic, ocular, behavioural, and environmental factors may influence both screen-use patterns and dry-eye outcomes, while confounding was inadequately controlled in several included studies (Craig JP, 2017).

Substantial heterogeneity in exposure thresholds, device types, exposure-assessment methods, outcome definitions, study populations, and analytical approaches prevented quantitative pooling and limits the generalizability of the findings to the broader adult population (Al-Marri K, 2021).

Clinical and Research Implications

Clinicians may consider documenting device type, daily and uninterrupted exposure, viewing behaviour, break frequency, refractive correction, and environmental conditions when evaluating adults with ocular-surface complaints, while avoiding attribution of symptoms to screen exposure alone (Wolffsohn JS, 2023) (Craig JP, 2017) (Wolffshon JS, 2017).

Future studies should use prospective designs, device-recorded exposure, harmonized duration categories, standardized dry-eye criteria, repeated ocular-surface measurements, and adequate adjustment for major confounders to clarify temporal and dose–response relationships (Wolffsohn JS, 2023) (Craig JP, 2017).

Strengths and Limitations

The principal strengths of this review were its predefined eligibility criteria, separate synthesis of subjective and objective outcomes, design-appropriate critical appraisal, and distinction between direct and contextual evidence, whereas the small evidence base,

incomplete numerical reporting, and inability to perform meta-analysis or assess publication bias were important review-level limitations (Page MJ M. J., 2021) (Moola S, 2020).

CONCLUSION

The available evidence suggests that prolonged digital screen exposure may be associated with increased dry eye symptom severity in certain adult populations and short-term reductions in tear film stability. However, associations with aqueous tear production and clinically diagnosed dry eye disease (DED) were inconsistent, and no reliable threshold for daily screen exposure was identified. Overall, the evidence remains inconclusive and insufficient to establish a causal relationship between prolonged digital screen exposure and DED.

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CONFLICT OF INTEREST

The author declares that this research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

AUTHOR CONTRIBUTION

The author is responsible for all stages of the research, including conceptualization, methodology development, literature search and selection, data analysis, interpretation of results, manuscript drafting, and final revision of the article. The author has read and approved the final version of the manuscript for publication.

GENERATIVE ARTIFICIAL INTELLIGENCE USAGE STATEMENT

The author declares that generative artificial intelligence (AI) was not used to generate research data, perform scientific analysis, or replace the author's intellectual contribution to the preparation of this manuscript. If used during the manuscript preparation process, AI was employed only in a limited capacity to assist with refining the language and structure of the text. The author remains fully responsible for the accuracy, integrity, and final content of the manuscript.

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