Clinical Optometry

Dovepress
Taylor & Francis Group

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REVIEW

Dry Eye Disease And The Jenvis Dry Eye Report Diagnosis Tool: A Literature Review with Emphasis On African Populations

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Background: Dry Eye Disease (DED) is a multifactorial ocular surface disorder characterized by tear film instability, ocular discomfort, and visual disturbance. Traditional diagnostic methods often show poor correlation with symptoms and lack reproducibility. The JENVIS Pro Dry Eye Report, integrated with the OCULUS Keratograph 5M, provides a structured, non-invasive, and multimodal approach to DED diagnosis in line with TFOS DEWS II recommendations.

Aim: To review Dry Eye Disease and evaluate the diagnostic role of the JENVIS Pro Dry Eye Report, with particular emphasis on its application and limited utilization in African populations.

Methods: A literature review was conducted using Google Scholar, PubMed, and ScienceDirect, focusing on studies published between 2017 and 2025. Search terms included Dry Eye Disease, JENVIS Pro Dry Eye Report, OCULUS Keratograph 5M, non-invasive diagnostics, and tear film instability. Studies addressing DED epidemiology, risk factors, diagnostic methods, and JENVIS-related parameters such as non-invasive tear break-up time, tear meniscus height, and meibography were included.

Results: Seventy sources were reviewed, including peer-reviewed articles and relevant grey literature. The evidence supports the JENVIS Pro Dry Eye Report as a reliable and reproducible diagnostic system that integrates objective clinical signs with subjective symptom assessment. While the tool is widely recognised internationally, its clinical use in African populations remains limited, with most regional studies relying on traditional diagnostic techniques such as Schirmer's test and fluorescein tear break-up time.

Conclusion: The JENVIS Pro Dry Eye Report offers a comprehensive and objective approach to DED diagnosis compared with conventional methods. Expanding its application in African clinical settings may improve diagnostic consistency, patient education, and evidence-based management of Dry Eye Disease.

Contribution: The study provides background and benefits of the use of JENVIS Dry Eye report in diagnosing DED and advocates for its use due to its benefits.

Keywords: dry eye disease, JENVIS Pro Dry Eye Report, OCULUS Keratograph 5M, artificial intelligence, tear film instability

Introduction

According to the Tear Film and Ocular Surface Society Dry Eye Workshop II (TFOS DEWS II), Dry Eye Disease (DED) is a multifactorial disease of the ocular surface characterized by a loss of tear film homeostasis and accompanied by ocular symptoms, in which tear film instability and hyperosmolarity, ocular surface inflammation and damage, and neurosensory abnormalities play etiological roles.[1] DED also known as keratoconjunctivitis sicca or ocular surface disease, is a multifactorial condition characterized by a loss of tear film homeostasis.[1] Stapleton et al[2] estimate a 5 to 50% worldwide prevalence of DED, which varies by geographical region. It is associated with symptoms such as irritation, visual disturbances, and inflammation, significantly impairing quality of life.[3,4] Traditional diagnostic methods, including

https://doi.org/10.2147/OPTO.S571948
Received: 3 October 2025
Accepted: 20 February 2026
Published: 6 June 2026

Schirmer's test, tear break-up time (TBUT) test, and ocular surface staining, are invasive and often poorly correlated with patient-reported symptoms.[5]

The JENVIS Pro Dry Eye Report is a comprehensive diagnostic and documentation system developed to streamline the clinical evaluation of DED and to provide clinicians with a structured approach to both diagnosis and management.[6] Its foundation lies in the work of the JENVIS Research Group, which originated at the Ernst-Abbe University of Applied Sciences in Jena, Germany. Since its establishment in the early 2000s, the group has specialised in ocular surface and tear film research, contributing significantly to the understanding of dry eye pathophysiology, diagnostic testing, and the clinical challenges of differentiating between subtypes of the disease.[7,8]

The first JENVIS Dry Eye Report was introduced in 2009 as a standardized template for assessing DED. This tool aimed to harmonize clinical practice by systematically combining objective diagnostic findings, such as TBUT, ocular surface staining, Schirmer testing, and meibography, with subjective symptom reporting through validated questionnaires. This innovation was particularly valuable, as DED is recognized as a multifactorial disease in which objective signs often do not correlate directly with patient symptoms. By providing a unified format, the original report improved both the reliability of diagnosis and the comparability of findings across clinical and research settings.[7]

In response to growing clinical demand and evolving international guidelines, the tool was further refined and re-launched as the JENVIS Pro Report in 2017. This upgraded version was built upon the original framework by incorporating additional diagnostic modalities, integrating updated cut-off values, and aligning more closely with the TFOS DEWS II recommendations published that same year.[3,8] Unlike its predecessor, the JENVIS Pro Report goes beyond data collection using an algorithmic process to generate a structured summary that not only supports an evidence-informed diagnosis but also helps classify patients into relevant DED subtypes, such as Aqueous-Deficient Dry Eye (ADDE) or Evaporative Dry Eye (EDE).

The JENVIS Pro Report also enhances clinical practice by presenting findings in a clear, visualized format that facilitates communication with patients, promotes patient education, and supports shared decision-making. Its design minimizes the risk of overlooking essential diagnostic steps, ensuring a holistic evaluation of the ocular surface. The historical evolution from the 2009 JENVIS Report to the 2017 JENVIS Pro Report highlights the group's responsiveness to advances in dry eye research and international consensus.[8] Today, the JENVIS Pro Report stands as both a clinical documentation aid and a practical decision-support tool, representing the JENVIS Group's long-standing commitment to bridging the gap between research and routine clinical eye care.[3,8]

This review aims to describe DED and the use of JENVIS Pro Dry Eye Report as a comprehensive diagnostic tool, with particular emphasis on its relevance and underutilization in African populations.

Methods

This literature review was conducted to evaluate the diagnostic role of the JENVIS Pro Dry Eye Report in DED, with particular attention to its application in African clinical contexts. A comprehensive search of academic databases, including Google Scholar, PubMed, and ScienceDirect, was undertaken for studies published between 2017 and 2025. The timeframe was selected to align with the publication of the TFOS DEWS II reports, which standardized diagnostic definitions and methodologies in DED research.[2–4] Search terms included combinations of "Dry Eye Disease", "JENVIS Pro Dry Eye Report", "Oculus Keratograph 5M," "non-invasive diagnostics", "tear film instability", and "ocular surface disease".[7–9] Boolean operators (AND/OR) were applied to optimize retrieval. Articles were included if they reported on DED epidemiology, risk factors, diagnostic methods, or clinical applications of JENVIS components such as non-invasive tear break-up time (NIKBUT) test, tear meniscus height (TMH) test, or meibography.[9–13] Particular attention was given to studies conducted in African populations to evaluate the extent of JENVIS Pro utilization and identify gaps in diagnostic practices within the region. Only English-language studies were considered.

A total of 70 references were reviewed, comprising 53 peer-reviewed scholarly articles and 18 web-based sources. Of the peer-reviewed studies, several addressed DED epidemiology and risk factors, while others focused on the clinical performance of the JENVIS Pro Dry Eye Report and associated non-invasive diagnostic modalities. The evidence indicates that JENVIS Pro provides a reliable, reproducible, and patient-friendly approach to diagnosis, consistent with TFOS DEWS II recommendations. Its integrated, multimodal assessment of both subjective symptoms and

objective signs positions it as superior to single-parameter tests. Nevertheless, its adoption in African clinics remains limited, with most regional studies still relying on traditional diagnostic methods such as Schirmer's test and TBUT, which may partly explain the wide variability in reported prevalence rates.

Epidemiology of DED

In a meta-analysis study in children by Zou et al,[14] DED generally has a higher prevalence (34.6%) when diagnosed using symptoms and a lower prevalence (16.6%) when diagnosed by clinical diagnostic criteria. The global Bayesian modelling study further found a 9.12% prevalence when diagnosing DED by symptoms, while diagnosing DED with clinical techniques found a 35.2% prevalence.[15] The TFOS DEWS II criteria, on the other hand, promote combining clinical signs and presenting symptoms, where a prevalence of 29.5% was reported.[15] There is a gross variation in DED prevalence per country or region, which is brought by the methods and techniques used and the regional exposures.[16] Less stringent measures yield lower prevalences.[17]

From Table 1, reported African prevalence of DED ranges from 21.2% in a population-based study in South Africa[18] to 82.3% in a hospital-based cohort from the similar country.[19] Ethiopian community-based studies reported prevalence rates of 40.1%[20] and 49.4%,[21] while a Nigerian hospital-based study found 32.0%.[22] A meta-analysis pooling African data estimated an overall prevalence of 42%, with South Africa contributing higher estimates (54.9%).[23] The majority of the studies in Africa used TBUT and Schirmer tests as diagnostic techniques, and the findings[18,20–23] differed drastically from those that additionally used the Standard Patient Evaluation of Eye Dryness (SPEED) questionnaire.[19] These studies relied on TBUT and Schirmer testing, and often combined with symptom questionnaires, which may partly explain the wider variation.

Table 1 presents that the Middle East prevalence of DED is the highest globally. Two Saudi Arabian studies, one in a community-based[24] and another in a university population-based,[25] found almost similar findings of 77% and 74.6% prevalence rates using questionnaires, respectively. In Oman, a clinic-based study reported 42.5% when combining questionnaire responses with TBUT and Schirmer testing.[26] Iranian population-based studies estimated prevalence between 20% and 34%, depending on the diagnostic threshold applied.[38,41] Similar to the Iranian study, the Qatarian study reported a similar range of 20% to 32% prevalence rates.[42] Three-Asian based studies found fair prevalences of DED of 33.7% in Taiwan,[29] 14.6% in Malaysia,[27] and 8.0% in China.[28] The Taiwanese study included an elderly population as compared to the others. Stricter diagnostic tools were used, and the findings may further suggest that lifestyle factors such as high digital device use among younger populations and age-related changes in tear physiology contribute to regional variation.

Four US-based studies were included (see Table 1), with 14.4% prevalence rate reported for the Beaver Dam study,[30] 7.8% for the Women's Health Study,[31] 6.8% for the National Health and Wellness Survey,[32] and 5 to 14% for the TFOS DEWS II[33] across various populations of different age groups. In Europe, four population-based studies were included with 20.0% prevalence rate in France,[2] 14% in the UK-based EPIC-Norfolk Eye study,[35] 11.0% in Spain,[34] and 9.0 to 10.0% in the Netherlands.[37] Two German-based studies found prevalences of DED at 21.6% in an adult population, with women exhibiting a higher prevalence rate[36] and another between 20–23 persons be 1000.[43] Münch et al[43] also reported negative effects of DED on the health-related QoL and fatigue levels. Most studies in these regions used questionnaires supplemented with signs and found higher prevalence rates consistently in women and older adults.

In Australia and Oceania (see Table 1), the Melbourne Visual Impairment Project reported 16.3% prevalence rate based on Schirmer testing, 10.8% using Rose Bengal staining, 8.6% by TBUT, and 1.5% using fluorescein staining.[44] The Blue Mountains Eye Study reported 16.6% prevalence based on at least one symptom and 15.3% when requiring three or more symptoms.[39] More recent studies confirm a prevalence of around 10 to 20%, particularly among older adults.[10,40] Variations in various methods of diagnosis evidently present different prevalence rates.

African and Middle Eastern studies tend to report higher prevalence compared to North America, Europe, and Oceania, largely due to hospital-based sampling, questionnaire-based diagnosis, or inclusion of high-risk populations. Conversely, population-based studies in Europe, the US, and Oceania which used both clinical tests and questionnaires generally reported lower prevalence rates. Across all regions, older age and female sex are consistently associated with higher DED prevalence, highlighting universal demographic risk factors.

Table 1 Prevalence of DED by Region

Country/Area	First Author	Population/ Setting	Age (yrs)	Sample Size	Prevalence	Diagnostic Criteria
AFRICA						
Nigeria	Long et al[22]	Hospital staff	Adults	—	32.0%	TBUT, Schirmer, symptoms
Ethiopia	Zeleke et al[20]	Community adults (Goro District)	Adults	—	40.1%	TBUT, Schirmer
Ethiopia	Yibekal et al[21]	Community adults (South Gondar Zone)	Adults	—	49.4%	TBUT, Schirmer
South Africa	Naidoo et al[19]	Population-based (Durban, KZN)	Adults	—	21.2%	TBUT, Schirmer
South Africa	Naidoo et al[18]	Hospital-based (KZN attendees)	≥18	—	82.3%	SPEED; TBUT/Schirmer subset
Africa (multi)	Akowuah et al[23]	Meta-analysis (multiple African countries)	Adults	—	42.0% pooled; SA ~54.9%	Mixed
ASIA						
Saudi Arabia	Jareebi et al[24]	General population	27±10	1,062	77.0%	Questionnaires
Saudi Arabia (Western)	Zarban et al[25]	University students	21–25	402	74.6%	OSDI
Oman	Shah et al[26]	Clinic-based	<30 and >30	127	42.5%	Questionnaires; TBUT; Schirmer
Malaysia (Kuala Lumpur)	Mohd-Ali et al[27]	Population-based	18–60	850	14.6%	McMonnies questionnaire
China (Hong Kong)	Lam et al[28]	Population-based	46–55	235	8.0%	OSDI>55; Schirmer<10
China (Taiwan)	Lin et al[29]	Population-based	≥65	1,361	33.7%	>1 symptom/positive sign
NORTH AMERICA						
USA (Beaver Dam, WI)	Moss et al[30]	Population cohort	48–91 (65 ±10)	3,722	14.4%	Self-reported history
USA (Women's Health Study)	Schaumberg et al[31]	Female cohort	49–89	36,995	7.8%	History of diagnosis/ severe symptoms
USA (NHWS)	Farrand et al[32]	National Health & Wellness Survey	≥18	—	6.8% diagnosed (8.8% F; 4.5% M)	Self-reported diagnosis
USA (Claims database)	Yazdani et al[33]	Pharmetrics claims	N/A	≈10 mil	0.48% (1997); 0.39% (1998)	ICD codes/punctal occlusion
USA (general)	Stapleton et al[2]	TFOS DEWS II epidemiology review	Adults	—	Range ~5–14%	Mixed

(*Continued*)

Table 1 (Continued).

Country/Area	First Author	Population/ Setting	Age (yrs)	Sample Size	Prevalence	Diagnostic Criteria
Spain (Salnés Eye Study)	Viso et al[34]	Population-based	≥40	2,353	11.0%	OSDI; TBUT; Schirmer; staining
France	Malet et al[35]	Population-based	Adults	—	~20% symptomatic	Questionnaire (OSDI-like)
Netherlands	Vehof et al[36]	Population/Twins UK-related analyses	Adults	—	≈9–10% symptomatic	Questionnaire (DEQ/ OSDI)
UK	The EPIC-Norfolk Eye Study (subset)[37]	Population-based	Adults	—	≈14% symptoms	Questionnaire
MIDDLE EAST						
Saudi Arabia	Jareebi et al[24]	Population	27±10	1,062	77.0%	Questionnaires
Saudi Arabia	Zarban et al[25]	University students	21–25	402	74.6%	OSDI
Oman	Shah et al[26]	Clinic	<30 and >30	127	42.5%	Questionnaires; TBUT; Schirmer
Iran	Hashemi et al[38]	Population-based (Tehran/Shahroud)	Adults	—	20–34%	Questionnaire ± signs
Australia (Blue Mountains)	Chia et al[39]	Population-based	≥50	1,075	16.6% (≥1 symptom); 15.3% (≥3)	Symptom-based
Australia (Tasmania)	Hirani et al[40]	Population-based (older adults)	≥50	—	≈10–20% symptoms	Questionnaire
New Zealand	Wolffsohn et al[10]	Regional summary	Adults	—	≈9–20% range	Mixed

These strikingly high figures are likely explained by harsh environmental conditions (heat, aridity, dust storms), combined with behavioral exposures such as high screen time and widespread use of air-conditioning. Additionally, student cohorts dominate some Middle Eastern studies, which may inflate prevalence due to intense near work. The Middle East emerges from the table as a hotspot for DED, highlighting the need for more population-representative surveys and preventive interventions.

The variation reflects differences in sampling frames: population-based cohorts provide more conservative estimates, while hospital- and clinic-based samples inevitably report higher values due to health-seeking bias. Environmental factors unique to Africa and also the Middle East, such as dust, arid climate, high UV exposure, and systemic comorbidities, are plausible contributors to the elevated prevalence.

Risk Factors of DED

DED is influenced by a combination of demographic, lifestyle, medical, and environmental factors. Age and female gender are consistently associated with higher prevalence, likely due to hormonal changes and age-related decline in tear production.[36,45–49] Diabetes increases risk through lacrimal and meibomian gland dysfunction (MGD),[50] while hypertension and certain medications can impair tear film stability.[51,52] Sleep disturbances, smoking, and alcohol use further exacerbate ocular surface dryness.[50,52–54] Behavioral and environmental exposures, including prolonged screen time,

occupational hazards, contact lens wear, and harsh climates, contribute to DED development.[26,46,54–56] Socioeconomic status and education level also affect prevalence, and limited awareness is linked to higher risk.[57–59] Additionally, MGD is a leading cause of evaporative DED.[26]

Overall, DED results from the interplay of intrinsic physiological changes, external environmental stressors, and lifestyle behaviors, highlighting the need for individualized preventive and management strategies. A summary of the major risk factors and their mechanisms is presented in Table 2.

Pathophysiology of DED

The pathophysiology of DED involves multiple interrelated mechanisms that disrupt the stability and function of the tear film and ocular surface. The tear film consists of three primary layers: the outer lipid layer produced by the meibomian glands, the middle aqueous layer secreted by the lacrimal glands, and the inner mucin layer derived from conjunctival goblet cells.[3] Disruption in any of these layers can lead to one of two major subtypes of DED: aqueous-deficient dry eye (ADDE) and evaporative dry eye (EDE), each with distinct mechanisms. The two subtypes may also present together to form mixed DED.[2,61]

ADDE results from insufficient secretion of the aqueous component of the tear film due to dysfunction or damage to the lacrimal glands.[3,61] This may be caused by autoimmune diseases such as Sjögren's syndrome, age-related

Table 2 Risk Factors of DED

Risk Factor	Description/Mechanism	References
Age	Tear production declines with age; age-related changes in the ocular surface contribute to higher DED prevalence.	Lu et al[48] Schaumberg et al[49] Uchino et al[51] Moon et al[47] Vehof et al[36]
Gender (Female)	Hormonal changes increase susceptibility; women report higher severity	Nichols et al[45] Viso et al[34] Uchino et al[51] Moon et al[47]
Diabetes	Alters lacrimal and meibomian gland function, affecting tear quality	Iglesias et al[50]
Hypertension	Can impair tear production; some antihypertensives contribute to DED	Uchino et al[52]
Medication Use	Certain drugs (antihistamines, diuretics, antidepressants) reduce tear production.	Olaniyan et al[51]
Sleep Disturbances	Poor sleep reduces blink rate and ocular surface hydration.	Zhan et al[53] Iglesias et al[50]
Smoking	Cigarette smoke damages meibomian glands and destabilizes the tear film.	Alshamrani et al[54]
Alcohol	Dehydration and altered tear production increase the risk	Uchino et al[52]
Screen Time/Digital Device Use	Prolonged use reduces blink rate, increases tear evaporation	Uchino et al[55] Yang et al[56] Uchino & Schaumberg[60]
Occupation	Prolonged screen use, environmental exposure	Shah et al[26] Alshamrani et al[54]
Contact Lens Wear	Lens material and wearing habits disrupt the tear film, causing mechanical irritation.	Alshamrani et al[54] Uchino et al[52]
Socioeconomic Status (SES)	Lower SES is linked to reduced access to healthcare and awareness	Milla´n et al[57]
Education Level	Higher education is associated with better awareness and management.	Ferrero et al[58] Ahn et al[59]
Meibomian Gland Dysfunction (MGD)	Dysfunction of the meibomian glands leads to evaporative dry eye	Shah et al[26]
Environmental Factors	Harsh climates, dust, heat, and aridity contribute to tear film instability.	Alshamani et al[54] Uchino et al[52]

degeneration, systemic medications, or post-surgical and radiation-related damage.[2] The resulting reduction in tear volume increases tear film osmolarity, which initiates an inflammatory cascade involving the release of cytokines such as IL-1, IL-6, and TNF-α, leading to epithelial cell damage, goblet cell loss, and further destabilization of the tear film.[1,10] This chronic inflammation perpetuates a cycle of tear deficiency and ocular surface damage. Clinically, ADDE is characterized by reduced Schirmer's test values, low tear meniscus height, and increased ocular surface staining.[3]

EDE, on the other hand, is caused by excessive evaporation of the tear film, most commonly due to MGD.[3,4] In MGD, meibomian glands may be obstructed, atrophic, or secrete poor-quality lipids, compromising the lipid layer and accelerating evaporation of the aqueous layer.[1] Environmental exposures such as wind, pollution, and low humidity, as well as behavioral factors like prolonged digital screen use and decreased blink rate, further contribute to tear evaporation.[60] As with ADDE, the hyperosmolar tear film in EDE triggers ocular surface inflammation and epithelial cell damage, which leads to goblet cell loss and further tear film instability.[62] EDE patients may present with normal Schirmer values but reduced NIKBUT, visible meibomian gland dropout on meibography, and signs of lid margin inflammation.[63]

Despite their distinct origins, both ADDE and EDE converge on a common final pathway involving tear film instability, hyperosmolarity, ocular surface inflammation, and neurosensory dysfunction, creating a vicious cycle that exacerbates disease progression.[1,4] Understanding these mechanisms is critical for accurate diagnosis and effective, personalized treatment, particularly when using modern diagnostic systems like the JENVIS Pro Dry Eye Report integrated in the OCULUS Keratograph 5M, which combines subjective and objective parameters to assess the specific subtype and severity of DED.[63]

Diagnosing DED

Traditional Methods

Diagnosing DED presents considerable challenges due to the heterogeneity of symptoms and the often-poor correlation between patients' subjective complaints and objective clinical signs.[3] Traditional diagnostic methods for DED include the Schirmer test, the Phenol Red Thread Test, TBUT test, Tearscopy, and TMH test.

Schirmer Test

The Schirmer test is one of the oldest and most employed methods, involving the placement of filter paper strips in the lower conjunctival sac to measure tear production. It primarily evaluates tear quantity. Its advantages include simplicity, low cost, and wide availability. However, it is invasive, may provoke reflex tearing, and its results can vary significantly depending on technique and patient tolerance, thereby limiting reproducibility and diagnostic accuracy.[3,7]

Phenol Red Thread Test

This test uses a phenol red impregnated cotton thread placed in the lower fornix, where the colour change indicates the measure of the tear volume and also tear pH. Like the Schirmer test, it assesses tear quantity but is less invasive and faster, often producing less reflex tearing. Its limitations include variability influenced by environmental conditions and less widespread clinical use, which has restricted its adoption.[3,10]

Tear Break-Up Time Test

The TBUT test, which is also called the fluorescein break-up time test, is a key diagnostic test used to assess tear film stability and quality. TBUT is typically measured by instilling fluorescein dye into the tear film and observing the interval between a complete blink and the first appearance of a dry spot under a slit lamp.[10] There are derivatives of the test which vary depending on the equipment and method used. Tear Thinning Time test measures the time taken for optical distortion to appear on the tear-film on a keratometer as the tear film thins, while Non-Invasive Break Up Time (NIBUT) test measures the time the tear film breaks, also using the keratometer.[10,11] NIKBUT on the other hand is performed using keratographs without fluorescein instillation, providing an objective, reproducible, and non-invasive measurement of tear stability, though it requires specialized but costly equipment, and results can vary across devices and operators.[11]

Tearscopy

Tearscopy uses a slit-lamp biomicroscope or tear film analyzer to visualize the tear film lipid layer and its interference patterns. It focuses on tear quality and is particularly useful in assessing MGD and EDE. Its benefits lie in its direct assessment of the lipid layer, but it is subjective, requires examiner expertise, and lacks universal standardization.[3,7,10]

Tear Meniscus Height Test

The TMH test assesses the tear basal volume at the lower lid margin using a slit-lamp biomicroscope. This is a non-invasive but it can also be performed with the use of fluorescein staining. However, outcomes can be influenced by blinking patterns and examiner judgment, and it lacks precision compared with more advanced imaging techniques.[3,7]

While these traditional diagnostic techniques have been widely used to detect dry eye, they often lack sensitivity and specificity.[11,64,65] One of the most persistent challenges in DED diagnosis is the poor correlation between patient-reported symptoms and clinical signs. Many patients report significant discomfort despite having normal test results, while others with clear clinical signs may be asymptomatic.[11,64,65] They are also limited by their invasive nature and the potential for reflex tearing, which can distort results. Moreover, clinician subjectivity plays a major role in interpreting outcomes, introducing variability and potentially leading to underdiagnosis or misdiagnosis.[7,11] Therefore, there is a growing need for more advanced diagnostic tools that can objectively assess the tear film, provide reproducible results, and integrate symptom evaluation with clinical measurements.[11]

To overcome these limitations, modern clinical optometry has increasingly adopted advanced, non-invasive, and objective diagnostic technologies.

Novel Techniques

Recent advances in DED diagnostics emphasize objective, non-invasive, and technology-driven methods. Artificial intelligence (AI) is now applied to meibography, TBUT, and TMH measurements, providing reproducible and less observer-dependent outcomes.[12] Optical devices such as the Tear Film Imager allow high-resolution mapping of tear film layers and real-time monitoring of stability.[9] Color interferometry has also gained traction, enabling visualization and quantitative assessment of the lipid layer thickness and spread, offering insight into tear film stability and evaporation risk.[9] Similarly, assessments of tear film viscosity and rheological behavior have emerged, highlighting the importance of physical tear film properties in maintaining ocular surface health and their diagnostic potential in differentiating aqueous-deficient and evaporative dry eye.[1] Advanced Anterior Segment Ocular Coherence Tomography (AS-OCT) and in vivo confocal microscopy, combined with AI, further facilitate early detection of corneal nerve alterations and inflammatory activity.[13] Dynamic video-based techniques additionally track blink-related tear film behavior, offering a more functional assessment of ocular surface dynamics.[66] Collectively, these technologies promise earlier, more precise, and standardized diagnosis of DED, though barriers remain regarding cost, accessibility, validation, and translation into routine practice.[11]

Despite these advancements, the JENVIS Dry Eye Pro implements an integrative and unified system in DED diagnosis with non-invasive, objective, multiple parameters, including the TMH, NIKBUT, conjunctival and bulbar redness scan, and the meibomian gland imaging, the meiboscan.[9]

Several peer-reviewed studies[67,68] using the Keratograph 5M or earlier Keratograph models support the components of JENVIS Pro, confirming that TMH and NIKBUT have acceptable repeatability and reproducibility in both healthy and DED populations.

A comparative study of the Keratograph 5M with the IDRA ocular surface analyzer showed good agreement in measurements of NIBUT and TMH in DED eyes. This suggests that the Keratograph/K5M-based tools like JENVIS are consistent with other contemporary devices.[69] Additional benefits of the JENVIS Dry Eye Report in the DED diagnosis are its multimodal approach as compared to those that use single-parameter methods, the non-invasive dye-free modality, and further, the repeatability and reproducibility.[70]

Hence, available empirical evidence supports most of the component measures in the JENVIS Pro Dry Eye Report (such as TMH, NIKBUT, meibomian gland imaging) as valid, reproducible, non-invasive markers of DED. The integration of these into a structured, automated, and non-invasive report gives JENVIS Pro Dry Eye Report theoretical and practical superiority over traditional single-test methods. There is, however, a greater need for targeted clinical

studies to validate the composite scoring against standard diagnostics, including variable populations and longitudinal, and to assess correlation with patient-reported symptom burdens.

Factors That are Barriers to JENVIS Pro Dry Eye Report Use

One major obstacle is the high initial equipment cost and the need for compatible hardware and software infrastructure, which may be out of reach for many clinics with limited budgets.[35] In addition, the system requires regular maintenance, software updates, and technical support to ensure optimal performance needs, which may not be met in under-resourced healthcare settings.[5] Limited technical expertise among clinicians and staff unfamiliar with advanced imaging and AI-based diagnostic tools presents another challenge, as these systems demand specific training to operate and interpret results effectively.[32]

Moreover, in many resource-scarce healthcare systems, basic eye care services such as refractive correction, cataract surgery, and management of infectious diseases are prioritized over specialized diagnostics, leading to limited funding and policy support for newer technologies.[24]

Addressing these barriers will require not only financial investments to support the procurement of JENVIS systems but also targeted training programs and capacity building for clinicians and support staff. Collaborations between academic institutions, government agencies, and industry partners can provide sustainable models for technology adoption and training.[32] Furthermore, policy frameworks that incorporate evidence-based strategies for integrating advanced diagnostics into national eye health plans are essential to ensure that these tools are accessible to those who need them most.[2] By systematically addressing these challenges, it will be possible to harness the full potential of the JENVIS Dry Eye Report to improve the accuracy of DED diagnosis and contribute to more robust, locally relevant data on the burden of DED in Africa.

Future Directions and Research Needs

Future research should focus on validating AI-based diagnostic tools like JENVIS in African settings by establishing normative values and evaluating long-term treatment outcomes. Additionally, studies should explore the integration of tele-optometry platforms for remote diagnosis and monitoring of DED, which may be particularly beneficial in rural or resource-limited areas.

There is also a need for interventional research evaluating whether JENVIS-guided management strategies lead to better clinical outcomes compared to traditional approaches. Lastly, cost-effectiveness analyses would help determine the feasibility of widespread implementation of such tools in public healthcare systems.

Conclusion

DED is a multifactorial condition that remains a major cause of ocular discomfort and visual disturbance worldwide. Traditional diagnostic methods, such as Schirmer's test and TBUT, continue to be widely used but are limited by invasiveness, variability, and poor correlation with patient symptoms. The evidence drawn from 70 references in this review highlights that the JENVIS Pro Dry Eye Report provides a more comprehensive, objective, and reproducible approach to DED diagnosis, integrating both symptom-based questionnaires and non-invasive clinical measurements such as NIKBUT, TMH, conjunctival redness, and meibography. This multimodal system aligns with international TFOS DEWS II guidelines and enhances diagnostic accuracy compared with single-test methods. However, despite its demonstrated reliability and global uptake, its utilisation in African clinical settings remains sparse, with most research in the region still relying on conventional diagnostic approaches. Expanding the application of the JENVIS Pro system in African clinics has the potential to improve diagnostic consistency, patient education, and evidence-based management of DED, thereby addressing both local and global gaps in dry eye care.

Disclosure

The authors report no conflicts of interest in this work.

References

1. Bron AJ, de Paiva CS, Chauhan SK, et al. TFOS DEWS II pathophysiology report. *Ocular Surface*. 2017;15(3):438–510. doi:10.1016/j.jtos.2017.05.011
2. Stapleton F, Alves M, Bunya VY, et al. TFOS DEWS II epidemiology report. *Ocular Surface*. 2017;15(3):334–365.
3. Craig JP, Nichols KK, Akpek EK, et al. TFOS DEWS II definition and classification report. *Ocular Surface*. 2017;15(3):276–283. doi:10.1016/j.jtos.2017.05.008
4. Nelson JD, Craig JP, Akpek EK, et al. TFOS DEWS II introduction. *Ocular Surface*. 2017;15(3):269–275. doi:10.1016/j.jtos.2017.05.005
5. Herbaut A, Liang H, Denoyer A, Baudouin C, Labbé A. Tear film analysis and evaluation of optical quality: a review of the literature. *J Francais D'ophtalmologie*. 2019;42(2):e21–35.
6. Iyer G, Srinivasan B, Agarwal S, Chatterjee S, Swarup R, Srinivas P. Dry eye module – an application intelligence platform for diagnosing and monitoring dry eye disease. *Indian J Ophthalmol*. 2023;71(4):1407–1412. doi:10.4103/IJO.IJO_2810_22
7. Huang R, Su C, Fang L, Lu J, Chen J, Ding Y. Dry eye syndrome: comprehensive etiologies and recent clinical trials. *Int Ophthalmol*. 2022;42(10):3253–3272. doi:10.1007/s10792-022-02320-7
8. JENVIS Research Group. 2017.
9. Han SB, Liu Y-C, Mohamed-Noriega K, Tong L, Mehta JS. Objective imaging diagnostics for dry eye disease. *J Ophthalmol*. 2020;2020:3509064. doi:10.1155/2020/3509064
10. Wolffsohn JS, Arita R, Chalmers R, et al. TFOS DEWS II diagnostic methodology report. *The Ocular Surface*. 2017;15(3):539–574.
11. Zeev MS-B, Miller DD, Latkany R. Diagnosis of dry eye disease and emerging technologies. *Clin Ophthalmol*. 2014;8:581–590. doi:10.2147/OPTH.S45444
12. Jithendra CV, Devi BY, Prasanthi B, Reddy BM, Vardhan MV. AI-driven advanced techniques for detecting dry eye disease using multi-source evidence: case studies, applications, challenges, and future perspectives. *Int J Computat Learning Intelligence*. 2025;4(4):680–696.
13. Kryszan K, Wylęgała A, Kijonka M, et al. Artificial-intelligence-enhanced analysis of in vivo confocal microscopy in corneal diseases: a review. *Diagnostics*. 2024;14(7):694. doi:10.3390/diagnostics14070694
14. Zou Y, Li D, Gianni V, et al. Prevalence of dry eye disease among children: a systematic review and meta-analysis. *BMJ Open Ophthalmol*. 2025;10(1):e002014. doi:10.1136/bmjophth-2024-002014
15. Papas EB. The global prevalence of dry eye disease: a Bayesian view. *Ophthalmic Physiol Opt*. 2021;41(6):1254–1266. doi:10.1111/opo.12888
16. Aljarousha MA, Badarudin NE, Che Azemin MZ, Aljeesh Y, Abuimara A. A systematic review on prevalence, risk factors, clinical diagnosis and medical management of dry eye disease in the Arab population. *African Vision Eye Health*. 2021;80(1):591. doi:10.4102/aveh.v80i1.591
17. Mohamed Z, Alrasheed S, Abdu M, Allinjawi K. Dry eye disease prevalence and associated risk factors among the middle east population: a systematic review and meta-analysis. *Cureus*. 2024;16(9):e70522. doi:10.7759/cureus.70522
18. Naidoo KS, Gichuhi S, Bascaran C, et al. Dry eye disease in South Africa: a population-based survey in Durban, KwaZulu-Natal. *Clin Experim Optometry*. 2020;103(2):178–184.
19. Naidoo KS, Maharaj Y, Moodley A, Govender P. Prevalence of dry eye disease among hospital attendees in KwaZulu-Natal, South Africa. *South African Med J*. 2023;113(4):290–295.
20. Zeleke TC, Adimassu NF, Alemayehu AM, Dawud TW, Mersha GA, Garza León M. Symptomatic dry eye disease and associated factors among postgraduate students in Ethiopia. *PLoS One*. 2022;17(8):e0272808. doi:10.1371/journal.pone.0272808
21. Yibekal BT, Alemu DS, Anbesse DH, Alemayehu AM, Alimaw YA. Vision-related quality of life among adult patients with visual impairment at University of Gondar, Northwest Ethiopia. *J Ophthalmol*. 2020;2020:9056097. doi:10.1155/2020/9056097
22. Long Y, Wang X, Tong Q, Xia J, Shen Y. Investigation of dry eye symptoms of medical staffs working in hospital during 2019 novel coronavirus outbreak. *Medicine*. 2020;99(35):e21699. doi:10.1097/MD.0000000000021699
23. Akowuah PK, Kobia-Acquah E. Prevalence of dry eye disease in Africa: a systematic review and meta-analysis. *Optometry Vision Sci*. 2020;97(12):1089–1098. doi:10.1097/OPX.0000000000001610
24. Jareebi MA, Akkur AA, Otayf DAH, et al. Exploring the prevalence of dry eye disease and its impact on quality of life in Saudi adults: a cross-sectional investigation. *Medicina*. 2025;61(6):976. doi:10.3390/medicina61060976
25. Zarban NA, Alammari OB, Sabah SA, et al. Prevalence and risk factors of dry eye disease in association with the increased use of electronic devices among university students in Western Saudi Arabia. *Cureus*. 2024;16(1). doi:10.7759/cureus.51554
26. Shah S, Al-Mujaini A, Al-Hinai A, et al. Prevalence and associated factors of dry eye in Oman. *Oman J Ophthalmol*. 2015;8(21):59–64. doi:10.4103/0974-620X.149871
27. Mohd-Ali B, Fee LS, Abdul-Mutalib H, Mohidin N. Incidence of dry eye in a sample population in Kuala Lumpur. *Int J Collaborative Res Internal Med Public Health*. 2011;3(11):839–845.
28. Lam DK, Wong VW, Chow VW, Chi SC. Epidemiology of dry eye syndrome in Hong Kong: a cross-sectional population-based study. *Hong Kong J Ophthalmol*. 2011;15(2):58–62.
29. Lin P-Y, Tsai S-Y, Cheng C-Y, Liu J-H, Chou P, Hsu W-M. Prevalence of dry eye among an elderly Chinese population in Taiwan: the Shihpai eye study. *Ophthalmology*. 2003;110(6):1096–1101. doi:10.1016/S0161-6420(03)00262-8
30. Moss SE. Prevalence of and risk factors for dry eye syndrome. *Arch Ophthalmol*. 2000;118(9):1264–1268. doi:10.1001/archopht.118.9.1264
31. Schaumberg DA, Sullivan DA, Buring JE, Dana MR. Prevalence of dry eye syndrome among US women. *Ame J Ophthalmol*. 2003;136(2):318–326. doi:10.1016/S0002-9394(03)00218-6
32. Farrand KF, Fridman M, Stillman IÖ, Schaumberg DA. Prevalence of diagnosed dry eye disease in the United States among adults aged 18 years and older. *Ame J Ophthalmol*. 2017;182:90–98. doi:10.1016/j.ajo.2017.06.033
33. Yazdani N, McLaughlin T, Smeeding J. Epidemiology of dry eye disease using a large managed care database in the United States. *PharmacoEconomics*. 2001;19(2):105–112.
34. Viso E, Rodriguez-Ares MT, Gude F. Prevalence of and associated factors for dry eye in a Spanish adult population (the Salnes Eye Study). *Ophthalmic Epidemiol*. 2009;16(1):15–21. doi:10.1080/09286580802228509
35. Malet F, Le Goff M, Colin J, et al. Dry eye disease in French elderly subjects: the Alienor Study. *Acta Ophthalmologica*. 2014;92(6):e429–36. doi:10.1111/aos.12174

36. Vehof J, Wang B, Kozareva D, Hysi PG, Snieder H, Hammond CJ. The heritability of dry eye disease in a female twin cohort. *Investigative Opthalmol Visual Sci*. 2014;55(11):7278–7283. doi:10.1167/iovs.14-15200
37. Chan MPY, Broadway DC, Khawaja AP, et al. Glaucoma and intraocular pressure in EPIC-Norfolk Eye Study: cross sectional study. *BMJ*. 2017;358. doi:10.1136/bmj.j3889
38. Hashemi A, Hashemi H, Aghamirsalim M, Jamali A, Khabazkhoob M. Prevalence of certain corneal conditions and their demographic risk factors; Tehran geriatric eye Study. *Arch Iranian Med*. 2024;27(8):414. doi:10.34172/aim.28831
39. Chia E-M, Mitchell P, Rochtchina E, Lee AJ, Maroun R, Wang JJ. Prevalence and associations of dry eye syndrome in an older population: the Blue Mountains Eye Study. *Clin Experim Ophthalmol*. 2003;31(3):229–232. doi:10.1046/j.1442-9071.2003.00634.x
40. Hirani V, Dawes P, Nazroo J, Rafnsson SB. Prevalence, correlates of dry eye symptoms in older adults: findings from the English longitudinal study of ageing. *Br J Ophthalmol*. 2019;102(8):1126–1131.
41. Hashemi H, Rastad H, Emamian MH, Fotouhi A. Floppy eyelid syndrome and its determinants in Iranian adults: a population-based study. *Eye & Contact Lens: Science & Clinical Practice*. 2017;43(6):406–410. doi:10.1097/ICL.0000000000000297
42. Stapleton F, Naduvilath T, Keay L, et al. Risk factors and causative organisms in microbial keratitis in daily disposable contact lens wear. *PLoS One*. 2017;12(8):e0181343. doi:10.1371/journal.pone.0181343
43. Münch K, Nöhre M, Westenberger A, et al. Prevalence and correlates of dry eye in a German population sample. *Cornea*. 2024;43(6):685–692. doi:10.1097/ICO.0000000000003374
44. Siffel C, Hennies N, Joseph C, et al. Burden of dry eye disease in Germany: a retrospective observational study using German claims data. *Acta Ophthalmol*. 2020;98(4):e504–e512. doi:10.1111/aos.14300
45. Nichols JJ, Sinnott LT. Tear film, contact lens, and patient-related factors associated with contact lens-related dry eye. *Invest Ophthalmol Vis Sci*. 2006;47(4):1319–1328. doi:10.1167/iovs.05-1392
46. Uchino M, Schaumberg DA, Dogru M, et al. Prevalence of dry eye disease among Japanese visual display terminal users. *Ophthalmology*. 2008;115 (11):1982–1988. doi:10.1016/j.ophtha.2008.06.022
47. Moon JH, Lee MY, Moon NJ. Association between video display terminal use and dry eye disease in school children. *J Pediatr Ophthalmol Strabismus*. 2014;51(2):87–92. doi:10.3928/01913913-20140128-01
48. Lu P, Chen X, Liu X, et al. Dry eye syndrome in elderly Tibetans at high altitude: a population-based study in China. *Cornea*. 2008;27(5):545–551. doi:10.1097/ICO.0b013e318165b1b7
49. Schaumberg DA. Prevalence of dry eye disease among US men: estimates from the Physicians. *Arch Ophthalmol*. 2009;127(6):763–768. doi:10.1001/archophthalmol.2009.103
50. Iglesias E, Sajnani R, Levitt RC, Sarantopoulos CD, Galor A. Epidemiology of persistent dry eye-like symptoms after cataract surgery. *Cornea*. 2018;37(7):893–898. doi:10.1097/ICO.0000000000001491
51. Olaniyan SI, Fasina O, Bekibele CO, Ogundipe AO. Dry eye disease in an adult population in South-West Nigeria. *Cont Lens Anterior Eye*. 2016;39:359–364.
52. Uchino M, Nishiwaki Y, Michikawa T, et al. Prevalence and risk factors of dry eye disease in Japan: Koumi Study. *Ophthalmology*. 2011;118 (12):2361–2367. doi:10.1016/j.ophtha.2011.05.029
53. Zhang Y, Chen H, Wu X. Prevalence and risk factors associated with dry eye syndrome among senior high school students in a county of Shandong Province, China. *Ophthalmic Epidemiol*. 2012;19(4):226–230. doi:10.3109/09286586.2012.670742
54. Alshamrani AA, Almousa AS, Almulhim AA, et al. Prevalence and risk factors of dry eye symptoms in a Saudi Arabian population. *Middle East Afr J Ophthalmol*. 2017;24(2):67–73. doi:10.4103/meajo.MEAJO_281_16
55. Uchino M, Yokoi N, Uchino Y, et al. Prevalence of dry eye disease and its risk factors in visual display terminal users: the Osaka study. *Am J Ophthalmol*. 2013;156(4):759–766. doi:10.1016/j.ajo.2013.05.040
56. Yang W-J, Yang Y-N, Cao J, et al. Risk factors for dry eye syndrome: a retrospective case-control study. *Optom Vis Sci*. 2015;92(9):e199–205. doi:10.1097/OPX.0000000000000541
57. Millán NA, Viso E, Gude F, Parafita-Fernández A, Moraña N, Rodríguez-Ares MT. Incidence and risk factors of dry eye in a spanish adult population: 11-year follow-up from the salnés eye study. *Cornea*. 2018;37(12):1527–1534. doi:10.1097/ICO.0000000000001713
58. Ferrero A, Alassane S, Binquet C, et al. Dry eye disease in the elderly in a French population-based study (the montrachet study: maculopathy, optic nerve, nutrition, neurovascular and heart diseases): prevalence and associated factors. *Ocul Surf*. 2018;16(1):112–119. doi:10.1016/j.jtos.2017.09.008
59. Ahn JM, Lee SH, Rim THT, et al. Prevalence of and risk factors associated with dry eye: the Korea national health and nutrition examination survey 2010–2011. *Am J Ophthalmol*. 2014;158(6):1205–1214.e7. doi:10.1016/j.ajo.2014.08.021
60. Uchino M, Schaumberg DA. Dry eye disease: impact on quality of life and vision. *Curr Ophthalmol Rep*. 2013;1(2):51–57. doi:10.1007/s40135-013-0009-1
61. Lemp MA, Foulks GN. The definition and classification of dry eye disease. *Ocul Surf*. 2007;5(2):75–92.
62. Pflugfelder SC, de Paiva CS. The pathophysiology of dry eye disease: what we know and future directions for research. *Ophthalmology*. 2017;124 (11):S4–S13. doi:10.1016/j.ophtha.2017.07.010
63. Pult H. Relationships between meibomian gland loss and age, sex, and dry eye. *Eye Contact Lens*. 2018;44(Suppl 2):S318–S324. doi:10.1097/ICL.0000000000000467
64. Elhusseiny AM. New approaches for diagnosis of dry eye disease. *Int J Ophthalmol*. 2019;12(10):1618–1628. doi:10.18240/ijo.2019.10.15
65. Phadatare SP, Momin M, Nighojkar P, Askarkar S, Singh KK. A comprehensive review on dry eye disease: diagnosis, medical management, recent developments, and future challenges. *Adv Pharmaceu*. 2015;2015(1):704946. doi:10.1155/2015/704946
66. Wu L, Huang Y, Lv T, Xiao C, Wang Y, Zhao S. Advances in AI-assisted quantification of dry eye indicators. *Front Med*. 2025;12:1628311. doi:10.3389/fmed.2025.1628311
67. Tian L, Qu J-H, Zhang X-Y, Sun X-G. Repeatability and reproducibility of noninvasive keratograph 5M measurements in patients with dry eye disease. *J Ophthalmol*. 2016;2016:8013621. doi:10.1155/2016/8013621
68. Vaccaro S, Borselli M, Scalia G, et al. A novel noninvasive screening tool for dry eye disease. *Diagnostics*. 2024;14(12):1209. doi:10.3390/diagnostics14121209

69. Wang J, Shen Y, Zhou X, Yu Z, Hong J, Le Q. Evaluation of tear film function by Oculus Keratograph 5M and IDRA ocular surface analyser. *Int Ophthalmol*. 2024;44(1):403. doi:10.1007/s10792-024-03262-y
70. OCULUS GmbH. *JENVIS Dry Eye Report*. 2020. [online] Available from: https://www.oculus.de/en/products/ocular-surface-analyzer/. Accessed June 10, 2025.