Original Article

Digital eye strain among the Omani university population: prevalence, contributing factors, and preventive practices

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ABSTRACT

Background: University students are increasingly exposed to prolonged digital device use for academic activities, which places them at risk of digital eye strain (DES). While prevalence is widely reported, limited attention has been given to students' awareness and preventive practices. This study aimed to determine the prevalence of DES, associated behavioral patterns, and preventive practices among university students.

Methods: A descriptive cross-sectional study was conducted during the Spring semester of the 2025–2026 academic year at the University of Buraimi, Oman. Using stratified random sampling, 240 undergraduate students were recruited from all four colleges. Data were collected through an online survey comprising demographic characteristics, digital device usage habits, the validated Computer Vision Syndrome Questionnaire (CVS-Q), and items assessing awareness and preventive practices.

Results: Overall, 58.8% (n = 141) of participants were classified as having DES, with the majority experiencing mild symptoms (n = 89, 37.1%), followed by moderate (n = 40, 16.7%) and severe (n = 12, 5.0%) symptoms. The most commonly reported symptoms were tearing (n = 137, 57.1%), ocular dryness (n = 125, 52.1%), eye redness (n = 115, 47.9%), burning sensation (n = 104, 43.3%), and itching (n = 104, 43.3%). Prolonged screen exposure was common, with 72.5% (n = 174) reporting ≥ 5 h of daily use, alongside frequent use of multiple devices and suboptimal ergonomic practices, including close viewing distances and poor posture. Awareness of DES was reported by 37% (n = 87) of participants, yet adoption of preventive practices was inconsistent. A statistically significant association was observed between engagement in preventive practices and lower DES severity ($P < 0.05$), whereas awareness alone was not significantly associated with symptom severity ($P > 0.05$).

Conclusions: The findings of this study indicate a 58.8% prevalence of DES among Omani university students. Prolonged screen time emerged as a key predictive factor. Awareness of DES was limited, and adherence to preventive practices remained low. These results underscore the need for targeted educational interventions on eye health, emphasizing simple and effective strategies such as the 20-20-20 rule to reduce the burden of DES among university students.

KEYWORDS

online learning, distance education, eyestrain, eyedrop, smartphones, handheld computer, screen exposure, postures, primary disease prevention, questionnaire, disease frequency survey, university, students

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INTRODUCTION

The integration of digital technology into higher education has transformed teaching and learning processes globally, making the use of laptops, smartphones, tablets, and electronic learning platforms an essential component of university education [1, 2]. University students represent one of the most digitally exposed populations, with prolonged screen use for academic coursework, participation in e-learning, research activities, and leisure purposes [3]. While digitalization has improved access to education, it has simultaneously contributed to the emergence of digital eye strain (DES), also termed computer vision syndrome (CVS), as a growing public health concern [4].

DES is reported as highly prevalent among digital device users. Evidence suggests that over 50% of computer users experience at least one symptom of DES, such as eye strain, dryness, redness, blurred vision, burning sensation, or headache [5, 6]. A recent large-scale systematic review and meta-analysis involving 66 577 participants across multiple regions reported a pooled global prevalence of approximately 69.0%, with reported prevalence ranging from 12.1% to 97.3% across different populations and settings [7]. University students consistently display some of the highest prevalence rates due to prolonged screen exposure, continuous near-work demands, and suboptimal visual ergonomics [7–10].

The development of DES is multifactorial, with contributors broadly categorized as behavioral, ergonomic practice, environmental risk, and individual factors. Prolonged daily screen time, use of multiple digital devices, infrequent blinking, incorrect device distance, improper posture, and inadequate lighting conditions have been associated with increased DES symptoms and severity levels [11, 12]. Despite the well-documented burden, studies consistently report a disparity between awareness of DES and the regular practice of preventive strategies like taking periodic breaks, adjusting screen brightness, frequent blinking, maintaining appropriate viewing distance, and using blue light filters [11, 13].

Within the Gulf Cooperation Council region, digital exposure among university students is markedly high, driven by rapid technological adoption and the widespread integration of online and blended learning modalities. Studies from Saudi Arabia and Jordan employing the CVS-Q indicate a substantial burden of DES, with prevalence estimates ranging from 76.1% to 94.5% [10, 14, 15]. This elevated prevalence is accompanied by prolonged screen exposure, with approximately one-third to over half of students reporting ≥ 6 h of daily digital device use [10, 13]. Moreover, adherence to evidence-based preventive practices remains inconsistent. Awareness and regular application of the 20–20–20 rule range from 37.4% [14] to 63.9% [10], highlighting a significant gap between knowledge and actual behavior [10, 14]. These findings underscore the ongoing challenge of mitigating DES in the region and stress the need for targeted interventions that foster both awareness and sustained behavioral change.

In Oman, the rapid expansion of digital learning within higher education has intensified students' exposure to prolonged screen use, with recent evidence reporting a DES/CVS prevalence of 73.7% and significant associations with close viewing distance, poor posture, and extended screen time [16]. Despite confirming DES as a substantial ocular health concern, existing studies remain limited in scope, primarily addressing prevalence and risk factors while providing insufficient insight into students' awareness and the actual adoption of preventive practices. Additionally, there is a paucity of comprehensive evidence examining the relationship between preventive behaviors and DES severity, particularly in terms of symptom frequency and intensity, within the Omani university context. Addressing this gap is essential to inform targeted health education, promote safer digital habits, and support institutional strategies aimed at reducing DES burden. Therefore, this study aimed to assess the prevalence of DES among university students in Oman, identify its associated risk factors, and evaluate the level of awareness and implementation of preventive practices, including their relationship with DES severity.

METHODS

The present study employed a quantitative descriptive cross-sectional design conducted at the University of Buraimi in Al Buraimi Governorate, Sultanate of Oman. The study population comprised undergraduate students enrolled in the 2025–2026 academic year who were available and willing to participate at the time of data collection. Ethical approval was obtained from the Ethical and Research Committee of the University of Buraimi's College of Health Sciences, and all procedures adhered to principles of confidentiality, anonymity, and data privacy. Data were collected through a structured online survey administered via Google Forms following the acquisition of informed voluntary consent from all participants.

A stratified random sampling approach was utilized to ensure proportional representation from all four colleges within the university. The required sample size was determined using Slovin's formula, where the total student population (N = 3942) and a margin of error of 0.05 yielded a minimum sample size of 363 participants. To account for potential non-response, an additional 10% was added, resulting in a target sample size of approximately 400 students. However, due to the limited duration of data collection and reliance on voluntary participation, a total of 240 completed responses were obtained and included in the final analysis.

Eligible participants were undergraduate students aged 18–25 years, enrolled as full-time students in the 2025–2026 academic year, engaging with digital devices (including smartphones, laptops, or tablets) for at least 2 h daily, and capable of reading and understanding either English or Arabic. Exclusion criteria were pre-existing ocular conditions unrelated to digital device use (such as cataracts or glaucoma), ocular surgery undergone within the preceding six months, absence during the data collection period, and declining to provide informed consent.

The data collection instrument consisted of a structured questionnaire divided into four components. The first component captured demographic characteristics, including age, sex, college affiliation, and academic year. The second component assessed behavioral and ergonomic factors related to digital device use, including wearing corrective lenses, type of main device used [13], daily screen time duration [11], posture during device use [11], viewing distance from the screen [17], ambient lighting conditions [11], use of blue light filters [13], and use of eye drops [12].

The third component evaluated the prevalence of digital eye symptoms using the CVS-Q, which includes 16 symptoms assessed in terms of both frequency and intensity. These symptoms comprise burning, itching, foreign body sensation, tearing, excessive blinking, redness, ocular pain, dryness, blurred vision, headache, heavy eyelids, diplopia, difficulty with near focusing, photophobia, perception of colored halos, and perceived worsening of vision [4, 18]. Frequency was scored as 0 (never), 1 (occasionally), or 2 (often/always) [18], while intensity was graded as 1 (mild to moderate) or 2 (severe); symptoms reported as "never" were assigned an intensity score of 0. For each symptom, the score was calculated by multiplying frequency by intensity. The total CVS score was obtained by summing the individual symptom scores and was interpreted as follows: 0–5 (no CVS), 6–12 (mild CVS), 13–18 (moderate CVS), and > 18 (severe CVS) [19].

The final component assessed participants' awareness of DES and their adoption of preventive practices, including regular breaks, screen brightness adjustments, use of lubricating eye drops, and application of blue light filters [11].

Statistical analysis was performed using IBM SPSS Statistics (version 29.0, IBM Corp., Armonk, NY, USA). Data normality was assessed using skewness, kurtosis, and the Shapiro-Wilk test. Descriptive statistics, including frequencies, percentages, means, and standard deviations (SDs), were used to summarize participant characteristics and prevalence of digital eye symptoms. Associations between categorical variables and digital eye symptoms were evaluated using chi-square tests, while continuous variables such as screen time were analyzed accordingly. A P-value < 0.05 was considered statistically significant.

RESULTS

A total of 240 undergraduate students were included in the analysis. Mean (SD) age was 21.6 (3.4) years, with a predominance of male participants (n = 188, 78.3%). Over half of the respondents were from the College of Engineering (n = 124, 51.7%), followed by the College of Health Sciences (n = 76, 31.7%) and the College of Business (n = 40, 16.7%). The largest proportion of students were in their fourth academic year (n = 74, 30.8%), followed by third-year (n = 58, 24.2%) and second-year students (n = 41, 17.1%). Overall, 30.4% (n = 73) of participants reported wearing corrective glasses (Table 1).

Regarding digital device use and related behaviors, the most reported usage pattern was the use of multiple devices (n = 125, 52.1%), followed by smartphones (n = 74, 30.8%). In terms of daily screen exposure, prolonged usage was common, with 36.3% (n = 87) reporting 5–7 h and 21.7% (n = 52) reporting 8–10 h of screen time per day, while only 12.1% (n = 29) reported < 2 h. With respect to posture, slouching in bed was the most frequently reported position (n = 107, 44.6%), followed by sitting upright (n = 52, 21.7%). Nearly half of the participants maintained a viewing distance of 31–50 cm (n = 114, 47.5%), whereas 45.0% (n = 108) used devices at distances < 30 cm. Most students reported moderate lighting conditions (n = 137, 57.1%), while 22.1% (n = 53) used devices in dim lighting (Table 2).

The distribution of ocular and extraocular symptoms based on frequency and intensity is presented in Table 3. Burning and itching eyes were reported occasionally by 43.3% of participants, with tearing (57.1%) and dryness (52.1%) among the most frequently reported symptoms. In terms of intensity, tearing eyes (41.3%) and dryness (29.2%) had the highest proportion of severe symptoms, followed by eye redness (25.4%). Certain symptoms, including double vision and increased sensitivity to light, were reported with no severe intensity, while colored halos and perceived worsening of vision were not reported by any participants (Table 3).

Based on total symptom scores, 41.2% (n = 99) of participants were classified as having no CVS, while 37.1% (n = 89) had mild symptoms, 16.7% (n = 40) moderate symptoms, and 5.0% (n = 12) severe symptoms (Table 4).

Table 1. Demographic characteristics of the 240 participants

Variables		Values
Age (y), Mean ± SD		21.6 ± 3.4
Sex (Male / Female), n (%)		188 (78.3) / 52 (21.7)
College, n (%)	**Engineering**	124 (51.7)
	Health Sciences	76 (31.7)
	Business	40 (16.7)
Academic Year, n (%)	**First**	36 (15.0)
	Second	41 (17.1)
	Third	58 (24.2)
	Fourth	74 (30.8)
	Fifth	31 (12.9)
Wearing Glasses, n (%)	**No**	167 (69.6)
	Yes	73 (30.4)

Abbreviations: y, year; SD, standard deviation; n, number of participants; %, percentage.

Table 2. Factors associated with digital eye strain among university students

Variables	Category	n (%)
Devices Use	**Smartphone**	74 (30.8)
	Laptop	17 (7.1)
	Tablet	21 (8.8)
	Desktop	3 (1.3)
	Multiple devices	125 (52.1)
Daily Screen Time	**<2 h**	29 (12.1)
	2–4 h	37 (15.4)
	5–7 h	87 (36.3)
	8–10 h	52 (21.7)
	>10 h	35 (14.6)
Typical Posture	**Sitting upright**	52 (21.7)
	Slouching on bed	107 (44.6)
	Lying down	33 (13.8)
	Multiple	48 (20.0)
Viewing Distance	**<30 cm**	108 (45.0)
	31–50 cm	114 (47.5)
	>50 cm	18 (7.5)
Lighting Condition	**Bright**	50 (20.8)
	Moderate	137 (57.1)
	Dim	53 (22.1)

Table 3. Frequency and intensity of ocular and extraocular DES symptoms (n = 240)

Symptoms	Frequency		Intensity	
	Never n (%)	Occasionally * n (%)	Mild to Moderate n (%)	Severe n (%)
1. Burning eyes	136 (56.7)	104 (43.3)	71 (29.6)	33 (13.7)
2. Itching	136 (56.7)	104 (43.3)	71 (29.6)	33 (13.7)
3. Foreign body sensation	137 (57.1)	103 (42.9)	40 (16.7)	63 (26.2)
4. Tearing eyes	103 (42.9)	137 (57.1)	38 (15.8)	99 (41.3)
5. Excessive blinking	188 (78.3)	52 (21.7)	15 (6.3)	37 (15.4)
6. Eye redness	125 (52.1)	115 (47.9)	54 (22.5)	61 (25.4)
7. Eye pain	158 (65.8)	82 (34.2)	30 (12.5)	52 (21.7)
8. Dryness in the eyes	115 (47.9)	125 (52.1)	55 (22.9)	70 (29.2)
9. Blurred vision	157 (65.4)	83 (34.6)	27 (11.3)	56 (23.3)
10. Headache	158 (65.8)	82 (34.2)	30 (12.5)	52 (21.7)
11. Heavy eyelids	158 (65.8)	82 (34.2)	40 (16.7)	42 (17.5)
12. Double vision	198 (82.5)	42 (17.5)	42 (17.5)	0 (0.0)
13. Difficulty focusing at near	197 (82.1)	43 (17.9)	12 (5.0)	31 (12.9)
14. Increased sensitivity to light	158 (65.8)	82 (34.2)	82 (34.2)	0 (0.0)
15. Colored halos around objects	240 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)
16. Feeling that sight is worsening	240 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)

*** If a symptom is reported as "occasional" in frequency, its intensity is further categorized as either "moderate" or "severe".**

Table 4. Association between level of awareness and preventive practices with level of DES based on intensity of symptoms

Variables	Category	Level of DES based on symptom score, n (%)				*P*-value
		No DES	Mild	Moderate	Severe	
Awareness on DES	**No (n = 153)**	56 (36.6)	61 (39.9)	28 (18.3)	8 (5.2)	0.282
	Yes (n = 87)	43 (49.4)	28 (32.2)	12 (13.8)	4 (4.6)	
Preventive practices	**Regular break (n = 61)**	29 (47.5)	26 (42.6)	5 (8.2)	1 (1.6)	**0.003**
	Adjust brightness (n = 70)	24 (34.3)	30 (42.9)	13 (18.6)	3 (4.3)	
	Eye drops (n = 25)	7 (28.0)	5 (20.0)	12 (48.0)	1 (4.0)	
	Blue light filter (n = 10)	6 (60.0)	2 (20.0)	1 (20.0)	1 (10.0)	
	All above practices (n = 74)	33 (44.6)	26 (35.1)	9 (12.2)	6 (8.1)	

Abbreviations: DES, digital eye strain; n, number of participants; %, percentage. Note: *P*-value< 0.05 is shown in bold; CVS severity distribution: no CVS, n = 99 (41.2%); mild CVS, n = 89 (37.1%); moderate CVS, n = 40 (16.7%); and severe CVS, n = 12 (5.0%).

Analysis of awareness of DES demonstrated no statistically significant association with symptom severity ($P > 0.05$). Although a higher proportion of students who were aware of DES reported no symptoms (49.4%) compared to those unaware (36.6%), this difference was not statistically significant. In contrast, preventive practices showed a statistically significant association with DES severity ($P < 0.05$) (Table 4).

Students who reported taking regular breaks exhibited a more favorable symptom profile, with the highest proportion classified as mild (n = 26, 42.6%) and the lowest proportions being moderate (n = 5, 8.2%) and severe symptoms (n = 1, 1.6%). Similarly, participants adopting multiple preventive practices displayed better outcomes, with 44.6% (n = 33) classified as having no CVS and 35.1% (n = 26) mild CVS. Among the small subgroup using blue light filters (n = 10), the majority (60.0%) reported no symptoms. Conversely, participants using eye drops alone showed a higher proportion of moderate symptoms (n = 12, 48.0%), suggesting that this practice may be more commonly adopted by individuals with greater symptom burden rather than serve as an effective preventive strategy (Table 4).

DISSCUSSION

This study demonstrated that over half of university students experienced DES, with 58.8% classified as having mild-to-severe symptoms, predominantly of mild intensity, and smaller proportions exhibiting moderate and severe symptoms. Prolonged screen exposure, particularly ≥ 5 h per day, and suboptimal ergonomic practices were commonly reported. Awareness of DES was limited (37%), and the adoption of preventive measures remained inconsistent. Notably, engagement in preventive practices was significantly associated with lower DES severity, underscoring the potential role of behavioral modifications in mitigating symptom burden.

The present study showed a prevalence of DES of 58.8% among Omani university students, underscoring it as a notable ocular health concern in this population. This estimate falls within the pooled global prevalence of 66%, with a 95% confidence interval of 59–74% reported in a recent systematic review and meta-analysis [20]; it aligns with findings from comparable regional and international student populations, where DES/CVS prevalence ranges from 50.9% to 76.1%. Specifically, reported prevalence rates include 73.7% in Oman [16], 76.1% in Iran [21], 68.53% in Saudi Arabia [22], and 50.9% in Egypt [23]. Similarly, among professionals with substantial occupational screen exposure, such as clinical radiologists, prevalence has been reported at approximately 50% [24], comparable to the current findings. These observations may reflect widespread digital device use across both academic and professional settings, where prolonged screen exposure, suboptimal ergonomic practices, and multi-device use contribute to visual fatigue and ocular discomfort.

The predominance of symptoms such as tearing eyes (57.1%), dryness (52.1%), eye redness (47.9%), burning sensation (43.3%), itching (43.3%), and foreign body sensation (42.9%) observed in this study is consistent with the classical symptom profile of DES, in which ocular surface-related complaints predominate due to reduced blink rate and sustained near-visual tasks [11]. In the present study, the proportion of eye drop use was slightly higher among students with moderate DES (48%) compared to those with mild DES (20%), suggesting that ocular lubricants are more frequently used by individuals experiencing greater symptom burden rather than as a primary preventive measure. This observation aligns with evidence indicating a complex and potentially bidirectional relationship between eye drop use and DES severity. For example, students who did not use lubricating eye drops have been reported to have a significantly higher risk of severe DES, supporting a protective role of tear supplementation in mitigating symptom progression [22]. Conversely, multivariate analyses have identified the use of rewetting drops as being significantly associated with DES [12], likely reflecting reverse causality, whereby symptomatic individuals are more likely to initiate treatment. Findings suggest that while artificial tear use may provide symptomatic relief, its higher prevalence among individuals with more pronounced symptoms underscores its predominantly reactive role. This highlights the importance of comprehensive management strategies that emphasize early behavioral and ergonomic interventions alongside symptomatic treatment to effectively reduce DES burden.

Prolonged screen use ≥ 5 h per day emerged as a major contributing factor in the present study, reported by 174 (72.5%) of participants, reinforcing the central role of sustained digital exposure in the development of DES. The finding is strongly supported by a large-scale meta-analysis of 71 633 university students that demonstrated a clear dose-response relationship between screen time and adverse outcomes. This indicated that once daily exposure exceeds 2.5 h, the risk of DES increases sharply, rising by more than 15% with each additional hour of use [25]. Consistently, increased screen time, particularly in the context of online academic activities, has been identified as a significant determinant of DES [26], with higher DES scores observed among students with prolonged daily screen exposure [27]. Additionally, multivariate analyses confirm a significant association between duration of digital device use and DES [12], underscoring cumulative visual load as a key driver of ocular discomfort and visual fatigue. Beyond duration alone [28], the present findings highlight the contribution of behavioral and ergonomic factors, including the concurrent use of multiple devices, close viewing distances, poor posture, and suboptimal lighting conditions, which are consistent with previously reported determinants among university populations [12]. Such observations are further corroborated by multivariable analyses identifying female sex, prolonged and intensive screen use, lack of regular breaks, frequent virtual learning exposure, and academic-related screen use as significant predictors of increased DES risk [29]. These findings highlight the multifactorial nature of DES and the combined effects of screen exposure, ergonomics, and individual susceptibility on symptom severity.

In the present study, awareness of DES was limited, reported by only 37% of participants, and the adoption of preventive measures remained inconsistent, indicating a clear awareness-practice gap. Similar discrepancies are reported in prior studies, where although 45.5% of participants were aware of CVS, fewer than half (41.62%) possessed adequate knowledge of recommended preventive measures such as regular breaks [5]. These findings suggest that awareness alone is insufficient to drive behavioral change, and that depth of knowledge and practical understanding of preventive strategies are critical for effective DES mitigation. Other investigations have demonstrated that despite a high prevalence of symptoms, awareness and comprehensive knowledge of DES remain suboptimal, with only 34.1% of medical students displaying awareness and an even smaller proportion exhibiting good knowledge [30]. These findings highlight a persistent gap between knowledge and practice, underscoring the need for targeted, evidence-based educational interventions, including structured eye health programs, ergonomic training, and optimization of the learning environment, to promote sustained adoption of preventive strategies and reduce DES burden [31].

The observed significant association between preventive practices and DES severity, based on symptom intensity rather than frequency, suggests that such measures may attenuate symptom severity rather than prevent symptom occurrence. This distinction aligns with existing evidence indicating that behavioral and ergonomic interventions, including regular screen breaks and optimized workstation practices, primarily reduce visual discomfort and symptom intensity rather than fully eliminate symptom onset [11]. Adherence to preventive strategies, such as periodic breaks, appropriate viewing distance, and ergonomic adjustments, is associated with improved visual comfort and reduced severity of DES symptoms. These findings underscore the importance of targeted, evidence-based educational interventions in university settings, emphasizing practical strategies such as the 20-20-20 rule, ergonomic posture correction, optimal lighting, and regulated screen use to mitigate symptom severity and promote long-term ocular health in populations with sustained digital exposure [12, 22, 31–33].

This study offers a comprehensive evaluation of DES among Omani university students, integrating prevalence, symptom patterns, awareness, and preventive practices within a single analytical framework. The use of a validated instrument (CVS-Q) strengthens the reliability and comparability of findings, while stratified random sampling across all university colleges enhances sample representativeness. Moreover, the combined assessment of symptom frequency and intensity alongside preventive behaviors provides nuanced insight into DES severity, an area often insufficiently explored. Several limitations should be acknowledged. The final sample size (n = 240) fell below the calculated target, potentially limiting generalizability and introducing non-response bias. The cross-sectional design precludes causal inference, and reliance on self-reported data may introduce recall bias. The single-institution setting and absence of objective ophthalmic assessments may restrict external validity and diagnostic precision. These findings underscore the need for targeted health education initiatives within universities to promote effective preventive practices, including ergonomic optimization and structured screen breaks. Future research should adopt longitudinal or interventional designs, incorporate objective clinical measures, and evaluate the effectiveness of evidence-based strategies to mitigate DES in student populations.

CONCLUSIONS

This study demonstrates that DES affects over half (58.8%) of Omani university students, with symptoms predominantly of mild severity. Prolonged screen exposure and suboptimal ergonomic practices were commonly reported among participants. Awareness of DES was limited and the adoption of preventive measures remained inconsistent, indicating a gap between knowledge and practice. Notably, engagement in preventive behaviors was associated with lower symptom severity. These findings suggest that DES is common within university settings and highlight the need for targeted, evidence-based educational initiatives and institutional strategies that promote healthy digital behaviors, including ergonomic optimization, regular breaks, and appropriate screen use. Integrating digital eye health strategies into academic environments may help reduce symptom burden and support student well-being in increasingly technology-dependent learning contexts.

ETHICAL DECLARATIONS

Ethical approval: Ethical approval was obtained from the Ethical and Research Committee of the University of Buraimi's College of Health Sciences, and all procedures adhered to principles of confidentiality, anonymity, and data privacy. Data were collected through a structured online survey administered via Google Forms following the acquisition of informed voluntary consent from all participants.

Conflict of interests: None.

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