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Original Article

Ophthalmology Section

Assessment of the Impact of Varying Durations of Computer Usage on Dry Eye Parameters in Employees of a Tertiary Care Teaching Hospital of Uttar Pradesh, India

AMIT KUMAR JAIN[1], DADAN JI PANDEY[2]

ABSTRACT

Introduction: Dry eye (keratoconjunctivitis sicca) is a common disorder of the tear film having multifactorial aetiology. Now-a-days, a large portion of population is affected with Dry Eye Disease (DED) because of substantial increase in usage of computers and digital devices.

Aim: To evaluate the effect of varying durations of computer usage on parameters of DED.

Materials and Methods: In this prospective study, total 120 participants were divided into two groups. Group I (n=58) included participants who used computer daily for less than six hours while group II (n=62) included those who used computer for more than six hours daily. Routine eye examination was done and dry eye parameters i.e., Ocular Surface Diseases Index (OSDI), Schirmer Test (ST) and Tear Film Break Up Time (TFBUT) were performed and analysed for any significant difference between groups I and II using unpaired t-test. SPSS 16.0 was used and p-value <0.05 was considered as statistically significant. Pearson's correlation test was performed to analyse correlation of OSDI score with TFBUT and ST values.

Results: Mean OSDI scores in group I and group II were 37.39±8.98 and 49.54±11.7 (p<0.001), respectively; while TFBUT values were 10.19±2.27 seconds and 8.12±2.9 seconds (p<0.001), respectively. ST values were 12.82±3.32 mm in group I and 10.80±3.86 mm in group II (p=0.0027). Significant inverse correlation between OSDI score and TFBUT values was found in both group I (r=-0.557, p<0.001) and group II (r=-0.439, p<0.001). Similarly, correlation of OSDI score with ST values in group I (r=-0.787, p<0.001) and group II (r=-0.320, p=0.011) was also inversely significant. On the basis of OSDI score, 38 (65.5%) participants in group I and 54 (87.08%) participants in group II had severe dry eye. According to TFBUT values 12 (20.68%) participants in group I and 29 (46.77%) participants in group II and as per ST values 17 (29.31%) participants in group I and 30 (48.38%) participants in group II had severe dry eye.

Conclusion: Usage of computer or digital displays more than six hours per day is a potential cause for the development of severe DED.

Keywords: Ocular surface diseases index, Schirmer test, Tear film break up time

INTRODUCTION

Globally, one of the most common clinical problems presented to an ophthalmologist in the Outpatient Department (OPD) is dry eye disorder [1,2]. DED is the disorder of tear film resulting due to insufficient tear secretion or immoderate tear evaporation and causes symptoms of discomfort, irritation in eyes and visual disturbances [2].

Moist and healthy ocular surface is the prerequisite for a normal visual acuity in individuals [2]. Various factors like adequate quantity of tears secreted from lacrimal gland, normal composition and stability of tear film, proper distribution mechanism of tears on the ocular surface, proper eyelid closure and adequate and regular blinking of eyes keep the ocular surface healthy and moist [1,2]. Disturbance in any of these factors may give rise to an unhealthy ocular surface and subsequently dryness of eyes [1].

Many a times the dry eye condition remains subclinical and under-diagnosed because the symptoms of dry eye may vary from patient to patient and thus remains the major cause of frustration for patient as well as for clinicians [2,3]. In majority of dry eye patients the disease may not be curable however; symptoms of dry eye usually can be improved with appropriate treatment [2,3]. Furthermore, unrecognised DED is generally associated with reduced visual quality and thus can interfere with visual outcomes following cataract or corneal refractive surgeries [4]. Prevalence of dry eye depending on the age, occupation and lifestyle of person and surrounding environment varies from 5% to 35% in different countries [4,5]. It is considered as a multifactorial disease and many a times it becomes difficult for treating clinician to find out the exact cause for dry eye [5]. However, possibility of dry eye is increased with advancement of age, usage of contact lenses, longer exposure to less humid environment, too much use of computers and visual displays and reading for prolonged period [3]. In today's scenario a large portion of population is using computer or other digital devices for prolonged period of time and thus is experiencing symptoms of Digital Eye Strain (DES) [6]. Exposure to digital rays from digital devices for prolonged time is associated with instability of tear film, decreased concentration of mucin, reduction in blinking of eyes, and increased tear evaporation thus causing harm to ocular surface [7,8]. Various eye and vision related problems arising due to use of digital devices and computers are termed as Computer Vision Syndrome (CVS) or DES [6]. Individual affected with CVS may present with dry eye, eye strain, blurring of vision, redness and burning of eye, too much tearing, headache, pain in neck and shoulder etc., [9]. Thus, visual problems and ocular discomfort arising due to CVS is reducing performance and productivity at work place as well as affecting the quality of life of computer users [9]. Various diagnostic tests and questionnaires are available that can be used to assess clinical severity, stability of tear film, damage of corneal or conjunctival surface in DEDs [8]. Some tests that may be carried out to evaluate severity of dry eye include ST, TFBUT, Fluorescein and Rose Bengal staining, and measurement of Tear Meniscus Height

(TMH) [10]. Additionally, several questionnaires also exist to identify symptomatology of dry eye. OSDI which was introduced in 1977 by Outcomes research Group is one of the most commonly used validated questionnaire used for DED [10].

The present study was conducted to evaluate the effects of varying durations of computer usage on ocular surface, specifically for dryness of eyes by using OSDI score, ST and TFBUT.

MATERIALS AND METHODS

The present hospital based, prospective non-interventional study was conducted in the Department of Ophthalmology at a tertiary care teaching hospital at Uttar Pradesh, India from February 2019 to July 2019. Ethical approval (IEC/2019/02/01) for the study was obtained from the Institutional Ethical Committee (IEC) before beginning of the study.

Presuming the prevalence rate of dry eye as 19% with the precision of 7% and a confidence limit of 95% the sample size calculated was 120. Thus, 120 employees out of total employees of any age group of either sex working on computers and other digital displays in various departments of institute were enrolled by simple random sampling for the study.

Employees unwilling to give informed consent, having best corrected visual acuity less than 6/18 by Snellen's chart, working on computers or digital displays irregularly, regular contact lens wearer, having gross ocular surface disorder and taking any medications that may cause dryness of eyes were excluded from the study.

For data collection all the enrolled participants (n=120) were divided into 10 sub-groups. The data was collected at ophthalmology OPD from each participant initially by completing OSDI questionnaire followed by other tests for every sub-group.

A well designed case record form was used to record the required information from the participants. To analyse the impact of varying duration of computer usage all the study participants (n=120) were divided into two study groups on the basis of number of working hours per day in front of computer or digital displays. Group I (n=58) included participants who worked less than six hours per day on computers and digital display, while group II (n=62) included participants who worked for more than six hours per day on computers and digital displays.

OSDI questionnaire was provided to all the participants for completion [11]. After collection of filled OSDI questionnaire sheets, visual acuity of participants was tested using Snellen's chart [11]. Subsequently, Schirmer I test and TFBUT test (15 minute after Schirmer I test) were performed on the participants.

Tear Film Break-Up Time (TFBUT): TFBUT was estimated by observing the time interval between last blink and first appearance of dry black spot using sterile fluorescine strip [4,8]. Mean TFBUT value of right and left eyes were considered for statistical analysis. A value of more than 10 seconds for the first appearance of a black spot was considered as normal and a value 7-10 seconds was considered as mild/moderate dry eye, whereas value of less than 6 seconds was recorded as severe dry eye [4,8].

Schirmer test: To perform this test standard sterile filter strips of 35 × 5 mm were used. The strip was folded about 5 mm at one end and was inserted into the lower eyelid (at the junction between medial two third and lateral one third) without touching the cornea or eyelashes. The amount of strip wetness was observed after five minutes [8]. During test duration all external stimuli like fan and air conditioner etc were switched off and patient was instructed not to blink. As no topical anaesthesia was used for Schirmer I test, a wetness reading on sterile strip of more than 15 mm was considered as normal; wetness of 10-15 mm was mild/moderate dry eye and ≤10 mm wetness of strip was considered as severe dry eye [12]. Mean ST value of right and left eyes were taken for statistical analysis [11,12].

Ocular Surface Diseases Index (OSDI): OSDI is a commonly used tool to assess the seriousness of DED as well as to evaluate the effectiveness of therapy used for dry eye treatment [13].

OSDI questionnaire consists of total 12 items distributed in three subscales (A, B and C). Subscales A, B and C are used to evaluate the dry eye symptoms, performance limitations due to eye problem and the contributing environmental factors at workplace, respectively [7]. Questions in all the subscales were assessed at 5-point Likert scale from 0 (none of the time) to 4 (all the time). Total number of questions answered by the participants were recorded as N [7]. The OSDI score was calculated as **OSDI score=(A+B+C)×25/N [6]**. OSDI score ranges from 0-100 where 0-12 score represents normal, 13-22 mild DED, 23-32 moderate DED and 33-100 severe DED [4]. Higher OSDI score indicates the greater degree of dryness and helps in distinguishing between normal and DED patients [13].

STATISTICAL ANALYSIS

Data was analysed using Statistical Package for Social Sciences 16.0 (SPSS, IBM). Values were presented as actual number, percentage, mean and standard deviation (mean±SD). Both study groups were compared by student's unpaired t-test. Pearson's correlation coefficient was performed to analyse correlation of OSDI score with TFBUT and ST values. The p-value of <0.05 was considered as statistically significant.

RESULTS

A total of 120 participants including 86 (71.6%) males and 34 (28.4%) females were enrolled for this study. Mean age of all study participants was 31.48±9.0 years. Out of total 120 participants 58 (48.3%) belonged to Group I (using computer or digital devices <6 hours/day) with mean age of 32.4±10.3 years, while 62 (51.6%) belonged to group II (using computer or digital devices >6 hours/day) with mean age of 30.64±7.6 years [Table/Fig-1].

Characteristics	Total participants (n=120)	Group I (n=58) (<6 hours/day)	Group II (n=62) (>6 hours/day)
Age (Mean±SD)	31.48±9.0	32.4±10.3	30.64±7.6
Male (Mean±SD)	33.27±9.5	35.8±11.2	31.5±7.8
Female (Mean±SD)	26.94±5.5	27.45±6.2	25.7±3.65
Gender n (%)			
Male	86 (71.6)	34 (58.6)	52 (83.8)
Female	34 (28.4)	24 (41.4)	10 (16.2)
Age range (years) n (%)			
21-30	64 (53.4)	31 (53.4)	33 (53.2)
31-40	34 (28.2)	14 (24.2)	20 (32.2)
41-50	14 (11.6)	7 (12.0)	7 (11.2)
Above 50	8 (6.6)	6 (10.4)	2 (3.2)
Visual acuity n (%)			
6/6-6/9	66 (55)	34 (58.6)	32 (51.6)
6/12-6/18	54 (45)	24 (41.4)	30 (48.4)

[Table/Fig-1]: Distribution of participants according to demographic characteristics and visual acuity.
n: Number of participants; SD: Standard deviation

Number of participants having OSDI score ≤12 (normal/no dry eye) in group I were 6 (10.34%) whereas, in group II none of the participants had OSDI score ≤12. An OSDI score ≥33 (severe dry eye) was found in 38 (65.52%) participants of group I and 54 (87.1%) participants of group II. Overall, prevalence of dry eye in group I and group II in participants having OSDI score ≥13 was 52 (89.6%) and 62 (100%), respectively [Table/Fig-2].

A 26 (44.82%) participants of group I and 11 (17.74%) participants of group II had TFBUT value of ≥10 seconds (normal/no dry eye). TFBUT ≤6 seconds (severe dry eye) was observed in 12 (20.68%) of group I and 29 (46.77%) of group II participants. DED prevalence

Participants n (%)	Ocular Surface Disease Index (OSDI) score		
	Normal/No dry eye ≤12	Mild/Moderate dry eye 13-32	Severe dry eye ≥33
Group I	6 (10.34)	14 (24.14)	38 (65.52)
Group II	Nil (0)	8 (12.9)	54 (87.1)
Total	6 (5.0)	22 (18.34)	92 (76.66)

[Table/Fig-2]: Distribution of participants according to scoring of OSDI in study groups
n: number of participants

having TFBUT score ≤10 seconds was found 32 (55.2%) in group I and 51 (82.2%) in group II participants [Table/Fig-3].

Participants n (%)	Tear Film Break-up Time (seconds)		
	Normal/No dry eye ≥10 seconds	Mild/Moderate dry eye 7-10 seconds	Severe dry eye ≤6 seconds
Group I	26 (44.82)	20 (34.48)	12 (20.68)
Group II	11 (17.74)	22 (35.48)	29 (46.77)
Total	37 (30.83)	42 (35)	41 (34.16)

[Table/Fig-3]: Distribution of participants according to TFBUT in study groups.
n: number of participants

ST value of ≥15mm wetness (normal or no dry eye) was present in 19 (32.75%) and 12 (19.35%) of group I and group II participants, respectively. The ST value of ≤10 mm wetness was observed in 17 (29.31%) of group I and 30 (48.38%) of group II participants. Prevalence of DED on the basis of ST score ≤15 mm was 39 (67.2%) in group I and 50 (80.6%) in group II participants [Table/Fig-4].

Participants n (%)	Schirmer test (ST) score (mm)		
	Normal/No dry eye ≥15 mm wetness	Mild/Moderate dry eye 10-15 mm wetness	Severe dry eye ≤10 mm wetness
Group I	19 (32.75)	22 (37.94)	17 (29.31)
Group II	12 (19.35)	20 (32.25)	30 (48.38)
Total	31 (25.83)	42 (35)	47(39.16)

[Table/Fig-4]: Distribution of participants according to ST values in study groups.
n: number of participants

Mean OSDI score for group I and II was 37.39±8.98 and 49.54±11.7, respectively (p<0.001). Mean TFBUT for group I and group II was 10.19±2.27 seconds and 8.12±2.9 seconds, respectively (p<0.001). Mean Schirmer values were 12.82±3.32 mm and 10.8±3.86 mm for group I and group II participants, respectively (p=0.0027) [Table/Fig-5].

Participants	OSDI score	TFBUT (seconds)	Schirmer Test (mm)
Group I (n=58)	37.39±8.98	10.19±2.27	12.82±3.32
Group II (n=62)	49.54±11.7 (p<0.001**)	8.12±2.9 (p<0.001**)	10.80±3.86 (p=0.0027*)
Total (n=120)	43.46±12.2	9.12±2.8	11.78±3.7

[Table/Fig-5]: Mean Ocular Surface Disease Index (OSDI) score, Tear Film Break-Up Time (TFBUT) and Schirmer Test (ST).
Data were represented as mean±SD. The unpaired student's t-test was applied to compare data between group I and group II. p<0.05 *statistically significant; p<0.001 **statistically highly significant

The prevalence of severe dry eye (i.e., OSDI score ≥33, TFBUT ≤6 seconds and Schirmer value ≤10 mm) increased proportionally with the advancement of age of the participants [Table/Fig-6].

Age group (years)	Number of participants	OSDI score (≥33) n (%)	TFBUT (≤6 seconds) n (%)	ST (≤10 mm) n (%)
21-30	64	45 (70.31)	17 (26.56)	19 (29.68)
31-40	34	27 (79.41)	12 (35.29)	14 (41.76)
41-50	14	12 (85.71)	7 (50)	8 (57.14)
Above 50	8	8 (100)	5 (62.5)	6 (75)

[Table/Fig-6]: Distribution of severe dry eye according to age group of participants.
n: Number of participants

Statistically, highly significant inverse correlation was found between OSDI and TFBUT scores in group I and group II. Similarly a statistically, significant inverse correlation was observed between OSDI and ST scores in group I as well as in group II [Table/Fig-7].

Group	OSDI score			
	Group I		Group II	
	r	p-value	r	p-value
TFBUT	-0.557	<0.001**	-0.439	<0.001**
ST	-0.787	<0.001**	-0.320	0.011*

[Table/Fig-7]: Correlation analysis between OSDI score, TFBUT and Schirmer Test (ST) in study groups.
r: Correlation coefficient; *Correlation significant at the 0.05 level; **Correlation significant at 0.001 level

DISCUSSION

The present study was carried out to compare the OSDI scores, TFBUT and ST values in participants who used computer or digital display daily for varying durations. In the present study, mean OSDI score in group II participants who used computer for more than six hours per day was higher (49.54±11.7) than the group I participants who used it for less than six hours per day (37.39±8.98) and there was statistically significant difference between the two groups (p<0.001). These results indicate that the symptoms of dry eye enhance as the duration of exposure to computer screen or digital displays increases. In a study, Patil SD et al., found that in the subjects who used computers for more than six hours daily, the mean OSDI score (38.86) was significantly (p<0.001) higher as compared to subjects who used computers 4-6 hours per day (mean OSDI= 27.99) and 2-4 hours per day (mean OSDI= 26.59) [14]. Findings obtained from the study of Gajta A et al., also confirmed that working on a computer for longer time significantly increases the risk of DED [7]. In their study, mean OSDI score (63.24±14.83 vs. 33.16±10.58) was found more in computers users (8-10 hours daily) than who used computers occasionally [7]. In another study Bayhan HA et al., compared the OSDI score of computer users group with non-computer users groups and found statistically significant (p<0.005) difference between the mean OSDI score (42.84±23.95 vs. 9.75±10.65) of both the groups [15]. However, results of present study are in contrast with the study of Akkaya S et al., in which no significant difference in OSDI score between the computer (8 hours/day) and non-computer users (<1 hours/day) was observed [16].

A significant difference (p<0.001) was found when mean TFBUT value of participants of group I (10.19±2.27 seconds) was compared with participants of group II (8.12±2.9 seconds) which indicates that stability of tear film decreased considerably in the participants using computer for more than six hours daily. Several previous studies have reported significant decrease in TFBUT in the computer users as compared to non-computer users [15-17]. In one study, TFBUT was found to be 16.15 seconds in the right eye and 16.6 seconds in left eye in the computer users (less than six hours daily) while it was 11.51 seconds in right eye and 12.6 seconds in left eye in the users (more than six hours daily) [14]. These results support the notion that continuous staring on computer screen is associated with incomplete blinking as well as decrease in the blink rate thus leading to evaporation of tears and tear film instability [8,16,18].

In present study mean value of ST was 11.78±3.7 mm in all enrolled participants. In Group I and II the mean ST values were 12.82±3.32 mm and 10.8±3.86 mm, respectively (p=0.0027). Unlu C et al., in their study reported mean ST score of 25.80±8.43 mm in the subjects who spent more than six hours in front of computers which is comparatively higher than present study finding [11]. Another study performed by Patil SD et al., showed lower ST values (Right Eye=12.51 mm, Left Eye=11.6 mm) in subjects using computer more than six hours than who used computer for less than six hours (Right Eye=20.68 mm, Left Eye=20.65 mm) [14]. Similarly, in a study performed by Lam DK et al., a statistically significant difference in the mean ST score (p=0.026) was found between computer user groups working on computer <3 hours per day and >3 hours per day [10]. However, in some studies no significant difference in ST values was found between the computer and non-computer users' groups [16,19]. Possible explanation for conflicting results of ST values reported in some studies between computer and non-computer users' group may be due to reflex tearing and/or use of topical anaesthesia that may alter the secretion and drainage of tear system and results in variable ST values [19].

In present study, ST value of less than 10 mm was found in 29.31% and 48.38% computer users' participants of group I (<6 hours/day) and group II (>6 hours/day), respectively. In a similar study Gajta A et al., reported ST value of <10 mm in 24.42% subjects who used computer occasionally and 42% in those who used computer daily for 8 to 10 hours [7]. Another study done by Damle V et al., showed that 11% subjects using computers 6-9 hours/day and 8% patients using computers <6 hours/day had severe dry eye [8]. In contrast to present finding in a study of Unlu C et al., only 5% of patients showed ST value ≤10mm [11]. Results of ST may vary and may not be correlated with symptoms of dry eye as indicated in various previous studies. There may be epiphora due to reflex mechanism during ST and result of test may be misinterpret as normal even though patient is having DED [11,20].

In this study, 65.5% of participants of group I and 87.1% participants of group II had high OSDI score (≥ 33) whereas, 20.6% of group I and 46.7% of group II participants had reduced TFBUT (≤ 6 seconds) values indicating that high OSDI scores corresponds to reduction in TFBUT. Similarly, Ozcura F et al., in their study found that mean TFBUT was less than five seconds in subjects having high OSDI score [21]. Unlu C et al., also noted that 35% and 42% of computer users had severe dry eye in their study on the basis of high OSDI score and low TFBUT value, respectively [11]. These findings of high OSDI score and lower TFBUT among computer users for diagnosis of dry eye have been further supported by other studies [18,22].

In present study, on the basis of OSDI score, TFBUT and ST values, the overall prevalence was 89.6%, 55.2% and 67.2%, respectively in subjects using computers for less than six hours daily (group I) while it was 100%, 82.2% and 80.6%, respectively in computer users more than six hours daily (group II) indicating that exposure to computer screen or digital displays for longer duration increases the evaporation of tear and symptoms of dry eye. Study done by Patil SD et al., on computer users showed that prevalence of dry eye on the basis of OSDI score was 33.3% (computer usage 4-6 hours per day) and 74.28% (computer usage 6-8 hours per day) indicating that prevalence of dry eye increases with the hours of computer usage per day [14].

Various studies done in previous years have shown that with the increase in the age of person, the prevalence of DED had increased [2-4]. In the present study also, the percentage of participants diagnosed with DED on the basis of OSDI, TFBUT and ST were higher in the groups of participants with advanced age (41-50 and >50 years). Structure and function of lacrimal gland undergo modification with increase in age leading to reduction in the production of tear so it might be responsible for more prevalence of DED in elderly population [2]. A study done previously by Patil SD et al., reported prevalence of dry eye 13.04% among 20-30 years and 51.64% among 31-40 years age group in computer users suggesting that dry eye prevalence increases with advancement of age [14]. However, Uchino M et al., found no age related trend in relation to prevalence of dry eye among visual display terminal users, probably because the majority (68.8%) population in this study was between 30-49 year age group [23]. These observations prove that prevalence of DED progressively increases with long duration exposure to computers or digital display devices along with the advancing age of persons working on computers.

Correlation analysis was also performed in both study groups to find out degree of correlation of OSDI with TFBUT and ST according to the duration of daily usage of computer. We found significant inverse correlation between OSDI and TFBUT (r=-0.557, p<0.001) in group I and (r=-0.439, p<0.001) in group II as well as OSDI and ST values (r=-0.787, p<0.001) in group I and (r=-0.320, p=0.011) in group II, indicating that as the stability of tear film (decreased TFBUT) and tear production (decreased ST) reduced, the symptoms related to dry eye (OSDI score) are increased. Few researchers Unlu C et al., (r=-0.385, p=0.022), Ozcura F et al., (r=-0.296, p=0.014) and Suman S and Goyal P (r=-0.597, p<0.001) have also reported inverse correlation between OSDI and TFBUT in their studies done on computer users [11,21,24]. However, in contrast to present study no significant correlation was found between the OSDI score and ST values (Unlu C et al., r=-0.133, p=0.445, Ozcura F et al., r=-0.182, p=0.138 and Suman S and Goyal P, r=-0.142, p=0.158) in these studies [11,21,24].

Limitation(s)

The study had some limitations and more large scale studies need to be conducted to establish the effects of variable durations of computer usage on the different dry eye parameters and the prevalence of DED. Control groups of age and sex matched non-computer users were not included in this study. Furthermore, other confounding factors such as history of smoking and alcohol consumption, concomitant medication use, past eye procedures or surgeries were not considered in this study which may alter the stability of tear film and may influence the results.

CONCLUSION(S)

In the present study, an attempt was made to observe the effect of computer exposure for variable durations on dry eye parameters. Continuous exposure to the digital screen radiations and advancement of age is associated with decreased blinking rate and reduction in tear secretions as well as excessive tear evaporation, predisposing the person to DED. This study concluded that prevalence and severity of DED increases with the increase in number of working hours spent on computer or digital display devices. OSDI score with TFBUT and ST can be used as easier, less costly and wider approach methods to diagnose the DED among computer users.

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PARTICULARS OF CONTRIBUTORS:
1. Assistant Professor, Department of Ophthalmology, Rajshree Medical Research Institute, Bareilly, Uttar Pradesh, India.
2. Professor, Department of Ophthalmology, Saraswati Institute of Medical Sciences, Ghaziabad, Uttar Pradesh, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Amit Kumar Jain,
Department of Ophthalmology, Rajshree Medical Research Institute,
Bareilly, Uttar Pradesh, India.
E-mail: dramitjain75@gmail.com

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