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Diagnosis and management of transient smartphone blindness: A literature review

Azzahra Afifah*[1,2,3], Fara Syafira[2], Dini Dharmawidiarini[3]

[1]Undaan Eye Hospital, Surabaya, Indonesia
[2]Faculty of Medicine, Universitas Sriwijaya, Palembang, Indonesia
[3]Lens, Cornea and Refractive Surgery Division, Undaan Eye Hospital, Surabaya, Indonesia

Literature Review

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***Corresponding author:**
zahraaff4@gmail.com

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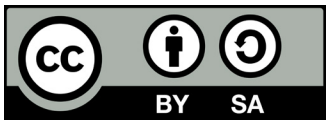

ABSTRACT

The development of smartphones worldwide has rapidly increased the number of smartphone users. Although smartphones have many benefits, prolonged use causes various visual disorders, of which transient smartphone blindness (TSB) is one of the most important concerns. This study aims to analyse the phenomenon of TSB and explore its etiology, pathophysiology, symptoms, and examination to determine the diagnosis and management. Transient smartphone blindness is a new physiologic phenomenon caused by exposure to a certain level of smartphone bright light and the body posture of the smartphone user. It leads to the use of monocular vision to stare at the smartphone. By exploring recent literature, this study found that patients with TSB experienced retinal photopigment bleaching, which decreased light sensitivity. Typically, the sensitivity returned physiologically after several minutes. Patients with this blindness showed several symptoms. For example, they perceived shapes, outlines, or figures during the blackout. The diagnosis of TSB should be primarily based on a detailed history of smartphone use, with the differential diagnosis based on circumstance or occurrence. This diagnosis is useful to distinguish it from transient ischemic attack (TIA). Transient smartphone blindness is a basic monocular transient loss that does not require therapy or drugs. However, it was found that the reassurance of patients' condition and suggestions on smartphone use were sufficient for the intervention. With a limited scientific study of TSB, this review is the first to raise the discussion topic. It is expected to help physicians to diagnose TSB significantly. In addition, this study will enrich the literature, particularly on the scientific and clinical mechanisms of recognising TSB for clinical diagnosis and management.

Perkembangan ponsel pintar di seluruh dunia telah meningkatkan jumlah pengguna ponsel pintar dengan cepat. Meskipun ponsel pintar memiliki banyak manfaat, tetapi penggunaan ponsel pintar yang berlebihan menyebabkan berbagai gangguan visual, di antaranya adalah TSB yang menjadi salah satu perhatian utama. Penelitian ini bertujuan untuk menganalisis fenomena TSB dan menggali etiologi, patofisiologi, gejala, dan pemeriksaan untuk menentukan diagnosis dan penanganannya. TSB adalah fenomena fisiologis baru yang disebabkan oleh paparan cahaya terang dari ponsel pintar pada tingkatan tertentu dan posisi tubuh pengguna ponsel pintar, sehingga mengakibatkan penggunaan penglihatan monokuler untuk menatap layar ponsel pintar. Dengan mengeksplorasi literatur terkini, kami menemukan bahwa pasien dengan TSB mengalami kondisi pemutihan pigmen fotoreseptor retina yang mengakibatkan penurunan sensitivitas terhadap cahaya. Biasanya, kondisi ini pulih secara fisiologis setelah beberapa menit. Pasien dengan kondisi ini menunjukkan beberapa gejala. Misalnya, mereka melihat bentuk, garis, atau gambar selama kehilangan penglihatan sementara. Diagnosis TSB harus didasarkan pada riwayat penggunaan ponsel pintar yang terperinci, dengan diagnosis banding berdasarkan keadaan atau kejadian. Hal ini untuk membedakannya dari TIA. Transient smartphone blindness merupakan keadaan kehilangan penglihatan monokuler sementara

yang tidak memerlukan terapi. Namun, ditemukan bahwa memberikan kepastian kondisi pasien dan saran penggunaan ponsel pintar sudah cukup sebagai intervensi. Penelitian ilmiah tentang TSB saat ini memang kurang. Tinjauan literatur ini kemudian menjadi yang pertama dalam membahas topik pembahasan ini, sehingga diharapkan dapat membantu dokter dalam mendiagnosis TSB. Selain itu, kajian ini akan memperkaya literatur, terutama tentang mekanisme ilmiah dan klinis pengenalan TSB untuk diagnosis klinis dan pengelolaannya.

INTRODUCTION

The development of smartphones worldwide has rapidly increased the number of smartphone users compared to conventional mobile phones.[1] The latest report shows that smartphone users have reached 5.2 billion and are forecasted to reach 6.2 billion in 2028.[2] With adolescents and young adults as the dominant users,[3,4] smartphones have become a necessity of society in this technological era. It can perform multiple functions and tasks that can make life much easier,[4] bring many beneficial effects of technology use and facilitate social interaction.[5] Despite the benefit of its convenience, the prolonged use of smartphones burdens the visual system and generates various visual disorders, one of which is TSB.[4,6]

Transient smartphone blindness is a visual disorder that has just been found recently. It was introduced in 2016 and described as a temporary monocular vision loss due to excessive smartphone use when people lay down in the dark.[7] This new phenomenon affects vision with unknown conditions.[8] However, physicians and smartphone users must immediately pay attention to anticipating its long-term consequences.[9] The loss of vision is generally a patient's concern. At the same time, healthcare providers are concerned about the serious underlying conditions[10] and the potential misdiagnosis of TSB.[8,11] With a typically unilateral vision loss, TSB is more likely to make patients have physical and mental health issues.[12] Thus far, TSB is recognised as a physiologic phenomenon associated with differential retinal light sensitivity,[13] with consistently a time course with the patients' accounts.[14]

Reports reveal that smartphone users consistently spend more time staring at the screen than users of ordinary mobile phones.[3] This activity makes the eyes the most affected organ by smartphone overuse,[15] particularly its effect in the dark setting.[16] Thus, recent publications claim that examining smartphone blindness is essential to avoid unnecessary investigations, misdiagnosis,[8] and life-long medication use.[11] However, more data in the medical literature is needed to understand how smartphones affect the eyes.[17] Visual disorders have been an irrefutably global challenge, distributed to different age groups, and significantly affected the economic and financial sectors.[18] The latest data showed that in 2020, 1.1 billion people worldwide have visual impairment. Among this, 43 million were classified blind, 295 million were at moderate to severe level, 258 million were at a mild level, and the remaining had weakened vision.[19] More than 80% of them live in developing countries.[18]

Despite the growing number of studies on visual impairment, those specifically investigating transient smartphone blindness are very limited. Recent evidence has been revealed in clinical case reports of these limited studies.[7,11,20,21] Other studies introduce and suggest precautions needed to prevent TSB,[9] as well as figure out the link between smartphone screen time and digital eye strain.[22] A neuro-ophthalmic approach has also been investigated to localise the diagnosis of transient vision loss.[6] However, it classifies various retinal disorders and only the pinpoint of the study that specifically discusses the symptoms of TSB. Indeed, some studies have attempted to provide literature on transient smartphone blindness[23] and to systematically review smartphone use and how it affects the eyes.[4] However, their scope is restricted to the occurrence of visual impairments directly associated with smartphone use. In short, no studies specifically conducted a literature review on TSB.

For this reason, this study aimed to fill the gap by reviewing numerous studies on TSB. This study reviews the latest publications on transient smartphone blindness by elucidating its aetiology, pathophysiology, symptoms, and examination to determine its diagnosis and management. To our knowledge, this study is the first to review this topic and is expected to help physicians diagnose TSB. In addition, it can enrich the literature, particularly on the scientific and clinical mechanisms of recognising TSB for clinical diagnosis and management.

Etiology

Transient smartphone blindness is a new condition of visual problems.[20] Some clinical cases reported that TSB might be caused by prolonged smartphone usage for a certain period while switching the lights off.[7,11,13,20,21] In addition, TSB is influenced by a certain level of light emitting from a smartphone and the body posture of the smartphone user. These make people use monocular vision to stare at the smartphone.[13] Precipitated by bright light, photoreceptors cannot regenerate photopigment normally,[24] particularly if the eye is regularly exposed to a bright smartphone screen in a dark setting.[11] Furthermore, the smartphone user's posture is on the side of his or her body, which is opposite the affected eye[6] It occurs when a blue light smartphone emits, thus promoting the development of the TSB.[9] Some patients who suffered TSB have been reported to have a history of long-time use of smartphones,[7,13,20] Several studies argue that spending more time on a smartphone statistically contributed to visual impairment.[12,15]

Pathophysiology

Patients with TSB showed the condition of retinal photopigment bleaching that causes light sensitivity to decrease. Typically, the vision returns physiologically after several minutes.[23] This "bleaching" was reported as the effect of the transient depletion of 11-cis-retinal, which cannot recover quickly. These findings were then tried to be re-investigated by a group of researchers, e.g., Alim et al., using objective electroretinogram (ERG) recording. This study found that a smartphone screen in a slightly low light setting with one covered eye indicated that the visual sensitivity of the uncovered eye decreased after the screen was turned off, although it would return in several minutes. In particular, the B-wave amplitude decreased in the light-exposed eye. It sheds light on the potential risks associated with smartphone usage in certain conditions. It emphasises the need for awareness and precaution regarding this transient smartphone-induced visual impairment, especially in the context of increasing smartphone usage.[7,25]

The specific part of the retina affected by transient smartphone blindness has been investigated. For instance, Mahroo et al. reported that the condition arose from interocular differences in retinal adaptational states. This means that one eye adjusts to the dark while the other is emitted to the bright light of the smartphone screen. The contrast between the two eyes' adaptive states can lead to transient blindness for the eyes exposed to bright light.[14] Yamauchi et al. discussed the occurrence of transient macular damage in individuals following prolonged smartphone usage. The study presented cases where patients, particularly young individuals, experienced macular damage detectable through optical coherence tomography (OCT) after prolonged staring at smartphone screens. This phenomenon is highlighted as a potential consequence of excessive smartphone usage, shedding light on the impact of digital devices on ocular health, especially in younger populations.[26]

Scholars recorded that patients with TSB had similar eye conditions of differential bleaching of retinal photopigment. The observations indicated that the eye not covered by a pillow adjusted to light, while the covered eye adapted to darkness.[6,7] As a result, when both eyes were exposed to darkness, the eye that had adapted to light appeared to be blind, and this difference in adaptation could persist for several minutes. This phenomenon demonstrates the duration of scotopic recovery following exposure to a bright light.[7,13] A peculiar phenomenon where individuals experience transient monocular visual loss after looking at their smartphone screens in the dark with one eye while the other eye is occluded. This phenomenon is attributed to the light adaptation process of the eyes, where one eye is adapted to the dark while the other is exposed to the bright light from the smartphone screen. The right eye could only perceive the outlines of objects in darkness or when the lights were turned off. The authors present two cases of this TSB and suggest that this phenomenon is likely underreported and underrecognised.[7] A report presented a case of a perplex rarity recurrent transient, monocular visual loss caused by differential bleaching of the retinal pigment.[13] The degree of visual impairment experienced was not complete as it resulted from the photolysis of a fraction of rhodopsin. This phenomenon elucidates why individuals affected by this condition typically still perceive shadows or figures, enabling clinicians to distinguish it from more severe conditions.[20]

Available literature offers a few potential mechanisms. Firstly, the retinal adaptation mechanism is related to interocular differences in retinal adaptational states. When using a smartphone in the dark, one eye may be adapted to the darkness. Meanwhile, the other eye is exposed to the bright light emitted by the smartphone screen. This difference adapts the retina, leading to temporary vision loss in the eye exposed to smartphone light.[14]

After that, excessive smartphone use, particularly when walking or in distracting environments, has been associated with inattentional blindness. Inattentional blindness refers to individuals failing to notice unexpected stimuli because their attention is distracted. This may occur when individuals are engrossed in their smartphones and fail to perceive their surroundings. Likewise, this condition can make people lose their vision temporarily.[27]

Then, the multiple functions of smartphones nowadays have increased their complexity and the cognitive demands of users. Phone activities like prolonged texting or gaming may contribute to transient smartphone blindness. These tasks require significant attention and cognitive resources, which can lead to decreased situational awareness and inattention blindness.[27]

Symptoms

Visual symptom of TSB is typically monocular, painless, and sudden.[28] The symptoms are dissimilar to amaurosis fugax. It is transient vision loss, which is commonly caused by vascular, neurologic, or ophthalmic. Transient smartphone blindness does not show physical symptoms, but the light-adapted eye can see the shape, outline, or figure.[7,11,20] Typically, the symptoms manifest on the opposite side of the body on which the individual was lying. This occurs because when lying down, one eye experiences dark adaptation due to light blockage while the other eye continues to undergo normal visual adaptation.[9] Transient smartphone blindness is a transient vision loss disturbance after viewing a smartphone in that scotopic setting.[6] As generally a transient visual disturbance, TSB occurs shortly and lasts beyond one hour.[28] Clinical case reports confirmed that patients had TSB for 5 to 30 minutes, with the length of smartphone use prior to the blackout being 15 to 60 minutes.[7,11,20,21] Table 1 provides a compilation of clinical reports that discuss TSB, as described in various sources

Moreover, the symptoms occurred most often at night. A patient was even reported to have it until morning.[13] It usually occurs when the patients excessively stare at the smartphone's bright screens before the lights are switched off,[11] and the same symptom is exposed in their affected eye's vision, such as shapes, outlines, or figures.[7,11]

Examination

A thorough medical history and clinical examination may explain the TSB diagnosis.[10,30] It is possible to improve the examination to include systemic evaluation beyond the visual system,6 such as the records of the patient's frequency of using a smartphone in bed after turning off the lights in the evening.[30] So far, available TSB examination in the medical literature follows the transient monocular vision loss examination. An ophthalmological examination can be conducted

Table 1. Clinical case reports on transient smartphone blindness

Author	Smartphone use before blackout	Length of "blackout"	Affected eye	Timing
Alim-Marvasti et al. (2016)[7]	Several minutes	15 minutes (2-to-3 times a week at night)	Right	Night
Irshad & Adhiyaman (2017)[11]	30-60 minutes	5-20 minutes	Right	Night
Yamauchi et al. (2018)[26]	60 minutes	5 minutes	Left	Night
Huang et al. (2019)[29]	8 hours	Within sometime	Both	Night
Arunkumar & Sood (2020)[13]	15-20 minutes	Within sometime	Right	Morning
Eriksen & Jorstad (2021)[30]	40 minutes	10-15 minutes	Right	Night
Robles-Amor (2022)[20]	40 minutes	5 minutes	Right	Night
Amarnath (2020)[21]	45 – 60 minutes	20-30 minutes	Right	Night

as an initial examination to check afferent visual functions.[6] In addition, the possible examination can involve an anterior segment, fundoscopy, and OCT.[13] Other examinations include fundus examination with an indirect ophthalmoscope and photo stress test to utilise this photoreceptor bleaching phenomenon.[14] However, in some clinical cases, ophthalmic, cardiovascular,[7,24,31] and cerebrovascular[13] examinations on patients were found normal. This result rules out any severe ocular disease and underlines that the history is sufficient for the diagnosis.

Differential diagnosis

Diagnosis of TSB must be conducted thoroughly to produce correct results. Any error in diagnosis can be harmful to patients. For instance, if patients were mistakenly diagnosed with amaurosis fugax, they may be unnecessarily commenced on anticoagulation, such as aspirin.[7] Therefore, with the growing access to smartphones among people, this physiological phenomenon should be carefully considered before a more severe disorder is identified and therapy begins. This is so especially considering the side effects that therapy may cause to the patients.[32]

The diagnosis of TSB is suggested to consider the detailed medical history, which is vital to prevent costly hospitalisations.[23] As TSB is a new disorder, a detailed history of the use of smartphones will give the diagnosis an important history of how much exposure to screen time has been received by the patients. It realises that the symptoms of TIA or multiple sclerosis are ruled out.[9]

History

Clinical diagnosis of transient smartphone blindness is essentially based on the history of monocular viewing (Table 2).[14] The history of patients provides specific data that may either increase or decrease the probability of TSB. Therefore, it is suggested that the diagnosis of TSB should be considered as one of the potential causes in the differential diagnosis of transient monocular blindness,[13] which specifies clinical manifestation, duration, and circumstance when the TSB episode occurred.[28]

The clinical manifestation of TSB may not be perceived physically,[28] as based on some findings, an affected eye was examined in normal condition.[7,11] The vision phenomena endured by the patients were shapes, shadows, or figures,[7,11,20] which may confirm the diagnosis. The history of patients for diagnosis should also mainly consider the duration.

Table 2. Transient smartphone blindness according to circumstances or occurrences.

Circumstances of occurrence	Key findings
Smartphone overuse	The history of smartphone overuse prior to the occurrence of TSB.
Exposure to smartphone light	Light sensitivity: retinal photopigment bleaching leads to decreased light sensitivity to a light-adapted eye in a dark setting.
Posture	Smartphone users lie on one side (frequently left) while glancing at their smartphone.
Duration	5 to 60 minutes. It mostly occurs at night and tends to occur in the morning.
Vision phenomena	Photolysis of a fraction of rhodopsin: An affected eye perceives shape, shadow, and/or figure.

TSB: Transient smartphone blindness

Psychophysical evaluation

Scholars suggest that TSB diagnosis should involve a detailed history of how patients use their smartphones on a daily basis.[9] This suggestion is due to the transient nature of the disorder, which makes the ocular examination often normal. However, when the history is non-contributory, the examination can explain the cause of TSB.[28] In addition to general ophthalmological assessment as the initial examination for TSB diagnosis, the recovery sensitivity of the disorder can be explained by psychophysical evaluations, which determine visual sensitivity when viewing the smartphone and after the recovery.[7] This further examination is done by considering that the patients with this ocular disorder cannot be reassured.[31] Psychophysical testing was conducted by adapting to patients' circumstances to lose vision in one eye adapted to a dark setting. It is

mainly to recreate the circumstances that caused the disorder to help confirm the diagnosis.[6] By analysing electrophysiologically, a study on TSB with psychophysical testing concluded that visual sensitivity experienced a significant decline following smartphone usage. It took several minutes for the sensitivity to recover, and this decrease in sensitivity was quantifiable at the retina level.[7] Hence, the observed variation in sensitivity, which is a physiological but uncommon phenomenon, indicated that there might be an issue with the retina.[14]

Distinguishing TSB from TIA

Transient smartphone blindness is a new eye disorder in medical science. Several publications reported that some attending physicians misdiagnosed patients with TSB as TIA,[7] which definitely caused unnecessary treatment. Therefore, the differential diagnosis should also be conducted under the transient monocular blindness causes in distinguishing TSB from TIA.

Transient ischemic attack has obviously different mechanisms, symptoms, and clinical manifestations with TSB. While TIA is based on focal neurologic signs or symptoms[33] caused by cerebral, spinal cord or retinal ischemia,[28] TSB is a retinal phenomenon, basically an ocular disorder[7] and non-ischemic ocular disease.[28] Moreover, TIA shows symptoms in the face, arms, and speech, which show clear clinical signs, such as vertigo, dizziness, loss of balance, weakness, and others.[34,35] In contrast, TSB only shows the shape or figure in one eye vision,[11] with no serious condition.

Compared to the difference in symptoms and mechanisms, the duration and frequency of TIA and TSB are quite similar. Low-risk TIA occurs between 1-60 minutes and higher risk is more than 60 minutes with a frequency of many (high risk) to one or few occurrences (low risk).[33] Similarly, some clinical reports showed that TSB started from the minute after using the smartphone to 30 minutes, but with less frequency.[7,11,13,20,21]

Table 3. The differences between TSB and TIA

Clinical features	Transient ischemic attack	Transient smartphone blindness
Mechanism	Transient thromboembolic events in the vertebrobasilar circulation.	A smartphone user with a history of prolonged smartphone use views a smartphone in the dark monocularly, which causes differential bleaching of retinal photopigments.
Symptom	Difficulty in seeing (blur) with single or both eyes or double vision, vertigo, dizziness, or loss of balance or coordination Weakness or ischemic numbness.	Patients suffer temporary vision loss after viewing a smartphone in a scotopic setting. Monocular (unilateral), painless, and sudden. Perceived a shadow or figure, and non-ischemic.
Duration	1-60 minutes, even 24 hours	1 to 60 minutes
Frequency	Many (low risk) and less (high risk)	Less
Diagnosis Evaluation	Neuroimaging with cranial CTA, or MRI/A can be useful.	History of monocular transient viewing. Ophthalmological examination

TIA: Transient ischemic attack, TSB: Transient smartphone blindness, CTA: Computed tomography angiography, MRI/A: Magnetic Resonance Imaging/Angiography

Management of TSB

Transient smartphone blindness is a retinal sensitivity phenomenon,[14] classified as a source of transient monocular vision loss.[6] Based on several reports, patients were misdiagnosed with TIA; thereby, they were given aspirin therapy for treatment[7,10,11] and a dose of statin with a similar diagnosis as TIA.[11,21] Low-dose aspirin therapy is indeed used for treating ocular surface inflammatory disease[36] and is effective for amaurosis fugax.[37] Moreover, statin was used in low to high doses for TIA,[38] which could significantly reduce the risk of recurrent ischemic events.[39] However, recent publications suggested avoiding unnecessary investigations, misdiagnosis,[9,11] and intervention[13] due to the danger that may appear from initiating inappropriate treatments when it should be unnecessary. [7,8,13] Thus, some studies recommended sufficient TSB intervention through reassurance[37–39] and suggested patients be sensibly using smartphones.[4]

Reassurance

Reassurance has been suggested as a sufficient treatment for TSB.[6,7,21] It is vital for removing the fears and concerns about the illness,[40] unwanted medications,[21] and hospitalisation.[21,41] Patients with visual problems are usually very frightened and concerned about losing their vision.[10,42] Hence, the first priority is to manage the patients' anxiety.[43] Furthermore, reassurance is important not only to a wide range of patient groups with long-term medical conditions,[44] but also to address non-specific conditions.[37] By providing the word of reassurance, the patients can avoid starting to use unwanted medication[21] and hospitalisation, which makes patients often experience a new and unfamiliar environment that turns out to be a source of anxiety and psychological unrest for patients and their families.[38] Moreover, reassurance can cover a wide range of worrying cognitions, which are not expressed during the consultation.[45]

Reassurance is a psychological intervention that is commonly used in clinical practice.[38] It can be applied by adopting a calm, sympathetic, reassuring, yet authoritative presence.[39] To optimise it, practitioners should provide the patient with information about the nature of the disease and decide on a management plan.[37] Transient smartphone blindness does not cause permanent loss of vision and occurs temporarily. Thereby, reassurance on TSB patients needs to be done by giving a detailed history and information about the condition of retinal physiology.[7]

Suggestions on smartphone use

The smartphone is a main cause of TSB.[32] One of the early ways to prevent it from happening is by managing the proper use of smartphones. An empirical study has proven that the excessive use of smartphones mainly causes ocular disorders related to visual problems. The study found that 36% of smartphone users had ocular symptoms that started directly after using a smartphone. More than half (58%) of them responded that smartphone use did not increase their ocular manifestations.[4] The results of this survey indicate the massive use of smartphones with a lack of awareness of its impacts.

Almost all studies on TSB and monocular transient vision loss suggested that patients should avoid prolonged smartphone use since its bright light generates ocular disorders.[6–11,20,21] Particularly, patients should conversely be advised against smartphone usage in dark settings to prevent recurrence.[9] The patients with TSB have a history of viewing smartphones for a long time.[7] Thus, they were suggested to be responsible and wise in using smartphones as a way to deal with this disorder.[13] Rod et al. presented a novel study design based on high-resolution smartphone data to investigate the potential public health implications of overnight smartphone use. The study focused on the round-the-clock use of smartphones and its potential impact on sleep duration and quality, which may have adverse health consequences, including increased risk of obesity and cardiovascular diseases. The authors highlight the need to address the emerging public health challenge posed by excessive smartphone use, especially during night-time, and emphasise the importance of further research in this area to inform public health interventions and policies. The patients can keep their smartphones away during the evening in order to prevent the light radiance from emitting and interfering with their sleep. Too much exposure to this light radiance might harm their sleep quality.[46]

Seek medical evaluation

If individuals experience recurrent or persistent episodes of transient smartphone blindness, they are recommended to consult a healthcare professional, preferably an ophthalmologist, for a comprehensive evaluation and appropriate management.[8]

Prognosis

Patients with a history of prolonged smartphone use, especially excessive viewing of smartphone screens while lying in bed, are more likely to suffer from TSB. It is certainly a basis of transient monocular vision loss, which does not have severe risk factors. The prognosis of TSB in the absence of transient monocular blindness (TMB) or amaurosis fugax and TIA is usually good and not associated with long-term sequelae or severe consequences. TMB refers to a significant and transient episode of sudden, unilateral visual loss that typically lasts for a short duration, ranging from a few minutes to an hour, and is followed by complete spontaneous restoration of vision.[28] Meanwhile, TIA is more

severe than TSB and has a different mechanism. As TSB does not have risk factors and needs reassurance and sensible use of smartphones, several actions may be dangerous for the patients, such as misdiagnosis, ambiguous examination results, and inappropriate treatments.[8]

CONCLUSION

TSB is a condition characterised by temporary monocular vision loss without any identifiable risk factors. This study provides valuable insights into the mechanisms, symptoms, duration, frequency of occurrence, and appropriate management of TSB. While reassurance is often sufficient for treatment, psychophysical evaluation may sometimes be necessary. Future studies should focus on assessing the frequency, severity, and evaluation methods of TSB.

CONFLICT OF INTEREST

The authors declare no conflict of interest in this research project.

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AUTHOR CONTRIBUTION

AA contributed to shaping the research concept and conducting the literature review. FS made substantial contributions to tasks such as literature searching, quality assessment, and enhancing the language and style of the article. DD meticulously reviewed and edited the manuscript, ultimately providing approval for the final version. All authors critically examined and approved the final draft, taking responsibility for its content and ensuring the manuscript's originality.

LIST OF ABBREVIATION

TSB: transient smartphone blindness; TIA: transient ischemic attack; ERG: electroretinogram; OCT: optical coherence tomography; TMB: transient monocular blindness.

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