

## Impact of Screen Time on Hematological Inflammatory Markers and Stress Levels

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### Abstract:

**Background:** Excessive screen time has become increasingly common among young adults and may adversely affect psychological well-being and physiological health through stress-related inflammatory responses.

**Aim:** To evaluate the impact of screen time on hematological inflammatory markers and perceived stress levels among healthy young adults.

**Methods:** This cross-sectional study included 100 undergraduate students aged 18–25 years. Participants were categorized into low (<4 hours/day) and high (≥4 hours/day) screen time groups. Perceived stress was assessed using the Perceived Stress Scale (PSS-10). Hematological inflammatory markers including neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), lymphocyte-to-monocyte ratio (LMR), and systemic immune-inflammation index (SII) were calculated from complete blood count parameters.

**Results:** Participants with high screen time demonstrated significantly higher PSS scores, NLR, PLR, and SII values, along with lower LMR compared to the low screen time group ( $p < 0.05$ ). Screen time showed a positive correlation with perceived stress and inflammatory markers.

**Conclusion:** Prolonged screen exposure is associated with increased stress levels and low-grade systemic inflammation among young adults, highlighting the importance of healthy digital habits.

**Keywords:** Screen time, stress, inflammation, NLR, PLR, SII.

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### Introduction

The widespread adoption of digital technology has dramatically increased daily screen time among adolescents and young adults worldwide. Smartphones, tablets, computers, and other electronic devices have become essential tools for education, communication, entertainment, and social networking. Although these technologies offer numerous benefits, excessive screen exposure has emerged as a significant public health concern due to its potential adverse effects on physical and mental well-being.

Recent studies have linked prolonged screen time with sedentary behavior, poor sleep quality, reduced physical activity, anxiety, depression, and increased perceived stress levels [1,2]. Psychological stress induced by excessive screen use may activate the hypothalamic-pituitary-adrenal (HPA) axis, resulting in increased secretion

of cortisol and other stress-related hormones. Chronic activation of stress pathways has been shown to alter immune function and contribute to low-grade systemic inflammation [3,4]. Inflammation plays a crucial role in the pathogenesis of several chronic diseases, including cardiovascular disorders, metabolic syndrome, and mental health conditions [5].

Hematological inflammatory markers derived from routine complete blood count parameters have gained considerable attention as inexpensive and readily available indicators of systemic inflammation. Among these, the neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), lymphocyte-to-monocyte ratio (LMR), and systemic immune-inflammation index (SII) have demonstrated utility in assessing inflammatory and stress-related responses in both

healthy and diseased populations [6,7]. Psychological stress and lifestyle-related factors have been reported to influence these hematological indices through neuroendocrine and immunological mechanisms [8]. Despite growing evidence regarding the psychological consequences of excessive screen exposure, limited research has explored its association with hematological inflammatory markers. Understanding this relationship may provide valuable insights into the physiological effects of prolonged screen use among young adults. Therefore, the present study aimed to evaluate the impact of screen time on hematological inflammatory markers and perceived stress levels among healthy young adults, thereby contributing to the growing body of evidence on digital lifestyle-related health outcomes.

### Material & Methodology

This cross-sectional analytical study was conducted in the Department of Physiology after obtaining approval from the Institutional Human Ethics Committee. The study included 100 healthy undergraduate students aged 18–25 years who voluntarily participated after providing written informed consent. Participants with acute or chronic inflammatory disorders, autoimmune diseases, hematological disorders, recent infections within the previous four weeks, current medication affecting immune function, smoking, alcohol dependence, or known psychiatric illnesses were excluded from the study.

A detailed demographic profile, including age, sex, body mass index (BMI), sleep duration, physical activity, and daily screen time, was recorded using a structured questionnaire. Screen time was defined as the total duration spent daily on smartphones, tablets, laptops, computers, and television for educational, occupational, and recreational purposes. Based on self-reported screen exposure, participants were categorized into two groups: low screen time (<4 hours/day) and high screen time ( $\geq$ 4 hours/day).

Perceived stress levels were assessed using the validated Perceived Stress Scale (PSS-10). [9] The questionnaire consists of ten items evaluating stress perception during the preceding month, with higher scores indicating greater perceived stress.

Venous blood samples (3 mL) were collected under aseptic conditions from all participants. Complete blood count analysis was performed using an automated hematology analyzer. Hematological inflammatory markers including neutrophil-to-

lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), lymphocyte-to-monocyte ratio (LMR), and systemic immune-inflammation index (SII) were calculated from the hematological parameters obtained.

Data were entered into Microsoft Excel and analyzed using IBM SPSS version 26.0. Quantitative variables were expressed as mean  $\pm$  standard deviation, while categorical variables were presented as frequencies and percentages. Independent t-test was used to compare hematological markers and stress scores between groups. Pearson's correlation coefficient was applied to assess the relationship between screen time, inflammatory markers, and perceived stress scores. A p-value of less than 0.05 was considered statistically significant.

### Result

A total of 100 healthy undergraduate students participated in the study, comprising 46 males and 54 females, with a mean age of  $20.8 \pm 1.9$  years. Based on daily screen exposure, 45 participants were categorized into the low screen time group (<4 hours/day) and 55 into the high screen time group ( $\geq$ 4 hours/day). Participants with high screen time demonstrated significantly higher perceived stress scores and inflammatory markers compared to those with lower screen exposure.

The mean Perceived Stress Scale (PSS) score was significantly higher in the high screen time group ( $22.6 \pm 4.8$ ) than in the low screen time group ( $16.3 \pm 3.9$ ;  $p < 0.001$ ). Similarly, the neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR) were significantly elevated among participants with prolonged screen use ( $p < 0.01$ ). Conversely, lymphocyte-to-monocyte ratio (LMR) was significantly lower in the high screen time group ( $p = 0.002$ ). The systemic immune-inflammation index (SII) was also significantly increased in individuals reporting prolonged screen exposure ( $p < 0.001$ ). (Table 1)

Correlation analysis revealed a positive association between screen time and perceived stress scores ( $r = 0.58$ ,  $p < 0.001$ ), NLR ( $r = 0.41$ ,  $p < 0.001$ ), PLR ( $r = 0.37$ ,  $p = 0.001$ ), and SII ( $r = 0.45$ ,  $p < 0.001$ ). A negative correlation was observed between screen time and LMR ( $r = -0.32$ ,  $p = 0.002$ ). These findings suggest that excessive screen exposure is associated with increased psychological stress and a state of low-grade systemic inflammation among young adults. (Table 2)

**Table 1: Comparison of Hematological Inflammatory markers and stress scores according to screen time**

Parameter	Low Screen Time (<4 Hours/day) (n=45)	High Screen Time (>4 Hours/day) (n=55)	p- Value
Age (Years)	20.5 ± 1.8	21.0 ± 2.0	0.241
PSS Score	16.3 ± 3.9	22.6 ± 4.8	<0.001*
NLR	1.82 ± 0.52	2.48 ± 0.71	<0.001*
PLR	118.4 ± 22.7	142.9 ± 28.6	0.001*
LMR	4.76 ± 1.08	3.89 ± 0.92	0.002*
SII	425.7 ± 112.4	612.8 ± 154.3	<0.001*

**Table 2: Correlation of Screen time with stress levels and inflammatory markers**

Parameter	Correlation coefficient (r)	p- Value
PSS Score	0.58	<0.001*
NLR	0.41	<0.001*
PLR	0.37	0.001*
LMR	-0.32	0.002*
SII	0.45	<0.001*

**P<0.05 considered statistically significant.**

## Discussion

The present study evaluated the association between screen time, hematological inflammatory markers, and perceived stress levels among healthy young adults. The findings demonstrated that participants with higher daily screen exposure exhibited significantly elevated perceived stress scores, increased NLR, PLR, and SII values, along with reduced LMR, indicating the presence of low-grade systemic inflammation associated with excessive screen use.

The significantly higher perceived stress scores observed among participants with prolonged screen exposure are consistent with previous studies. Twenge and Campbell (2019) [1] reported that increased digital media use was associated with lower psychological well-being, greater emotional distress, and higher stress levels among adolescents and young adults. Similarly, Stiglic and Viner (2019) [2] concluded that excessive screen time negatively affects mental health, sleep quality, and psychosocial well-being. Thomée (2018) [10] and Elhai et al. (2017) [11] further reported significant associations between excessive smartphone use, anxiety, depression, and psychological distress. Prolonged exposure to digital devices may contribute to chronic activation of the hypothalamic-pituitary-adrenal (HPA) axis, resulting in increased cortisol secretion and sustained physiological stress responses, as described by McEwen (1998) [3].

Stress-induced activation of neuroendocrine pathways can influence immune regulation and inflammatory processes. Segerstrom and Miller (2004) [6] demonstrated that psychological stress alters leukocyte distribution and immune function, resulting in increased inflammatory activity. Similarly, Dhabhar (2014) [12] and Cohen et al. (2012) [13] reported that chronic stress promotes

immune dysregulation, glucocorticoid resistance, and systemic inflammation. In the present study, participants with higher screen time demonstrated significantly elevated NLR and PLR values. Elevated NLR has been recognized as a sensitive marker of systemic inflammation and physiological stress (Forget et al., 2017; Zahorec, 2001) [7,14]. Increased PLR has also been linked to chronic inflammatory states and stress-related conditions [15]. The adverse psychological effects associated with prolonged screen exposure observed in the present study are also supported by Liu et al (2020) [16] Christensen et al. (2020) [17], who emphasized that digital technologies can significantly influence mental health outcomes and stress-related behaviors among young individuals.

The significantly lower LMR and higher SII values observed among high screen-time users further support the presence of systemic inflammatory changes. Furman et al. (2019) [5] described chronic low-grade inflammation as a key biological mechanism linking lifestyle factors with the development of metabolic, cardiovascular, and neuropsychiatric disorders. Yang et al. (2018) [8] demonstrated that SII serves as a comprehensive indicator of immune and inflammatory status by integrating neutrophil, lymphocyte, and platelet counts into a single index.

Moreover, Fest et al. (2019) [18] reported that elevated inflammatory indices are associated with adverse long-term health outcomes in the general population. Similar findings were reported by Batur et al. (2019) [19], who demonstrated a significant association between psychological stress, anxiety, and elevated hematological inflammatory markers, including NLR and PLR, suggesting that stress-induced immune activation may contribute to systemic inflammation.

Sleep disturbance may represent another important pathway linking excessive screen exposure with inflammation and stress. Previous studies have shown that prolonged screen use can impair sleep quality and circadian rhythms, thereby contributing to heightened inflammatory responses and psychological distress [2]. Firth et al. (2019) [20] suggested that excessive internet use may influence cognition, behavior, and emotional regulation, potentially affecting overall health and well-being. Sleep disturbance may represent an important mechanism linking excessive screen exposure with increased stress and inflammation. Buysse (2014) [21] highlighted that adequate sleep is a critical component of overall health, and impaired sleep quality can adversely affect emotional regulation, immune function, and inflammatory processes.

The positive correlations between screen time, perceived stress scores, NLR, PLR, and SII observed in the present study suggest that excessive screen exposure may contribute to both psychological stress and inflammatory dysregulation. These findings emphasize the importance of promoting healthy digital habits and limiting unnecessary screen exposure among young adults. Further longitudinal studies are warranted to establish causality and explore the underlying biological mechanisms responsible for these associations.

### Conclusion

The present study demonstrated a significant association between prolonged screen time, increased perceived stress levels, and alterations in hematological inflammatory markers among young adults. Participants with higher screen exposure exhibited elevated NLR, PLR, and SII values along with reduced LMR, suggesting the presence of low-grade systemic inflammation. Excessive screen use was also positively correlated with psychological stress. These findings highlight the potential impact of digital lifestyle habits on both mental and physiological health and emphasize the need for strategies promoting balanced screen use among young adults.

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