

Investigation of Screen Time Inclination and the Accompanying Visual and Musculoskeletal Discomfort in Young Smartphone Users

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Abstract

The purpose of this study is to investigate the screen time inclination and its accompanying visual and musculoskeletal discomfort in young smartphone users. Thirty-one smartphone users aged between 20 - 30 years old were recruited through convenient sampling. The screen time patterns were recorded daily for a week and documented using Action Dash on Google Play Store according to the times of the day (morning, afternoon evening and night). Accompanying visual and musculoskeletal symptoms were examined through a self-reporting questionnaire survey. The questions used in the questionnaire were adapted and modified from the Asthenopia Questionnaire and Nordic Musculoskeletal Questionnaire. Results showed that young smartphone users spent approximately 30 % of their time on screen and were relatively similar for different times of the day. Daily screen time was approximately 7.36 ± 1.74 h. Most users engaged in WhatsApp (74 %), followed by YouTube (68 %), Instagram (65 %) and Twitter (39 %). Tired eyes were reported by all smartphone users. A positive correlation was only found between weekly screen time and eye strain ($p < 0.05$). All musculoskeletal symptoms were self-reported by young smartphone users in our study but anatomical locations varied in percentages. Neck pain was the most significant musculoskeletal symptom associated with screen time (OR = 4.80, 95 % CI: 0.95 - 24.14, $p < 0.05$). Every smartphone user reported at least 1 type of visual symptom. All smartphone users reported tired eyes. In conclusion, our results showed that smartphone users spent one third of their time daily on-screen and mostly on social media. Tired eyes and neck pain were the most common accompanying symptoms. Visuo-skeletal symptoms are common among young and healthy smartphone users. Our findings advocate that future strategic plans to address digital related health problems from the perspective of health education, promotion and protection should be inclusive of youth.

Keywords: Smartphone, Screen time, Visual discomfort, Musculoskeletal discomfort

Introduction

The advancement in digital technology and the availability of digital networks have changed the ecosystem of human living unprecedentedly [1-4]. Excessive screen time has developed into a significant health concern in recent year [5-9]. Screen time is the time spent in front of screen-based electronic devices. Adverse health implications have been linked to excessive electronic usage or screen time [10,11]. Musculoskeletal symptoms have been connected to screen time in previous studies [12-14]. Decline in vision quality has also been evident [15,16]. Excessive exposure to electronics emitting light is a health concern [17-19]. Blue light emitted from a light emitting diode display induces phototoxicity and oxidative stress [20-22]. Not only do humans of all ages look at electronic displays, they tend to stare at them. Prolonged electronic device usage is associated with higher risks of developing visual discomfort [23,24]. Electronic device users may experience eye fatigue, dry eyes, headaches, blurred vision, neck and shoulder pain, eye twitching and red eyes [25,26]. Approximately 70 % of children have an average of 3.1 h of screen time a day, surpassing the recommended screen time of 2 h maximally [3]. The use of digital devices has been associated with eye strain in school children [27] and asthenopia among college students [28]. Approximately 26 and 12 % of adolescents in Finland experienced neck and back pain during computer-related activities [29].

Initially designed solely for verbal communication, the capabilities and utilities of a phone have been entirely redefined. The advent of smartphone functions such as camera, voice recorder, email access, eBook access, social and networks, video streaming and digital games are a product of revolutionary phone technology. Screen time is inadvertently increased as a result. Hence, our study aims to examine visual and musculoskeletal discomfort in relation to screen time in smartphone users.

Materials and methods

A cross sectional study was done to investigate the screen time inclination and its associated visual and musculoskeletal symptoms. Ethical approval was obtained from the UiTM Research Ethics Committee (600-TNCPI (5/1/6) REC/01/2020 (UG/MR/29)). Our study adhered to the declaration of Helsinki. Forty-one participants were recruited through convenient sampling. All subjects went through ophthalmic vision screening inclusive of history taking, amplitude of accommodation, cover test and subjective refraction. The information on ocular disease and systemic diseases was based on ocular health and general health in history taking. The inclusion criteria were young adults aged 20 to 30 years old who had access to a screen time app called Action Dash and an android smartphone. Subjects with known history of ocular and systemic diseases were excluded. The sample size was calculated using the following formula with standard deviation of 1.65 h/day for screen time that was associated with the lifestyle [30]. The precision value was 0.5.

N is sample size.

Z is critical value (1.96).

σ is standard deviation.

Δ is precision value.

$$n = [(Z \times \sigma) \div \Delta]^2$$

$$n = [(1.96 \times 1.65) \div 0.5]^2$$

$$n = 41.$$

After obtaining a written informed consent, subjects were requested to install the app 'Action Dash' from the Google Play Store on their smartphone. The app functions in 2 distinct manners. Firstly, it recorded the total screen time by the user (hourly). Secondly, it recorded the type of activities the user engages in and stratified them into proportions. These 2 data were consolidated using 24 h clock time at 23.55 daily by the app. A week's worth of data was collected from each user.

A questionnaire survey was carried out to acquire information on visual and musculoskeletal symptoms in relation to smartphone usage. It was a 2-part questionnaire consisting of 16 questions in total. The 1st part consisted of 8 questions dedicated to elicit visual symptoms. The 2nd part consisted of another 8 questions to probe for musculoskeletal symptoms. Components from the Asthenopia Questionnaire were adapted in our questionnaire to investigate visual symptoms [25]. Eight target vision symptoms were covered including tired eye, sore/itching eye, irritated eye, watery eye, dry eye, eyestrain, hot/burning eye and blurred vision. Each visual symptom was probed with a 7 point Likert scale (from 0 (none) - 6 (severe)). Score of '0' signified no symptom; '1 - 2' suggested mild discomfort; '3 - 4' indicated moderate discomfort; and '5 - 6' for severe discomfort. Spearman's Rank Correlation Coefficient was used to measure the strength of association between visual symptoms and screen time. Elements from the Nordic Musculoskeletal Questionnaire were adapted into our questionnaire to assess musculoskeletal symptoms [12]. Eight body parts including the neck, shoulder, elbow, wrist/hands, upper back, lower back, hip/thighs and ankle/feet were included in the questionnaire. Musculoskeletal symptoms were probed using a dichotomous question approach ("Yes" or "No"). Screen time was categorized into binary nominal, which was 1 (5 h and more) and 0 (less than 5 h), based on the grouping criteria used in a previous study [31].

Results and discussion

Data from 10 participants were excluded in the final analysis due to incomplete data. Thirty-one data from 7 males and 24 females were included in the analysis. Screen time inclination was defined by 2 main factors: The total screen time (h) and activity preferences on screen. The usage patterns of each smartphone user was also analyzed. **Table 1** shows the usage pattern of smartphones during different times of the day (morning, afternoon, evening and night). The percentages of real screen time engagement were about 25, 38, 31 and 12 % in the morning, afternoon, evening and night respectively. Daily screen time engagement was approximately 31 % (7.36 h out of 24 h).

Table 1 Smartphone usage pattern according to times of the day.

Times of the day	Respective hours of investigation	Real screen time engagement (in h)		
		Minimum	Maximum	Mean ± Standard Deviation
Morning (6 am to 11.59 am)	6	0.46	3.00	1.49 ± 0.63
Afternoon (12 pm to 4.59 pm)	5	0.99	2.84	1.89 ± 0.54
Evening (5 pm to 9.59 pm)	5	0.45	3.18	1.56 ± 0.64
Night (10 pm to 5.59 am)	8	0.65	3.70	2.12 ± 0.84
Daily	24	4.50	10.70	7.36 ± 1.74

The distribution in the type of on-screen activity is summarized in **Figure 1**. A large proportion of participants spent their screen time on WhatsApp (74 %), followed by YouTube (68 %), Instagram (65 %) and Twitter (39 %).

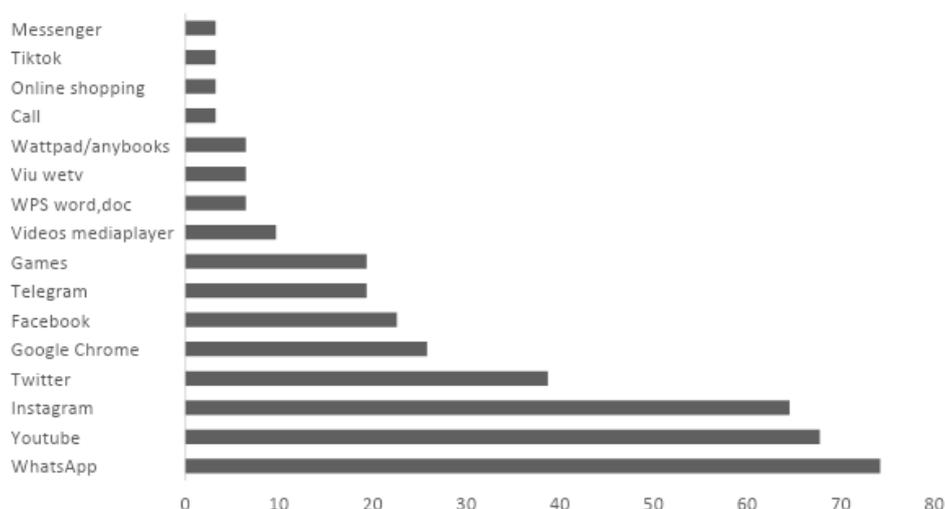


Figure 1 Distribution of on-screen activities. Y-axis displays the type of activity engaged on screen based on data from this study. X-axis indicates the percentage of participants involved in respective on-screen activity.

Self-reporting visual discomfort is summarized in **Table 2**. There was a significant but weak positive relationship between screen time and visual discomfort (Spearman’s Rank Correlation Coefficient: $r = 0.31$ and $p < 0.05$). Tired eyes were reported by all smartphone users. A positive correlation was only found between weekly screen time and eye strain ($p < 0.05$). The distribution of the musculoskeletal discomfort is summarized in **Figure 2**. A significant association was observed between screen time and neck pain (Odd Ratio = 4.80, Confidence Interval = 0.95 - 24.14, $p < 0.05$). No other parts of body discomfort were found significant (**Table 3**).

Table 2 Summary of self-reporting visual symptoms according to classifications. The numbers indicate the counts of smartphone users.

Visual symptoms	Classification based on Likert Scale (in total count of reporting smartphone users)				Correlation to Screen Time (r)
	None	Mild	Moderate	Severe	
Tired eyes	0	6	18	7	0.13, $p > 0.05$
Sore/aching eyes	4	12	15	0	0.17, $p > 0.05$
Irritated eyes	3	13	12	3	0.10, $p > 0.05$
Watery eye	8	8	10	5	-0.19, $p > 0.05$
Dry eye	2	9	9	11	-0.03, $p > 0.05$
Eye strain*	2	7	15	7	0.36, $p < 0.05$
Hot/burning eye	10	8	12	1	-0.06, $p > 0.05$
Blurred vision	9	12	8	2	-0.01, $p > 0.05$

*significant correlation between screen time and visual symptoms (Spearman’s Rank Correlation).

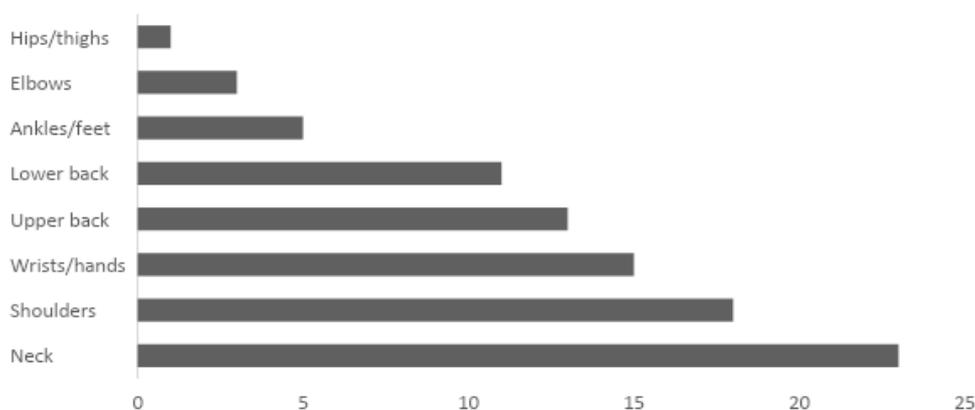


Figure 2 Distribution of the musculoskeletal discomfort. Y-axis indicates the body part. X-axis indicates the percentage of self-reported musculoskeletal discomfort.

Table 3 Correlation between screen time and musculoskeletal discomfort.

Body part	Screen time OR (95 % CI, p -value)
Neck*	4.80 (0.95 - 24.14), $p < 0.05$
Shoulder	1.63 (0.36 - 7.43), $p > 0.05$
Upper back	0.92 (0.20 - 4.31), $p > 0.05$
Elbow	1.13 (0.95 - 1.35), $p > 0.05$
Wrist/hand	0.42 (0.05 - 3.53), $p > 0.05$
Lower back	0.60 (0.12 - 2.91), $p > 0.05$
Thigh	0.66 (0.50 - 0.85), $p > 0.05$
Ankle/feet	2.12 (0.21 - 21.89), $p > 0.05$

OR: Odds ratio and CI: Confidence interval

*statistically correlation between musculoskeletal discomfort and screen time by Pearson's correlation.

Discussion

Although there is no general consensus on what the safe amount of screen time is for adults, a limited screen time and an active lifestyle have been advocated by health professionals [32]. Screen time has been reported to have both physical and mental health implications. Longer screen time has been associated with obesity and sleeping problems [33-35]. Habitual scrolling on smartphones may present an

opportunity cost in terms of lost-time for physical activities and sleeping. Reduced physical activity and sleep may lead to weight gain and sleeping disorders [36-38]. Inadequate sleep and high amount of screen time can affect mental health and performance for the day [39-41]. Increasing screen time coupled with sedentariness has been linked to mental health effects such as anxiety and depression [42,43]. People who spend 6 h or more on screen are more likely to suffer from moderate to severe depression. Young smartphone users in our study were found to spend 30 % of their time daily on screen (about 8 h a day). Malaysia has the highest rate of obesity and overweight among Asian countries with more than half of the male and female population being either obese or overweight [44,45]. Ideally, adults should limit their screen time similarly to children at about 2 h a day [3]. In contrast to that, young smartphone users in our study spent a staggering amount of 8 h per day looking at a screen. If screen time directly correlates with obesity [36], this poses an imminent health risk in the long run.

The impact of screen time on academic performance depends on the length and content of exposure. Screen time can enhance academic performance if the content is academic related. Regardless of the content, the length of usage can lead to various health issues. Our study revealed that WhatsApp, YouTube, Instagram and Twitter were among the popular choices of on-screen activities. Participants were not requested to specify if the usage of these apps were for academic or leisure purposes, which poses a limitation to our discussion.

Excessive screen time exposure has been reported to affect skills of literacy, cognition and language in children [10,46]. Screen use can also affect interpersonal skills [37]. Although there are no such indications in adults, the possibility of such negative impacts is yet to be proven.

Vision problems associated with the use of electronic screens have gradually shifted from being exclusively a workplace health issue to a major public health concern [47]. Profound use of digital devices for both leisure and work purposes leads to vision problems [47]. Nearsightedness, eye fatigue, dry eyes, and loss of focus flexibility are among some of the few visual impacts from excessive screen time [25,26]. Every smartphone user reported at least 1 type of visual symptom from our questionnaire. There was a significant but weak positive relationship between screen time and visual discomfort. "Tired eyes" was reported by all smartphone users. Skimming may have a different effect compared to intensive reading on screen. More research is required to ascertain the link between the nature of screen time usage and the consequential visual symptoms to provide evidence-based guidelines.

Poor posture may trigger musculoskeletal pain. This is due to poor ergonomics. Some of the most commonest locations for musculoskeletal symptoms are the head (headaches), neck and back [48]. This is especially when users are in a prolonged sitting posture, leading to increased bending angle of the neck and back [8]. Myofascial pain is the most likely the type of musculoskeletal symptom experienced by screen users with poor posture [49]. Musculoskeletal discomfort was reported to be rampant amongst data processing workers and those who work with visual display units [12,15,50]. Musculoskeletal symptoms reported were predominantly above the waist line in our study. Neck pain was the most frequently reported area of concern. Its correlation to screen time was statistically significant in our study. No statistically significant correlation was found between screen time and musculoskeletal discomfort in other parts of the body. Prolonged viewing, poor screen quality and poor environmental conditions may potentiate the adverse effects of prolonged screen time. Prolonged smartphone usage in a tilted position in reading the screen of the smartphone has been associated with faulty posture such as forward neck posture, slouched posture, or rounded shoulders [51-54]. Prolonged engagement with the screen of the smartphone can also reduce the blinking rate of the users [55]. This may explain the neck pain and eye strain found in our study. One possible way of overcoming the problem is to constantly be mindful about the abnormal posture and blinking reduction. With proper health education, youth can develop good habits of proper posture and full blinking.

If screen time is unavoidable due to work or study related commitments, self-care steps may help eliminate some visual and body discomforts. Taking frequent breaks from using digital devices. Reducing overhead lighting to eliminate screen glare. Positioning electronic devices at arm's distance away from the screen for proper viewing distance. Increasing text size on devices to better define content on the screen. Practicing good visual hygiene such as the "20-20-20" rule may help to reduce symptoms. Taking a 20-s break every 20 min to look at something 20 feet in the distance.

Due to the small sample size, our data might have limitations to reach a convincing generalization. However, our data did reveal some interesting trends about the young smartphone users to give rise to more future research in health related concern. A proportionate of male and female ratio should be taken into consideration in designing future study because gender distribution can affect the ocular surface and musculoskeletal health. Additional data such as screen illumination level to associated visuo-skeletal tasks and the menstrual cycles for female subjects could be included too.

Conclusions

There is a huge paradigm shift in the ways of living in today's world. Many aspects of our lives including work, school, leisure and more have shifted toward digital mediums. Hours spent on the screens of our digital devices especially smartphones by individuals today are unprecedented. Health and safety concerns slowly emerge as this new shift persists. High incidence of self-reported physical discomforts (including visual and musculoskeletal) suggests the potential harms of prolonged screen time and the need to develop screen time guidelines. Digital visual hygiene awareness programs can be embedded into our education to inculcate healthy digital habits at an early age as preventive health care in supporting the sustainable development goal through healthy lifestyle.

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