IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 25, Issue 1 Ser. 1 (January. 2026), PP 12-17
www.iosrjournals.org

A Comparative Study On The Effect Of Display Size On Accommodation And Ocular Discomfort In Users Of Smart Devices

Ezeigbo A.C, Omaka A.C, Obioma-Izuogu D.C
Department Of Optometry, Faculty Of Health Sciences, Abia State University, Uturu, Nigeria)

Abstract:
Background: *Accommodation refers to changes in the dioptric power of the crystalline lens to obtain and maintain a focused retinal image. With the rapid proliferation of smart devices, concerns about visual health, particularly accommodation and ocular discomfort, have increased. This study aimed to investigate how different display sizes of smart devices affect accommodative function and ocular discomfort in young adults.*
Materials and Methods: *In this cross-sectional comparative study, 50 participants (24 males and 26 females) aged 18–35 from Abia State University, Nigeria, were recruited. A questionnaire collected demographic data and rated ocular discomfort symptoms, while eye exams assessed accommodative functions before and after using devices with small (smartphone) and large (laptop) displays. Accommodative amplitude, facility, relative accommodation, and accommodative lag were measured. Data were analyzed using descriptive statistics, paired t-tests, and chi-square tests.*
Results: *Significant differences were found in accommodative functions and discomfort symptoms after using small vs. large displays. Smartphone use led to greater reduction in accommodative amplitude (8.16±1.67 D) compared to laptop use (9.14±1.67 D). Accommodative facility decreased more substantially after smartphone use (15.94±1.52 cpm) than after laptop use (18.14±1.41 cpm). Ocular discomfort symptoms were more pronounced after smartphone use, with a strong positive correlation between accommodative functions and symptom severity (r=0.408; p=0.003).*
Conclusion: *Display size significantly affects accommodative function and ocular discomfort, with smaller displays (smartphones) causing greater strain and discomfort than larger displays (laptops). These findings highlight the need for ergonomic design considerations and user guidelines to mitigate visual strain.*
Key Word: *Accommodation, Ocular Discomfort, Smart Devices, Display Size, Visual Fatigue*

Date of Submission: 22-12-2025 Date of Acceptance: 02-01-2026

I. Introduction

The proliferation of smart devices—smartphones, tablets, and laptops—has fundamentally transformed modern life, enabling unprecedented connectivity, productivity, and access to information. However, this digital integration has come with unintended consequences for visual health, particularly concerning ocular discomfort and accommodative strain[1]. As screen time continues to rise globally, understanding the ergonomic and physiological impacts of device use has become a pressing public health concern.

Recent statistics underscore the scale of this issue. As of early 2023, there were approximately 5.16 billion internet users worldwide, representing 64.4% of the global population[18]. Mobile connectivity is similarly ubiquitous, with 5.44 billion unique mobile phone users—an increase of 168 million from the previous year. In Nigeria specifically, there were 122.5 million internet users and 193.9 million cellular mobile connections as of January 2023[19]. Estimates suggest between 25 to 40 million smart device users in Nigeria, a number that continues to grow. This widespread adoption highlights the critical need to investigate how device characteristics—especially display size—affect visual function and comfort.

Accommodation, the eye's ability to adjust focus for near and distant objects, is a key physiological process that can be significantly strained by prolonged near work[2]. When viewing digital screens, the ciliary muscle contracts to increase the curvature of the crystalline lens, allowing clear focus at close distances[5]. Extended periods of this activity can lead to accommodative fatigue, reduced amplitude of accommodation, and increased lag—all of which contribute to symptoms collectively known as digital eye strain or computer vision syndrome[17].

Ocular discomfort associated with smart device use encompasses a range of symptoms, including eye strain, dryness, blurred vision, headache, photophobia, and foreign body sensation[11]. These symptoms not only reduce user comfort and productivity but may also have longer-term implications for ocular surface health and binocular vision function[3]. While factors such as viewing distance, screen brightness, and content type have been studied, the role of display size remains less clearly defined—particularly in direct comparison between common device categories such as smartphones and laptops.

Prior research has yielded mixed findings[2,8,9]. Some studies suggest smaller screens impose greater accommodative demand due to smaller text size and closer viewing distances, while others indicate that larger screens may encourage more dynamic eye movements and varied focal points, potentially reducing sustained accommodative effort[10]. Furthermore, most existing studies have focused on single device types or simulated environments rather than real-world comparative use[2,7].

This study addresses this gap by conducting a direct, controlled comparison of accommodative function and ocular discomfort symptoms between users of small-display smartphones and large-display laptops. By examining parameters such as accommodative amplitude, facility, relative accommodation, accommodative lag, and subjective discomfort ratings, this research aims to clarify the visual ergonomic implications of display size. The findings are intended to inform evidence-based guidelines for device design, user education, and clinical practice—ultimately supporting healthier interaction patterns in an increasingly screen-dependent world.

II. Materials And Methods

Study Design and Setting

This was a cross-sectional comparative study conducted at the Department of Optometry, Abia State University, Uturu, Nigeria, between June and September 2023. The study was designed to compare accommodative function and ocular discomfort symptoms in users of smart devices with small versus large displays.

Participants

A total of 50 young adults (24 males, 26 females) aged 18–35 years were enrolled. Participants were required to have a corrected visual acuity of at least 6/9, no history of accommodative or binocular vision disorders, and no active ocular disease or previous ocular surgery. Individuals with presbyopia, systemic conditions affecting accommodation, or those using medications with ocular side effects were excluded.

Sample Size Calculation

Sample size was determined using the Taro Yamane formula for finite populations. With an estimated population of 18,000 students and a margin of error of 14.1%, a minimum sample size of 50 was calculated.

Devices and Display Parameters

Two device categories were used:

- Small display: Samsung Galaxy Note 10 Plus (6.75-inch display, 1440 x 3040 pixels)
- Large display: MacBook Air 2020 (13.3-inch display, 2560 x 1600 pixels) Viewing distance was fixed at 30 cm, with screen brightness set to maximum under standardized room illumination (280 lux).

Study Procedure

Participants attended two sessions on separate days in randomized order. Each session involved:

1. Baseline assessment of accommodative function[7]
2. 30 minutes of movie viewing with subtitles on the assigned device
3. Post-task reassessment of accommodative function
4. Completion of the Ocular Discomfort Analog Scale (ODAS) questionnaire

Accommodative Function Assessment

Accommodative parameters were measured with habitual refractive correction using standardized clinical protocols[7]:

- Accommodative amplitude: Minus lens to blur method at 35 cm[7]
- Accommodative facility: ±2.00 D flipper lenses at 40 cm, recorded as cycles per minute (cpm)[6]
- Relative accommodation: Positive (PRA) and negative (NRA) measured with ±0.25 D steps at 40 cm[6]
- Accommodative lag: Dynamic near retinoscopy at 40 cm[5]
- Objective refraction: Autorefractor measurements pre- and post-task

Ocular Discomfort Assessment

The ODAS questionnaire evaluated seven symptoms (photophobia, tightness/pressure, dryness, foreign body sensation, tearing, blurred vision, fatigue) on a 0–10 scale, with categories of severity (none to extreme) and recording of onset time[11].

Data Analysis

Statistical analysis was performed using SPSS version 25. Descriptive statistics, paired t-tests, chi-square tests, and Pearson correlation coefficients were used. A p-value < 0.05 was considered statistically significant.

Ethical Considerations

Ethical approval was obtained from the Department of Optometry Research and Ethics Committee **(ABSU/OD/2023/014).** Written informed consent was obtained from all participants before enrollment.

III. Results

Demographic and Baseline Characteristics

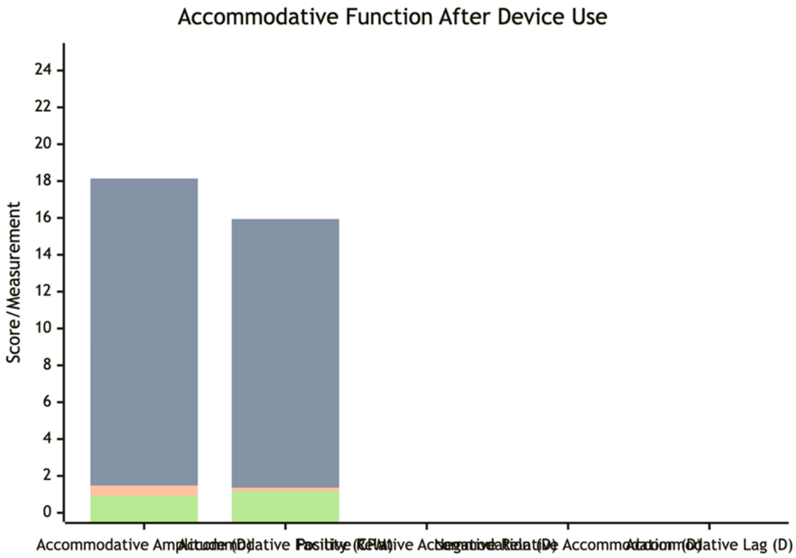
The study population had a mean age of 22.04 ± 2.128 years. Refractive error distribution included hyperopia (+0.5D < SE) in 32%, emmetropia (-0.5D < SE ≤ +0.5D) in 6%, and myopia (-3D < SE < -0.5D) in 62% of participants. Gender distribution was balanced (52% female, 48% male).

Accommodative Function Changes

Significant differences were observed in accommodative parameters after device use (Table 1):

Table 1: Comparison of accommodative function before and after device use

Parameter	Before Use	After Laptop	After Smartphone	p-value*
AA (D)	9.14±1.67	9.14±1.67	8.16±1.67	0.000
AF (cpm)	19.94±1.30	18.14±1.41	15.94±1.52	0.000
PRA (D)	2.04±0.42	1.48±0.24	1.36±0.27	0.000
NRA (D)	-0.93±0.24	-0.67±0.15	-0.62±0.16	0.000
AL (D)	0.92±0.30	0.92±0.30	1.17±0.30	0.001



AA = Accommodative amplitude, AF = Accommodative facility, PRA = Positive relative accommodation, NRA = Negative relative accommodation, AL = Accommodative lag. p-value for smartphone vs laptop comparison.

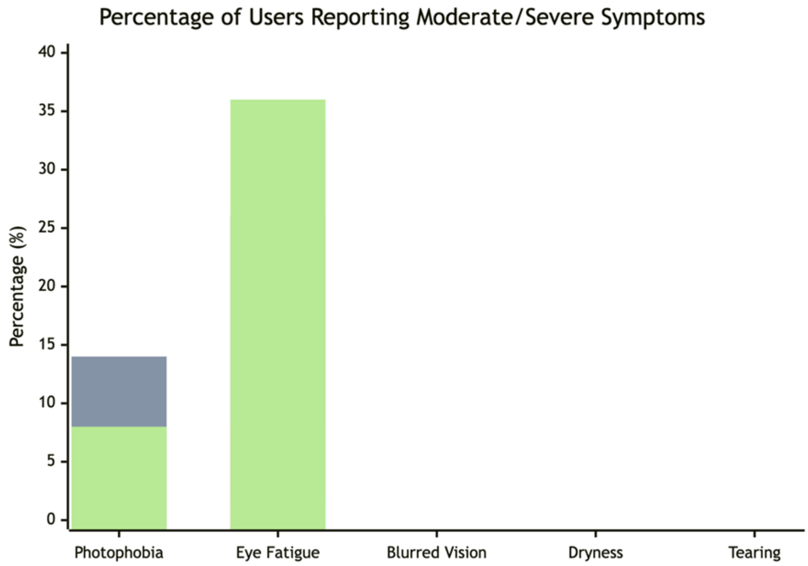
Smartphone use resulted in significantly greater reductions in accommodative amplitude and facility compared to laptop use (p < 0.001)[18]. Accommodative lag increased more substantially after smartphone use (1.17 ± 0.30 D) than after laptop use (0.92 ± 0.30 D)[13].

Ocular Discomfort Symptoms

Smartphone users reported higher severity scores across all ocular discomfort symptoms (Table 2). The most pronounced differences were observed for photophobia (34% moderate-severe with smartphone vs 8% with laptop), tearing (22% vs 8%), and eye fatigue (26% vs 14%)[11].

Table 2: Severity of ocular discomfort symptoms by device type

Symptom	None/Minimal (%) Laptop	Moderate/Severe (%) Laptop	None/Minimal (%) Smartphone	Moderate/Severe (%) Smartphone
Photophobia	92	8	66	34
Eye fatigue	86	14	74	26
Blurred vision	100	0	92	8
Dryness	96	4	98	2
Tearing	92	8	64	36



Correlation Analysis

A strong positive correlation was found between accommodative function changes and ocular discomfort severity ($r = 0.408$, $p = 0.003$). Display size showed no significant correlation with onset time of symptoms ($p = 0.654$).

Hypothesis Testing

Both null hypotheses were rejected:

1. There was a significant difference in accommodative function between small and large display users ($\chi^2 = 266.667$, $p < 0.001$)
2. There was a significant difference in ocular discomfort severity between device groups ($t = 19.988$, $p < 0.001$)

IV. Discussion

This study provides compelling evidence that display size significantly impacts both accommodative function and ocular discomfort during smart device use. Our findings indicate that smaller displays (smartphones) impose greater accommodative demand and elicit more severe ocular symptoms compared to larger displays (laptops), even with controlled viewing distance and content[1].

Accommodative Strain with Small Displays

The greater reduction in accommodative amplitude and facility observed with smartphone use aligns with previous research suggesting that smaller screens increase accommodative load. Narawi et al. (2020) similarly reported significant decreases in accommodative amplitude and facility after 20 minutes of smartphone use, though their study did not include comparative device analysis[1]. The increased accommodative lag observed with smartphones (1.17 ± 0.30 D vs 0.92 ± 0.30 D for laptops) may reflect greater difficulty maintaining accurate focus on small, detailed content, consistent with findings by Kang et al. (2021)[2].

Ocular Discomfort Mechanisms

The higher prevalence and severity of ocular discomfort symptoms with smartphones likely results from multiple interacting factors[3]. First, smaller text and image sizes may require more precise and sustained accommodation. Second, smartphone users often adopt closer viewing distances than the 30 cm standardized in this study, potentially exacerbating accommodative convergence demands[9]. Third, reduced blink rates during intense smartphone engagement may contribute to dry eye symptoms, though our study found relatively minor differences in dryness reports between devices[3].

Display Size vs. Onset Time

Interestingly, while symptom severity differed significantly between devices, onset time did not (27.57 minutes for laptops vs 27.29 minutes for smartphones, $p = 0.654$)[4]. This suggests that the initial triggering of discomfort may relate more to general near-work physiology than specific display characteristics, while sustained use reveals display-specific effects. This finding extends work by Tosha et al. (2009), who noted that accommodative fatigue manifests gradually but differentially across visual tasks[4].

Clinical and Ergonomic Implications

From a clinical perspective, these results support more targeted assessment of accommodative function in heavy smartphone users, particularly young adults who may not yet report symptoms but show measurable accommodative changes[7]. The strong correlation between accommodative parameters and symptom severity ($r = 0.408$) suggests that clinical interventions addressing accommodative function may alleviate discomfort[6].

For device design and ergonomic recommendations, our findings support advocating for larger displays when prolonged reading or detailed work is required[10]. However, the lack of onset time difference suggests that even with larger displays, regular breaks remain essential. This aligns with the 20-20-20 rule (every 20 minutes, look at something 20 feet away for 20 seconds) but adds nuance regarding display selection for extended tasks[10].

Study Limitations and Future Directions

This study was conducted under controlled laboratory conditions, which may not fully replicate real-world usage patterns including variable viewing distances, lighting, and multitasking[15]. Additionally, the sample was limited to young adults; future research should include older age groups and consider presbyopic corrections[16]. Further investigation of screen technology factors (OLED vs LCD, refresh rates, blue light filters) alongside display size would provide more comprehensive guidance for device design and usage recommendations[14].

V. Conclusion

This comparative study demonstrates that smart device display size significantly affects accommodative function and ocular discomfort, with smaller smartphone displays causing greater accommodative strain and more severe symptoms than larger laptop displays[12]. Key findings include greater reductions in accommodative amplitude and facility, increased accommodative lag, and heightened reports of photophobia, tearing, and eye fatigue with smartphone use[8,9].

These results have important implications for both clinical practice and device usage guidelines. Eye care professionals should consider display size when evaluating patients with digital eye strain complaints, and users should be educated about the potential benefits of larger displays for extended reading or work tasks[17]. While regular breaks remain essential regardless of device type, strategic selection of display size may help mitigate accommodative demand and improve visual comfort during prolonged smart device use[6,10].

Future research should explore interactions between display size, viewing distance, and individual visual characteristics to develop personalized recommendations for digital device use in our increasingly screen-dependent society[20].

References

[1]. Narawi WS, Razak SA, Azman N. The Effect Of Smartphone Usage On Accommodation Status. Malays J Med Health Sci. 2020;16(2):244-7.

[2]. Kang JW, Chun YS, Moon NJ. A Comparison Of Accommodation And Ocular Discomfort Change According To Display Size Of Smart Devices. BMC Ophthalmol. 2021;21(1):44.

[3]. Jaiswal S, Asper L, Long J, Lee A, Harrison K, Golebiowski B. Ocular And Visual Discomfort Associated With Smartphones, Tablets And Computers: What We Do And Do Not Know. Clin Exp Optom. 2019;102(5):463-77.

[4]. Tosha C, Borsting E, Ridder WH 3rd, Chase C. Accommodation Response And Visual Discomfort. Ophthalmic Physiol Opt. 2009;29(6):625-33.

[5]. Benjamin WJ. Borish's Clinical Refraction. 2nd Ed. St. Louis: Butterworth-Heinemann; 2006.

[6]. Rosenfield M. Clinical Measurement Of Accommodation. Optom Vis Sci. 2016;93(11):1121-31.

[7]. Grosvenor TP. Primary Care Optometry. 5th Ed. St. Louis: Butterworth-Heinemann; 2007.

[8]. Kwon KI, Kim HJ, Park M, Kim SR. The Functional Change Of Accommodation And Convergence In The Mid-Forties By Using Smartphone. J Korean Ophthalmic Opt Soc. 2016;21(2):127-35.

[9]. Padavettan C, Nishanth S, Vidhyalakshmi S, Madhivanan N. Changes In Vergence And Accommodation Parameters After Smartphone Use In Healthy Adults. Indian J Ophthalmol. 2021;69(6):1487-90.

[10]. Rempel D, Willms K, Anshel J, Jaschinski W, Sheedy J. The Effects Of Visual Display Distance On Eye Accommodation, Head Posture, And Vision And Neck Symptoms. Hum Factors. 2007;49(5):830-8.

[11]. Tahvildari M, Mohammadi SF, Feldman BH, Et Al. Ocular Discomfort. In: Eyewiki. American Academy Of Ophthalmology; 2022.

[12]. Allen L, Mehta J. The Impact Of Smartphone Use On Accommodative Functions: Pilot Study. Strabismus. 2023;31(1):1-8.

[13]. Shahri RZ, Jafarzadehpour E, Mirzajani A. Study Of Lag Of Accommodation After Using A Smartphone. Funct Disabil J. 2021;4(1):38-45.

[14]. Park M, Ahn YJ, Kim SJ, You J. Changes In Accommodative Function Of Young Adults In Their Twenties Following Smartphone Use. J Korean Ophthalmic Opt Soc. 2014;19(2):253-60.

[15]. Moulakaki AI, Recchioni A, Del Aguila-Carrasco AJ, Esteve-Taboada JJ, Montes-Mico R. Assessing The Accommodation Response After Near Visual Tasks Using Different Handheld Electronic Devices. Arq Bras Oftalmol. 2017;80(1):1-5.

[16]. Khurana AK. Comprehensive Ophthalmology. 7th Ed. New Delhi: Jaypee Brothers Medical Publishers; 2019.

[17]. American Optometric Association. Computer Vision Syndrome [Internet]. 2019 [Cited 2023 Sep 15]. Available From: Https://Www.Aoa.Org/Patients-And-Public/Caring-For-Your-Vision/Protecting-Your-Vision/Computer-Vision-Syndrome

[18]. Digital Around The World — Datareportal - Global Digital Insights [Internet]. 2023 [Cited 2023 Sep 15]. Available From: Https://Datareportal.Com/Global-Digital-Overview

[19]. Kemp S. Digital 2023: Nigeria — Datareportal - Global Digital Insights [Internet]. 2023 [Cited 2023 Sep 15]. Available From: Https://Datareportal.Com/Reports/Digital-2023-Nigeria

[20]. Ukai K, Oyamada H, Ishikawa S. Changes In Accommodation And Vergence Following 2 Hours Of Movie Viewing Through Bi-Ocular Head-Mounted Display. In: Accommodation And Vergence Mechanisms In The Visual System. Basel: Birkhäuser; 2000. P. 215-24.