



Effect of Smart Phone on Accommodation and Vergence Response in Bright and Dark Illumination with Different Positions

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Abstract

Background: In modern society, globally the use of electronic device for both professional and non- professional activities has been more prevalent. The relatively small screen found in this device may necessitate close working distance and small text size which may increase the demands placed on ocular accommodation and vergence.

Aim: To study effect of smart phone on accommodation and vergence before and after using a smart phone in bright and dark illumination with different position.

Methodology: It is a prospective study where the subjects were participated from Sankara college of optometry Bangalore. The following test such as Near point of accommodation, amplitude of accommodation, NRA – PRA Accommodative facility, NPC, vergence facility, Negative fusional vergence and positive fusional vergence evaluation were done. Then, the subjects were made to read a novel on a smart phone in bright and dark illumination in erect and supine position 30 minutes again accommodation and vergence test were repeated. Data analysis was done by using paired T-test with the help of SPSS software V23. The accommodation and vergence functions tests were compared for before and after reading novel on a smart phone in bright and dark illumination in erect and supine position about half an hour.

Result: A total of 30 subjects were evaluated under the Mean age group of 19.97 ± 1.67 year (range, 18-30years). Out of 30 subjects, 22(73%) were females and 8(27%) were males. There is significant change statistically and clinically in accommodation components such as NPA, AA and NRA, MEM and Vergence components such as NFV before and after reading novel on a smart phone in bright and dark illumination in erect and supine position about 30minutes.

Conclusion: In the current study, we found that prolonged reading of novel in the smart phone in bright and dark illumination in erect and supine position which was for a period of half an hour shows statistically significant effect on accommodative components such as NPA, amplitude of accommodation and NRA, MEM and also there was statistically significant effect on vergence components such as NFV. This study concludes that reading novel for half an hour on smart phone in bright and dark illumination in erect and supine position has effect on the accommodation and vergence function.

Keywords: Reading; Accommodation and Vergence Function Smart Phone; Bright illumination and Dark Illumination

Introduction

In modern Society, Globally the use of the electronic device for both professional and nonprofessional activities have been

more prevalent. Today's Visual requirements may include viewing laptops and tablet computers electronic devices either in the work place at home or in the portable equipment in any location [1].

Among all of these electronic device's smartphone (VDT) is the most common. In a recent study the number of smartphone users is forecast to grow from 2.1 billion in 2016 to around 2.5 billion in 2019 with smartphone penetration rates increasing as well, so the number of mobile phone users in India from 2013 to 2019. In this same year, the number of smartphone users in India forecasted to reach 340 million and reach almost 468 million by 2022 [2].

A recent Investigation of over 2000 American children between the ages of 8 and 18 years reported in an average day they spent 7.5 hours using entertainment media, 1.5 hours on a computer and over an hour playing video games, so the use of the smartphone for written communication (e.g.: text message, mail and internet access) is also becoming ubiquitous Contemporary Society [3].

The relatively small screen found in this device may necessitate close working distance and small text size, increase the demands placed on ocular accommodation and vergence. This can result in disabling symptoms which may include eyestrain, headache, ocular discomfort, dry eye, diplopia and blurred vision either near or when looking a distance after prolonged use [4].

Accommodation and vergence also play an important role during sustained near tasks and are influenced by different illumination levels. Viewing any form of near target requires appropriate accommodation and vergence response to provide a clear and single vision of the object regard [4].

A study done by Aikaterini, Moulakaki., *et al.* (2017). A study done on Assessing the accommodation response after near visual task using different handheld electronic device has proven that Accommodation system of the eye relaxed and visually stressed with a tablet and a smartphone for 10 minutes at a distance of 0.25m from the subject's eye. The accommodation response was not dependent on the electronic device employed in each condition and it was mainly associated with young age and level of amplitude of accommodation of the subjects [5].

The ciliary muscle is a circular ring of muscle that attaches around the lens. This ciliary muscle can change the shape of the crystalline lens by stretching it at the edges. It is attached to the lens by Zonules [6].

When we are looking at a near object the lens needs to become more rounded at the central surface to focus the light rays. The

ability to change focus for close-up objects is called accommodation [6]. The eyes should be strained more to distinguish the words on the page. If this occurs for an extended period leads to eyestrain including asthenopia headaches, back and neck pain, drooping of eyelids and blurred vision and dry eye, The environmental lighting system is also a major contributing factor to VDT related eye fatigue According to OSHA, the Average illumination is between 300lux to 700lux [7].

Methodology

A Prospective study which was conducted in the Sankara College of optometry Bangalore, the duration of study period was from December 2017- August 2018. The research was approved by the college authorities and a written consent from was taken by the subjects. Each subject was explained briefly about the purpose and procedure of the tests, required for the study before enrolling them in to the study.

Inclusion criteria

- Age (18-30) years
- Best corrected Visual acuity \leq 0.00 and 20/20

Exclusion criteria

Any diagnosed ocular diseases and ocular motor abnormalities.

Any Ocular condition which effects the binocular function (amblyopia, nystagmus and ocular infections) Binocular anomalies.

The examination for all subjects were initially with Visual Acuity for distance and near, then retinoscopy and subjective acceptance was performed. Subjects with their best corrected visual Acuity was evaluated for their binocular vision.

The baseline examination of Binocular vision includes such as Stereopsis, W4DT, Cover test, uncover test, amplitude of accommodation, accommodative facility, Negative relative accommodation, Positive relative accommodation, Near Point of convergence, Vergence facility, Negative fusional Vergence, Positive fusional vergence was measured. The Sensory function of the subjects was measured by W4DT for both distance and near. Also, the stereopsis was done for near. The motor function of the subjects was measured by cover test and uncover test for distance and near. After this test, accommodation and vergence test was performed.

then the subjects were made to read the novel on the smart phone in bright illumination in erect position (72 Lux) and supine position (52Lux) for 30minutes and then the accommodation and vergence test was performed. Again, the subjects were made to read the novel on the smart phone in dark illumination in erect position (2 Lux) and supine position (3 Lux) for 30minutes and then the accommodation and vergence test was performed.

Results

Data were analyzed using statistical package for social science (SPSS) software, Version 23. Paired T-test was used to compare accommodation and vergence before and after reading novel in smart phone in bright and dark illumination in erect and supine position. All the values are presented as mean ± standard deviations with significant (P) values $p < 0.05$ is significant value.

Total of 30 subjects between mean age group of 19.97 ± 1.67 (18-30 years) were participated from Sankara college of optometry Bangalore among them 8 were males and 22 were females.

Table 1 Base line evaluation of Accommodation and Vergence.

Tests		Mean ± SD
NPA	OD	8.76 ± 1.5
	OS	8.72 ± 0.7
	OU	8.22 ± 1.81
AA	OD	12.20 ± 3.26
	OS	12.15 ± 3.09
	OU	12.80 ± 3.28
MEM	OD	0.566 ± 0.425
	OS	0.567 ± 0.408
NRA		2.92 ± 0.342
PRA		3.25 ± 0.00
AF	OD	8.48 ± 5.703
	OS	8.91 ± 5.83
	OU	8.34 ± 5.98
NPC (accommodative target)		(6.09/7.32) ± (2.84/3.90)
NPC (non-accommodative target)		(6.77/7.80) ± (2.91/3.54)

NFV	Distance	(0.00/9.50/6.86) ± (0.00/5.91/5.22)
	Near	(14.50/12.10/9.33) ± (5.58/5.13/8.71)
PFV	Distance	(0.80/18.80/15.1) ± (3.22/8.83/6.10)
	Near	(0.83/27.86/20.72) ± (4.56/10.7/9.28)
VF		11.43 ± 5.32

Table 1: The mean value with the standard deviation (baseline) of accommodation and vergence function shows within normal ranges. After performing the base line evaluation, the subjects had given to read novel in the smart phone in bright and dark illumination in erect and supine position.

Table 2 comparison of accommodative assessment before and after reading novel in smart phone in bright illumination in erect position.

Accommodative Assessment		Before	After	p-value
		Mean ± SD		
NPA	OD	8.76 ± 2.15	8.00 ± 1.76	0.11
	OS	8.72 ± 2.07	7.73 ± 1.77	0.017
	OU	8.22 ± 1.81	7.79 ± 1.41	0.2
AA	OD	12.20 ± 3.26	13.20 ± 3.46	0.203
	OS	12.15 ± 3.09	13.58 ± 2.4	0.046
	OU	12.80 ± 3.28	13.39 ± 2.82	0.421
MEM	OD	0.56 ± 0.42	0.66 ± 0.28	0.16
	OS	0.56 ± 0.40	0.72 ± 0.30	0.58
NRA		2.92 ± 0.34	3.00 ± 0.39	0.38
PRA		3.25 ± 0.00	3.25 ± 0.00	0
AF	OD	8.48 ± 5.70	9.78 ± 5.45	0.11
	OS	8.91 ± 5.83	9.58 ± 4.98	0.42
	OU	8.34 ± 5.98	8.27 ± 4.94	0.95

Table 2: The accommodative function before and after reading novel in smart phone in bright illumination in erect position. NPA in OS and AA in OS and MEM shows some amount of changes clinically which is considered as significant and rest of the accommodative test was not significant.

Table 3 comparison of Vergence assessment before and after reading novel in smart phone in bright illumination in erect position.

Vergence Assessment		Before	After	p-value
		Mean ± SD		
NPC (accommodative target)	Break	6.09 ± 2.84	5.86 ± 3.81	0.77
	Recovery	7.32 ± 3.90	7.39 ± 5.41	0.95
NPC (non-accommodative target)	Break	6.77 ± 2.91	7.32 ± 2.59	0.3
	Recovery	7.80 ± 3.54	8.95 ± 3.84	0.14
NFV (distance)	Break	9.50 ± 5.91	15.5 ± 7.36	0
	Recovery	6.86 ± 5.22	6.14 ± 3.98	0.42
NFV (near)	Break	12.10 ± 5.13	12.30 ± 5.84	0
	Recovery	9.33 ± 8.17	9.80 ± 7.98	0.85
PFV (distance)	Break	18.80 ± 8.83	24.4 ± 11.85	0.26
	Recovery	15.1 ± 6.10	14.1 ± 8.82	0.43
PFV (near)	Break	27.8 ± 10.7	31.5 ± 12.3	0.21
	Recovery	20.2 ± 9.28	17.6 ± 8.85	0.29
VF		11.43 ± 5.32	11.87 ± 4.34	0.79

Table 3: The above table shows the vergence assessment before and after reading novel in smartphone in bright in erect position. NFV (break value) for distance and near shows some amount of changes clinically which as considered as significant and rest of the vergence test are insignificant.

Table 4 comparison of accommodative function before and after reading novel in smart phone in bright illumination supine position.

Accommodation assessment		Before	After	p - value
		Mean ± SD		
NPA	OD	8.76 ± 2.15	7.82 ± 1.61	0.27
	OS	8.72 ± 2.07	7.53 ± 1.52	0.006
	OU	8.22 ± 1.81	7.49 ± 1.80	0.019
AA	OD	12.20 ± 3.26	13.2 ± 2.70	0.12
	OS	12.15 ± 3.09	13.83 ± 3.24	0.035
	OU	12.80 ± 3.28	13.97 ± 3.10	0.056
MEM	OD	0.566 ± 0.42	0.67 ± 0.51	0.295
	OS	0.567 ± 0.40	0.68 ± 0.53	0.32

NRA		2.92 ± 0.34	3.10 ± 0.39	0.72
PRA		3.25 ± 0.00	3.25 ± 0.00	0
AF	OD	8.48 ± 5.70	9.82 ± 5.95	0.16
	OS	8.91 ± 5.83	9.20 ± 6.23	0.73
	OU	8.34 ± 5.98	8.15 ± 4.59	0.85

Table 4: The above table shows that the accommodation assessment before and after reading novel in smart phone in bright illumination in supine position. NPA in OS and NPA in OU and AA in OS and AA in OU shows some amount of changes clinically which as considered as significant. and rest of the accommodation test was insignificant.

Table 5 comparison of Vergence assessment before and after reading novel in smart phone in bright illumination supine position.

Vergence Assessment		Before	After	p-Value
		Mean ± SD		
NPC (accommodative target)	Break	6.09 ± 2.84	5.19 ± 3.06	0.23
	Recovery	7.32 ± 3.90	6.08 ± 4.25	0.32
NPC (non-accommodative target)	Break	6.77 ± 2.91	6.78 ± 1.56	0.97
	Recovery	7.08 ± 3.54	8.79 ± 3.30	0.2
NFV (distance)	Break	9.50 ± 5.91	9.40 ± 7.96	0.94
	Recovery	6.86 ± 5.22	5.83 ± 3.96	0.1
NFV(Near)	Break	12.10 ± 5.13	16.80 ± 5.16	0
	Recovery	9.33 ± 8.17	13.6 ± 5.00	0.16
PFV (distance)	Break	18.80 ± 8.83	22.2 ± 11.40	0.15
	Recovery	15.1 ± 6.10	13.7 ± 7.02	0.51
PFV(Near)	Break	27.8 ± 10.7	33.3 ± 10.7	0.07
	Recovery	20.2 ± 9.28	18.5 ± 9.31	0.63
VF		11.4 ± 5.32	12.5 ± 4.28	0.18

Table 5: The table shows that the vergence assessment before and after reading novel in smart phone in bright illumination in supine position there was only NFV (break value) for near shows some amount of changes clinically which as considered as significant and rest of the accommodative assessment were insignificant.

Table 6 comparison of accommodative assessment before and after reading novel in smart phone in dark illumination in erect position.

Accommodative Assessment		Before	After	p- value
		Mean ± SD		
NPA	OD	8.76 ± 2.15	8.01 ± 1.87	0.07
	OS	8.72 ± 2.07	7.89 ± 1.93	0.09
	OU	8.22 ± 1.81	7.92 ± 2.06	0.43

AA	OD	12.20 ± 3.26	13.3 ± 4.07	0.14
	OS	12.15 ± 3.09	13.5 ± 4.15	0.85
	OU	12.8 ± 3.28	13.8 ± 4.07	0.27
MEM	OD	0.566 ± 0.42	0.92 ± 0.48	0.009
	OS	0.56 ± 0.40	0.94 ± 0.52	0.006
NRA		2.92 ± 0.34	3.19 ± 0.49	0.03
PRA		3.25 ± 0.00	3.25 ± 0.00	0
AF	OD	8.48 ± 5.70	10.05 ± 5.98	0.08
	OS	8.91 ± 5.83	9.86 ± 5.91	0.3
	OU	8.34 ± 5.98	7.53 ± 5.14	0.377

Table 6: The above table shows that the accommodation assessment before and after reading novel in the smart phone in dark illumination in supine position. MEM both OD and OS & NRA shows some amount of changes clinically which as considered as significant and rest of the accommodative test was insignificant.

Table 7 comparison of vergence assessment before and after reading novel in smart phone in dark illumination in erect position.

Vergence Assessment		Before	After	P-value
		Mean ± SD		
NPC (accommodative target)	Break	6.09 ± 2.84	5.87 ± 3.04	0.76
	Recovery	7.32 ± 3.90	7.47 ± 3.80	0.89
NPC (non-accommodative target)	Break	6.77 ± 2.91	7.32 ± 2.36	0.35
	Recovery	7.80 ± 3.54	8.89 ± 3.54	0.2
NFV (distance)	Break	9.50 ± 5.91	9.07 ± 4.47	0.65
	Recovery	6.86 ± 5.22	6.87 ± 4.65	0.96
NFV(Near)	Break	12.10 ± 5.13	12.6 ± 4.93	0
	Recovery	9.33 ± 8.17	9.07 ± 4.47	0.46
PFV (distance)	Break	18.80 ± 8.83	23.6 ± 10.7	0.03
	Recovery	15.1 ± 6.10	15.3 ± 6.59	0.46
PFV (Near)	Break	27.86 ± 10.7	32.2 ± 11.6	0.089
	Recovery	20.22 ± 9.28	21.09 ± 9.88	0.4
VF		11.43 ± 5.32	11.1 ± 3.83	0.69

Table 7: The above table shows that the vergence assessment before and after reading novel in smart phone in dark illumination in erect position. There was only NFV (break value) for near shows some amount of changes clinically which is considered as significant and rest of the vergence insignificant.

Table 8 comparison of accommodative assessment before and after reading novel in smart phone in dark illumination in supine position.

Table 9 comparison of vergence assessment before and after reading novel in the smart phone in dark illumination in supine position.

Accommodative Assessment		Before	After	p- value
		Mean ± SD		
NPA	OD	8.76 ± 2.15	8.23 ± 2.26	0.24
	OS	8.72 ± 2.07	7.06 ± 2.15	0.01
	OU	8.22 ± 1.81	7.73 ± 1.89	0.19
AA	OD	12.20 ± 3.26	13.07 ± 4.11	0.26
	OS	12.15 ± 3.09	14.05 ± 4.19	0.029
	OU	12.80 ± 3.28	13.66 ± 4.03	0.26
MEM	OD	0.566 ± 0.42	0.966 ± 0.52	0.005
	OS	0.567 ± 0.408	0.985 ± 0.48	0.002
NRA		2.92 ± 0.34	3.15 ± 0.43	0.02
PRA		3.25 ± 0.00	3.25 ± 0.00	0
AF	OD	8.48 ± 5.70	9.70 ± 6.05	0.251
	OS	8.91 ± 5.83	10.19 ± 6.00	0.24
	OU	8.34 ± 5.98	8.25 ± 4.90	0.93

Table 8: The above table shows that the accommodation assessment before and after reading novel in smart phone in dark illumination in supine position. There was statistically significant in NPA in OS (p = 0.01) and AA in OS (p = 0.029) and MEM in OD (p = 0.002) was showing highly significant and also there was statistically in NRA (P= 0.02) and where rest of accommodation function was insignificant after reading novel in smart phone in dark illumination in supine position for 30 minutes.

Vergence Assessment		Before	After	P-value
		Mean ± SD		
NPC (accommodative target)	Break	6.09 ± 2.84	5.31 ± 2.70	0.25
	Recovery	7.32 ± 3.90	6.89 ± 3.83	0.46
NPC (non-accommodative target)	Break	6.77 ± 2.91	6.58 ± 1.84	0.73
	Recovery	9.50 ± 5.91	12.1 ± 12.13	0.25
NFV (distance)	Break	6.86 ± 5.22	6.56 ± 4.44	0.66
	Recovery	12.10 ± 5.13	18.2 ± 8.63	0
NFV(Near)	Break	9.33 ± 8.17	13.5 ± 5.41	0.27
	Recovery	18.80 ± 8.83	22.7 ± 11.91	0.085
PFV (distance)	Break	15.1 ± 6.10	14.1 ± 7.45	0.925
	Recovery	15.1 ± 6.10	14.1 ± 7.45	0.925
PFV (Near)	Break	27.86 ± 10.7	28.4 ± 9.47	0.85
	Recovery	20.2 ± 9.28	20.13 ± 6.16	0.56
VF		11.43 ± 5.32	12.20 ± 4.42	0.8

Table 9: The above table shows that the vergence function before and after reading novel in smart phone in dark illumination in supine position. There was only statically significant in NFV (break value) for near (p = 0.00) and rest of the vergence function was showed insignificant (p = 0.00) and rest of the vergence function was showed insignificant (P > 0.05) after reading novel in smart phone in dark illumination in supine position for 30 minutes.

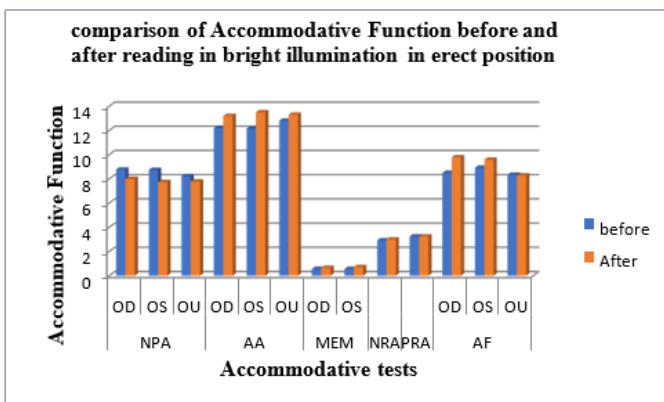


Figure 1: Comparison of accommodative assessment before and after reading novel in smart phone in bright illumination in erect position.

The above graph shows, the accommodative assessment before and after reading novel in smart phone in bright illumination in erect position there was statistically significant ($p = 0.017$) in NPA in OS and also there was statistically significant in amplitude of accommodation in OS ($p = 0.046$) and also MEM ($p = 0.05$) showed statistically significant in bright illumination.

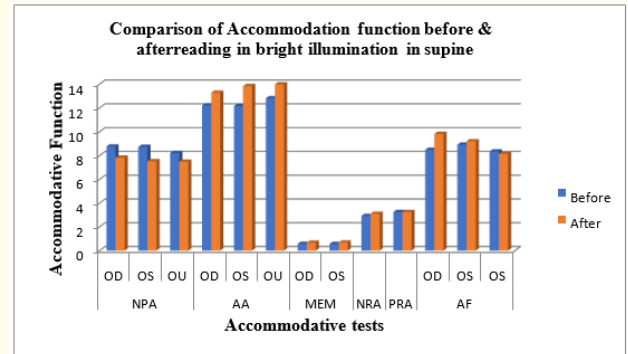


Figure 3: Comparison of accommodative assessment before and after reading novel in smart phone in bright illumination in supine position.

The above graphs shows that the accommodation assessment before and after reading novel in smart phone in bright illumination in supine position there was statistically significant in NPA in OS ($p = 0.006$) and OU ($p = 0.019$) and also statistically significant in amplitude of accommodation in OS ($p = 0.056$) after reading novel in smart phone for about 30 minutes.

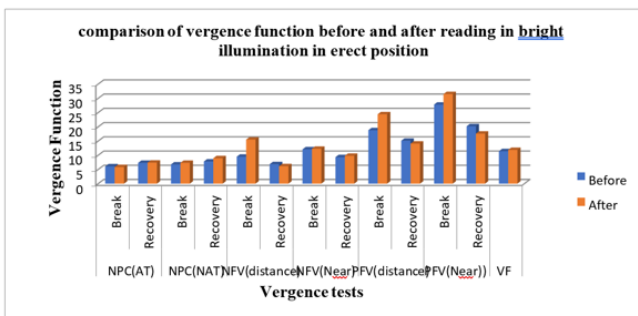


Figure 2: Comparison of vergence assessment before and after reading novel in the smart phone in bright illumination in erect position.

The above graph shows that the vergence assessment before and after reading novel in smart phone in bright illumination in erect position for 30 minutes there was statistically significant ($p = 0.00$) NFV for both distance and near.

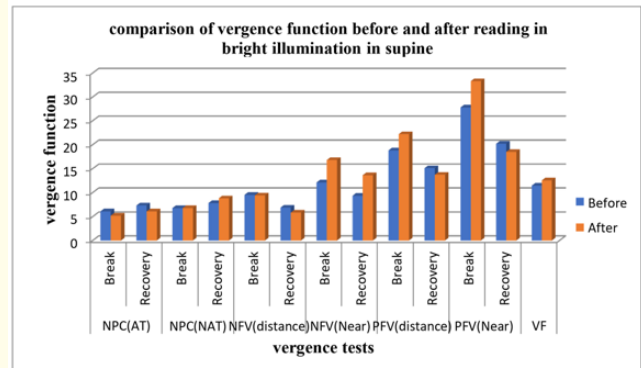


Figure 4: Comparison of vergence assessment before and after reading novel in smart phone in bright illumination in supine position.

The above graphs shows that the vergence assessment before and after reading in smart phone in bright illumination in supine position there was only statistically significant in NFV ($p = 0.00$) for near after reading novel in smart phone for about 30minutes.

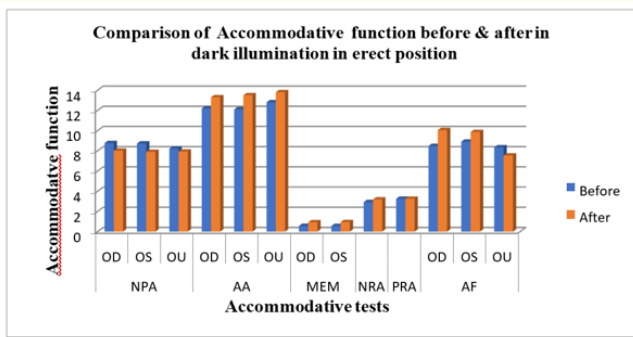


Figure 5: Comparison of accommodative assessment before and after reading novel in smart phone in dark illumination in erect position.

The above graph shows that the accommodation function before and after reading novel in smart phone in dark illumination in erect position. There was statistically significant in MEM in OD ($p = 0.009$) and OS ($p = 0.006$) and also there was statistically significant in NRA ($p = 0.030$) after reading novel in smart phone about 30 minutes.

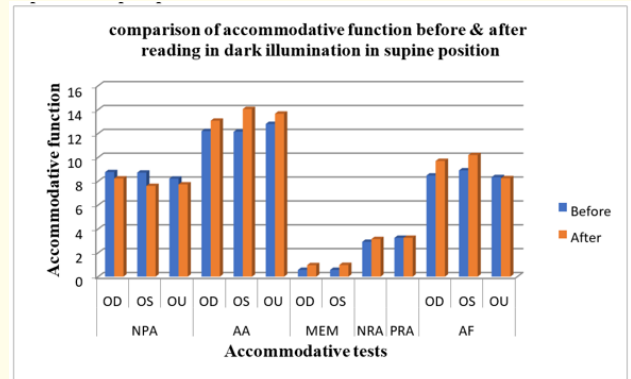


Figure 7: Comparison of accommodation assessment before and after reading novel in smart phone in supine position.

The above graph shows that the accommodation function before and after reading novel in smart phone in dark illumination in supine position. There was statistically significant in NPA in OS ($p = 0.01$) and amplitude of accommodation in OS ($p = 0.029$) and MEM in OD ($p = 0.005$) and OS ($p = 0.02$) after reading novel in smart phone for about 30 minutes.

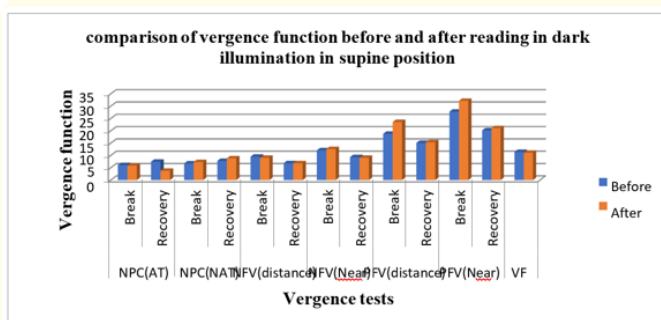


Figure 6: Comparison of vergence assessment before and after reading novel in smart phone in dark illumination in erect position.

The above graph shows that the vergence function before and after reading novel smart phone in dark illumination in erect position. There was only statistically significant in NFV ($p = 0.00$) after reading novel in smart phone in dark illumination for about 30minutes.

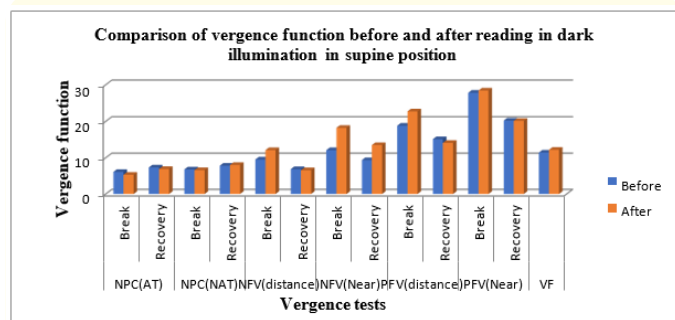


Figure 8: Comparison of vergence assessment before and after reading novel in the smart phone in dark illumination in supine position.

The above graph shows that the vergence function before and after reading novel in smart phone in dark illumination in supine position. There was only statistically significant in NFV for near ($p = 0.00$) after reading novel in smart phone in dark illumination for about 30minutes.

Discussion

Number of smart phone users are growing to increase by 30-60% increasing in next few years. VDT operators are strongly associated with accommodative process [1].

In current study, expect there was statistically significant ($p = 0.017$) in NPA in OS in bright illumination both erect and supine position ($p = 0.06$) and ($p = 0.019$) was statistically significant and ($p = 0.010$) in NPA OS in dark illumination in supine position. Statistically significant ($p = 0.04$) in amplitude of accommodation in OS in bright illumination in erect position and ($p = 0.03$) in amplitude of accommodation in OS in bright illumination in supine position was statistically significant. ($p = 0.05$) MEM in OS in bright illumination was statistically significant and ($p = 0.00$) and ($p = 0.00$) in MEM in OD and in OS in dark illumination in supine position was highly significant. Where rest of the accommodative function did not show any significant difference after reading for 30 minutes on smart phone. This result of ours has been supported by previous study conducted by Aikaterini, Moulakaki., *et al.* [1]. In their study they have compared accommodation response after near visual task using a different handheld electronic device and showed no statistically different were found in the accommodation stimulus after reading for 30 min on smart phone.

We have also compared the vergence function before and after reading in smart phone for 30 minutes in bright and dark illumination in erect position and supine position. There was statistically significant in ($p = 0.00$) in NFV and ($p = 0.00$) NFV both for distance and near in bright illumination in erect position. ($p = 0.00$) and ($p = 0.00$) in NFV for near in dark erect position and supine position and vergence function are insignificant ($p < 0.05$) which resembles by Ki-il Kwon., *et al.* [7] he found that significant reduction of negative fusional vergence were observed. So, accommodation and vergence stimulus is showing insignificant effect after using smart phone for 30 minutes. This could be because of all the subjects having normal range of accommodation and vergence on baseline evaluations so for shorter period of time using smart phone to read novels or any reading material is advisable in young adults. This is reported by Aikaterini as young subjects and their normal levels of accommodation and vergence was corresponding to their age.

Conclusion

In the current study, we found that prolonged reading of novel in the smart phone in bright and dark illumination in erect and supine position which was for a period of half an hour shows statistically significant effect on accommodative components such as NPA, amplitude of accommodation and NRA and also there was statistically significant effect on vergence components such as NFV.

This study concludes that reading novel for half an hour on smartphone in bright and dark illumination in erect and supine position has effect on the accommodative such as and Vergence components.

Future Scope

Research can be done for more hours of reading to find out whether reading a novel on a smart phone have an impact on accommodation and vergence function.

As uses of smartphone, tablets are increasing among young children. Research can be done to know long- term playing on electronic devices have any ocular effect.

Acknowledgment

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Conflict of Interest

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Bibliography

1. Moulakaki Aikaterini I., *et al.* "Assessing the accommodation response after near visual task using different handheld electronic devices". *Arquivos Brasileiros de Oftalmologia* 80.1 (2017).
2. Number of smart phone users worldwide from 2014 to 2020(in billions).
3. Rideout V J., *et al.* "Generation M2. Media in the lives of 8-18 years olds. A Kaiser family foundation study". January (2010).
4. Martin Emma Smart phone users surveyed unhappy with service. April 5 (2016).
5. "The eye- chart lass optometrist Diagram explaining the eye accommodation system".
6. Majumder Chiranjib. "Effect of illumination over positive fusional vergence when using VDU as target". *Journal of Clinical and Experimental Ophthalmology*. Published date May 29 (2017).
7. Ki-il Kwon., *et al.* "The functional changes of accommodation and convergence in the mid - forties by using smart phone". *Journal of Korean Ophthalmic Optics of Society* 21.2 (2016): 127-135.
8. Long J., *et al.* "Viewing distance and eyestrain with prolonged viewing of smart phone". *Clinical and Experimental Optometry* 100.2 (2016): 133-137.
9. Yuliya Bababekova., *et al.* "Front size and Viewing distance of handheld smart phones". *Optometry and Vision Science* 88.7 (2011): 795-797.
10. Scheiman Mitchell and Bruce Wick. "Clinical Management of binocular vision". Edi 4th Philadelphia: Wolters Kluwer Health; (2008): 14-32.