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The Potential Association between Asthenopia and its Risk Factors amongst Student at the University of Sunderland

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Abstract

Background

Asthenopia contributes to visual tiredness, and lack of sleep leading to low mental state, thus students put off completing their coursework, which negatively affects their academic performance. With limited information on the risk factors associated with asthenopia at the University of Sunderland. This study aimed to assess the potential risk factors associated with asthenopia among students at the University of Sunderland, North-East England.

Method

This cross-sectional research was conducted between May and August 2023 with 400 participants. A validated questionnaire was used to obtain responses. Descriptive and correlational statistics (bivariate analysis) were conducted to establish associations between asthenopia and potential risk variables, binary logistic regression was utilised to calculate the odds ratio.

Results

Females were more dominant (53.4) compared to males (46.6%), the prevalence of asthenopia was 69.9%, and headache 53.7% was the most prevalent symptom. Participants within age 43 and above were negatively associated with the development of asthenopia (r=-0.115, p<0.028, 95% Cl-0.215/-0.012). Asian Ethnic group had an odds ratio of 0.660 times (95% Cl=0.742-1.208, P<0.001). Astigmatism was significantly associated with asthenopia (r=0.107, p=<0.041, 95%Cl 0.04/0.207) and the odds ratio (OR) was 1.499 times (95% Cl, 0.99/2.257). Participants who studied (>6 hours) were 2.889 times more prone to developing asthenopia.

Conclusion

Refractive error (astigmatism), time spent of digital device (>6hours) and age (43years above) were associated with asthenopia. Asian ethnic group was shown to have lesser likelihood of experiencing asthenopia. Anti-reflective glasses and eye drop were good protective measures for reducing asthenopia.

Keywords: Asthenopia, Computer Vision Syndrome, Eye Strain, Digital Devices, Risk Factors, Astigmatism

Introduction

Asthenopia is characterized as a collection of vision and ocular issues that develop while utilizing visual display devices to perform near work, causing strain to the eyes. Asthenopia is sometimes referred to as computer vision syndrome [6]. With nearly sixty million people experiencing asthenopia globally [35] and one million new occurrences occur yearly [34], due to constant exposure of the eyes to the use of electronic video displays terminals, which include desktops, tablets, laptops, mobile devices among university students. These digital tools make it easier for them to find and save information quickly, while also carrying out educational or scientific research tasks [3, 18]. They tend to experience symptoms such as eye tiredness, burning sensation, pain, sore eyes, and headache which is grouped as the non-specific symptoms of asthenopia, whereas photophobia, blurry vision, itching eyes, tearing, dryness, and a sense of a foreign body as specific symptoms [12].

Studies had indicated female gender been a risk factor to the onset of asthenopia [7], due to female hormone [19], concluded that the influence of hormonal factors are higher in older women. On the contrary [16], highlighted that males were associated with the onset of asthenopia. Students within the age group (22 -29 years) of [9] were at risk of developing asthenopia when compared to other age group [9]. Additionally, refractive error has been shown to be associated with asthenopia, astigmatism a type of (refractive error) of only 0.50 to 1.00 diopters if left uncorrected may significantly worsen CVS symptoms [26].

Further studies by [14] conducted in Iran, concluded that astigmatic participants had 1.61 times likelihood of developing asthenopia than students without astigmatism. Furthermore, environmental factors such as bad sitting posture, incorrect viewing angle and distance, low screen brightness and contrast, insufficient illumination, as well as a disparity between the display, ambient illumination, and study length as also been linked to the onset of asthenopia [8, 11], suggested studying more than 6 hours was related to the onset of asthenopia, however [27] suggested 4 hours or more.
Several studies have been conducted in various parts of the world to ascertain the potential association between asthenopia and its risk factors, but none has been conducted or any journal publication from the United Kingdom. However, with the global statistics of the use of internet and knowing that the use of digital devices is part of everyday lives of students, it is quite imperative that a study be conducted among university students residing in the United Kingdom. Also, given that fewer studies have identified refractive error as a risk factor for asthenopia, in addition to [27] who recommended studies should be conducted to explore other possible risk factors of asthenopia. This research examined the risk factors linked to asthenopia among Sunderland University Student with a focus on refractive errors (due to lack of information on refractive error) and to explore any additional risk factors linked to asthenopia.

Methods

Study Design and Study Population

This was a cross-sectional study conducted between May to August 2023 in University of Sunderland, North-East of England, using 400 participants (undergraduates and postgraduates' students).

Sampling and Sample Size

The researcher recruited 400 students initially using convenience sampling technique. Convenience sampling was deemed appropriate for this research due to the short time frame for completion of the research. The university of Sunderland boost of a population of above ten thousand students, hence the researcher employed the [23].

Formular; Z^2 X StdDev X (1-StdDev)/ (Margin of error)^2,

Z-Score =1.96 (the Z-score is the 95% confidence level) this is a range of value that you can be certain contains the population mean.
Standard deviation represented as (StdDev)=0.5,
Margin of error (confidence interval) of +/-5%.

(0.05). $(1.96)^2$ x 0.5(0.5)) / $(0.05)^2$ =384.16,

Approximately 384 respondents.

Data collection

Questionnaire was tool used in recruitment of University of Sunderland students, students who were 18years and above, willing to join the research and were student at Sunderland university were recruited for the research after signing the consent form, otherwise was excluded from the research. The research was conducted online via various social media platforms such as WhatsApp, Facebook, twitter, emails and by word of mouth in school library and classrooms.

Participant information sheet (PIS), consent form and questionnaire which comprised of 16 questions, arranged into 5 different sections comprising of participants demographics, ocular status, digital device use, symptoms of asthenopia and preventive measures. The questionnaire was adopted from a previous study [27] and was validated by the institutional Review Board American University of Beirut in Lebanon. The adopted questionnaire was modified and restructured to meet the researcher aim. The adopted questionnaire was piloted before the study for validity and reliability. These three items were sent to the students, upon reading the (PIS) which gave them an understanding of what the research was all about and what was required from them, then they consent to indicate their willingness to be part of the research and completed the questionnaire. The research was conducted via Qualtrics online platform which was used to send the questionnaire and to receive their responses. Data gathered was passworded on a hard drive only accessible by the researcher.

Data Analysis

Data collected was analysed using (Statistical package for social sciences IBM version 28), descriptive statistics using frequencies and percentages was used to measure demographics characteristics such as age, gender, and education. Asthenopia was defined as the occurrence of more than one symptom been experienced by students [14], hence symptoms were grouped into two; (1) to represent student with more than one symptom and (0) for student with one or less. Correlational statistics using bivariate analysis (Pearson product moment correlation) was used to determine the association between potential risk factors such as gender, age, refractive error, duration of digital use, preventive measures and asthenopia. For p-values <0.01, binary logistics regression was further carried out to ascertain the likelihood of the variable causing asthenopia. For all analyses, we used a *P*-value of 0.05 and 95% confidence interval (CI) to assess statistical significance.

Ethical consideration

Ethical approval was requested and obtained from the University of Sunderland Ethics Committee through the project supervisor. Participants were assured of strict confidentiality and anonymity.

Results

A total of 400 responses were gotten, 25 were excluded due to incomplete responses gotten, while 365 valid results were analysed.

Demographics

The Table 1 below shows the demographic characteristics of participants, from the 365 valid responses, males were 170 in total (46.6%), and females were 195 (53.4%). Participant within age group of 28-32years were more dominant in the survey 116 (31.8%), while age 43 and above were the least age group comprising of 24 (6.6%) students. Educational status comprised of undergraduates 79 (21.6%) and postgraduates 286 (78.4%).
Participant of Black/African/Caribbean origin were more dominant in the survey 266 (72.9%), White origin was 54 (14.8%), Asian origin were 36 (9.9%), mixed, other backgrounds (Arab) and few participants preferring not to say their origin had 3 responses (0.8%) respectively.

Table 1: Showing Demographic characteristics of students

Characteristics	Frequency (%)
Gender	
Male	170 (46.6%)
Female	195 (53.4%)
Age	
18-22	38 (10.4%)
23-27	70 (19.2%)
28-32	116 (31.8%)
33-37	74 (20.3%)
38-42	43 (11.8%)
43 and above	24 (6.6%)
Education	
Undergraduate	79 (21.6%)
Postgraduate	286 (78.4%)
Ethnicity	
White	54 (14.8%)
Black/African/Caribbean	266 (72.9%)
Asian	36 (9.9%)
Other Background (Arab).	3 (0.8%)
Mixed Ethnic group	3 (0.8%)
Prefer not to say.	3 (0.8%)
Refractive Error	
Yes	154 (42.2%)
No	176 (48.2%)
Not aware	35 (9.6%)
Types of Refractive Error	
Hyperopia	45 (12.3%)
Astigmatism	24 (6.6%)
Myopia	53 (14.5%)
Presbyopia	32 (8.8%)
Laser Refractive Surgery	
Yes	11 (3.0%)
No	354 (97.0%)

Table 2: Showing the Digital device use

Digital Device Used	Frequency (%)
Most frequently used device	
Smart Phone	344 (53.4%)
Laptop/Desktop	240 (37.3%)
Tablet	60 (9.3%)
How many hours per day in total do you spend on digital screen	
2hrs	20 (5.5%)
2-4hrs	42 (11.5%)
4-6hrs	109 (29.9%)
>6hrs	194 (53.2%)
How many hours per day in total do you spend in a Bright room	
2hrs	36 (9.9%)
2-4hrs	84 (23.0%)
4-6hrs	136 (37.3%)
>6hrs	109 (29.9%)
How many hours per day in total do you spend in an Ambient room	
2hrs	88 (24.1%)
2-4hrs	110 (30.1%)
4-6hrs	97 (26.6%)
>6hrs	70 (19.2%)
How many hours per day in total do you spend in a Dark room	
2hrs	165 (45.2%)
2-4hrs	98 (26.8%)
4-6hrs	65 (17.8%)
>6hrs	37 (10.1%)
Reason for using a digital device	
Study	314 (86.0%)
Work	236 (63.0%)
Entertainment	269 (73.7%)
Communication	262 (71.8%)
Hours Spent Studying	
<2hrs	49 (13.4%)

2-4hrs	103 (28.2%)
4-6hrs	75 (20.5%)
>6hrs	87 (23.8%)
Preventive Measures	
Adjustable Chair	89 (13.5%)
Adjustable Screen	203 (30.8%)
Regular breaks	216 (32.8%)
Use of Eyedrop	41 (6.2%)
Antireflective Glasses	110 (16.7%)

Asthenopia was defined as participant who experienced two or more asthenopic symptoms during their course of study, while those with just a symptom was grouped as no asthenopia, this definition was previously adopted by a study conducted in Iran [14]. In this research, prevalence of asthenopia was 69.9% which was high.

Bivariate analysis (Pearson correlation product moment) was to ascertain if there was any correlation between demographic characteristics and asthenopia. Thus, there was no statistical correlation between gender, age and participant who were asthenopic in this research, although there was a moderate relationship observed between the various age groups, which might have happened by chance. On further analysis of various age group, participant within age group 43 and above showed a significant weak negative correlation, r=-0.115, p-value 0.028. This can be interpreted as an increase in age is proportional to a decline in asthenopia as shown in table [3].

Still on demographics due to the location of the study (Sunderland, England). University of Sunderland consist of different ethnic community group, the researcher decided to take advantage of the heterogenous nature to conduct a bivariate analysis to assess if there is a correlation between ethnicity and asthenopia. On analysis of specific ethnic group against asthenopia, Asian group showed a negative weak correlation and was statistically significant, r=-0.119, p-value = 0.024 at a 95% Cl. This can be interpreted as the possibility of developing asthenopia within this ethnic group was reduced when compared to other ethnic group such as Black/African ethnic group were there was a relationship, however this was not significant. The high dominance of these ethnic group might be the reason for the strong relationship as shown in table [3].

Table 3: Showing Bivariate and Binary Logisitic regression Analysis

Variables	Pearson (95% CL)	P-Value	Unadjuasted OR (95% CL)	P-Value	Adjusted OR (95% CL)
Gender					
Male	1				
Female	0.097(-0.006/-1.98)	0.064			
Age					
18-22	1				
23-27	-0.11(-0.113/1.920)	0.838			
28-32	-0.29 (-0.131/0.071)	0.582			
33-37	0.51 (-0.052/0.153)	0.333			
38-42	-0.25 (-0.08/0.078)	0.631			
43 and above	-0.115 (-0.215/-0.012)	0.028	0.403 (0.17/0.928)	0.033	0.403 (1.75/9.285)
Enthnic Group					
Asian	-0.119 (-0.218/0.016)	0.024	0.436 (0.217/0.875)	0.020	0.436 (0.217/0.875)
White	0.005 (-0.983/0.107)	0.024			
Black	0.803 (-0.20/0.084)	0.114			
Mixed	-0.067 (-0.169/-0.36)	0.199			
Others (ARAB).	-0.066 (-0.109/-0.96)	0.194			
Prefer Not to Say	-0.066 (-0.109/-0.96)	0.194.			
Refractive Error					
Astigmastism	0.107 (0.04/0.207)	0.0041	3.368 (0.987/11.496)	0.0053	1.499 (0.99/2.257)
Myopia	0.101 (-0.903/0.112)	0.075			
Hyperiopa	0.102 (-0.93/0.113)	0.846			
Presbyopia	-0.71 (-0.172/0.32)	0.177			
Environmental Factors					
<2HRS	0.503 (-0.505/0.155)	0.311			
2-4HRS	-0.807 (-0.1886/0.160)	0.098			
4-6HRS	-0.136 (-2.35/-0.34)	0.090			
>6HRS	- 0.240 (0.141/0.334)	<0.001	2.899 (0.822/4.579)	<0.001	2.899 (0.822/4.579)
Preventive Measures					
Regular Breaks	0.401 (-0.75/0.134)	0.433			
Adjustable Chairs	-0.005 (-1.08/0.98)	0.926			
Adjustable Screen	-0.540 (-0.156/0.049)	0.030			
Eyedrops	-0.107 (-0.207/-0.04)	<0.042	0.501(0.258/0.975)	<0.044	0.507 (0.0261/0.983)
Antireflective Glasses	-1.05 (-0.2481/-0.048)	0.004	0.449 (0.280/0.723)	<0.005	0.503 (0.313/0.808)

Ocular Status

A total of 154 (42.2%) participant responded "yes" to have had refractive error, 176 (48.2%) responded "no" to having refractive error, and 35 (9.6%) responded "not aware" to refractive status. Among participants who responded "yes" to refractive error, 53 (14.5%) participants reported having myopia (shortsightedness) which was the highest among students while astigmatism was the least recorded as 24 (7.6%). In the study, 354 (97.0%) participants responded not to have had laser refractive surgery, while 11 (3.0%) responded yes to have had laser refractive surgery as shown in table [1].

Astigmatism was statistically significant among the different types of refractive error, r=0.1070, p-value=0.041. This can be interpreted as astigmatic (refractive error) students in the population, are at risk of experiencing asthenopic symptoms. On further analysis the odds ratio of astigmatism was 1.499 times (95% Cl, 0.99/2.257) was observed in the result at a p-value of 0.043, which shows a statistical significance between the two variables. This can be interpreted as the likelihood of astigmatic student developing asthenopia was 1.499 times compared to other students in the population as shown in table [3].

Duration of Digital Device Used

Based on the duration of digital device used, 20(5.5%) spend <2hours daily on digital device, 42 (11.5%) spend 2-4hours daily on digital device, 88 (24.1%) spend 4-6hours on digital device and 215 (58.9%) spend more than 6hours on digital device, smart phone was the most used device 344 (53.7%), studying was the reason use digital device 314 (86.0%)as shown in Table 2.

There was no relationship between the various categories of time spent using digital device except those who spent more than 6 hours which was statistically significant r=0.236, p-value=<0.001, the odds ratio OR was 2.899 times (95% Cl, 1.822/4.579) at P-value =< 0.001. Hence using digital device for a duration of more than 6 hours was statistically as shown in Table 3.

Room illumination

Bivariate analysis (Pearson correlation product of moment) was conducted to determine if there is any association between room illuminations (bright, ambient, and dark room illumination) and asthenopic symptoms, there was no association as regard use of device in various room illuminations and asthenopic symptoms been experienced respectively as shown in Table 3.

Asthenopic symptoms

A total of 255 (69.9%) participants experienced two or more symptoms of asthenopia, females had a higher percentage of asthenopia 132 (36.2%) compared to males 117 (31.2%), Headache 218 (59.7%) was most experienced symptoms, with the 128 (37%) females and 90 (26%) males experiencing headaches, while pinching sensation 49(14.2%) was the least experienced symptoms consisting of 25 (7.2%) females and 24 (6.9%) males as shown in Table 1.

Preventive Measures

Three hundred and forty-two (93.7%) of participants practice one or more forms of preventive measures, regular breaks 216 (32.8%) and the use of adjustable screen 203 (30.8%) respectively was the two most practiced preventive measures among participants, while the use of eyedrops (artificial tears) 41 (6.2%) was the least practiced measures by students as shown in Table 2.

The five different preventive measures were analysed against asthenopic symptoms using bivariate analysis to test for significance. Adjustable screen, adjustable chair and regular breaks were statistically insignificant. However, the use of eyedrops and anti-reflective glasses showed a negative correlation and were both statistically significant, r=-0.107, p-value =0.042, r=-0.150, p-value =0.004, at a 95% confidence interval level respectively. Thus, this can be interpreted as an increase in the use of eyedrops (artificial tears) and use of anti-reflective glasses, there is a decline in asthenopia. The odds ratio antireflective glasses and eyedrop (artificial tears) was 0.503 and 0.507 times able to act as preventive measures to asthenopia as shown in Table 3.

Discussion

This study is the first of its kind in England at the time this study was conducted. The study investigated the potential risk factors associated with asthenopia among students in the University of Sunderland. In this study asthenopia was defined as two or more symptoms experienced during the use of digital device [14], the prevalence rate of asthenopia for this research was 69.9%. Our findings were similar to the findings of other studies where high prevalence rate was recorded. This includes study by [19] which recorded a prevalence rate of 77.5%, [26] in a study in Lebanon reported a prevalence rate of 67.7%, also [2] reported a prevalence rate of 64% in Ghana. However, [11], reported 94.5% prevalence rate, these were because ocular and non-ocular asthenopic symptoms such as joints pains were included in the study. Also [2], reported a prevalence of asthenopia to be 90%, this could be attributed to the period the research was conducted (during the Covid-19) as most activities was by digital device.

Concerning symptoms of asthenopia, this study followed similar studies reporting headache as the most prevalent symptom. In this research, 59.7% reported headache as the most prevalent asthenopic symptoms. Similarly [17], reported a 93% prevalence of headache in Pakistan, also [5] also reported 68% prevalence of headache in Saudia Arabia. Although all studies recorded headache with a large margin [30], reported headache (40.8%) as the most prevalent asthenopic symptoms in South Africa, more also [9] reported headache (20.1%) in Spain, although the percentage was small when compared to previous reports.

In this study, there was no significant association between gender and asthenopia. This was in agreement with [19], who reported that there was no statistical association between asthenopia and gender. Additionally, [27], in Lebanon discovered no statistical relationship between gender and asthenopia. Furthermore, there was a negative statistical association between age group 43 and above (r=-0.115, p-value =0.028). This can be interpreted as an increase in age was proportional to a decline in asthenopia. Similarly, [28, 32], who reported that the highest prevalence of asthenopia was seen in the first and second decades respectively and starts to decline at the age 40 years and above. Additionally, older age (odds ratio [OR]=0.403, 95% CI=1.748-9.285, P=0.033), this means the odds of this age group experiencing asthenopia was 0.403times.

The Asian group showed a statistically weak negative correlation, r=-0.119, p-value = 0.024 at 95% Cl (-2.18/-0.016), this means that the risk of asthenopia decreases

within the Asian ethnic group. Previous studies around the Asian ethnic group showed a moderate prevalence level of asthenopia [14]. prevalence of asthenopia in Iran was 49% [29], prevalence in China was 51% and [10] prevalence in China was 55%. The prevalence of asthenopia was seen to be moderate in this group potentially because of high prevalence of myopia of about 80%-90% in this ethnic group [36]. Thus, people of this group tend to experience less eye strain when performing near work activates due to their high myopic nature.

In this study, 42.2% had refractive error and was statistically significant (r=0.281, p=value <0.001), while those who had no refractive error (Emmetrope) was 48.2% and was statistically significant (r=0.239, p=value <0.001). The researcher focuses mainly on those with refractive error, from the different types of refractive error, astigmatism was statistically significant to the development of asthenopia (r=0.1070, p-value=0.041). To ascertain the chances of students with astigmatism experiencing asthenopia, binary logistic regression conducted showed, the odds ratio (OR) of astigmatic student experiencing asthenopia was 1.499 times (95% Cl interval 0.995/2.237). This was supported by [15] in an Iranian study, were the odds ratio of astigmatic student experiencing asthenopia was 1.61times. Refractive error been a visual deviation is an important risk factor to the development of asthenopia and there is a need for proper correction to reduce the chances of the development of asthenopia.

Student who spends more than 6 hours on screen time was statistically significant with the development of asthenopia, this was supported by [12, 29] who concluded that computer workers and students aged 18-30 years who spend more than 6 hours on screen time had higher chances of developing asthenopia. More [11] reported that student who spend more than 6 hours was significantly associated with the development of asthenopia.

Binary logistics regression analysis conducted between students who spend more than 6 hours on screen time to ascertain who had higher chances of developing asthenopia, the odds ratio OR was (2.89, 95% Cl:1.822-4.579, P<0.001). Students who studied more than 6 hours had 2.89 times chances of developing asthenopia than any other student in the survey.

Still on environmental factors, analysis conducted on different room illumination (bright, ambient, and dark room illumination) showed no statistical relationship (r=-0.40, p-value=0.445, r=-0.84, p-value=0.111 and r=-0.63, p-value=0.232) respectively. This was supported by [26] where dark room illumination showed no statistical correlation. However, contrary to [4], who reported that room illumination (bright and dark room) showed statistically significant difference between the two groups of students (Medicine and Business class students) (p<0.0001). Studies have showed that use of a tablet, smartphone, and laptop, before bedtime in darkroom causes a circadian phase delay and melatonin suppression, which affects the quality of sleep [31]. Concluded that college students are especially impacted by the negative consequences of sleep deprivation and daytime sleepiness, which may lead to lower grade point averages, a higher risk of academic failure, diminished learning, lowered mood, and an increased risk of automobile accidents [15]. With most digital devices having blue ray filters and night mode, it may be that Sunderland student practice proper workspace ethics.

Also in this study, 93.7% of the student practice at least one of the five preventive measures in the questionnaire, among which only two were significantly correlated with asthenopia eyedrop and use of anti-reflective glasses. Those who use eyedrop were negatively associated with asthenopia r=-0.107, (95% Cl-0.207-0.004, P<0.001), and had 0.507times chances of having asthenopia at 95% Cl=0.2601-0.983, P<0.044). A reduced blink rate and incomplete blinks due to constant staring of the digital device, are associated with increased asthenopic symptom of eye strain, tearing, and itching and ocular dryness [21]. This reduction in blinking reduces tear secretion, thus eyedrops serves as ocular lubricants reducing the occurrence of asthenopia [6]. Contrary to this [27], reported a positive correlation with the use of eyedrop and students who used eyedrops were 0.375times likely to have asthenopia.

The Use of anti-reflective were negatively associated with asthenopia (r=-0.150, P<0.004) and was significant to the reduction of asthenopia. On the contrary, [27] reported no significant association between asthenopia and use of glasses. Also, [16] also reported a significant association with the development of asthenopia on the use of spectacle as compared to non-users. Student who uses anti-reflective glasses were 0.503time (95%Cl, 0.313-0.808, P<0.005) less likely to develop asthenopia when compared to student who do not use anti-reflective glasses. The use of anti-reflective glasses helps to prevent the effect of blue light rays in digital device, thereby aiding sleep by promoting melatonin responsible for sleep [6].

The Use of adjustable chair, adjustable screen, and regular breaks, although were associated to the development of asthenopia but were statistically insignificant. Taking regular pauses, using an LCD monitor, and adjusting the brightness of the monitor screen all significantly contribute to these ocular symptoms among computer users, according to [29]. Additionally, it was noted by [27] that taking frequent pauses was negatively related to the development of asthenopia. According to [6] the 20-20-20 rule, which implies take a 20-second break to view something 20 feet away every 20 minutes. Student should be made aware the need to practices these tips as this could help keep the eyes moist by ensuring the blink frequently.

The distance between the eyes and the centre of the computer display should be between 20 and 28 inches, or 15 to 20 degrees below eye level, materials should be placed beside the display and above the keyboard [6, 22], suggested that when it is impossible to manage ambient light sources, filters may be used to decrease glare. On the computer, sometimes adjust the brightness, contrast, and text size to improve visibility and increase productivity by reducing asthenopic symptoms.

Strength

To the researcher's knowledge this study is first of its kind in England at the time this research was conducted, hence the reason for the large turnout of sample size as student were keen on knowing the effect of daily usage of digital device. Also, the researcher was able to lay a foundation on the possibility of ethnicity been a possible risk factor for asthenopia. Respondents had enough time to participate in the research at their own time, while upholding confidentiality, allowing them to at least reply to questions more freely and honestly without holding back.

Limitations

Firstly, the researcher did not meet the required sample size of 385 needed for the research. The researcher did achieve a 95% responses rate, thus establishing the generalisability of the research. According to [22] who emphasised that determining whether a study is generalizable depends on the proportion of participants stating that for a study to be free from response bias in a survey, at least 50% of the sample must take part. However, recent studies indicate that there is no set standard for what constitutes a high response rate, but a response rate of 80% or greater is ideal. A high response rate is a crucial component of a good research study since it contributes to its validity, reliability, and generalizability [24]. Secondly, convenience sampling was used in recruiting target participant. Convenience sampling was employed due to the time constrain, affordability, ease of participant recruitment [24]. However, this sampling method those do not give every student the opportunity to participate in the study, thus the researcher employed all ethnic groups and all students who meet the inclusion criteria the university and the large sample size and high response rate reduces the chances of bias. Thirdly, the researcher based its refractive status subjectively, as target populations might not know their refractive status before participating in the study, some participant did not know their refractive status. Also, some participants might have not been conscious of the exact hours they spend on digital devise before experiencing asthenopic symptoms and as such may not give accurate response.

Recommendation

The study findings revealed a high level of asthenopia among student in the University, which indicate the need for public health awareness, health campaigns and education on the need to constantly protect the eyes from blue ray light emitting from the digital screens. Encouraging student on the need for a yearly routine eye check as refractive error do contribute a lot to the development of asthenopia, while also educating student on the various preventive measures as stated by [6] and other occupational health related authorities [25]. Further research should be done on the possible risk factors of asthenopia (ethnicity as a possible risk factor to asthenopia) to determine the ethnic group with high risk of developing asthenopia. Also, future research should incorporate non-ocular symptoms of asthenopia, such as joint pains, muscle, and back pains.

Conclusion

This study was aimed at investigating risk factors that triggers asthenopia among student in the university of Sunderland. The study being first of its kind, thus no literature to compare within England. However, in this research the prevalence of asthenopia among the university of Sunderland student was 69.9%, refractive error (Astigmatism), duration of 6 hours or more were reason student experience one or more forms of asthenopia. Use of antireflective glasses and eyedrops served as a good preventive measures. Antireflective glasses help to prevent blue rays from digital devices from entering the eyes, thereby reducing the likelihood of asthenopic symptoms. The use of eyedrop which serve as an ocular lubricant was significant in helping to keep the eyes moist, thereby reducing the effect of asthenopia. Ethnicity was the new additional possible risk factors discovered, as Asian ethnic group was found to have reduced chances of experiencing asthenopic symptoms.

Finally, Refractive error (astigmatism), environmental factors; the duration of time spent on digital devices (6 hours or more), Age (43 years and above) were risk factors associated with asthenopia and the use of eyedrops and antireflective glasses were good measures able to reduce asthenopia.

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