IMPACTS OF VISUAL FATIGUE AMONG STUDENTS USE DIGITAL DEVICES AT HAINAN UNIVERSITY OF SCIENCE AND TECHNOLOGY IN YUNLONG CAMPUS

ZHANG YUMENG

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摘要

题目:海南科技大学云龙校区学生使用数码设备对视觉疲劳的影响

作者:张雨濛

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指导老师:

Assistant Professor Dr. Kanjanar Pintakham 首席顾问

Assistant Professor Dr. Pinatthinee JitKham 联合顾问

本横断面描述性研究旨在确定海南科技大学云龙校区使用电子设备的学生的视觉疲劳水平，评估视觉疲劳的影响，并探讨视觉疲劳相关因素对学生的影响。本研究采用分层抽样方法，共抽取 430 名学生。数据收集采用结构化问卷，问卷内容包括个人信息、电子设备使用行为、视觉疲劳评估和视觉疲劳影响评估四个部分。数据采用频数、百分比、均值、标准差、卡方检验、Fisher 精确检验进行分析。

研究结果显示，学生的视觉疲劳总体水平较高（2.62±0.58），视觉疲劳的总体影响程度为中等（2.20±0.47）。性别、学年、每日平均屏幕使用时间、眼睛与屏幕的距离以及所使用的电子设备类型等因素与视觉疲劳的影响显著相关

（$p< 0.05$）。这些发现表明，教育机构有必要加强学生的用眼健康意识，并鼓励学生养成良好的电子设备使用习惯，以减轻视觉疲劳的影响。

关键词: 视觉疲劳；数码设备；大学生；影响因素

ABSTRACT

Title : Impacts of Visual Fatigue Among Students Use Digital Devices at Hainan University of Science and Technology in Yunlong Campus

Author : Miss Zhang Yumeng

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Advisors:

Assistant Professor Dr. Kanjanar Pintakham, Major Advisor

Assistant Professor Dr. Pinatthinee JitKham Co- Advisor

This cross- sectional descriptive study aimed to determine the level of visual fatigue, to assess the impacts of visual fatigue, and to examine the factor associated impacts of visual fatigue among students use digital devices at Hainan University of Science and Technology in Yunlong Campus. A total of 430 students were selected through stratified sampling. Data were collected using a structured questionnaire consisting of four sections: personal information, digital device usage behavior, assessment of visual fatigue, and assessment of the impacts of visual fatigue. Data were analyzed using frequency, percentage, mean, standard deviation , chi-square test and Fisher's exact test.

The results showed that the overall level of visual fatigue among students was high (Mean2.62 ± SD0.58). The overall impact of visual fatigue was rated at a moderate level (Mean2.20 ±SD 0.47). Factors significantly associated with the impacts of visual fatigue included gender, year of study, average length of time , distance between eyes and screen, and the type of digital device used ($p < 0.05$). These findings suggest the need for educational institutions to promote eye health awareness among students and encourage proper digital device usage habits to mitigate the effects of visual fatigue.

Keywords: Visual Fatigue/Digital Devices/College Students/Impact factors

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CHAPTER I

INTRODUCTION

Background and Rationale

Digital devices with the technological update has not been limited by time and space, to a large extent, not only enriches people's daily life, improve people's quality of life and level, but also changing people's way of life, become an indispensable existence of people's life and work, can be realized online communication and exchange of information, online shopping entertainment and a variety of activities With the rapid development of modern society and the continuous improvement of technology level the rapid development of global digital electronic devices and the increasing demand of users have further promoted the update and functional upgrade of global digital products. According to statistics, the size of the global consumer electronics market will be USD 773.4 billion in 2023 and is expected to grow to USD 1,467.94 billion in 2032. The expansion of the global digital electronics market will not only increase the strength of technological research and development, but also better reflect the strength of the modern population's demand for digital electronic products. (Consumer Electronics Market Size, Share and Industry Analysis,2024).

China's digital electronics industry market is currently showing rapid growth and continuous updating trend, with the science and technology and economic strength of the continuous strengthening of consumer demand for digital electronic equipment is increasing, digital equipment products in various fields of application more and more widely. The information age has given enough space for the development of digital electronic industry. According to the 53rd Statistical Report on Internet Development in China issued by China

Internet Network Information Centre (CNNIC), as of December 2023, the scale of Internet users in China has reached 1.092 billion, and mobile phone network has reached 1.091 billion, with the proportion of Internet users using mobile phones to access the Internet reaching 99.9%. While people are increasingly relying on the convenience of digital electronics to fulfil their needs through the Internet, they are overlooking the possible negative effects of excessive use of digital devices over time. This issue has been widely recognized as one of the key issues that deserves global public health attention from all sectors and societies. These health problems not only harm the physical and mental health of individuals and increase the prevalence of myopia in the population, but also these diseases are gradually tending to progress at a younger age, with the average age of the affected population getting lower and lower, and myopia has become a hot topic of national and social concern. In recent years, digital electronic devices have been adapted to the needs of people's lives and work, to meet the realisation of people's online functions, and have gradually entered into people's daily lives, with a more significant impact on the younger generation, and the incidence of myopia has risen sharply among children and adolescents. The cost of treating and managing these health problems poses a financial burden on individuals and countries, and families need to invest in healthcare to prevent or protect their eyesight. In parallel with the impact, the community has begun to take positive measures to address the problem, including promoting ‘healthy eye’ education, encouraging outdoor activities and reduced screen time, and advocating regular eye check-ups. The education sector and medical institutions are also strengthening co-operation to develop and implement more effective preventive and intervention measures to reduce the incidence of myopia. In addition, technology companies are also studying how to design more eye-friendly devices and software to minimise the impact of prolonged use on vision. The public's awareness of eye protection and the health of the population will be enhanced at multiple levels.

The widespread integration of digital devices into daily life has raised significant public health concerns, particularly in relation to visual well-being. Prolonged exposure to video screens has been associated with a variety of physical and psychological health issues, including dizziness, headaches, dry eyes, vision impairment, musculoskeletal discomfort, and both visual and mental fatigue. College students represent a particularly vulnerable group in this context. As they transition from adolescence to adulthood, they often exhibit less external regulation over their digital device usage and tend to engage in extended periods of screen exposure due to academic, social, and recreational purposes. Empirical evidence has shown that excessive and uncontrolled use of digital devices among college students may lead to visual fatigue, decreased academic performance, and diminished overall well-being. According to Zhou Zhili (2020), the lack of self-regulation among students contributes to health neglect and an increased risk of internet addiction, which may further exacerbate both physical and mental health conditions. A study by Xie Yang et al. (2020) found that 27.5% of individuals with mobile phone addiction had an elevated risk of suicidal ideation and attempts, underscoring the urgency of addressing these issues. Furthermore, long-term exposure to digital screens has been linked to a progressive decline in visual acuity. Wang Mengli (2020) highlighted a significant trend in deteriorating vision among Chinese university students since the 1980s. This concern is supported by the National Visual Health Report issued by the China Health Development Research Centre of Peking University, which reported a myopia rate of 82.68% among college students. The prevalence of myopia and the tendency to form maladaptive screen-use behaviors suggest a critical need for greater awareness and targeted interventions.

In response to these concerns, the present study aims to investigate the phenomenon of visual fatigue among college students. The specific objectives of this research are: 1) to determine the level of visual fatigue among students using digital devices at Hainan University

of Science and Technology, Yunlong Campus; 2) to assess the impacts of visual fatigue on students' health and daily functioning; and 3) to examine the factors associated with the impacts of visual fatigue. The findings are expected to contribute to the development of effective strategies for promoting visual health and digital well-being in higher education settings.

Students at Hainan University of Science and Technology in Yunlong Campus are highly dependent on electronic devices, such as mobile phones, computers and tablets, for daily study and entertainment. Frequent use of these devices can easily lead to visual fatigue, making them an ideal group for studying the effects of digital device use on vision. The school is a research site with a clear geographical scope, a concentrated number of students, and is convenient for questionnaire surveys and data collection. Therefore, college students at the Hainan University of Science and Technology Yunlong Campus were selected as the research subjects for this survey.

Objective

1. To determine the level of visual fatigue among students use digital devices at Hainan University of Science and Technology in Yunlong Campus.

2. To assess the impacts of visual fatigue among students use digital devices at Hainan University of Science and Technology in Yunlong Campus.

3. To examine the factor associated impacts of visual fatigue among students use digital devices at Hainan University of Science and Technology in Yunlong Campus.

Research question

1. What is the level of visual fatigue among students use with digital devices at Hainan University of Science and Technology in Yunlong Campus?

2. How the impacts of visual fatigue among students use digital devices at Hainan University of Science and Technology in Yunlong Campus?

3. What are the factor associated impacts of visual fatigue among students use digital devices at Hainan University of Science and Technology in Yunlong Campus?

Hypothesis

1. There is a high level of visual fatigue among students use with digital devices at Hainan University of Science and Technology in Yunlong Campus.

2. The personal factors such as gender, age, year of study, and types of digital are significantly associated with impacts of visual fatigue among students use digital devices at Hainan University of Science and Technology in Yunlong Campus

Operational definition

Digital Devices refers to use device that students use in their studies and work include computers or notebook or smartphones or tablet/iPad or in this study

Internet addiction refers to a pattern of behavior in which an individual becomes overly dependent on Internet use, as evidenced by a strong desire to engage in Internet activities, uncontrollable prolonged use of the Internet, and negative impacts on daily life, work, and

interpersonal relationships. This addiction may include an addiction to social media, online gaming, video streaming, and other online activities that cause the individual to neglect real-life responsibilities and needs. Internet addiction may have a serious impact on an individual's mental health, social relationships, and quality of life.

Visual fatigue refers to overuse of the eyes resulting in visual discomfort. It causes dry eyes, astringent eyes, sore eyes, blurred vision, and even vision loss directly affecting people's work and life. Eyestrain is mainly due to people usually concentrating on watching computers or mobile phones, or tablet

Blue light radiation refers to the shorter wavelengths and higher energies of blue light in the visible spectrum. In the spectrum, blue light wavelengths range from approximately 380 to 500 nanometers. Blue light radiation is an important environmental and physical factor that people are exposed to daily and is one of the causative factors of retinal damage. Blue light radiation exists not only in natural light but also in artificial light sources, such as displays of electronic devices and LED lights. Prolonged exposure to electronic devices such as smartphones, computers, and tablets may expose you to blue light radiation.

Poor posture refers to incorrect or unhealthy body positions or postures located when using digital devices or performing other activities. For example, postures such as having your eyes too close to or too far from the screen, bowing your head for long periods of time, and lying flat on your back while using a digital electronic device can have an adverse effect on various parts of the body, especially on the neck, back, and wrists, which can cause stress and burden and lead to discomfort and health problems.

Screen time refers to the length of daily active screen use for a range of online activities using a digital electronic device.

Prevalence: Refers to the prevalence of visual fatigue caused by prolonged and excessive use of digital electronic devices.

Blurred vision refers to a situation in which the eye still has some degree of vision but is unable to recognise objects clearly, see distant and near objects clearly, or see objects that overlap, which may be manifested by looking at things with unclear edges, blurred details, or the entire field of vision becoming blurred.

Pterygium refers to an overgrowth of triangular fibrovascular-like tissue on the surface of the cornea with roots attached to the conjunctiva. This occurs between the lids, usually originating from the lateral aspect of the nose, and usually develops in both eyes. Symptoms include compromised eye aesthetics, sensation of eye irritation and loss of vision.

Cataract refers to the lens of the eye becomes cloudy, which interferes with the entry of light into the eye and leads to vision loss. The development of cataracts is generally categorised into the incipient, immature, mature and over-mature stages. Symptoms include blurred vision, loss of contrast, and halos in front of the eyes.

Xeropthalmia refers to as it often causes significant ocular discomfort, patients with severe dry eye disease may experience significant vision loss, affecting their work and quality of life. Caused by a variety of factors, it is characterised by visual disturbances and tear film instability with underlying ocular surface damage.

Visual light sensitivity refers to the sensitivity of the visual system to changes in light intensity, i.e. the degree to which the eye adapts to the brightness of the screen of an electronic device, and visual light sensitivity is an important component of visual health that affects visual performance in a variety of lighting conditions

Expected Benefits and Applications

Individuals

1. Through this survey, students can have a basic understanding of the duration and frequency of their use of electronic products and their vision health, and take the initiative to be aware of the hazards of the prolonged use of electronic and digital devices, so as to reduce the frequency of the use of digital devices from the root cause and to avoid the emergence of addictive behaviors as a result of the excessive use of digital devices.

2. It is conducive to the enhancement of students' awareness of the need to protect their eyesight, the reduction of the hours of use of electronic products, and the alleviation of students' visual fatigue and eye discomfort, thereby enhancing the overall eye and vision health of students.

3. Improvement of the quality of sleep and physical health of students.

College

1. To understand students' perception and awareness of their visual condition and their habits of using electronic digital devices.

2. Targeted health education and publicity activities related to the protection of eyesight, and a more comprehensive understanding of and concern for students' vision levels.

3. To remind students that they should make reasonable arrangements for the use of digital devices and identify and resolve vision problems in a timely manner in order to safeguard their healthy development.

Social

1. All sectors of the community should pay more attention to the protection of students' eyesight and raise public awareness of the need to take care of eye health.

2. To disseminate to the public the knowledge and methods of proper eye use and to inform the public of the scientific and reasonable arrangement of the average daily hours of use of digital devices.

3. To create a social environment conducive to healthy eye use and vision protection, and to improve the quality and standard of life of all people.

CHAPTER II

LITERATURE REVIEW

This chapter summary outlines the following aspects that explain the overall conceptual framework embodied in the research, and the following specific studies that support this research are as follows;

1. Digital Device
    1.1 Definition of digital device
    1.2 Characteristics of digital device
2. Usage of digital device
    2.1 Increase in the use of digital device
    2.2 Use of digital electronic device by children
    2.3 Use of digital electronic device by young people
    2.4 Use of digital electronic device by university students
    2.5 Use of digital electronic device by adults
3. Vision
    3.1 Definition of retina
    3.2 Visual fatigue
    3.3 Measures to relieve visual fatigue
4. Health effects of prolonged use of digital devices
    4.1 Radiation from digital device
    4.2 Hazards of prolonged use of digital device
    4.3 Impact on the physical and mental health of university students
5. Research related to this study

6. Conceptual Framework

Digital Device

Definition of digital device

Digital electronic devices are a variety of devices manufactured using digital technology and electronic components, typically for processing, storing, transmitting, and displaying information. These devices may include, but are not limited to, personal computers, smartphones, tablet computers, digital cameras, digital music players, smart watches, smart home devices, and the like. They usually have digital processing capabilities and can perform various functional operations and data processing through software. Common types of digital electronics can be seen in Figure 1.

Figure 1 Common Digital Electronic Device Product Types (Baidu, 2024)

Characteristics of digital device

The reason why digital electronic devices have become indispensable in people's daily lives, study, and work has a lot to do with their characteristics, the characteristics of digital electronic devices are as follows;

Convenience: Most digital devices are convenient, small in size and occupy little space, so people can easily carry and use them at any time and place. Digital:Digital electronic devices are tools for processing and transmitting data in the form of digital information, which can be converted, transmitted, stored, and analyzed using digital information technology.

Multifunctionality: With the progress and development of science and technology, digital electronic products have gradually tended to diversify from a single function, assuming the role of meeting people's daily lives and work. Smartphones are not only called tools, but also have the function of taking pictures, surfing the Internet, and playing video and music; computers, in addition to basic data and word processing, can also be used as tools for entertainment, learning tools, but also become the necessary work equipment; the use of cameras for people to record the beautiful moments of life, the photo as a medium, so that people feel a sense of happiness.

Real-time networking: digital devices usually have the characteristics of real-time networking, timely access to network information, people through the operation of digital devices connected to the Internet can carry out online activities and access information, the development of the Internet for the development of digital devices to provide space for the development of a more convenient way of life for people.

Usage of digital device

The 53rd Statistical Report on Internet Development in China released by the China Internet Network Information Centre (CNNIC) showed that as of December 2023, 99.9% of China's Internet users used mobile phones to access the Internet; the proportion of those who used desktop computers, laptops, televisions and tablets to access the Internet was 33.9%, 30.3%, 22.5% and 26.6% respectively.

Due to the gradual penetration and integration of science and technology and the Internet into people's daily lives and work, the proportion of people who own digital electronic products is showing a year-on-year increase in the proportion of digital electronic devices, people use the different functions and roles of these digital electronic devices to facilitate their daily life and work as well as maintain social and interpersonal relationships, and at the same time, they can use the Internet to access all kinds of information for knowledge and learning and recreational activities.

However, on the other hand, it also shows that people use digital electronics for too long and too often daily, over-relying on technological products and ignoring the problems of diseases caused by prolonged time spent, such as Internet addiction, visual fatigue, cervical vertebrae problems, and hand muscle injuries, etc. In addition, prolonged use of digital devices may lead to alienation of social relationships and degradation of communication skills, affecting the mental health and emotional development of individuals. Therefore, more attention needs to be paid to how to do a better job of effectively managing and balancing the use of technology to avoid these potential health and social problems.

Increase in the use of digital device

With the continuous upgrading and popularization of digital electronic devices as well as the diversification of various applications, the role, purpose, and duration of use of digital electronic devices vary among different age groups.

In recent years, with the popularity of digital devices such as smartphones, tablet PCs, and laptops, the screen time of students using electronic and digital products has increased significantlyAccording to the data of China Internet Network Information Centre (CNNIC), as of December 2023, the proportion of Internet users aged 20-29, 30-39, and 40-49 were 13.7%, 19.2%, and 16.0% respectively; the proportion of Internet users aged 50 and above rose from 30.8% in December 2022 to 32.5%, and the Internet has further penetrated the middle-aged and old-aged groups.

Use of Digital Electronic Devices by Children

The use of digital electronic devices by children, as the smallest group of people exposed to digital electronic devices, has become increasingly common in the development of modern society, where children live from an early age in a social environment characterized by the rapid development of the Internet and the proliferation of digital electronic devices. With the emergence and popularity of smart products, more and more younger children have increased access to the Internet and digital electronic products, and the market has strengthened the research and development of electronic products for children, such as children's watches and children's learning machines.

Relevant research shows that kindergartens and related institutions are actively trying to apply electronic digital products in the field of early childhood education, especially a series of electronic products represented by electronic displays (State Council. Outline of the National Medium- and Long- term Education Reform and Development Plan,2010- 2020) . , the continuous progress of science and technology for young children's electronic products not only

for the early childhood electronic market to bring more opportunities, but also for the early childhood education to bring a variety of learning experiences, but also provides personalized and interactive educational resources. Kindergartens and related organizations can create more vivid and engaging learning environments through these electronic and digital products, promoting the development of early childhood education.

In the UK, tablets have become the most popular electronic device product for 3-12-year-olds, with 44 percent owning a tablet and 30 percent of 3-4year-olds owning a tablet; in the US, 40 percent of 5-year-olds use tablets.

There is a large amount of literature on the analysis of the current situation of the use of electronic digital products by toddlers and preschool children and related countermeasures, in the ‘study of the relationship between toddlers’ behavior in the use of electronic products and self-control(Guan Guixia,2021),’ the 3-6-year-old toddlers as the object of the study, to explore the current situation of the behavior of toddlers in the use of electronic products and the level of self-control, and the results of the survey showed that the number of parents who reported that toddlers were using electronic products more than once a day accounted for 75.62% of the total survey population. The results of the survey showed that 75.62% of the total number of respondents reported that their children used electronic products more than once a day, indicating that the use of electronic products by young children has become a common phenomenon in modern daily life.

Preschoolers are at a stage where they are curious about the external environment and are easily influenced by their surroundings. This age group perceives the external environment by observing the behavior and actions of others and by imitating and learning how to interact with others, which is one of the main ways in which they learn new skills and explore the world. A survey and analysis based on the use of electronic products by preschool children aged 3-6

years old - with two kindergartens in Changsha City as an example - shows that children use digital electronic products for watching cartoons, with a proportion as high as 37.21 percent, and other use of electronic products for learning and listening to stories and music, with a proportion of 17.44 percent and 30.23 percent, respectively, which shows that pre-school children mainly use Electronic products are mainly used for leisure and entertainment (Chen Lidan et al,2020).

These studies have shown a significant increase in the amount of time preschoolers spend using video screens over time, raising concerns about the impact on children's visual health, cognitive development, and behavior. Prolonged use of electronic devices may lead to eye strain, increased risk of myopia, and poor concentration in children. In addition, electronic device use may also affect children's social interaction skills and physical activity levels, further raising concerns among parents and educators. Therefore, there is a need to strengthen the management and monitoring of children's electronic device use to ensure their health and overall development.

The use of children's digital electronic devices is easily influenced by various factors such as family, school, and social environment. Moderate and reasonable use of digital electronic devices can help children acquire information, develop their intelligence, and cultivate their hobbies, but overuse may hurt their physical and mental health, so parents, teachers, and the community should guide children to use digital electronic devices correctly and arrange the time of use reasonably, to safeguard their physical and mental health and growth.

Use of Digital Electronic Device by Young People

With the development of society, it has become a common phenomenon in society that adolescents have a higher rate of ownership of digital electronic devices. Teenagers

generally own smartphones and use them as their main communication tools and entertainment platforms, especially during their teenage years, when they tend to spend a lot of time playing games, which can easily lead to Internet addiction. Teenagers are busier in their studies, and using the Internet to learn and access information is also one of the purposes of teenagers' use of digital electronic devices.

Relevant studies (Xu Lei et al,2024)show that a total of 730 students in the sixth and seventh grades of a middle school in Shanghai conducted a survey study on the use of electronic products in junior high school students' behaviors and health impacts of the content of the study show that teenagers use the most electronic products in their daily life as tablet computers, accounting for 69.32%; followed by the use of excessive hours of electronic products for smartphones and laptops, accounting for 57.12% respectively and 38.36 percent, while the use of television and desktop computers was relatively small, accounting for 15.34 percent and 13.84 percent, respectively; 59.73 percent of students commonly used two or more types of electronic products.

The use of digital electronic devices by adolescents is mainly affected by a variety of factors such as personal interests, their own family environment, school education, etc. The moderate and reasonable use of digital electronic devices can help adolescents acquire information, develop their skills, and expand their interests, but overuse of digital electronic devices may affect their physical and mental health and schooling and also lead to the emergence of Internet addiction.

Studies have shown that about 29.9 percent of adolescents are likely to suffer from Internet addiction, with 3.3 percent of them being diagnosed as Internet addicts, and that the phenomenon of Internet addiction is becoming more and more prevalent among adolescents (TangJ, et al.2024). Internet addiction is a behavior that seriously endangers the physical and

mental health development of adolescents, leading to a decline in their social skills, easy-to-ignore real-life interpersonal relationships, inducing internal and externalized problematic behaviors, and there is a close link between Internet addiction and the occurrence of suicidal behaviors.

A total of 509 junior high school and high school students from 2 middle schools in Wuhan were selected by Xiao Chenchang et al. in 2024 and surveyed using questionnaires and scales (Internet Addiction Scale, Suicide Screening Scale Short Version, Pittsburgh Sleep Quality Index, and Streaming Centre Depression Scale), of which as many as 131 students, or 25.74%, were addicted to the Internet, and 45.97% had suicidal ideation in the past year(Xiao Chenchang,2024).

In summary, adolescent Internet addictive behaviors are increasing with the rise in the prevalence of electronic product use, and their adverse effects, not only can be detrimental to the physical development of adolescents but also affect the development of adolescents' mental health.

Use of digital electronic device by university students

College students, as the main audience of digital electronic devices, are in the age of transition to society, compared with other age groups, they use digital electronic devices relatively loose and free time, not subject to the constraints of family and work, the length and frequency of screen use is higher than others. A 2018 study based on Delhi University in India revealed that nearly 50 per cent of universities use digital electronic devices for more than four hours a day (Gupta A et al,2018).

Most college students use digital electronic devices mainly for recreational activities, while the rest can be used for their studies, Xing's hobbies, and meeting the needs of daily life. In the article ‘The Impact of Screen Time on Physical Activity and Physical Health of College

Students' published by Cao Bowen in 2021, 2001 undergraduate college students from seven colleges and universities in Yunnan Province were surveyed through questionnaires to explore the mediating effect of physical activity on the impact of screen time on college students' physical health. The results show that college students have a high rate of holding screen devices, among which the rate of holding mobile phones is as high as 100%, and the average daily screen time is as high as 9.74 hours, with mobile phone time being the highest among screen devices, with an average of 3.96 hours per day(Cao Bowen,2021).

The above study shows that college students spend too much time using digital electronic products and most of them are holding digital electronic products, the Internet addiction behavior of college students has gradually become one of the key topics of modern society. College students are relatively independent and free in terms of economy and time, and they have more opportunities to choose and buy by themselves, but at the same time, the long-term use of digital electronic products occupies a lot of study time and affects their normal life to a certain extent, and the resulting addictive behaviours make college students suffer from poor self-restraint, obvious damage to academic and social functions, increased dependence on mobile phones and other electronic products, and trance and other symptoms(Liu Guangxi et al,2019).

The extensive use of digital electronic products by college students allows them to take advantage of the development of network information technology to learn professional knowledge, master various skills, access various types of information, learn about hot social topics, and track social dynamics. However, it has also weakened the interaction of college students in modern social life, and college students spend more time on virtual networks, which leads to the emergence of vanity, addiction, violence, egoism, depression anxiety, and other negative emotions that are not conducive to physical and mental development. In this vicious

circle, college students are more prone to physical and mental illnesses, affecting their studies and lives. Therefore, more attention should be paid to the use of digital electronic products by college students, and college students should start from themselves strengthening their health awareness, and realizing the importance of correct eye use and the hazards of long-term overuse of digital electronic products.

Use of digital electronic device by adults

Adults compared to college students and other groups, adults use digital electronic devices by working hours and occupational factors, its mainly used for work, the use of computers to deal with text information, data information, etc., and administrative staff due to the needs of the work of the use of computers to work more time.

Post-working adults' dependence on mobile phones is deepening due to the increasing demands of their lives, families and livelihoods, and their time spent on the internet is on a gradual increase as their level of education improves. A study on the reasons for the use of mobile phones by office workers at work showed that 55.64 percent of adults used mobile phones at work for work reasons; 38.91 percent of the population needed to contact each other for urgent matters; 36 percent wanted to check the time; and 32 percent used mobile phones for office work(Chen Tian et al,2021).

Adults are under constant pressure from work and family factors to release negative emotions and pressure through the electronic network. Most adults usually choose to use on mobile phones at night, and most of them have the bad behavior of playing on mobile phones with the lights off, which is not only extremely harmful to eyesight but also prone to a series of physical illnesses, such as lumbar spine and neck pain

Vision

Definition of retina

The retina (retina) resides in the inner layer of the eye wall and is a transparent membrane. The retina consists of a pigmented epithelium and a retinal sensory layer, which can be separated from each other in pathological conditions called retinal detachment. The pigment epithelial layer is closely connected to the choroid and consists of pigment epithelial cells, which serve to support and nourish photoreceptor cells, shading, heat dissipation, and regeneration and repair. The specific internal structure of the retina can be seen in Figure 2.

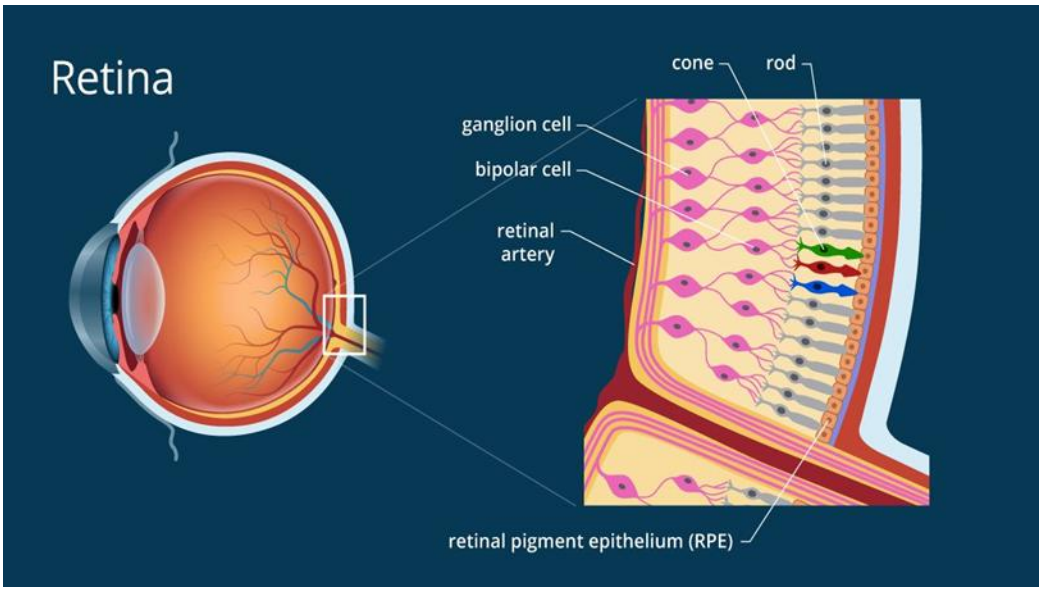

Figure 2 Internal structure of the retina (sensory epithelium, 2022)

Visual fatigue

Visual fatigue (Asthenopia) is a syndrome of intertwined organic and psychological factors of the eye or the whole body, which belongs to the category of psychosomatic medicine, and is a common ophthalmological disease, mostly due to prolonged use of the eyes, resulting in overexertion of the eyes or other diseases of the eyes caused by the discomfort of vision. Visual fatigue is mainly caused by long and frequent gazing at the screen of electronic products. Its severity and specific manifestation are affected by many factors, including the duration of eye use, the nature of visual work, the working environment, and the visual function of the individual, and its symptoms are mainly manifested in the following aspects;

Dry eyes and discomfort, caused by staring at a screen for long periods may lead to evaporation of water from the surface of the eyes, causing dry eyes and discomfort, sometimes accompanied by symptoms such as soreness, blepharospasm, and periorbital pain.

Visual impairment, Prolonged gaze at the screen tends to cause transient blurring of vision, reduction of visual sensory ability, and delayed transition between near and far vision.

Systemic symptoms, such as varying degrees of neck, shoulder, back, and lumbar pain; dizziness, headaches, and memory loss; and, in severe cases, nausea, vomiting, and mental exhaustion.

Measures to relieve visual fatigue

When your eyes become dry and uncomfortable, you should immediately take scientific and reasonable measures to relax appropriately and relieve the visual fatigue and discomfort caused by long hours of gazing at electronic screens.

Take regular breaks: Every once in a while temporarily away from the electronic product screen, close your eyes, you can look into the distance or look at green plants, it will help to relax the eye muscles and reduce eye fatigue, to ensure that enough quality of sleep to reduce the feeling of eye fatigue. Adjust the screen luminosity setting:

Adjust the screen brightness, contrast and color temperature of your electronic device to make it more comfortable for your eyes to gaze at and to reduce the feeling of irritation to your eyes, or you can turn on the device's eye-protection mode to maintain a soft luminosity.

Maintain an appropriate distance, Maintain an appropriate distance between your eyes and the screen, not too close or too far, it is generally recommended that the distance from the screen be at least twice the distance from your eyes to the screen.

Maintain good posture: Improving poor posture when using digital electronic devices and keeping your eyes level with the screen can reduce eye muscle fatigue.

Eye Massage, Gently massage the area around your eyes, and during breaks, you can help relax your eye muscles and relieve fatigue and discomfort by doing eye exercises such as eyeball rotation and switching between near and far focus.

Appropriate exercise, appropriate scientific physical activity can relieve muscle soreness, and an intervention study based on badminton exercise on visual fatigue in adolescents, (Yu Mingming,2023) intervened in adolescent visual fatigue through badminton, middle-distance running, and other sports, and the results showed that sports can effectively alleviate the symptoms of visual fatigue, improve adolescent visual health, and have a certain effect in improving the ocular and systemic symptoms of visual fatigue.

Participation in social activities, Active participation in activities is conducive to helping people build a good social network, enhance interpersonal exchanges and communication, and also allows people to temporarily put down their digital electronic devices and enjoy themselves.

Health effects of prolonged use of digital device

Radiation from digital device

Blue light radiation refers to the shorter wavelengths and higher energies of blue light in the visible spectrum. In the spectrum, blue light wavelengths range from approximately380 to 500 nanometers Blue light radiation is an important environmental physical factor that people are exposed to on a daily basis and is one of the causative factors of retinal damage. Blue light radiation exists not only in natural light, but also in artificial light sources, such as displays of electronic devices and LED lights. Prolonged exposure to electronic devices such as smartphones, computers and tablets may expose you to blue light radiation. Some relevant studies have shown that blue light in the visible spectrum is closely related to light-induced damage to the retina of the eye, which can cause retinal damage and lead to vision loss or loss of vision. China's 63.5 per cent of Internet users due to blue light radiation have vision loss, cataracts, blindness and other eye diseases of different degrees. While the Internet brings convenience to people's lives, the overuse of screens also affects people's physical and mental health.

Hazards of prolonged use of digital device

Excessive use of digital electronic devices not only induces eye diseases and leads to retinal damage, but also brings about irreversible physical and mental illnesses.

1. Prolonged use of digital electronic devices can easily induce eye fatigue and vision problems. Staring at digital electronic devices for too long will have a negative impact on the eyes, easily triggering eye fatigue, dryness and vision problems, and may also lead to, for example, vision loss, myopia deepening and other vision problems.

2. Most people in modern society are accustomed to turn off the light and play mobile phones before going to bed, digital electronic devices will interfere with the body's secretion system, and inhibit the secretion of melatonin, the use of digital electronic devices before going to bed will affect the quality of sleep, and long-term retention of this bad sleep habits may accumulate to become a chronic sleep disorders, and affect the daytime concentration and work efficiency.

3. People using digital electronic devices for a long time with their heads down, lying flat to play mobile phones, too close to the screen distance or too far away from the screen for a long time to maintain a bad posture, may induce head and cervical spine part of the pain, but also is not conducive to lumbar vertebrae, and seriously lead to lumbar vertebrae distortion and injury.

4. The screen size of digital electronic products will affect the viewing screen distance, the use of electronic devices with a smaller screen, the eyes from the electronic product screen are too close, and will affect the eyesight to cause greater damage.

5. The study by Nakshine Vaishnavi S et al. showed that frequent and prolonged watching of TV, and use of electronic devices such as smartphones, computers, etc. can harm the physical or psychological aspects, in terms of the physical aspects such as being overweight, obesity, cardiovascular diseases, etc. and in terms of the psychological aspects such as an increase in stress and anxiety, etc., affecting the quality of sleep, etc., which suggests that the prolonged use of digital and electronic devices can lead to social isolation and a lack of truly emotional communication, affecting mental health and physical health(Nakshine Vaishnavi S et al,2022).

6. Overweight and obesity in the population are strongly associated with screen time using digital electronic devices. Dong Liuxue et al. In 2024 explored the correlation between screen time and outdoor activity time on the effect of screening myopia co- morbid overweight/obesity in children and adolescents, and their results showed that screen time ≥2h/d was a risk factor for screening myopia co- morbid overweight/ obesity in primary school students in grades 4-6, and that prolonged viewing of digital electronic device screens for long periods or at a distance that was too close to the screen had a significant effect on the occurrence and development of myopia in the population. a significant impact on the occurrence and development of myopia in the population (Dong Liu Xue et al,2024). In addition, studies have shown that the longer children and adolescents spend looking at a video screen, the more sedentary time they spend and the less time they spend engaged in physical activity, resulting in energy build-up, which is also a possible cause of overweight/ obesity in children (Kerkadi A et al,2019).

People should pay attention to the negative impacts of prolonged use of digital products, which are not conducive to the development of physical and mental health, raise their own health awareness, reduce their bad lifestyles and habits, and promote the development of physical and mental health.

Impact on the physical and mental health of university students

Digital devices such as smartphones, tablets and laptops have become indispensable tools in the study and life of modern university students. However, over-reliance on these devices has led to significant health problems. In terms of visual health, as college students face electronic screens for long periods of time, this can lead to eye fatigue and dryness over time, and studies have shown that constant screen viewing can increase the burden on the eyes and aggravate myopia. Prolonged use of digital electronic devices not only affects the inability of college students to devote themselves to their studies, affecting their learning efficiency and negatively affecting their academic performance, but also increases their psychological pressure and negative emotions, and the emergence of anxiety and depression caused by excessive attention to online information is not conducive to the healthy development of college students' physical and mental health. According to a survey conducted by Liu Xiaohui and others on the screen time of students in four universities in Huizhou, nearly 80% of the students believed that long screen time may lead to health problems such as cervical spondylosis, lumbar spondylosis and eye diseases, and more than 50% of the students believed that screen time is the main cause of memory loss, weakened self-control and lack of concentration (Liu Xiaohui et al,2019)

Research related to this study

Xieyang et al (2020) Interaction between physical activity and mobile phone use problems on suicidal ideation among Chinese university students. The aim was to explore the interaction between physical activity and problematic mobile phone use and its effect on suicidal behavioral tendencies using Chinese college students as a sample population by recruiting 4787 participants who agreed to participate in the study from two universities in China. The correlations between low physical activity (PA), problematic mobile phone use (PMPU), and suicidal ideation and suicide attempts, as well as the interactions of PA and PMPU with suicidal ideation, were explored using a binomial logistic regression model. The results of the study showed that the prevalence of suicide attempts and suicidal ideation was 3.5% and 7.2%, respectively. Low PA was significantly associated with suicide attempts (OR = 3.48, 95% CI: 2.52-4.81) and suicidal ideation (OR = 1.90, 95% CI: 1.46-2.46). PMPU was significantly associated with suicide attempts (OR = 3.65, 95% CI: 2.66-5.01), and suicidal ideation (OR = 2.83, 95% CI: 2.25- 3.54) were significantly associated. Interaction analysis showed that low PA and PMPU were interactively associated with suicide attempts (OR = 9.51, 95% CI: 6.15-14.73, $p < 0.001$), RERI = 4.85 (1.20-8.50), AP = 0.51 (0.29-0.73), and SI = 2.32 (1.34-4.04).

Zou Zhili (2020) Use of video screen electronics by university students and its impact on physical health and behavior. College students use of video-screen electronic products and its effect on physical health and behavior' conducted in 2020, investigated the use of video-screen electronic products, physical health, and behavioral habits of the undergraduate population within a medical university in Shenyang City, to explore the use of video-screen electronic products by college students and their time of use, the frequency and time of use in

the hour before going to bed, and whether the use of video-screen electronic products before bedtime lights out before bedtime, and whether to use video-screen electronic products before bedtime have an impact on physical health and behavioral habits. This study adopted the survey method of convenience sampling and selected undergraduates of a medical university in Shenyang as the survey object, and the survey included four aspects: individual general situation, the use of video screen electronic products, physical health status, and behavioral habits. The results of the study show that undergraduates tend to overuse video electronic products (> 6 h/d) and often use video electronic products before going to bed. Excessive use of video gadgets and higher weekly frequency of using video gadgets before bedtime, higher time spent using video gadgets within one hour before bedtime, and use of video gadgets with lights out before bedtime were all likely to lead to the emergence of poor physical health symptoms and behavioral problems.

Cao Bowen (2021). The Effect of Screen Time on Physical Activity and Physical Fitness in College Students delved into the complex relationship between screen use time, physical activity, and college students' physical health. The study took a sample of 2001 undergraduate college students from seven colleges and universities in Yunnan Province and systematically collected relevant data through questionnaires and physical health tests. The results showed that the presence of sports media in screen media became an important indirect factor in promoting college students' participation in physical exercise, increasing physical activity, and improving physical health.

Wang Xin. (2021). A Current Survey and Correlation Study of Smartphone Addiction and Depressed Mood in Adults. Smartphone Addiction and Depressed Mood, explored the current situation of adults' smartphone addiction and depressed mood and the relationship between the two and initially explored the differences in mobile phone use habits as well as mobile phone use preferences among people with different levels of depression. The survey method of convenience sampling was adopted, and 490 adults were surveyed with questionnaires using measurement scales including the Adult Smartphone Addiction Scale, the Mobile Phone Use Preference Questionnaire, the Self- administered General Situation Questionnaire, the SDS Depression Self- Rating Scale, and the Mobile Phone Use Habits Questionnaire. Its results showed that respondents' age class, occupation, education level, monthly salary level, and marital status were influential factors for smartphone addiction and that subjects with different levels of depression showed different characteristics in mobile phone use preference and mobile phone use habits.

Wang Mengli (2021). A study on the current status of myopia and its influencing factors among students of a university in Henan Province. The current situation of myopia in a university in Henan and the factors affecting it, through the survey research, self- designed questionnaires, the use of random sampling of research methods, to get a valid questionnaire 1881, to collect college students and their basic information and daily habits and eye behavior related information, to understand the current situation of myopia and its epidemiology of a university in Henan students and the relevant characteristics of the study. The results of the

study showed that the myopia detection rate of the respondents was high, and the number of refractive errors had increased to different degrees in the past 2 years; there were gender and urban/rural differences in the detection rate of myopia, and the development of myopia was related to genetics, nutritional status, ocular environment, ocular behaviors, and ocular health care, among other factors.

Federico Salfi et al (2021). Changes of evening exposure to electronic devices during the COVID-19 lockdown affect the time course of sleep disturbances. In 2021 Federico Salfi et al. based on ‘Changes of evening exposure to electronic devices during the COVID-19 lockdown affect the time course of sleep disturbances’ did a study on the relationship between changes of evening screen exposure and the time course of sleep disturbances during home quarantine due to COVID-19, the use of electronic devices increased globally during the home quarantine and prolonged exposure to backlit screens before bedtime affects the circadian rhythm system, which in turn negatively affects sleep health, the present study was conducted on 2123 Italians in the third week of the epidemic lockdown and the seventh week of the epidemic. The seventh week was tested experimentally, and sleep quality and insomnia symptoms were assessed by the Pittsburgh Sleep Quality Index and Insomnia Severity Index. Participants who used electronic devices for extended periods in this experimental study showed reduced sleep quality, increased insomnia symptoms, shorter sleep duration, longer sleep latency, and delays in bedtime and wake-up time, with an increased prevalence of poor sleepers and individuals reporting moderate or severe insomnia symptoms in the experimental group, whereas subjects with reduced screen exposure showed improved sleep quality and insomnia symptoms.

Hao-Yi Lee (2021) A study on the impact of 'Civic Education + Tai Chi Chuan' on the physical and mental health of college students addicted to mobile phones. It is pointed out that through the scientific guidance for mobile phone addicted college students, the intervention method of combining ideological education and sports is used to explore a new type of comprehensive intervention to improve the physical and mental health of mobile phone addicted college students, and to provide relevant scientific theoretical basis, empirical evidence and corresponding development countermeasures for college students' mobile phone addiction. Through literature, questionnaire survey, expert interviews, experiments and other methods, it is shown that the integrated intervention of ' Civic and political education + taijiquan' is proved to be effective, which is conducive to the in- depth development and utilisation of the resources of Civic and political education and sports, and promotes the in-depth integration of these two fields, which helps to improve the physical and mental health of mobile phone-addicted college students. Physical and mental health.

Sivaletchumi Sigamani et al,(2022), Changes in accommodation with visual fatigue among digital device users. Changes in adaptation to the use of digital devices at different levels of visual fatigue were assessed in students at a private university in Malaysia. The researchers conducted a comprehensive eye examination of the students, and after estimating the level of visual fatigue, the adjustment amplitude (AA), accommodation facility (AF), and monocular estimation method (MEM) were measured, and the participants filled out a visual fatigue questionnaire. Participants were categorised into low, moderate and high visual fatigue groups based on their visual fatigue scores. Adaptation parameters were measured for each group and

compared between the two groups (i.e., low visual fatigue group and moderate to severe visual fatigue group). Significant differences were found in binocular AA and right eye AF values between the low visual fatigue group (Group 1) and the moderate to severe visual fatigue group (Group 2) (both $P < 0.05$), and binocular AA and monocular AF were significantly different between the visual fatigue groups.

Yu Mingming,(2023) , An intervention study of badminton on visual fatigue in adolescents. Intervention Study of Badminton Sports on Visual Fatigue in Adolescents, the effects of sports such as badminton and middle- distance running on visual fatigue in adolescents were investigated by examining subjects' visual fatigue and related visual function parameters. It was found that long-term badminton exercise could enhance the metabolic level of the organism, and the ocular conditioning promoted the increase of blood flow, improved ocular muscle conditioning and ocular metabolism, which led to the improvement of visual acuity and alleviation of visual fatigue symptoms. These results provide an important reference for the improvement of adolescents' visual health through sports.

Mohamed W Bin Maneea et al,(2024) , Digital Eye Straining: Exploring Its Prevalence, Associated Factors, and Effects on the Quality of Life. A comprehensive exploration of the symptoms, severity, and associated influences of digital eye strain (DES) was conducted in a cross- sectional study among participants with diverse demographic backgrounds, using a questionnaire distributed to collect data on participant characteristics, patterns of electronic device use, symptoms of DES, and their impact on various aspects of

quality of life, using statistical analyses to assess association and significance. The results showed that the majority of participants reported symptoms of DES, with dry eyes, headaches and eye redness being the most prevalent, that there was a significant correlation between the prevalence of digital eyestrain and longer screen exposure times, and that the findings highlighted the importance of age, behaviour and eye health in understanding and addressing DES.

Conceptual Framework

Based on the overall literature review, the conceptual framework contains independent and dependent variables, the conceptual framework of this thesis is shown below:

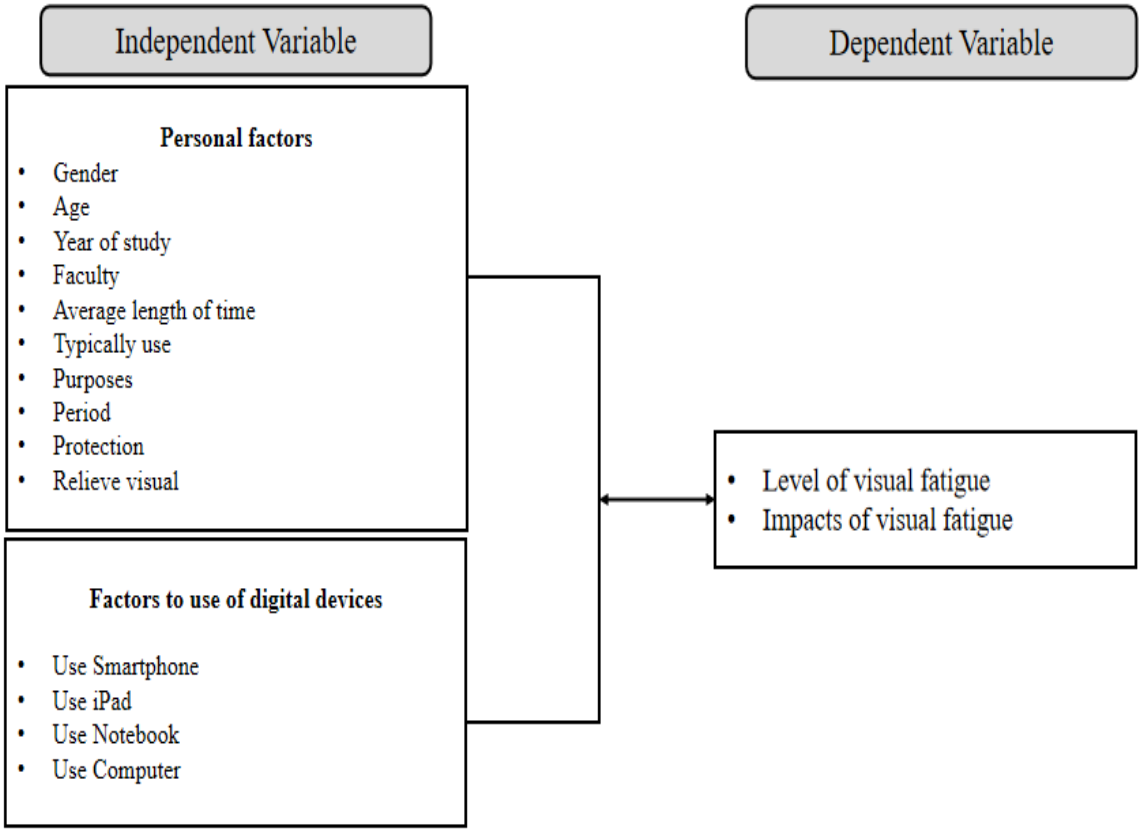

Figure 3 Conceptual Framework of this study

CHAPTER III

RESEARCH METHODOLOGY

This chapter focuses on the level of visual fatigue, the impacts of visual fatigue, and the factor associated impacts that visual fatigue among students use digital devices at Hainan University of Science and Technology in Yunlong Campus. This study is divided into the following seven sections;

1 Research design

2. Population and sample size

    2.1 Population

    2.2 Sample Size and Sampling Technique

    2.3 Inclusion Criteria

    2.4 Exclusion Criteria

3. Study area

4. Study period

5. Measurement instruments

    5.1 Measurement Tool

    5.2 Tool development process

    5.3 Research tool quality

    5.4 Reliability

6. Data collection

7. Data analysis

Research design

The research design of this study was a cross-sectional descriptive study. All samples were collected at Hainan University of Science and Technology in Yunlong Campus.

Population and sample size

Population

This study selected at Hainan University of Science and Technology in Yunlong Campus, Haikou City, Hainan Province, which, according to the data statistics, had a total of 14,187 university students in Yunlong Campus. There are five colleges, namely, College of Medicine, College of Nursing, College of Accounting, College of Urban Construction, and College of Education and Music.

Sample Size and Sampling Technique

The population of this research study was 14,187 faculty students enrolled in the Yunlong Campus of the Hainan University of Science and Technology Vocational Studies, which was determined based on the inclusion and exclusion criteria for the selection of research subjects, and the rate of withdrawal of the researchers due to illness or unavoidable unforeseen circumstances was expected to be less than 10 percent. The sample size was calculated by the Taro Yamane formula., the eligible participants were 430 students.

$$n = \frac{N}{1 + N_{e^2}}$$

$$n = \frac{14187}{1+14187*(0.05)^2} \qquad n \approx 389$$

n=sample size (sample size of 389 subjects extracted)

N=Population (14,187 college students enrolled at Yunlong Campus of Hainan University of Science and Technology)

e=acceptable level of error (0.05)

Considering 10.5% sample loss: 389×10.5%=40.8≈41

Sample size: 389+41=430

Sampling Technique

This study employed proportionate stratified random sampling to select a representative sample of 430 students from the university's total population of 14,187 students. The population was first divided into five strata based on faculty as follows: Faculty of Medicine=95, Faculty of Nursing=180, Faculty of Accountancy=61, Faculty of Urban Construction=72, and Faculty of Education and Music=22. The number of students selected from each faculty was proportionate to the size of that faculty in the overall student population. Finally, accidental sampling was used within each stratum to select the participants. According to the inclusion criteria and exclusion criteria, with the following number of people.

Table 1 Population and sample size

Faculty in University	Population (N)	Sample size(n)
Faculty of Medicine	3,120	95
Faculty of Nursing	5,955	180
Faculty of Accountancy	2,021	61
Faculty of Urban Construction	2,365	72
Faculty of Education and Music	744	22
Total	**14,187**	**430**

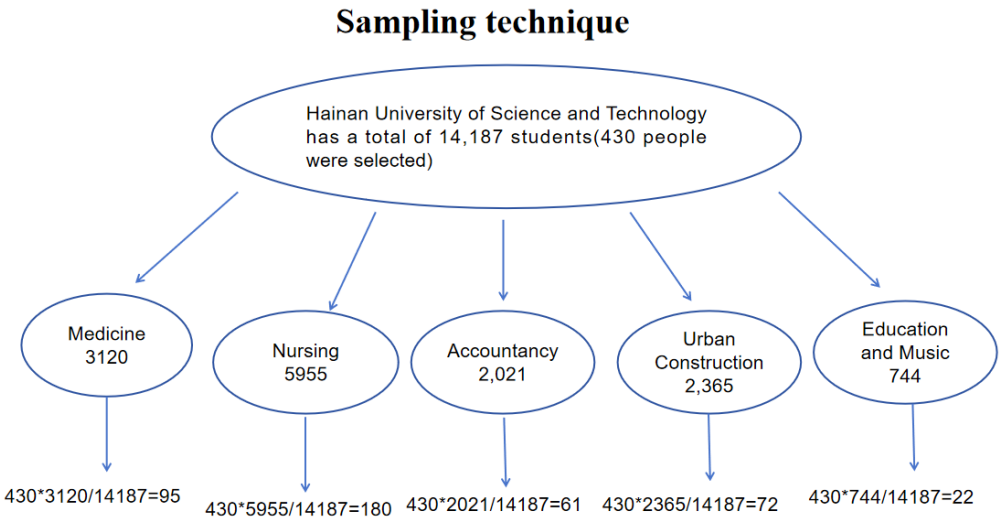

Figure 4 Number of students selected from faculty

Inclusion Criteria

1. Students currently enrolled at Hainan University of Science and Technology, Yunlong Campus.

2. Students who regularly use digital devices.

3. Voluntary participation in this research.

2.4 Exclusion Criteria

1. Students with a pre-existing diagnosed eye disease (e.g., glaucoma or retinal disorders).

2. Students who have undergone eye surgery in the past 6 months.

3. Students who are not available to complete the questionnaire or follow study procedures.

Study area

The study area was selected as Hainan Province in the southern region of China, and the specific study site was the Yunlong Campus of Hainan University of Science and Technology, located at No. 118, Yunding Road, Yunlong Town, Haikou City, Hainan Province. There are three reasons for choosing this location: first, Haikou City, Hainan Province, has a superior geographic location, a good environment, a low air pollution index, and fewer environmental factors that can be used to exclude and be affected by the outside world; second, the Yunlong Campus of the Hainan University of Science and Technology is located in the suburbs, with fewer facilities in the vicinity, and most of the effects on students' vision come from their behavioral factors; and third, it is convenient for me to research the effects of Third, it is convenient for me, for professional reasons, to conduct a research study

on the effects of prolonged use of digital electronic devices on the visual fatigue of students in Yunlong Campus of Hainan University of Science and Technology.

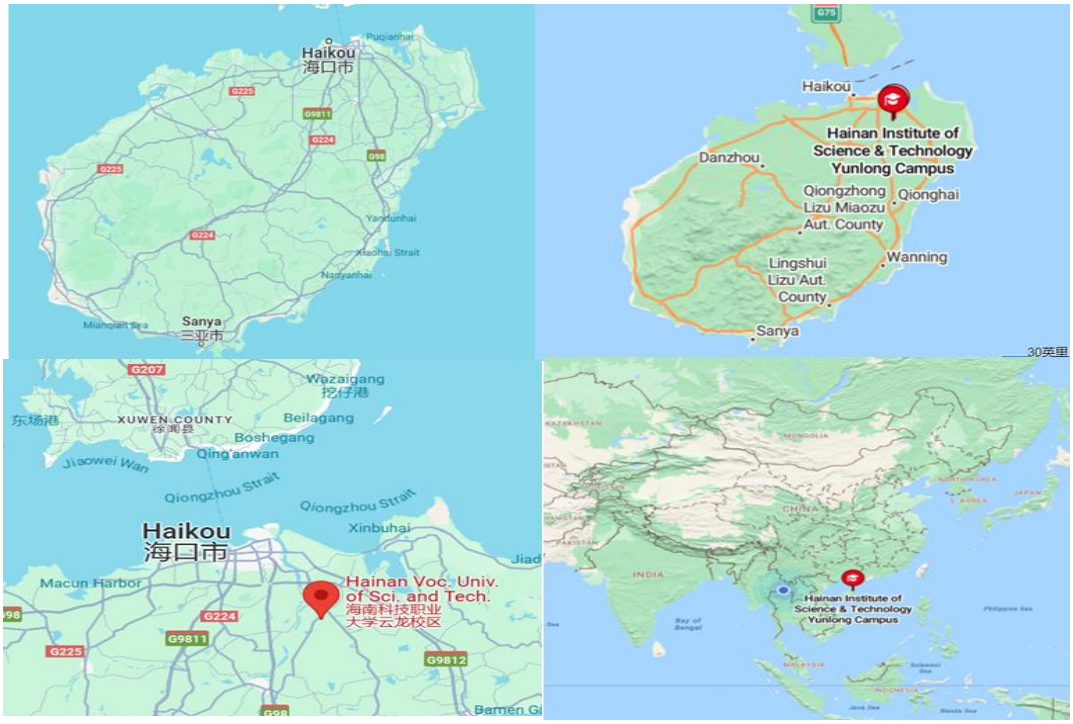

Figure 5 Map at Hainan University of Science and Technology in Yunlong Campus. (Google Map, 2024)

Study period

This study was conducted from August 2024 to March 2025.

Measurement instruments

Measurement Tool

Part I Personal factors

The basic personal details of the respondents to the questionnaire should include the gender, age, grade, and college of the respondents, the average number of hours of daily use of digital electronic devices, the type of digital electronic devices used, and their main purpose, the average time of rest after each long period of time spent looking at the screen of the digital electronic devices, and the means of obtaining information on the use of digital electronic devices and related aspects of eyesight preservation, Information on measures taken to reduce visual fatigue.

Part II Factors to use of digital devices

Ask about the usage of smartphones, iPads, notebooks, and computers in the past month such as distance between eyes and screen, screen size, screen light intensity, screen viewing posture, screen color to a warm tone, usage type.

Part III Assess the visual fatigue

The questionnaire assessed the level of visual fatigue experienced by participants over the past month. Respondents were asked whether they had experienced any of the following symptoms: itchy eyes, eye irritation, eye fatigue, eye strain, dry eyes, excessive tearing, poor vision, light sensitivity, blurred or unclear vision, delayed focusing when looking at objects, and headaches during or after the use of digital devices. A 3-point Likert scale was used to evaluate the frequency of each symptom, with response options as follows:

Always 3 score

Sometimes 2 score

Never 1 score

The criteria for finding the average of the results using the formula of the width in the class interval are as follows (Panchakarma Pothibenjakul, 2007: 67).

From the formula, the width of the class interval = (highest value ─ lowest value)/Number of classes = (3─1)/3 = 0.66

The criteria for the level of visual fatigue divided into 3 levels as follows:

An average score of 1.00 - 1.66 Low level of visual fatigue

An average score of 1.67 - 2.33 Medium level of visual fatigue

An average score of 2.34 - 3.00 High level of visual fatigue.

Part IV Assess the impacts of visual fatigue

The questionnaire asks about the impacts of visual fatigue are eye diseases such as cataracts, pterygium, dry eye disease, and eye allergies. Vision disorders such as myopia, astigmatism, and hyperopia. Headaches such as dizziness, headache, and migraine. The score used as follows;

Always 3 score

Sometimes 2 score

Never 1 score

The criteria for the levels of visual fatigue were categorized based on the average score into 3 levels of impact as follows:

An average score of 1.00 - 1.66 Low impacts of visual fatigue

An average score of 1.67 - 2.33 Medium impacts of visual fatigue

An average score of 2.34 - 3.00 High impacts of visual fatigue

Because the Fisher exact test statistic is only applicable to 2*2 contingency tables, when using this method in Chapter 4, it will be divided into two levels: not high (low+medium) and high.

5.2 Tool development process

1. Research literature, including literature related to the research, to optimize the research questionnaire.

2. Consult the supervisor's research questionnaire

3. Submit the questionnaire to three experts for evaluation

4. Modify the questionnaire according to expert suggestions. The above is appropriate

5. Conduct sample tests in the study area

5.3 Research tool quality

The accuracy of the study content requires the expert to believe that the research question is determined to meet the measured content or the purpose of the study

A score of +1 means to be certain of the content/purpose of the question.

A score of 0 means being uncertain about the content/purpose of the question.

A score of -1 means to identify an issue without measuring its content/purpose

index of item-objective congruence IOC

According to the formula:

$$IOC = \Sigma R/N$$

R stands for the sum of expert reviews.

N represents the number of majors

If the IOC criterion is 0.05 or above, then the problem is objective

Reliability

The modified questionnaire was pretested on 30 students from the Hainan University of Science and Technology Meilan Campus, who were representative of the target population. The data from the pre- study were analyzed to assess the reliability of the instrument. The section measuring visual fatigue obtained a Cronbach's alpha coefficient of 0.864, while the section assessing the effects of visual fatigue achieved a coefficient of 0.808, indicating excellent internal consistency. These results confirmed that the instrument was suitable for students from the Yunlong Campus of Hainan University of Science and Technology.

Data collection

1. Development of questionnaire

Determine the research questions and research objectives, review relevant literature, and develop a questionnaire based on the research content to collect data on the time of use, the environment of use, the feeling of visual fatigue, and the concern for visual health, to provide empirical support and scientific basis for the reduction of visual health problems brought about by the use of digital devices.

2. Questionnaire distribution and collection

Based on the inclusion and exclusion criteria of the study population, the most representative sample group was selected. This study adopted the method of online questionnaire distribution and used the online platform Wenjuanxing to collect questionnaire information. During the questionnaire collection process, invalid questionnaires with incomplete answers or answers that obviously did not meet the standards were eliminated to ensure the validity and reliability of the data. Afterwards, a detailed data analysis of the screened valid questionnaires will be conducted to explore the impact of long-term use of digital devices on the visual health of students at Hainan University of Science and Technology and its potential mechanisms.

3. Data processing

The collected data were systematically collated and analyzed, and data were processed using statistical software such as SPSS or Excel to quantify and compare the relationships between different variables. The results of the analyses may include the correlation between the duration of use of digital devices and the perception of visual fatigue and the differences in the effects of different types of devices on visual fatigue.

Data analysis

The descriptive statistics analyzed the personal factors, factors to use of digital devices, the level of visual fatigue, and the impact of visual fatigue were frequencies, percentages, mean, and standard deviation.

The inferential statistics analyzed the factor associated impacts of visual fatigue among students who play digital devices at Hainan Vocational University of Science and Technology as a Chi-square test and Fisher exact test statistic.

CHAPTER IV

RESULTS

This chapter aims to determine the prevalence of visual fatigue, to assess the impacts of visual fatigue, and to assess the factor associated impacts that visual fatigue among students use digital devices at Hainan University of Science and Technology in Yunlong Campus. The results include 5 components as follows;

1. Personal factors
2. Factors to use of digital devices
3. Assess the visual fatigue
4. Assess the impact of visual fatigue
5. Factors associated the impacts of visual fatigue

Personal factors

Table 2 Frequency and percentage gender of student（n=430）

Gender	Number(n=430)	Percentage (%)
Male	264	61.40
Female	166	38.60
Total	**430**	**100**

Table 2 shows the frequency and percentage gender of student were 264 males (61.40%) and 166 females (38.60%).

Table 3 Frequency and percentage age of student（n=430）

Age	Number(n=430)	Percentage (%)
19	91	21.16
20	118	27.44
21	108	25.12
22	113	26.28
Mean=20.5 Minimum=19 Maxinum=22		
Total	**430**	**100**

Table 3 shows the frequency and percentage age of student, the majority of respondents was 20 years old, with a total of 118 individuals (27.44%), and 108 individuals (25.12%) were 21 years old, the lowest represented was 19 years old, accounting for 91 individuals (21.16%).

Table 4 Frequency and percentage year of study of student（n=430）

Year of study	**Number(n=430)**	**Percentage (%)**
Year one	166	38.60
Year two	117	27.21
Year three and above	147	34.19
Total	**430**	**100**

Table 4 shows the frequency and percentage year of study of student, it was found that the majority of respondents were first-year students, with a total of 166 individuals (38.60%), and 147 (34.19%) respondents were year three and above, while the lowest represented group was year of two students, accounting for 117 individuals (27.21%).

Table 5 Frequency and percentage faculty of student（n=430）

Faculty	Number(n=430)	Percentage (%)
Faculty of Medicine	97	22.56
Faculty of Urban Construction	64	14.88
Faculty of Nursing	182	42.32
Faculty of Accountancy	61	14.19
Faculty of Education and Music	26	6.05
Total	**430**	**100**

Table 5 shows the frequency and percentage faculty of student the majority of respondents were from the faculty of nursing, with a total of 182 individuals (42.32%), and 97 respondents (22.56%) were from the faculty of medicine, while the lowest represented group was from the faculty of education and music, accounting for 26 individuals (6.05%).

Table 6 Frequency and percentage average length of time use digital electronic devices on a daily basis of student（n=430）

Average length of time	Number(n=430)	Percentage (%)
Less than 4 hours	73	16.98
4-6 hours	153	35.58
More than 6 hours	204	47.44
Total	**430**	**100**

Table 6 shows the frequency and percentage average length of time use digital electronic devices on a daily basis of student, it was found that the majority of respondents spent more than 6 hours on average, with a total of 204 individuals (47.44%), and 153 respondents (35.58%) spent 4-6 hours, while the lowest of respondents spent less than 4 hours, accounting for 73 individuals (16.98%).

Table 7 Frequency and percentage typically use types of digital electronic devices of student

Types of digital electronic devices	Number	Percentage (%)
Smartphone	356	82.79
Ipad	175	40.70
Notebook	141	32.79
Computer	127	29.53

Table 7 shows the frequency and percentage typically use types of digital electronic devices of student, it was found that the majority of respondents used smartphones, with a total of 356 individuals (82.79%), and 175 respondents (40.70%) used iPad, the lowest used device was the computer accounting for 127 individuals (29.53%).

Table 8 Frequency and percentage main purpose of using digital electronic devices of student

Main purpose	Number	Percentage (%)
Study (reviewing materials, preparing for exams or watching online classes, etc.)	241	56.05
Entertainment (watching videos, playing games, etc.)	206	47.91
Social platform	382	88.84
Taking photos and videos	298	69.30
Other	54	12.56

Table 8 shows the frequency and percentage main purpose of using digital electronic devices of student, it was found that the majority of respondents used social platforms on digital electronic devices, with a total of 382 individuals (88.84%), 298 respondents (69.30%) used devices for taking photos and videos, the lowest chosen purpose was categorized as "Other," accounting for 54 individuals (12.56%).

Table 9 Frequency and percentage of take a break after each prolonged period of looking at the screen of a digital device（n=430）

Take a break after each prolonged period	Number(n=430)	Percentage (%)
0-10 minutes	333	77.44
Over 10 minutes	97	22.56
Total	**430**	**100**

Table 9 shows the frequency and percentage of take a break after each prolonged period of looking at the screen of a digital device ,it was found that the majority of respondents took a break of 0-10 minutes after each prolonged period, with a total of 333 individuals (77.44%), and 97 respondents (22.56%) took breaks of over 10 minutes.

Table 10 Frequency and percentage of how to get information about using digital devices and protecting your eyesight of student

Get information about using digital devices and protecting your eyesight	Number	Percentage (%)
Internet search	261	60.70
School education	180	41.86
Information from doctors and professionals	247	57.44
Reminders for stay-at-home parents	310	72.09
Other	97	22.56

Table 10 shows the frequency and percentage of how to get information about using digital devices and protecting your eyesight of student , it was found that the majority of respondents obtained information about using digital devices and protecting their eyesight from reminders for stay-at-home parents, with a total of 310 individuals (72.09%), and 261 respondents (60.70%) acquired information through internet searches, while the lowest chosen source was categorized as "Other," accounting for 97 individuals (22.56%)

Table 11 Frequency and percentage of take measures to relieve visual fatigue

Take measures to relieve visual fatigue	Number	Percentage (%)
Take regular breaks and step away from the screen every so often	273	63.49
Use eye protection mode or blue light filtering screen protectors	324	75.35
Adjusting screen brightness and contrast	307	71.40
Eye exercises or eye massage	180	41.86
Other	77	17.91

Table 11 shows the frequency and percentage of take measures to relieve visual fatigue,the majority of respondents took measures to relieve visual fatigue by using eye protection mode or blue light filtering screen protectors, with a total of 324 individuals (75.35%), and 307 respondents (71.40%) adjusted screen brightness and contrast, while the lowest chosen measure was categorized as "Other," accounting for 77 individuals (17.91%).

Factors to use of digital devices

Use smartphone

Table 12 Frequency and percentage distance between eyes and smartphone screen of student

Distance between eyes and smartphone screen	Number	Percentage (%)
Less than or equal to 40cm	258	72.47
More than 40 cm	98	27.53

Table 12 shows the frequency and percentage distance between eyes and smartphone screen of student, it was found that the majority of respondents kept a distance of less than or equal to 40cm between their eyes and the smartphone screen, with a total of 258 individuals (72.47%). Additionally, 98 respondents (27.53%) maintained a distance of more than 40cm.

Table 13 Frequency and percentage smartphone screen size of student

Smartphone screen size	Number	Percentage (%)
4 - 7 inches	296	83.15
More than 7 inches	60	16.85

Table 13 shows the frequency and percentage smartphone screen size of student, it was found that the majority of respondents used smartphones with a screen size of 4-7 inches, with a total of 296 individuals (83.15%),and 60 respondents (16.85%) used smartphones with a screen size of more than 7 inches.

Table 14 Frequency and percentage smartphone screen light intensity of student

Smartphone screen light intensity	Number	Percentage (%)
1-50 lux	121	33.99
51-100lux	235	66.01

Table 14 shows the frequency and percentage smartphone screen light intensity of student, the majority of respondents used smartphone screen light intensity between 51-100 lux, with a total of 235 individuals (66.01%), while 121 respondents (33.99%) used a lower screen brightness of 1-50 lux.

Table 15 Frequency and percentage smartphone screen viewing posture of student

Smartphone screen viewing posture	Number	Percentage (%)
Below and parallel to eye level	306	85.96
Above eye level	50	14.04

Table 15 shows the frequency and percentage smartphone screen viewing posture of student, it was found that the majority of respondents view the smartphone screen below and parallel to eye level, a total of 306 people (85.96%), and 50 (14.04%) respondents viewed their smartphones at above eye level.

Table 16 Frequency and percentage set the smartphone screen color to a warm tone of student

Set the Smartphone screen color to a warm tone	Number	Percentage (%)
Yes	171	48.03
No	185	51.97

Table 16 shows the frequency and percentage set the smartphone screen color to a warm tone of student, it was found that 171 respondents (48.03%) changed the color of their smartphone screens to warmer tones and 185 people (51.97%) would not set their smartphone screen color to warm tones.

Table 17 Frequency and percentage duration of use of smartphone per day of student

Duration of use of smartphone per day	Number	Percentage (%)
1-6 hours	170	47.75
More than 6 hours	186	52.25

Table 17 shows the frequency and percentage duration of use of smartphone per day of student, the majority of respondents use smartphones for more than 6 hours a day, with a total of 186 people (52.25%), and 170 (47.75%) people use their smartphones for 1-6 hours a day.

Use iPad

Table 18 Frequency and percentage distance between eyes and screen distance of iPad of student

Distance between eyes and screen distance of iPad	Number	Percentage (%)
Less than or equal to 40cm	45	25.71
More than 40cm	130	74.29

Table 18 shows the frequency and percentage distance between eyes and screen distance of iPad of student, it was found that the distance between the eyes of most respondents and the iPad screen is between more than 40cm, a total of 130 people (74.29%), a total of 45 respondents (25.71%) said that the distance between their eyes and the iPad screen was less than or equal to 40cm.

Table 19 Frequency and percentage set the iPad screen color to a warm tone of student

Set the iPad screen color to a warm tone	Number	Percentage (%)
Yes	105	60.00
No	70	40.00

Table 19 shows frequency and percentage set the iPad screen color to a warm tone of student,105 people (60.00%) set the screen color of their iPad to warm tones and 70 (40.00%) people did not choose to set the iPad screen color to warm tones.

Table 20 Frequency and percentage iPad screen viewing posture of student

iPad screen viewing posture	Number	Percentage (%)
Below eye level	140	80.00
Eye level and above	35	20.00

Table 20 shows frequency and percentage iPad screen viewing posture of student, it was found that the majority of respondents viewed their iPad screens below eye level, with a total of 140 individuals (80.00%), and 35 respondents (20.00%) viewed the iPad screen at eye level and above.

Table 21 Frequency and percentage duration of use of iPad per day of student

Duration of use of iPad per day	Number	Percentage (%)
1-6 hours	76	43.43
More than 6 hours	99	56.57

Table 21 shows frequency and percentage duration of use of iPad per day of student, it was found that the majority of respondents used an iPad for more than 6 hours per day, with a total of 99 individuals (56.57%),and 76 respondents (43.43%) used an iPad for 1-6 hours per day.Use Notebook

Table 22 Frequency and percentage distance between eyes and screen distance of Notebook of student

Distance between eyes and screen distance of Notebook	Number	Percentage (%)
Less than or equal to 50cm	13	9.22
More than 50cm	128	90.78

Table 22 shows frequency and percentage distance between eyes and screen distance of Notebook of student ,the majority of respondents maintained a distance of more than 50 cm between their eyes and the notebook screen, with a total of 128 individuals (90.78%), and 13 (9.22%) respondents chose the distance between their eyes and the Notebook screen as less than or equal to 50cm.

Table 23 Frequency and percentage the font size on a Notebook of student

The font size on a Notebook	Number	Percentage (%)
Smaller	21	14.89
Medium	87	61.70
Larger	33	23.41

Table 23 shows frequency and percentage the font size on a Notebook of student , it was found that the majority of respondents set the font size on their notebooks to medium, with a total of 87 individuals (61.70%) and 33 respondents (23.41%) used larger fonts, while the lowest chosen font size was smaller, accounting for 21 individuals (14.89%).

Table 24 Frequency and percentage set the Notebook screen color to a warm tone of student

Set the Notebook screen color to a warm tone	Number	Percentage (%)
Yes	47	33.33
No	94	66.67

Table 24 shows frequency and percentage set the Notebook screen color to a warm tone of student, 47 people (33.33%) set their Notebook screens to warm tones and 94 (66.67%) people did not set the screen to warm tones.

Use Computer

Table 25 Frequency and percentage sitting distance from the computer screen of student

Sitting distance from the computer screen	Number	Percentage (%)
Less than or equal to 50cm	5	3.94
More than 50cm	122	96.06

Table 25 shows frequency and percentage sitting distance from the computer screen of student , it was found that the majority of respondents sat at a distance of more than 50cm from the computer screen, with a total of 122 individuals (96.06%), and 5 respondents (3.94%) were less than or equal to 50cm away from the computer screen.

Table 26 Frequency and percentage the font size on a computer of student

The font size on a computer	Number	Percentage (%)
Smaller and Medium	103	81.10
Larger	24	18.90

Table 26 shows frequency and percentage the font size on a computer of student, it was found that the majority of respondents set the font size on their computers to smaller and medium, with a total of 103 individuals (81.10%), and 24 respondents (18.90%) chose to set the font size to a larger size .

Table 27 Frequency and percentage computer screen brightness of student

Computer screen brightness	Number	Percentage (%)
Low	48	37.80
Medium	34	26.77
Bright	45	35.43

Table 27 shows frequency and percentage computer screen brightness of student, it was found that the majority of respondents set their computer screen brightness to low, with a total of 48 individuals (37.80%) , and 45 respondents (35.43%) set to a bright screen , while the lowest chosen brightness level was medium, accounting for 34 individuals (26.77%).

Table 28 Frequency and percentage set the computer screen color to warm tone of student

Set the computer screen color to warm tone	Number	Percentage (%)
Yes	49	38.58
No	78	61.42

Table 28 shows frequency and percentage set the computer screen color to warm tone of student, 49 people (38.58%) set their computer screens to warm tones and 78 people (61.42%) would not set the computer screen color to warm tones.

Table 29 Frequency and percentage install a screen filter or use light-blocking glasses of student

Install a screen filter or use light-blocking glasses	**Number**	**Percentage (%)**
Yes	17	13.39
No	110	86.61

Table 29 shows frequency and percentage install a screen filter or use light-blocking glasses of student, 17 people (13.39%) installed computer filters or used students' light-blocking glasses and 110 (86.61%) did not install computer filters or use students' light-blocking glasses.

Assess the visual fatigue

Table 30 The level of visual fatigue in the past month

In the past month, have you had any of the following symptoms?	**Always（3）**		**Sometimes（2）**		**Never（1）**		**Mean**	**SD**	**Level**
	Frequency	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**			
1. Itchy eyes	236	54.88	137	31.86	57	13.26	2.42	0.71	High
2. Eye irritation	333	77.44	83	19.30	14	3.26	2.74	0.51	High
3. Eye fatigue	319	74.19	100	23.25	11	2.56	2.72	0.51	High
4. Eye strain	316	73.49	100	23.25	14	3.26	2.70	0.52	High
5. Dry eyes	333	77.44	83	19.30	14	3.26	2.74	0.51	High
6. Tears flow	188	43.72	151	35.12	91	21.16	2.23	0.77	Medium
7. Poor vision	333	77.44	86	20.00	11	2.56	2.75	0.49	High
8. Vision-light sensitivity	247	57.44	125	29.07	58	13.49	2.44	0.72	High

Table 30 (Continued)

In the past month, have you had any of the following symptoms?	Always（3）		Sometimes（2）		Never（1）		Mean	SD	Level
	Frequency	Percent	Frequency	Percent	Frequency	Percent			
9.Blurred vision, unclear vision	339	78.84	76	17.67	15	3.49	2.75	0.51	High
10.Eyes slow to focus when looking at objects	280	65.12	128	29.77	22	5.11	2.60	0.59	High
11.Headache during or after the use of digital devices	333	77.44	84	19.54	13	3.02	2.74	0.50	High
Average total							**2.62**	**0.58**	**High**

The table 30 results showed that the level of visual fatigue in the past month. The overall mean score of visual fatigue was found to be at a high level (2.62 ± 0.58). Most visual fatigue symptoms reported are at a high level, with mean scores ranging from 2.23 to 2.75. Among these, blurred or unclear vision (Mean2.75 ± SD0.51) and poor vision (Mean2.75 ± SD0.49) recorded the highest mean score , followed closely by dry eyes and eye irritation (Mean2.74 ± SD0.51). Conversely, the symptom "tears flow" was reported at a medium level (Mean2.23 ± SD0.77), indicating comparatively lower frequency.

Assess the impact of visual fatigue

Table 31 The impact of visual fatigue

Impacts of visual fatigue	**Always（3）**		**Sometimes（2）**		**Never（1）**		**Mean**	**SD**	**Level**
	Frequency	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**			
Eye Diseases	628	28.40	230	30.71	862	64.33	1.86	0.35	Medium
Vision Disorders	632	28.58	238	31.78	420	31.34	2.17	0.54	Medium
Headache	951	43.01	281	37.52	58	4.33	2.69	0.55	High
Average total							**2.20**	**0.47**	**Medium**

Table 31 the impact of visual fatigue showed the overall mean score across all items was medium level (2.20 ± 0.47), the majority of respondents reported symptoms related to headaches at a high level (2.69 ± 0.55), followed by vision disorders at a medium level (2.17 ± 0.54). In contrast, eye diseases were reported at a medium level (1.86 ± 0.35), indicating that they were the least commonly reported impacts among the participants.

Table 32 The impact of Eye Diseases

Impacts of visual fatigue	**Always（3）**		**Sometimes（2）**		**Never（1）**		**Mean**	**SD**	**Level**
	Frequency	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**			
Eye Diseases									
1.Cataracts	0	0.00	0	0.00	430	100.00	1.00	0.00	Low
2.Pterygium	7	1.63	20	4.65	403	93.72	1.08	0.33	Low
3.Dry Eye Disease	315	73.26	103	23.95	12	2.79	2.70	0.51	High
4.Eye Allergies	306	71.17	107	24.88	17	3.95	2.67	0.55	High
Average total							**1.86**	**0.35**	**Medium**

Table 32 the impact of eye diseases showed the overall mean score across all items was medium level (Mean1.86 ± SD0.35), the majority of respondents reported to dry eye disease symptoms at a high level (Mean2.70 ± SD0.51), followed by eye allergies, which were rated at a high level (Mean2.67 ± SD0.55). In contrast, cataracts were reported at a low level (Mean1.00 ± SD0.00), indicating that they were the least commonly experienced impacts among the participants.

Table 33 The impact of Vision Disorders

Impacts of visual fatigue	Always（3）		Sometimes（2）		Never（1）		Mean	SD	Level
	Frequency	Percent	Frequency	Percent	Frequency	Percent			
Vision Disorders									
1.Myopia	341	79.30	77	17.91	12	2.79	2.77	0.49	High
2.Astigmatism	277	64.42	111	25.81	42	9.77	2.55	0.67	High
3.Hyperopia	14	3.25	50	11.63	366	85.12	1.18	0.46	Low
Average total							**2.17**	**0.54**	**Medium**

Table 33 the impact of vision disorders showed the overall mean score across all items was medium level (Mean2.17 ± SD0.54), the majority of respondents reported to myopia symptoms at a high level (Mean2.77 ± SD0.49) ,followed by astigmatism at a high level (Mean2.55 ± SD0.67). In contrast, hyperopia were reported at a low level (Mean1.18 ± SD0.46), indicating that they were the least commonly reported impacts among the participants.

Table 34 The impact of Headache

Impacts of visual fatigue	**Always（3）**		**Sometimes（2）**		**Never（1）**		**Mean**	**SD**	**Level**
	Frequency	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**			
Headache									
1.Dizziness	328	76.28	87	20.23	15	3.49	2.73	0.52	High
2.Headache	328	76.28	88	20.46	14	3.26	2.73	0.51	High
3.Migraine	295	68.61	106	24.65	29	6.74	2.62	0.61	High
Average total							**2.69**	**0.55**	**High**

Table 34 the impact of headache showed the overall mean score across all items was high level (Mean2.69 ± SD0.55), both dizziness and headache were the majority of respondents reported symptoms, each with a high mean score of (Mean2.73 ± SD0.52) and (Mean2.73± SD0.51), migraine was also reported at a high level, with a slightly lower mean score of (Mean2.62 ± SD0.61), indicating that headache-related symptoms were commonly experienced among the participants.

Factors associated the impacts of visual fatigue

Table 35 The relationship between gender and the impacts of visual fatigue

Personal factors		**Impacts of visual fatigue Level**			**X2**	**P-value**
		Low	**Medium**	**High**		
Gender	Male	12(4.55%)	204(77.27%)	48(18.18%)	6.360	0.042*
	Female	5(3.01%)	114(68.68%)	47(28.31%)		

* significant at p-value < 0.05

Table 35 shows a statistically significant association between gender and the impacts of visual fatigue ($p < 0.05$).

Table 36 The relationship between age and the impacts of visual fatigue

Personal factors		Impacts of visual fatigue Level		**X2**	**P-value**
		Not high (Low+Medium)	**High**		
Age	19	72(79.12%)	19(20.88%)	1.158	0.763
	20	93(78.81%)	25(21.19%)		
	21	86(79.63%)	22(20.37%)		
	22	84(74.34%)	29(25.66%)		

* significant at p-value < 0.05

Table 36 shows relationship between age and the impacts of visual fatigue was not a statistically insignificant p< 0.05.

Table 37 The relationship between students' study year of study and the impacts of visual fatigue

Personal factors		**Impacts of visual fatigue Level**		**X2**	**P-value**
		Not high (Low+Medium)	**High**		
Year of study	Year one	119(71.69%)	47(28.31%)	6.222	0.045*
	Year two	97(82.91%)	20(17.09%)		
	Yearthree and above	119(80.95%)	28(19.05%)		

* significant at p-value < 0.05

Table 37 shows a statistically significant association between students' study years and the impacts of visual fatigue (p < 0.05).

Table 38 The relationship between faculty and the impacts of visual fatigue

Personal factors		Impacts of visual fatigue Level		X2	P-value
		Not high (Low+Medium)	High		
Faculty	Faculty of Medicine	74(76.29%)	23(23.71%)	4.092	0.394
	Faculty of Urban Construction	47(73.44%)	17(26.56%)		
	Faculty of Nursing	144(79.12%)	38(20.88%)		
	Faculty of Accountancy	52(85.25%)	9(14.75%)		
	Faculty of Education and Music	18(69.23%)	8(30.77%)		

* significant at p-value < 0.05

Table 38 shows relationship between faculty and the impacts of visual fatigue was not a statistically insignificant p< 0.05

Table 39 The relationship between students' average length of time and the impacts of visual fatigue

Personal factors		**Impacts of visual fatigue Level**		**X2**	**P-value**
		Not high (Low+Medium)	**High**		
Average length of time	Less than 4 hours	52(71.23%)	21(28.77%)	12.306	0.002*
	4-6 hours	109(71.24%)	44(28.76%)		
	More than 6 hours	174(85.29%)	30(14.71%)		

* significant at p-value < 0.05

Table 39 shows a statistically significant association between students' average length of time and the impacts of visual fatigue ($p < 0.05$).

Table 40 The relationship between students' take a break after each prolonged period and the impacts of visual fatigue

Personal factors		**Impacts of visual fatigue Level**		**X2**	**P-value**
		Not high (Low+Medium)	**High**		
Take a break after each prolonged period	0-10 minutes	255(76.58%)	78(23.42%)	1.518	0.218
	Over 10 minutes	80(82.47%)	17(17.53%)		

* significant at p-value < 0.05

Table 40 shows relationship between students' take a break after each prolonged period and the impacts of visual fatigue was not a statistically insignificant $p< 0.05$.

Table 41 The relationship between students' distance between eyes and smartphone screen and the impacts of visual fatigue

Factors to use of digital devices		**Impacts of visual fatigue Level**			**X2**	**Value**
		Low	**Medium**	**High**		
Distance between eyes and smartphone screen	Less than or equal to 40cm	8(3.10%)	201(77.91%)	49(18.99%)	14.516	＜0.001*
	More than 40cm	8(8.16%)	57(58.17%)	33(33.67%)		

* significant at p-value < 0.05

Table 41 shows a statistically significant association between students' distance between eyes and smartphone screen and the impacts of visual fatigue ($p < 0.05$).

Table 42 The relationship between students' smartphone screen size and the impacts of visual fatigue

Factors to use of digital devices		Impacts of visual fatigue Level		X2	P-value
		Not high (Low+Medium)	High		
Smartphone screen size	4 - 7 inches	228(77.03%)	68(22.97%)	0.004	0.952
	More than 7 inches	46(76.67%)	14(23.33%)		

* significant at p-value < 0.05

Table 42 shows relationship between students' smartphone screen size and the impacts of visual fatigue was not a statistically insignificant p< 0.05.

Table 43 The relationship between students' smartphone screen light intensity and the impacts of visual fatigue

Factors to use of digital devices		Impacts of visual fatigue Level			X2	P-value
		Low	Medium	High		
Smartphone screen light intensity	1-50 lux	8(6.61%)	96(79.34%)	17(14.05%)	9.444	0.009*
	51-100lux	8(3.40%)	162(68.94%)	65(27.66%)		

* significant at p-value < 0.05

Table 43 shows a statistically significant association between students' smartphone screen light intensity and the impacts of visual fatigue ($p < 0.05$).

Table 44 The relationship between students' smartphone screen viewing posture and the impacts of visual fatigue

Factors to use of digital devices		**Impacts of visual fatigue Level**		**X2**	**P-value**
		Not high (Low+Medium)	**High**		
Smartphone screen viewing posture	Below and parallel to eye level	243(79.41%)	63(20.59%)	7.350	0.007*
	Above eye level	31(62.00%)	19(38.00%)		

* significant at p-value < 0.05

Table 44 shows a statistically significant association between students' smartphone screen viewing posture and the impacts of visual fatigue ($p < 0.05$).

Table 45 The relationship between students' set the smartphone screen color to a warm tone and the impacts of visual fatigue

Factors to use of digital devices		**Impacts of visual fatigue Level**			**X2**	**P-value**
		Low	**Medium**	**High**		
Set the Smartphone screen color to a warm tone	Yes	6 (3.51%)	116 (67.84%)	49 (28.65%)	6.201	0.045*
	No	10 (5.40%)	142 (76.76%)	33 (17.84%)		

* significant at p-value < 0.05

Table 45 shows a statistically significant association between students' set the smartphone screen color to a warm tone and the impacts of visual fatigue ($p < 0.05$).

Table 46 The relationship between students' duration of use of smartphone per day and the impacts of visual fatigue

Factors to use of digital devices		**Impacts of visual fatigue Level**			**X2**	**P-value**
		Low	**Medium**	**High**		
Duration of use of smartphone per day	1-6 hours	6 (3.53%)	115 (67.65%)	49 (28.82%)	6.455	0.040*
	More than 6 hours	10 (5.38%)	143 (76.88%)	33 (17.74%)		

* significant at p-value < 0.05

Table 46 shows a statistically significant association between students' duration of use of smartphone per day and the impacts of visual fatigue ($p < 0.05$).

Table 47 The relationship between students' distance between eyes and screen distance of iPad and the impacts of visual fatigue

Factors to use of digital devices		**Impacts of visual fatigue Level**		**Exact P-value**
		Not high (Low+Medium)	**High**	
Distance between eyes and screen distance of iPad	Less than or equal to 40cm	41(91.11%)	4(8.89%)	0.003*
	More than 40cm	90(69.23%)	40(30.77%)	

* significant at p-value < 0.05, Fisher's Exact Test

Table 47 shows a statistically significant association between students' distance between eyes and screen distance of iPad and the impacts of visual fatigue ($p < 0.05$).

Table 48 The relationship between students' set the iPad screen color to a warm tone and the impacts of visual fatigue

Factors to use of digital devices		**Impacts of visual fatigue Level**		**X2**	**P-value**
		Not high (Low+Medium)	**High**		
Set the iPad screen color to a warm tone	Yes	80(76.19%)	25(23.81%)	0.248	0.619
	No	51(72.86%)	19(27.14%)		

* significant at p-value < 0.05

Table 48 shows relationship between students' set the iPad screen color to a warm tone and the impacts of visual fatigue was not a statistically insignificant p< 0.05.

Table 49 The relationship between students' iPad screen viewing posture and the impacts of visual fatigue

Factors to use of digital devices		Impacts of visual fatigue Level		X2	P-value
		Not high (Low+Medium)	High		
iPad screen viewing posture	Below eye level	110(78.57%)	30(21.43%)	5.131	0.024*
	Eye level and above	21(60.00%)	14(40.00%)		

* significant at p-value < 0.05

Table 49 shows a statistically significant association between students' iPad screen viewing posture and the impacts of visual fatigue ($p < 0.05$).

Table 50 The relationship between students' duration of use of iPad per day and the impacts of visual fatigue

Factors to use of digital devices		Impacts of visual fatigue Level		X2	P-value
		Not high (Low+Medium)	High		
Duration of use of iPad per day	1-6 hours	59(77.63%)	17(22.37%)	0.549	0.459
	More than 6 hours	72(72.73%)	27(27.27%)		

* significant at p-value < 0.05

Table 50 shows relationship between students' duration of use of iPad per day and the impacts of visual fatigue was not a statistically insignificant p< 0.05.

Table 51 The relationship between students' distance between eyes and screen distance of Notebook and the impacts of visual fatigue

Factors to use of digital devices		**Impacts of visual fatigue Level**		**Exact P-value**
		Not high (Low+Medium)	**High**	
Distance between eyes and screen distance of notebook	Less than or equal to 50cm	10(76.92%)	3(23.08%)	1.000
	More than 50cm	96(75.00%)	32(25.00%)	

* significant at p-value < 0.05, Fisher's Exact Test

Table 51 shows relationship between students' distance between eyes and screen distance of notebook and the impacts of visual fatigue was not a statistically insignificant p< 0.05.

Table 52 The relationship between students' the font size on a notebook and the impacts of visual fatigue

Factors to use of digital devices		**Impacts of visual fatigue Level**		**X2**	**P-value**
		Not high (Low+Medium)	**High**		
The font size on a notebook	Smaller	9(42.86%)	12(57.14%)	18.708	＜0.001*
	Medium	75(86.21%)	12(13.79%)		
	Larger	22(66.67%)	11(33.33%)		

* significant at p-value < 0.05

Table 52 shows a statistically significant association between students' the font size on a notebook and the impacts of visual fatigue ($p < 0.05$).

Table 53 The relationship between students' set the Notebook screen color to a warm tone and the impacts of visual fatigue

Factors to use of digital devices		**Impacts of visual fatigue Level**		**X2**	**P-value**
		Not high (Low+Medium)	**High**		
Set the Notebook screen color to a warm tone	Yes	34(72.34%)	13(27.66%)	0.304	0.581
	No	72(76.60%)	22(23.40%)		

* significant at p-value < 0.05

Table 53 shows relationship between students' set the Notebook screen color to a warm tone and the impacts of visual fatigue was not a statistically insignificant p< 0.05.

Table 54 The relationship between students' sit distance from the computer screen and the impacts of visual fatigue

Factors to use of digital devices		**Impacts of visual fatigue Level**		**Exact P-value**
		Not high (Low+Medium)	**High**	
Sit distance from the computer screen	Less than or equalto 50cm	1(20.00%)	4(80.00%)	0.006*
	Morethan 50 cm	100(81.97%)	22(18.03%)	

* significant at p-value < 0.05, Fisher's Exact Test

Table 54 shows a statistically significant association between students' sit distance from the computer screen and the impacts of visual fatigue (p < 0.05).

Table 55 The relationship between students' the font size on a computer and the impacts of visual fatigue

Factors to use of digital devices		**Impacts of visual fatigue Level**		**X2**	**P-value**
		Not high (Low+Medium)	**High**		
The font size on a computer	Smaller and Medium	82(79.61%)	21(20.39%)	0.002	0.961
	Larger	19(79.17%)	5(20.83%)		

* significant at p-value < 0.05

Table 55 shows relationship between students' the font size on a computer and the impacts of visual fatigue was not a statistically insignificant p< 0.05.

Table 56 The relationship between students' computer screen brightness and the impacts of visual fatigue

Factors to use of digital devices		**Impacts of visual fatigue Level**		**X2**	**P-value**
		Not high (Low+Medium)	**High**		
Computer screen brightness	Low	38(79.17%)	10(20.83%)	0.010	0.995
	Medium	27(79.41%)	7(20.59%)		
	Bright	36(80.00%)	9(20.00%)		

* significant at p-value < 0.05

Table 56 shows relationship between students' computer screen brightness and the impacts of visual fatigue was not a statistically insignificant $p< 0.05$

Table 57 The relationship between students' set the computer screen color to warm tone and the impacts of visual fatigue

Factors to use of digital devices		**Impacts of visual fatigue Level**		**X2**	**P-value**
		Not high (Low+Medium)	**High**		
Set the computer screen color to Warm Tone	Yes	40(81.63%)	9(18.37%)	0.217	0.641
	No	61(78.21%)	17(21.79%)		

* significant at p-value < 0.05

Table 57 shows relationship between students' set the computer screen color to warm tone and the impacts of visual fatigue was not a statistically insignificant $p< 0.05$.

Table 58 The relationship between students' install a screen filter or use light-blocking glasses and the impacts of visual fatigue

Factors to use of digital devices		**Impacts of visual fatigue Level**		**Exact P-value**
		Not high (Low+Medium)	**High**	
Install a screen filter or use light-blocking glasses	Yes	17(100.00%)	0(0.00%)	0.022*
	No	84(76.36%)	26(23.64%)	

* significant at p-value < 0.05, Fisher's Exact Test

Table 58 shows a statistically significant association between students' install a screen filter or use light-blocking glasses and the impacts of visual fatigue

CHAPTER V

CONCLUSION AND DISCUSSIONS

The title of the study was impacts of visual fatigue among students use digital devices at Hainan university of science and technology in yunlong campus.This study aims to determine the level of visual fatigue among students use digital devices at Hainan University of Science and Technology in Yunlong Campus, to assess the impacts of visual fatigue among students use digital devices at Hainan University of Science and Technology in Yunlong Campus and to examine the factor associated impacts of visual fatigue among students use digital devices at Hainan University of Science and Technology in Yunlong Campus. The study population consists of the university students in Yunlong Campus of Hainan University of Science and Technology in Haikou City, Hainan Province,according to the data statistics, has a total of 14,187 individuals university students in Yunlong Campus. There are five colleges, namely, College of Medicine, College of Nursing, College of Accounting, College of Urban Construction, and College of Education and Music. The sample size was determined using Taro Yamane's formula, yielding a final sample of 430 individuals,selected through stratified sampling method. The study employed a structured questionnaire as the primary research instrument comprising the following sections: Section 1: Personal factors, Section 2: Factors to use of digital devices, Section, 3: Assess the visual fatigue, Section, 4: Assess the impacts of visual fatigue. The collected data were analyzed using statistical software, employing the Descriptive Statistics,Chi-square test method for data processing. The study findings are structured as follows:

1 Conclusion

2 Discussion of results

3 Generalizability

4 Recommendation for further research

Conclusion

Personal factors

The number of samples collected was 430, of which males accounted for more (61.40%). The majority of them were 20 years old, accounting for 27.44%; first-year students accounted for the highest proportion, which was 38.60%; due to the large base of the total sample size of students in the School of Nursing, the school they were from was mainly the School of Nursing, accounting for 42.32%, the largest number of people. The majority reported using digital devices for more than 6 hours per day (47.44%), and smartphones were the most commonly used device (82.79%). Most students used digital devices mainly for social platforms (88.84%) and took 0-10 minutes breaks after prolonged use (77.44%). The most common source of information on protecting eyesight was reminders from stay-at-home parents (72.09%), and the most frequently adopted measure to relieve visual fatigue was using eye protection mode or blue light filters (75.35%).

The level of visual fatigue

The overall incidence of visual fatigue among students is at a high level (2.62 ± 0.58). The symptoms with the highest mean severity were blurred vision (2.75 ± 0.51) and poor vision (2.75 ± 0.49), which were classified as high level. This was followed by high levels of dry eyes (2.75±0.51), eye irritation (2.74±0.51), and headaches during or after

using digital devices (2.74±0.50). In contrast, tears flow was the least frequently reported symptom (2.23 ± 0.77), categorized as medium, indicating it was less commonly experienced compared to other symptoms.

The impact of visual fatigue

The level of impact of visual fatigue on students was reflected by evaluating symptoms such as eye diseases, visual disorders, and headaches. In the level of impact of using electronic devices on visual fatigue, the overall average score of all items was at a medium level (2.20 ± 0.47), among which the severity of headache symptoms was high (2.69 ± 0.55), which was a high level, followed by the medium level of visual impairment (2.17 ± 0.54), and the least affected was eye diseases, with a medium level (1.86 ± 0.35).

Regarding the visual fatigue impact of eye diseases, the overall mean score of the impact of eye diseases was at a medium level (1.86 ± 0.35), the level of dry eye symptoms was high (2.70 ± 0.51) , while the overall mean score of the impact of visual impairment was at a medium level (2.17 ± 0.54), the majority of respondents reported severe myopia symptoms (2.77 ± 0.49) and it was a high level, and the impact of headaches was high and the overall mean score of all items was high (2.69). ± 0.55), dizziness (2.73 ± 0.52) and headache (2.73± 0.51) were the symptoms reported by the majority of respondents (2.73± 0.51) as being at high level.

Factors associated the impacts of visual fatigue

This study used the chi-square test method to analyze the relationship between different factors and the impact of visual fatigue. It was found that the p-values of gender, year of study, average length of time use digital devices on a daily basis, distance between eyes and digital devices screen, smartphone screen light intensity, posture when using digital electronic device screens, smartphone screen color settings, daily smartphone device

usage time, distance between eyes and iPad screen , iPad screen view posture,Notebook font size and install a screen filter or use light-blocking glasses were all less than 0.05, indicating that they were significantly correlated with the degree of visual fatigue. These may be factors that cause visual fatigue in students.

Discussion of results

The level of visual fatigue

The survey results of this study found that college students at the Yunlong Campus of Hainan University of Science and Technology generally suffer from visual fatigue when using digital devices. In the past month, the average score of visual fatigue was 2.62 (standard deviation was 0.58), indicating that the prevalence of visual fatigue is relatively high. Among the specific symptoms of visual fatigue, symptoms such as eye fatigue, dry eyes, and blurred vision appear more frequently, indicating that these symptoms are the main manifestations of visual fatigue. In addition, the use of digital electronic devices may cause users to experience symptoms such as eye irritation and headaches, which are also manifestations of visual fatigue. A survey on Computer Vision Syndrome (CVS) conducted at a private university in Paraguay showed that more than 82.5% of medical students with an average age of 22.3 years old had CVS and a high prevalence of visual fatigue(Coronel-Ocampos et al,2022), which is consistent with the high incidence of visual fatigue in this study, indicating that students are very prone to visual fatigue-related problems when using digital devices. In an article published in 2019 by Hao Zhixia titled "Analysis on the Correlation between College Students' Use of Electronic Products and Visual Fatigue"(Hao Zhixia,2019), it was written that a survey was

conducted on 8,000 students in a school from 2017 to 2018. The results showed that the prevalence of visual fatigue among college students exceeds 50%. Visual fatigue is relatively common among college students and they are highly dependent on electronic products. 1,451 students participating in the survey expressed their dependence on electronic products, and 875 students had symptoms of visual fatigue, with a prevalence rate as high as 60.3%. The high incidence of visual fatigue affects students' vision health and leads to a series of vision problems. Long-term visual fatigue can even cause eye diseases. Mohamed W Bin Maneea.(2024)Studies have shown a significant correlation between the incidence of digital eyestrain and longer screen exposure time. This phenomenon needs to attract more attention from students, who should pay attention to their own vision health, improve their health awareness, and take effective measures to prevent the occurrence of visual fatigue.

The impacts of visual fatigue

The impact of visual fatigue on college students is mainly reflected in eye diseases, visual disorders and headaches. The results of the research show that the symptoms of visual fatigue of students are dry eyes, myopia and headaches with a high frequency, indicating that these are the main effects of visual fatigue. From the overall data, the comprehensive impact of students' visual fatigue is moderate, with an average score of 2.20 (standard deviation of 0.47), which not only affects the daily eye comfort of college students, but also may cause long-term damage to eye tissues and affect the normal physiological function of the eyes. This view is also confirmed in the article "Digital Eye Straining: Exploring Its Prevalence, Associated Factors, and Effects on the Quality of Life" published by Mohamed W Bin Maneea in 2024. The study found that visual fatigue has a significant negative impact on the quality of life, especially after using digital devices for a

long time（Mohamed W Bin Maneea,2024). The myopia rate among Chinese students has ranked second in the world, with 28% among primary school students, 60% among junior high school students, and 85% among high school students. More than 90% of college students have myopia(National Health Commission,2020) Myopia is common among college students, and the impact of visual fatigue is high enough to attract attention. College students are an important group affected by myopia and visual fatigue. The series of vision problems they bring will not only seriously affect their vision and life, but may also lead to addiction, affecting their physical and mental health."Current Status of College Students' Eye Health and Analysis of Causes of Myopia" conducted a questionnaire survey on college students' eye health and eye usage habits. The results showed that more than 70% of college students often experience symptoms of visual fatigue such as dry eyes, blurred vision, and foreign body sensation. Most students are highly dependent on the long-term use of digital electronic devices. 61.98% of students believe that long-term use of electronic products is the main cause of myopia（Zhu Hangwei and Lu Junjie,2023), which is highly consistent with the results of this study, and further proves that long-term use of electronic devices will have an adverse effect on students' visual fatigue, resulting in a series of eye or headache symptoms. Studies by Rosenfield, M (Rosenfield, M, 2011) and Ji-Woo Lee (Ji-Woo Lee, et al, 2019) have shown that long-term use of digital devices can cause symptoms such as dry eyes, fatigue, blurred vision, and increase physical and eye discomfort, affecting eye health and visual function.Consistent with the effects of visual fatigue on ocular health in this study, it further supports the multifaceted effects of visual fatigue. This result shows that although visual fatigue has not yet caused extremely serious impact on the college student group, the problem can no longer be ignored. It still requires the joint attention of colleges and universities, families and college students themselves to

take effective measures to alleviate visual fatigue, such as reasonably controlling the time of using digital devices, maintaining correct eye posture, and increasing outdoor activities. In order to reduce the negative impact of visual fatigue on college students and protect their visual health.

The factor associated impacts of visual fatigue

The chi-square test was used to analyze the relationship between various factors and the impact of visual fatigue, and it was found that gender, Year of study, average daily use of digital devices, distance between the eyes and the device screen, screen light intensity, screen viewing posture, screen color settings, device usage time and other factors were significantly correlated with the impact of visual fatigue, P-value < 0.05. For example, a statistically significant association between students' average length of time and the impacts of visual fatigue ($p < 0.05$), the longer the average daily screen usage time, the higher the visual fatigue score; the shorter the rest time after watching the screen, the higher the visual fatigue score. When using digital electronic devices, most students have bad behavior habits, which pose a serious threat to their visual health. According to a survey of students at the Yunlong Campus of Hainan University of Science and Technology, when using smartphones, 72.47% of students keep their eyes less than or equal to 40cm from the screen. This close-up eye use behavior violates the standard distance requirement for maintaining eye health. When using iPads, most students keep their eyes more than 40cm from the screen (74.29%). Although this distance is relatively reasonable, the usage time of more than 6 hours/day accounts for 56.57%. Excessive use time can also cause eye fatigue and greatly increase the burden of eye adjustment. Watching the screen too close for a long time can easily lead to eye fatigue, myopia, dizziness, headaches and other problems. In 2021, Wang Mengli described the epidemiological characteristics of myopia

among college students in the article "A Study on the Current Status and Influencing Factors of Myopia among Students in a University in Henan Province", and conducted a correlation analysis on the influencing factors, indicating that using the eyes too close and incorrect eye posture are both risk factors for myopia(Wang Mengli,2021). The survey results of "A Study on the Correlation between Mobile Phone Use and Visual Fatigue among College Students"(Yu Nan et al,2019)showed that the eyes being too close to the device screen (less than 15cm) will increase the risk of eye pain, and the survey also showed that decreased vision is significantly associated with the length of time a digital electronic device is used at a time. This is consistent with the results of this study, in which the average daily use time of digital devices is significantly correlated with the degree of visual fatigue (x^2=15.038, p=0.020), indicating that the longer the use time, the higher the degree of visual fatigue. The results are consistent, indicating that long-term use of digital electronic equipment products will have a certain impact on visual fatigue. The study by Coronel-Ocampos et al. mentioned that taking a break at least every 20 minutes and every hour when using electronic devices can reduce the prevalence of CVS by 7% and 6%, respectively. That the length of rest time after watching the screen has an impact on visual fatigue, and both emphasize the importance of reasonable rest in alleviating visual fatigue(Coronel-Ocampos et al,2022). Kim et al. (2020) compared the effects of smart devices with different screen sizes on eye adjustment and discomfort. The results showed that smaller screens (such as smartphones) led to greater adjustment load and eye discomfort, especially after long-term use. This is consistent with the results of this study that the screen size of electronic devices of different sizes is significantly associated with visual fatigue.This shows that students' eye habits and behaviors in daily study and life have a key impact on their vision health. Correct sitting posture can protect vision to a

certain extent, but the inappropriate distance between the eyes and the device screen, lack of good eye habits, and using the eyes in strong sunlight or dim light environments all increase the risk of myopia. This means that the vision health problems of the student population are serious, and students themselves, schools and families need to pay attention and take active measures to guide students to develop good eye habits and improve the eye environment, so as to effectively prevent and control the occurrence and development of myopia.

Generalizability

This study around Hainan vocational university of science and technology campus students, college students use the correlation between digital electronic equipment and visual fatigue, its result has certain universality and applicability, after reasonable adjustment can be applied to other groups, help to more widely understand and solve the problem of visual fatigue.

Generalizability of the study

1. In modern society, with the continuous advancement and development of science and technology, digital electronic devices have been widely popularized and entered into people's life, study and work. The dependence of different groups on digital devices has increased significantly. From children to adults, they all use digital devices to facilitate their daily lives. The frequency of college students' use of digital electronic devices in this study reflects this general trend. Other groups have similar behaviors in the use of digital devices and are facing potential health risks caused by long-term use of screens.

2. The impact of long-term use of digital electronic devices on visual fatigue is a common health problem. The health problem affects a wide range of groups and is significantly reflected among different age and occupational groups. In the study, college students experienced symptoms of visual fatigue such as dry eyes and blurred vision, which are also likely to occur in other groups who use digital electronic devices for a long time.

Applicability of the study

1. For children, who are relatively young, curious and like to imitate others, you can refer to the research on the duration of use of digital electronic devices, the distance between the device screen and the font size of the device. For children, more emphasis should be placed on the reasonable duration of use of digital electronic devices and the correct eye distance. Parents and schools can strengthen supervision of children's use of digital devices.

2. The study is applicable to college students in other schools. The questionnaire content can be adjusted according to the school situation and the students' own situation to explore the correlation between students' use of digital electronic devices and visual fatigue. This will help colleges and universities understand students' visual fatigue level and health status, and carry out targeted health education on healthy eye use and relief of visual fatigue.

3. Compared with the above two groups, adults spend longer time using digital electronic devices on a daily basis due to their working hours. They can pay more attention to the impact of using digital electronic products on physical health, and improve and reduce visual fatigue and physical discomfort by taking measures to relieve visual fatigue, taking regular rest, and doing eye exercises.

Recommendation for Further Research

Based on the purpose, results and limitations of this study, the following suggestions for improvement are proposed to facilitate more in-depth research and enhance the in- depth understanding of visual fatigue among students using digital electronic products.

1. Expand the scope and region of the sample size of the research subjects. This study only selected students from the Yunlong Campus of Hainan University of Science and Technology, and the sample was limited. Subsequent research can include students from different regions and different levels of colleges and universities, as well as students from regions with different economic development levels, so as to compare the differences in students' habits of using digital electronic devices and visual fatigue in different environments, understand the prevalence of visual fatigue among students, and strengthen students' self-awareness of protecting their vision health.

2. This study mainly uses questionnaire surveys. Subsequent research can integrate multiple research methods and add experimental research methods. By adopting randomized controlled trials, a control group and an experimental group can be established. The control group will not receive any intervention measures, while the experimental group will regularly receive eye protection mode intervention measures. By comparing the degree of visual fatigue of the two groups of participants, the effectiveness of the intervention measures can be evaluated more intuitively.

3. This study was designed as a cross- sectional study, and it is difficult to determine the causal relationship between the variables in the studies. Subsequent studies can add longitudinal research methods based on the previous study, conduct long- term

tracking reports after the informed consent of the investigators, measure the relationship between digital device usage and visual fatigue at different time points, clarify the causal relationship between the two, and provide a scientific basis for early prevention and intervention.

4. Explore other potential influencing factors. This study focused on investigating the impact of using digital electronic devices on visual fatigue. However, in addition to this, there may be other potential external factors that can lead to visual fatigue (such as bad behavioral habits such as using electronic products at night, family factors, psychological stress levels, and sleep quality). Further research can provide a more comprehensive understanding of the causes and influencing factors of visual fatigue.

5. Study the profound effects of long-term use of digital electronic devices on vision and body and mind, including the effects on vision such as the deepening of myopia and the increased risk of eye diseases, as well as the effects on physical and mental health such as Internet addiction, shoulder and neck fatigue, and the generation of negative psychological emotions. Provide data support for the formulation of long-term eye protection measures and the improvement of students' health awareness, guide students to use digital electronic devices reasonably and establish long-term healthy eye behavior habits.

6. Based on the research results, formulate corresponding intervention measures and evaluate the actual effects, such as conducting health publicity lectures on protecting eyesight and healthy eye use in schools, improving the conditions for using digital devices in the learning environment, etc. By comparing the degree of visual fatigue and vision changes of students after the intervention, the effectiveness of the intervention measures can be tested, and optimization and adjustment can be made according to the evaluation

results to improve the practicality and effectiveness of the intervention measures and effectively improve the visual health of students.

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APPENDIX

Appendix A

Interview forms

Impacts of visual fatigue among students who play digital devices at Hainan University of Science and Technology in Yunlong campus

Consent Day Date.....Month.....Year.....

I am Mr./Mrs./Miss..... address.....
Read the details from the information sheet for participants in the research project and I agree to voluntarily participate in the research project.

I have received a copy of the consent form that I signed and dated, along with an information sheet for research participants. This is before signing the consent form to conduct this research. I explained to the researcher the purpose of the study. The duration of the research, research methods, dangers or symptoms that may arise from the research. or from the medicine used Including the benefits that will emerge from the research and guidelines for treatment by other methods in detail, I have had enough time and opportunity to ask questions until I have a good understanding. The researcher answered various questions willingly and without concealment until I was satisfied.

I have the right to terminate my participation in the research project at any time. There is no need to inform the reason. and termination of my involvement in this research It will not affect treatment or other rights that I will continue to receive.

The researcher guarantees that my personal information will be kept secret. and will be disclosed only with my consent. Other persons on behalf of the research sponsoring company Human Research Ethics Committee the Food and Drug Administration may be permitted to inspect and process my information. This must be done to verify the accuracy of the information only. By agreeing to participate in this study, I am giving consent to have my medical history reviewed.

I have read the above and have a complete understanding of it. Willing to participate in research willingly. Therefore, signed this consent document.

.....Sign the person giving consent.

(.....) Name of person giving consent

Date .....Month.....Year.....

I have explained the purpose of the research, the research methods, dangers or adverse reactions or risks that may arise from the research. or from the medicine used Including the benefits that will arise from thorough research. Let the participants in the research project named above know and have a good understanding. Ready to sign the consent document willingly

.....

Signed by the researcher

(.....)

Name of the researcher in detail

Date .....Month……..Year…….

.....	.....
Witness signature	Witness signature
(.....)	(.....)
Name of witness in detail	Name of witness in detail
Date .....Month…..Year…….	Date .....Month……..Year…….

Impacts of visual fatigue among students who play digital devices at Hainan University of Science and Technology in Yunlong campus

Dear Participants

The research study will be conducted on the prevalence, impacts of visual fatigue, and the factor-related impacts of visual fatigue among students who play digital devices at Hainan Vocational University of Science and Technology in Yunlong campus. The participants in this study are voluntary and the information you give us will be confidential, which means your name will not be mentioned anywhere and information provided by you will be presented only in a summarized form.

Please select carefully the answer for each question and the possible responses. Choose and mask (√) the response option that best represents your opinion, knowledge, attitude, and practice. Please notify the interviewer if you have any concerns about the questions or other problems.

The questionnaire is divided into four parts as follows;

Part I Personal factors

Part II Factors to use of digital devices

Part III Assess the visual fatigue

Part IV Assess the impacts of visual fatigue

The researcher hopes for your cooperation very much and I would like to thank you very much for this opportunity.

Zhang Yumeng

Master of Public Health

Chiang Rai Rajabhat University

Part I: Personal factors

Guidance: Please select carefully the answer for each question and choose the answer by marking (√) the response option that best represents.

Details	Code
1. Gender	Gender
( ) Male ( ) Female	
2. Age ……. years	Age
3. Year of study	Year
( )Year one ( ) Year two ( )Year three and above	
4.The Faculty in which it is located:	Faculty
( ) Faculty of Medicine ( ) Faculty of Urban Construction ( ) Faculty of Nursing ( ) Faculty of Accountancy ( ) Faculty of Education and Music	
5.. What is the average length of time you use digital electronic devices on a daily basis?	Average length of time
( ) Less than 4 hours ( ) 4-6 hours ( ) More than 6 hours	
6. What types of digital electronic devices do you typically use? (Multiple choice)	Typically use
( ) Smartphone ( ) iPad ( ) Notebook ( ) Computer	

7. What are the main purposes for which you use digital electronic devices? (Multiple choice)	Purposes
( ) Study (reviewing materials, preparing for exams or watching online classes, etc.) ( ) Entertainment (watching videos, playing games, etc.) ( ) Social platform ( ) Taking photos and videos ( ) Other	
8. On average, how long do you take a break after each prolonged period of looking at the screen of a digital device?	Period
( ) 0- 10 minutes ( ) over 10 minutes	
9. How do you usually get information about the use of digital electronic devices and the protection of your eyesight? (Multiple choice)	Protection
( ) Internet search ( ) School education ( ) Information from doctors and professionals ( ) Reminders for stay-at-home parents ( ) Other	
10.What steps do you usually take to relieve visual fatigue? (Multiple choice)	Relieve visual
( ) Take regular breaks and step away from the screen every so often ( ) Use eye protection mode or blue light filtering screen protectors ( ) Adjusting screen brightness and contrast ( ) Eye exercises or eye massage ( ) Other	

Part II: Factors to use of digital devices

Guidance: Please select carefully the answer for each question and choose the answer by marking (√) the response option that best represents.

Ask about the usage of smartphones, iPads, notebooks, and computers in the past month.

No.	Data to use of digital devices	code
Use Smartphone		
1	Distance between eyes and smartphone screen ( ) Less than or equal to 40cm ( ) More than 40cm	Smartphone Distance….
2	Smartphone screen size ( ) 4 - 7 inches ( ) More than 7 inches	Screen size
3	Smartphone screen light intensity ( ) 1-50 lux ( ) 51-100lux	Light intensity…..
4	Smartphone screen viewing posture ( ) Below and parallel to eye level ( ) Above eye level	Smartphone Posture…..
5	Set the Smartphone screen color to a warm tone ( ) Yes ( ) No	Smartphone Warm tone..
6	Duration of use of smartphone per day ( ) 1-6 hours ( ) More than 6 hours	Smartphone Duration….

Use iPad		
1	Distance between eyes and screen distance of iPad ( ) Less than or equal to 40cm ( ) More than 40cm	iPad Distance…
2	Set the iPad screen color to a warm tone ( ) Yes ( ) No	iPad warm tone…
3	iPad screen viewing posture ( ) Below eye level ( ) Eye level and above	iPad Posture…..
4	Duration of use of iPad per day ( ) 1-6 hours ( ) More than 6 hours	iPad Duration….
Use Notebook		
1	Distance between eyes and screen distance of Notebook ( ) Less than or equal to 50cm ( ) More than 50cm	Notebook Distance…
2	The font size on a Notebook ( ) Smaller ( ) Medium ( ) Larger	Notebook Font…..
3	Set the Notebook screen color to a warm tone ( ) Yes ( ) No	Notebook warm tone…

Use Computer		
1	Sitting distance from the computer screen ( ) Less than or equal to 50cm ( ) More than 50cm	Computer Distance…
2	The font size on a computer ( ) Smaller and Medium ( ) Larger	Computer Font…..
3	Computer screen brightness ( ) Low ( ) Medium ( ) Bright	Brightness.
4	Set the computer screen color to Warm Tone ( ) Yes ( ) No	Computer warm tone…
5	Install a screen filter or use light-blocking glasses. ( ) Yes ( ) No	Glasses…

Part III: Assess the visual fatigue

Guidance: Please select carefully the answer for each question and choose the answer by marking (√) the response option that best represents

In the past month, have you had any of the following symptoms?	Symptoms		
	Always (3)	Sometime (2)	Never (1)
1. Itchy eyes			
2. Eye irritation			
3. Eye fatigue			
4. Eye strain			
5. Dry eyes			
6. Tears flow			
7. Poor vision			
8. Vision-light sensitivity			
9. Blurred vision, unclear vision			
10. Eyes slow to focus when looking at objects			
11. Headache during or after the use of digital devices			

Part IV: Assess the impacts of visual fatigue

Guidance: Please select carefully the answer for each question and choose the answer by marking (√) the response option that best represents

No.	Impacts of visual fatigue	Six months recently		
		Always (3)	Sometime (2)	Never (1)
Eye Diseases				
	Cataracts			
	Pterygium			
	Dry Eye Disease			
	Eye Allergies			
Vision Disorders				
	Myopia			
	Astigmatism			
	Hyperopia			
Headache				
	Dizziness			
	Headache			
	Migraine			

Appendix B

Validity and Reliability

Part I Personal factors

Guidance: Please select carefully the answer for each question and choose the answer by marking (√) the response option that best represents.

Question	Comment Scores			Total score	IOC	Summary
	1	2	3			
1. Gender ( ) Male ( ) Female	+1	+1	+1	3	1	/
2. Age …… years	+1	+1	+1	3	1	/
3. Class ( ) Class of 2021 ( ) Class of 2022 ( ) Class of 2023 ( ) Class of 2024	-1	+1	+1	1	0.3	×

Question	Comment Scores			Total score	IOC	Summary
	1	2	3			
4. The Faculty in which it is located: ( ) Faculty of Medicine ( ) Faculty of Urban Construction ( ) Faculty of Nursing ( ) Faculty of Accountancy ( ) Faculty of Education and Music	+1	+1	+1	3	1	/
5. What is the average length of time you use digital electronic devices on a daily basis? ( ) Less than 4 hours ( ) 4-6 hours ( ) More than 6 hours	+1	+1	+1	3	1	/

Question	Comment Scores			Total score	IOC	Summary
	1	2	3			
6. What types of digital electronic devices do you typically use? (Multiple choice) ( ) Smartphone ( ) iPad ( ) Notebook ( ) Computer	0	+1	+1	2	0.7	/
7. What are the main purposes for which you use digital electronic devices? (Multiple choice) ( ) Study (reviewing materials, preparing for exams or watching online classes, etc.) ( ) Entertainment (watching videos, playing games, etc.) ( ) Social platform	0	+1	+1	2	0.7	/

Question	Comment Scores			Total score	IOC	Summary
	1	2	3			
( ) Taking photos and videos ( ) Other						
8. On average, how long do you take a break after each prolonged period of looking at the screen of a digital device? ( ) 0-10 minutes ( ) over 10 minutes	+1	+1	+1	3	1	/
9. How do you usually get information about the use of digital electronic devices and the protection of your eyesight? (Multiple choice) ( ) Internet search ( ) School education ( ) Information from doctors and professionals	0	+1	+1	2	0.7	/

Question	Comment Scores			Total score	IOC	Summary
	1	2	3			
( ) Reminders for stay-at-home parents ( ) Other						
10. What steps do you usually take to relieve visual fatigue? (Multiple choice) ( ) Take regular breaks and step away from the screen every so often ( ) Use eye protection mode or blue light filtering screen protectors ( ) Adjusting screen brightness and contrast ( ) Eye exercises or eye massage ( ) Other	0	+1	+1	2	0.7	/

Part IIFactors to use of digital devices

Ask about the usage of smartphones, iPads, notebooks, and computers in the past month.

Details		Comment Scores			Total score	IOC	Summary
		1	2	3			
No.Data to use of digital devices							
Use Smartphone							
1	Distance between eyes and smartphone screen ( ) Less than 30 centimeters ( ) 60- 30centimeters	+1	+1	0	2	0.7	/
2	Smartphone screen size ( ) 4 - 7 inches ( ) More than 7 inches	+1	+1	+1	3	1	/
3.	Smartphone screen light intensity ( ) 1-50 lux ( ) 51-100lux	+1	+1	+1	3	1	/
4	Smartphone screen viewing posture ( ) Below eye level ( ) Eye level ( ) Above eye level	+1	+1	+1	3	1	/
5	Set the iPad screen color to a warm tone	+1	+1	+1	3	1	/

Details		Comment Scores			Total score	IOC	Summary
		1	2	3			
No.Data to use of digital devices							
	( ) Yes ( ) No						
6	Smartphone usage type ( ) Social ( ) Study ( ) Work ( ) Watch movies ( ) Play games ( ) Watch movies equally ( ) Social Play games equally ( ) Social Watch movies Play games equally	0	+1	+1	2	0.7	/
7	Duration of use of smartphone per day ( ) 1-3 hours ( ) 4-6 hours ( ) 7-9 hours ( ) More than 10	+1	+1	+1	3	1	/
Use iPad							
1	Distance between eyes and screen distance of iPad ( ) Less than 12nches ( ) More than 12 inches	+1	+1	0	2	0.7	/

Details		Comment Scores			Total score	IOC	Summary
		1	2	3			
No.Data to use of digital devices							
2	Set the iPad screen color to a warm tone ( ) Yes ( ) No	+1	+1	+1	3	1	/
3	iPad screen viewing posture ( ) Below eye level ( ) Eye level ( ) Above eye level	+1	+1	+1	3	1	/
4	Duration of use of iPad per day ( ) 1-3 hours ( ) 4-6 hours ( ) 7-9 hours ( ) More than 10	+1	+1	+1	3	1	/
5	iPad usage type ( ) Social ( ) Study ( ) Work ( )Watchmovies ( ) Play games ( ) Watch movies equally	0	+1	-1	0	0	×

Details		Comment Scores			Total score	IOC	Summary
		1	2	3			
No.Data to use of digital devices							
	( ) Social Play games equally ( ) Social Watch movies Play games equally						
Use Notebook							
1	The font size on a notebook ( ) Smaller ( ) Medium ( ) Larger	+1	+1	+1	3	1	/
2	Set the iPad screen color to a warm tone ( ) Yes ( ) No	+1	+1	+1	3	1	/
3	Notebook usage type ( ) Social ( ) Study ( ) Work ( ) Watch movies ( ) Play games ( ) Watch movies equally ( ) Social Play games equally	0	+1	-1	0	0	×

Details		Comment Scores			Total score	IOC	Summary
		1	2	3			
No.Data to use of digital devices							
	( ) Social Watch movies Play games equally						
Use Computer							
1	Sitting distance from the computer screen ( ) < 50 cm ( ) > 50 cm	+1	+1	0	2	0.7	/
2	The font size on a computer ( ) Smaller ( ) Medium ( ) Larger	+1	+1	+1	3	1	/
3	Computer screen brightness ( ) Low ( ) medium ( ) bright	+1	+1	+1	3	1	/
4	Set the computer screen color to Warm Tone ( ) Yes ( ) No	+1	+1	+1	3	1	/

Details		Comment Scores			Total score	IOC	Summary
		1	2	3			
No.Data to use of digital devices							
5	Install a screen filter or use light-blocking glasses. ( ) Yes ( ) No	+1	+1	+1	3	1	/

Part III Assess the visual fatigue

Guidance: Please select carefully the answer for each question and choose the answer by marking (√) the response option that best represents

In the past month, have you had any of the following symptoms?	Symptoms			Comment Scores			Total score	IOC	Summary
				1	2	3			
	Always (3)	Sometime (2)	Never (1)	+1	+1	+1	3	1	/
1. Itchy eyes				+1	+1	+1	3	1	/
2.Eye irritation				+1	+1	+1	3	1	/
3. Eye fatigue				+1	+1	+1	3	1	/
4. Eye strain				+1	+1	+1	3	1	/
5. Dry eyes				+1	+1	+1	3	1	/
6. Tears flow				+1	+1	+1	3	1	/
7. Poor vision				+1	+1	+1	3	1	/
8. Vision- light sensitivity				+1	+1	+1	3	1	/
9. Blurred vision, unclear vision				+1	+1	+1	3	1	/
10. Eyes slow to focuswhen looking at objects				+1	+1	+1	3	1	/

Part IV: Assess the impacts of visual fatigue

Guidance: Please select carefully the answer for each question and choose the answer by marking (√) the response option that best represents

No.	Impacts of visual fatigue	Symptoms			Comment Scores			Total score	IOC	Summary
					1	2	3			
		Always (3)	Sometime (2)	Never (1)						
Eye Diseases										
	Cataracts				0	+1	0	1	0.3	×
	Pterygium				0	+1	0	1	0.3	×
	DryEye Disease				0	+1	+1	2	0.7	/
	Eye Allergies				0	+1	+1	2	0.7	/
Vision Disorders										
	Myopia				0	+1	+1	2	0.7	/
	Astigmatism				0	+1	+1	2	0.7	/
	Hyperopia				0	+1	0	1	0.3	×
Headache										
	Dizziness				0	+1	+1	2	0.7	/
	Headache				0	+1	+1	2	0.7	/
	Migraine				0	+1	+1	2	0.7	/

Measurement	Conbach's alpha coefficient
Assess the visual fatigue	0.864
Assess the impacts of visual fatigue	0.808

According to the overall reliability coefficient, it can be seen that the standardized reliability coefficient is 0.864 and 0.808, indicating that the overall reliability of the questionnaire is excellent.

Measurement	KMO
Assess the visual fatigue	0.932
Assess the impacts of visual fatigue	0.883

The coefficient result of the KMO test was 0.932 and 0.883, indicating that the overall validity of the questionnaire was excellent.

BIOGRAPHY

Name - Surname Ms. Yumeng Zhang

Date of birth 14 August 2001

Current address

Chayanee Court 89 M.5 Bandu District Mueang, Chiang Rai 57100 Thailand

Educational record

Date: September 2007- July 2013 Primary school

Graduated from:Anyang First Experimental Primary School

Date: September 2013-July 2016 Junior high school

Graduated from:Anyang Sixty-sixth Middle School

Date: September 2016-July 2019 High school

Graduated from:Anyang City Thirty-nine Middle School

Date: September 2019- June 2023 University

Graduated from:Hainan University of Science and Technology

Studying

Bachelor's degree

Hainan University of Science and Technology

Work Experience

Date：August 2023 Until now

Adress : Hainan University of Science and Technology in Yunlong campus No.118 Yunlong Town, Yunding Road, Haikou City, Hainan Province, China