RETROSPECTIVE ANALYSIS OF BINOCULAR VISION ANOMALIES (STRABISMUS AND NON-STRABISMUS) IN A HIGHER EDUCATION OPTOMETRY CLINIC, KUANTAN, MALAYSIA FROM 2018 UNTIL 2021

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ABSTRACT

Introduction: Binocular single vision is required to see a single image with both eyes, so any disorders will impair visual function. It is supported by the normal visual apparatus, as well as sensory and motor systems. The anomaly on each component might lead to non-strabismus which are accommodation and vergence, as well as strabismus anomalies. **Aim:** This study was aimed to evaluate the retrospective data of non-strabismic and strabismic cases at International Islamic University Malaysia (IIUM) Optometry Clinic, Kuantan, Malaysia from 2018 until 2021. **Methodology:** A clinically based retrospective study was conducted, and all patients' files were thoroughly reviewed, and data collected were analyzed by different categories. The categories included demographic information such as age, gender, occupation, location, non-strabismus anomalies, including accommodation and vergence anomalies, as well as the type of strabismus. **Results:** The total sample size for the study was 91, with female participants accounting for 51.6 % of the total. The patients' ages ranged from 3 to 35 years (mean age: 12.03 ± 6.64 years), with one-third of them being under the age of ten. Most patients came from Pahang, with 57.1 % from the Kuantan district. 82 of the patients were still students, and the remaining of them worked as officers or non-officers. The most common cases were accommodation insufficiency, which affected 19.8 % of patients, while basic exophoria affected 9.9 %. Out of all strabismic patients, 67 patients had alternating exotropia at distance and near. **Conclusion:** Accommodation insufficiency, basic exophoria and intermittent exotropia dominated the binocular vision anomalies cases at the clinic. This data could be used in the clinic to forecast the trend of cases for the coming year. The awareness and prevention should be taken to reduce the number of cases especially on children.

KEYWORDS: Accommodation, vergence, strabismus, exophoria, exotropia

INTRODUCTION

Normal binocular vision can be achieved by simultaneous perception (O'Connor et al., 2010; South et al., 2019) as well as normal sensory and motor fusion (Paniccia & Ayala, 2015; She et al., 2021). These normal system results in superior three dimensional (3D) perception which is known as stereopsis, which is known as the hallmark of normal binocular vision (Kim et al., 2013; Wang et al., 2021). In order to achieve normal binocular vision, the eye visual system must have normal anatomy of visual apparatus (Bui Quoc & Milleret, 2014), normal sensory (Han, He, & Ooi, 2018) and normal motor (Niechwiej-Szwedo et al., 2017) systems. Anomalies in one or all eye visual systems could disrupt normal binocular vision which is known as binocular vision anomalies.

The anomaly of crystalline lens (Li et al., 2021) and disintegration between sensory and motor system of smooth ciliary muscle (Read et al., 2022) could lead to accommodation anomalies. Accommodation anomalies were classified as accommodation insufficiency, accommodation weakness, accommodation infacility, accommodation spasm, accommodation paralysis, and unequal accommodation (Darko-Takyi et al., 2016). Paniccia & Ayala, (2015) discovered that 39% of total 593 patients aged between 5 and 20 years old suffered accommodation insufficiency. In contrast, Paniccia & Ayala (2015) finding was not supported by Singh et al., (2020) whereby accommodative infacility was a common accommodation anomalies in 160 high school students. This similar trend of finding was also discovered by Wajuihian, (2022).

The anomaly occurs on the sensory and motor system at extraocular muscle could also lead to the vergence anomalies and strabismus (Kang et al., 2018). Wajuihian, (2022) conducted a study on 254 African patients aged 10 to 40 years to investigate the prevalence of vergence anomalies. It was found out that the most common vergence anomalies in the study population was convergence insufficiency. Similar findings was also discovered by Samsimon et al., (2020) whereby 23.4% of total 167 patients in a optometry clinic were having convergence insufficiency. Meanwhile, Nanjing Eye Study group conducted a study on 1986 children aged 48 to 60 months to evaluate the prevalence on the strabismus (Wang et al., 2021). Wang and co-author found that most of the subjects are having intermittent exotropia which consists of 4.89% of the total 167 patients.

However, the previous reported data was under explored for Malaysian populations. Therefore, this study was aimed to evaluate the retrospective data of non-strabismic and strabismic cases at International Islamic University Malaysia (IIUM) Optometry Clinic, Kuantan, Malaysia from 2018 until 2021.

MATERIALS AND METHODS

Data collection was conducted at IIUM Optometry Clinic, Kulliyyah of Allied Health Sciences, IIUM, Kuantan, Malaysia. Kuantan is a district in Pahang State which is located about 260-kilometer east capital city of Malaysia, Kuala Lumpur. It is also a city and the Pahang state capital. The district is located at the east coastal line and has its border with Terengganu state in the north.

All procedures conducted throughout the study were reviewed and approved by IIUM Research Ethics Committee (IREC) (IREC 2021-KAHS/DOVS01) and adheres to the tenets of the Declaration of Helsinki. This retrospective work was started in August 2021 and was completed in July 2022. All binocular vision anomalies patient records who received binocular vision treatment and therapy at IIUM Optometry Clinic from 2018 until 2021 were reviewed thoroughly. Patients who recorded agree to give consent to use their clinical data for research purposes in the patients' file were included in this study. Patients who were recorded having the history of ocular surface, ocular anterior and posterior, and systemic diseases, as well as active ocular allergy and ocular trauma, were excluded in this study.

The review process found that 91 patients attended the clinic throughout the period. Each patient file was labelled with a number and the collection of data was based on the labelled number for protecting their personal data. Demographic information, including patients' age, gender, the region, and state of residence, as well as type of binocular vision anomalies based on the clinician diagnosis, including a specific type of accommodation, vergence and strabismus anomalies were collected. The clinician diagnosis made for accommodative anomalies was based report from Singh et al., (2020). The clinician used the report from Khorrami-Nejad et al., (2018), Ma et al., (2019), Wang et al., (2021), and Zhang et al., (2021) to diagnose the vergence and strabismus anomalies. The collected data was inserted and analyzed using IBM®SPSS® Version 26.0. Descriptive analyses were calculated on all patients' demographic data and all types of binocular vision anomalies, including non-strabismic and strabismic types.

RESULTS

The study's total sample size was 91 individuals as demonstrated in Table 1 with 51.6 % being female. The patients ranged in age from 3 to 35 years (mean age: 12.03 ± 6.64 years). 71.5% of all 91 patients were 20 years old and below. 71.4% of total patients were coming from Pahang state, with 58.2 % coming from the Kuantan district community while the remainder (13.2%) from other districts. About 16.5% of the total patients originated from Terengganu state. Meanwhile, 82 patients (90.1%) were students and the remaining worked as officers and non-officers.

Table 1 Demographic data

Description N = 91	Mean (SD)	Minimum	Maximum	Frequency	Percentage (%)
Age (Years)	14.52 (7.50)	3	35		
0 –10				34	37.4
11 – 20				31	34.1
21 – 30				23	25.3
31 – 40				3	3.3
Ethnics					
Malay				87	95.6
Chinese				3	3.3
Others				1	1.1
Gender					
Male				44	48.4
Female				47	51.6
Origin of Patients					
Kuantan				53	58.2
Other district in Pahang state				12	13.2
Johor				1	1.1
Kedah				1	1.1
Kelantan				1	1.1
Kuala Lumpur				1	1.1
Penang				1	1.1
Perak				3	3.3
Selangor				2	2.2
Terengganu				15	16.5

Accommodation anomalies

All the necessary tests were performed on the patients with accommodation disorders. There was a higher incidence of patients with accommodation insufficiency in terms of accommodative dysfunctions (19.8 %), followed by accommodation excess, accommodation infacility and accommodation weakness. Table 3 summarized all the findings with the least number of patients having accommodation weakness.

Table 3 Data of accommodation anomalies

Type of accommodation anomalies (N = 91)	**Frequency**	**Percent (%)**
Accommodation excess	11	12.1
Accommodation infacility	3	3.3
Accommodation insufficiency	18	19.8
Accommodation weakness	2	2.2
NA	23	25.3
Normal	34	37.4

*NA: not applicable

Ocular alignment anomalies

Battery tests were done before deciding with a proper diagnosis. Table 4 showed the category for vergence anomalies, where 9.9 % of patients had basic exophoria, aside from patients with normal and not applicable (NA) data. Among all patients, 67 were strabismic, with intermittent exotropia having the highest prevalence as depicted in Table 5.

In each category, not applicable (NA) data was completely disregarded. This was caused by insufficient information being received to diagnose the patients and some of them had more profound anomalies such as strabismus, several accommodation tests were not performed on that situation yet.

Table 4 Data of vergence anomalies

Type of Vergence Anomalies (N = 91)	**Frequency**	**Percent (%)**
Normal	10	11.0
Convergence insufficiency (CI)	3	3.3
Convergence excess (CE)	1	1.1
Divergence excess (DE)	1	1.1
Basic esophoria	3	3.3
Basic exophoria	9	9.9
NA	64	70.3

*NA: Not applicable

Table 5 Prevalence of strabismic binocular disorder

Type of tropia		Frequency	Percent (%)
Normal		7	7.7
NA		17	18.7
Esotropia			
	Accommodative esotropia	2	2.2
	Divergence weakness	2	2.2
	Convergence excess	1	1.1
	Alternating	5	5.5
	Constant	6	6.6
	Other type	2	2.2
Exotropia			
	Constant	16	17.8
	Intermittent	26	28.6
	Alternating	13	14.3

DISCUSSIONS

Since the location of IIUM Optometry Clinic is in Kuantan district, most patients came from its district and other districts in Pahang state. However, 16.5 percent of total patients were living in Terengganu state. Due to the geographical location nearby Kuantan district, it might be convenient for the patients coming from the state to seek treatment at the clinic.

The result shows that 37.4% of total 91 patients were 10 years old and below. This age group are tendency to have strabismus if the signs of the eye deviation and anomaly of visual apparatus are left untreated (Hemptinne et al., 2020). The critical period for neuro-visual development occurs at this age of group which is between 18 to 24 months of life (Dennis et al., 2013) and the development of visual system becomes slow or matured after first seven years of life (Birch, 2013). Any anomaly of visual apparatus, as well as sensory and motor system could lead to amblyopia which is caused by visual deprivation due to lack of visual experience (Birch, 2013) and subsequently, leading to strabismus and binocular suppression (Scholl et al., 2013). Therefore, serious action is suggested to be taken by parents to bring their child for eye examination to prevent any visual anomalies in the age group which eventually results in strabismus and binocular suppression.

In the present study, it was found that the three most common accommodation anomalies at IIUM Optometry Clinic were accommodation insufficiency (19.8%), accommodation excess (11.0%), and accommodation infacility (3.3%). The finding was also agreed with a conducted in Ghana (Abdul-Kabir et al., 2015). Abdul-Kabir and the team conducted the study on 204 junior high school students, and it was discovered that about 32% of the total subjects were having accommodation insufficiency while 26% for accommodation infacility. A similar pattern was also reported by Samsimon et al. (2020) whereby the accommodation insufficiency patients consist of 26.3% of total patients came to optometry clinic, followed by accommodation excess (18.0%) and accommodation infacility (7.8%). Accommodation

insufficiency became most prevalent cases in accommodation anomalies might be due to academic demand of reading and writing (Abdul-Kabir et al., 2015). Moreover due to movement control order during COVID-19 pandemic in 2020 (Elengoe, 2020), the near work task might become exaggerated, especially on the digital devices (Trott, Driscoll, Irlado, & Pardhan, 2022) and subsequently could lead to the anomaly.

In terms of vergence anomalies, convergence insufficiency is the most prevalent problem (Trieu & Lavrich, 2018). A study was conducted in Puerto Rican pediatric population aged between 5 and 20 years, 593 patient records were reviewed between years 2004 and 2012 (Paniccia & Ayala, 2015). Patients with strabismus, amblyopia, nystagmus, vertical deviation, corneal pathology, retinal pathology, lens pathology, or any other parameter outside of population requirements were excluded. Paniccia and Ayala discovered that about 12.6% of total 593 patients were having convergence insufficiency, followed by convergence excess (9.1%). The identical pattern was also explored by Atiya et al., (2020). Atiya and co-author conducted a study on 66 ophthalmologist trainees (mean age: 29.3 ± 3.27 years) who had experience in surgical procedure attending a surgical training program at a tertiary eye care center. Convergence insufficiency was still recorded as the most common problem among the ophthalmologist trainees, which was 22% of the total subjects, followed by convergence excess (3%). However, the pattern of outcome was not demonstrated in this present study, whereby basic exophoria is recorded highest prevalence, followed by convergence insufficiency, and basic esophoria. This finding was in line with a study result in China which conducted on 415 Chinese participants aged between 21 and 38 years (Ma et al., 2019). Basic exophoria was seldom stated the most common diagnosis in previous prevalence studies with reported prevalence rates of 0.3% to 5.1% (Ma et al., 2019).

Intermittent exotropia cases dominated the strabismus anomalies among patients attending IIUM Optometry Clinic from 2018 until 2021. The discovery was identical with a study conducted in Hong Kong (Zhang et al., 2021). Zhang and the research team conducted a cross-sectional study involving 4273 children aged 6 to 8 years old. Only 133 children were diagnosed having strabismus. It was found that the 65 children were having intermittent exotropia, followed by constant exotropia (54 children), constant esotropia (12 children), and pure vertical strabismus (4 children). However, the finding in both investigations was contradicted with a study conducted in Iran (Khorrami-Nejad et al., 2018). The data was collected on 1174 patients aged between 0 to 18 years old from 2018 until 2014 at Farabi Hospital, Tehran, Iran. They found that accommodative esotropia accounted largest percentage, which was 25.04%, followed by intermittent exotropia, nonaccommodative esotropia and partially accommodative esotropia, with 12.09%, 11.24% and 10.39%, respectively (Khorrami-Nejad et al., 2018). This could be postulated that the western region of the World might have more esotropia cases while exotropia cases could commonly be demonstrated in eastern region.

CONCLUSIONS

In a nutshell, accommodation insufficiency and exophoria were suggested to dominate the non-strabismic anomalies among patients, especially for schoolchildren, teenagers, and work forces. Intermittent exotropia was suggested to be more prominent strabismus in eastern region of the World, while the number of esotropia cases, particularly accommodative esotropia might be enormous in the western region. These outcomes and discussions could be utilized as reference for the better management of non-strabismic and strabismic cases in future.

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