Original Article

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Knowledge of Cerebral Visual Impairment (CVI) in Children among Eye Care Professionals in Selangor and Kuala Lumpur, Malaysia

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Abstract:

Objective: Cerebral Visual Impairment (CVI), a brain-based visual disorder that affects neural networks that process incoming visual information throughout the brain, poses challenges in diagnosis and managing visual impairment in children. With the prevalence rise in CVI cases among children, there is a growing demand for ophthalmologists and optometrists to address these conditions, emphasising the importance of improving knowledge and awareness for better visual rehabilitation. This study intends to quantify the level of understanding of CVI in children among eye care professionals in Selangor and Kuala Lumpur, Malaysia.

Material and Methods: Two hundred thirty registered eye care professionals, including ophthalmologists and optometrists across Selangor and Kuala Lumpur, Malaysia, participated in this cross-sectional web-based survey. A standardised questionnaire was created through Google Forms and distributed via social media platforms between April and June 2022.

Results: The finding showed that the eye care professionals have significantly basic knowledge regarding CVI in children (x^2=369; df=2; p-value≤0.01). Most respondents correctly identified variable loss of vision, visual field defects, and abnormal behaviour as clinical features of CVI in children. Additionally, over half of the respondents selected magnetic resonance imaging (MRI) as the appropriate investigation choice.

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Conclusion: These findings indicate that eye care professionals have basic knowledge and awareness of CVI in children. More research is needed to enhance knowledge and raise awareness about CVI in children among eye-care professionals.

Keywords: children, cerebral visual impairment, eye care professionals, knowledge

Introduction

Cerebral Visual Impairment (CVI), also known as cortical visual impairment, refers to a loss of vision functions caused by damage or multifunction of visual pathways and centres in the brain, specifically the lateral geniculate bodies, optic radiations, occipital cortices, and visual associative areas, any combination or degree[1]. It may be caused or exacerbated by associated eye movement control disorders[2].

CVI is also commonly reported in prematurely born children, owing to the increased risk of insult to the developing brain caused by their prematurity[3]. Medical advances have increased the survival rate of extremely premature and low birth weight neonates, which is likely to have contributed to the increased prevalence of CVI[3]. In developed countries, CVI is a particularly prevalent root of pediatric visual impairment[4]. The most prevalent underlying cause, especially in premature children, is hypoxic-ischemic encephalopathy. Infections, trauma, seizures, hydrocephalus, and other conditions can also have a role. Children with CVI frequently present diagnostic and characterisation challenges due to neurologic comorbidities[5].

Developed countries have a comparatively high proportion of pediatric CVI due to better survival rates among preterm children as well as children with severe neurologic illnesses[6]. According to a World Health Organization (WHO) report, 28% of childhood blindness in established market economies is caused by the central nervous system. According to WHO, CVI is responsible for up to 48% of severe childhood visual impairment and blindness cases in the United Kingdom[5,7]. Meanwhile, in Malaysia, the reported prevalence of CVI was 2.5%[8].

Refractive errors and accommodation problems are typical in patients with CVI[9]. These visual impairments are frequently accompanied by structural issues such as cataracts, colobomas, optic atrophy, and retinal dystrophy. Conditions such as optic nerve hypoplasia and optic atrophy are connected with various brain disorders, impacting vision. Besides, eye movement control disorders such as strabismus, nystagmus, unstable fixation, inaccurate rapid eye movements, inadequate smooth pursuit movements, and paroxysmal deviations, in which the eyes intermittently stray upward, are common in children with CVI[2]. Consequently, head movements can partially compensate for problems with visually guided eye movements in children with head control, resulting in abnormal head posture[10].

A variety of techniques and instruments used in diagnosing and managing children with CVI, including health history surveys, ophthalmological and orthoptics assessments, neuropsychological evaluations, neuroradiological imaging like MRI, and genetic evaluations, are utilised[11]. However, the assessment of knowledge among eye care professionals reveals a notable lack of understanding concerning the clinical features, investigation methods, differential diagnosis, and visual prognosis of CVI in children[12], emphasising the urgent need for targeted educational initiatives to enhance their competence in addressing this crucial aspect of pediatric eye care. A preliminary study suggested that eye care professionals possess limited to non-existent knowledge of CVI, signaling a need for increased awareness, despite previous surveys showing a satisfactory level of awareness concerning CVI, with two-thirds of participants correctly answering around 70% of the questions[13].

Hence, for ophthalmologists and optometrists to ensure early detection and intervention for children with CVI, the understanding among eye care professionals need to be emphasised more. Lack of apprehension on this will make the problem less noticeable and unaware while managing cases related to this issue and will affect the patient's life sooner or later. In Malaysia, a small amount of study has been done regarding CVI among children. Surprisingly, the prevalence of CVI in Malaysia is much higher compared to other Asian countries, such as China, at 2.5% and 0.3%, respectively[8,14]. Therefore, the level of understanding among eye care professionals needs to be assessed first to increase awareness of CVI.

Material and Methods

Sample collection

This study employed a quantitative approach, utilizing a cross-sectional survey design for data collection. A questionnaire consists of multiple-choice questions regarding basic knowledge of CVI that has been retrieved and developed by the first author from a previous study[12]. The questionnaire used in this study consisted of multiple-choice questions to assess the knowledge regarding CVI in children[12]. They suggested that many cases of CVI remain undiagnosed, possibly due to the lack of information among eye care practitioners[12].

The questionnaire comprised ten questions and was divided into two sections. The first section was on the demographic and occupational status of the respective ophthalmologist and optometrist. Meanwhile, the second section consisted of questions regarding the general knowledge of CVI. This section allowed respondents to respond to several questions, including the following: the causes of CVI, the three leading causes of visual impairment in children of developed countries, the most common risk factor of CVI in children, the clinical features of CVI in children, investigation choice that available for the condition, identification of non-differential diagnosis CVI, the requirement of children with CVI to have an eye examination, the frequency in diagnosing children with CVI, management of CVI and vision status with CVI. The knowledge scores used in this study were explained based on a range of 0 to 1, where 0 indicates an incorrect answer and 1 signifies a correct answer. This scoring system was outlined by Gurpinar et al.[15]. The mean knowledge score obtained from the questionnaire categorises the level of knowledge as high (more than 50 to 100%), moderate (25 to 50%), and low (less than 25%)[16]. A score of more than 50% was considered adequate, and less than 50% was considered inadequate.

In the process of content validation, six experts specialising in paediatric vision care, comprising five optometry lecturers and an ophthalmologist, were recruited for the content validation of the questionnaire. All experts received written information via email about the objective of the study and their role as expert panels. The experts assessed all items in the questionnaire on relevance, clarity, and understandability. They ranked each item on a 4-point Likert scale; 1 represented the lowest, and 4 represented the highest value. The acceptable content validation index (CVI) value must be at least 0.83 for an expert group of six[17]. The CVI values of the questionnaire were 1.0, 0.91, and 0.91 for relevance, clarity, and understandability, respectively, indicating high validity. This study was approved by the Research Ethics Committee of Universiti Teknologi MARA (FERC/FSK/MR/2022/0067).

The population of ophthalmologists in population of 31.9 million in Malaysia is low, with only one ophthalmologist per 50,000 people[18]. Meanwhile, there are more than 2,000 optometrists in Malaysia nowadays, resulting in a ratio of approximately one optometrist for every 22,000 patients[19]. Based on the Report of Health Indicators 2021, Ministry of

Health, Malaysia, and Malaysian Society of Ophthalmology, the estimated total population of ophthalmologists and optometrists in Selangor and Wilayah Persekutuan Kuala Lumpur was 1,120[20,21]. The sample size of 230 eye care professionals was calculated using Raosoft software with a 95% confidence interval, 5% error, 20% dropout rate, and a 50% response distribution. All participants involved in this study were voluntarily selected based on inclusion and exclusion criteria. To be included participants are currently eye care professionals, namely ophthalmologists and optometrists, who are currently practicing in various settings such as hospitals, retail sectors, industries, and eye clinics in Selangor and Wilayah Persekutuan Kuala Lumpur. Participants were obtained using purposive sampling as this study focused on a specific population. Data was collected from selected individuals at a time to gather data on the knowledge of CVI in children among ophthalmologists and optometrists. The data collection for this study was between May to June 2022. The questionnaire via Google form was distributed randomly on different social media platforms such as WhatsApp, Instagram, and Twitter. Additionally, physical copies were distributed at respective optometry private practices to reach a larger crowd. The participants were allocated around five minutes to answer the questions with respect to their privacy and convenient time.

Data analysis

The questionnaire was then retrieved through Google Forms and was thoroughly checked for completeness. Subsequently, the completed surveys were analyzed using IBM Statistical Package for Social Sciences (SPSS) software version 28 (IBM SPSS, Armonk, NY, USA), and the level of normality of collected data was determined using the Kolmogrov-Smirnov test. Using SPSS version 28, socio-demographic variables were analyzed descriptively.

Results

Demographic characteristics of participants

A total of 230 eye care professionals, consisting of 28 ophthalmologists and 202 optometrists, participated in this study. The demographic profile of these respondents are summarized in Table 1.

Table 1 Demographic profile of the respondents

Variables	Frequency	Percentage (%)
Demographics	n=230	
Gender		
Male	48	20.9
Female	182	79.1
Type of care professional		
Ophthalmologist	28	12.2
Optometrist	202	87.8
Employment status		
Full-time	211	91.7
Part-time	19	8.3
Year of experience		
1-3 years	103	45.0
4-10 years	83	36.0
More than 10 years	44	19.0

The majority of these respondents, comprising 45%, possessed up to three years of working experience, while 36% reported having worked for four to ten years, and 19% indicated having more than ten years of working experience. Further analysis of the relationship between years of experience and CVI knowledge among eye care professionals revealed no significant relationship between these two variables in this study. Additionally, a Pearson correlation coefficient was computed to evaluate

the association between the years of experience and awareness of CVI in children among eye care professionals. The analysis revealed a negative correlation, r (230)= −0.022, p−value=0.746, indicating that years of experience have no substantial impact on the knowledge of eye care professionals regarding CVI in children.

Knowledge of cerebral visual impairment (CVI) among eye care professionals

The mean knowledge score among eye care professionals in this study was 13.78±1.17 (n=230), as presented in Table 2.

Table 2 Knowledge score among eye care professionals on CVI in children regarding the correct answer to questions related with CVI

Variable (n=230)	Frequency of respond with correct answer	Percentage (%)	Mean knowledge score
What is the cause of CVI in children? (Answer: damage to the visual areas of brain)	164	71.3	1.71
Three leading causes of visual impairment in children in developed countries? (Answer: retinopathy of prematurity, cerebral visual impairment, optic nerve hypoplasia)	111	48.3	1.48
What is the most common risk factor of CVI? (Answer: perinatal hypoxia)	63	27.4	1.28
What are the clinical features of CVI in children? (Answer: variable loss of vision, visual field defects and abnormal behavior)	84	36.5	1.46
Investigation of choice in CVI in children? (Answer: MRI brain)	214	93.0	1.92
Which is not a differential diagnosis of CVI in children? (Answer: Refractive error)	10	4.3	1.04
Do children with CVI need an eye examination? (Answer: always)	44	19.1	1.19
How often do you diagnose CVI in children in ophthalmology department per month?			
<5 cases	13	5.7	
5−10 cases	2	0.9	
>10 cases	0	0.0	
Rarely	51	22.2	
None of the above	164	71.3	
What is the management of CVI in children? (Answer: multidisciplinary rehabilitative approach)	201	87.4	1.88
Does vision improve in CVI? (Answer: sometimes)	188	81.7	1.83
Total of knowledge score mean			13.78±1.17

CVI=Cortical visual impairment, MRI=Magnetic resonance imaging

Based on the calculated mean knowledge score, the knowledge levels of respondents on CVI were categorized with high, moderate, and low knowledge regarding CVI. Out of 230 respondents, 214 (93%) have a moderate level of knowledge of CVI, while 14(6.1%) and 2(0.9%) have high and low knowledge regarding CVI, respectively. The chi-square goodness-of-fit test yielded a significant result (x^2=369; df=2; p-value≤0.01), indicating that most eye care professionals possess significantly moderate knowledge regarding CVI in children.

Besides, among 230 respondents, 93% were familiar with the entity CVI in children, while 7% were unaware of this concept.

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Choice of investigation in cerebral visual impairment (CVI)

A question regarding the choice of investigation in CVI also had been asked among the respondents, with options including Visual Evoked Potential (VEP), Electroretinogram (ERG), magnetic resonance imaging (MRI) of the brain, and Fundus Fluorescein Angiography (FFA). Based on the SPSS analysis, 93% of respondents, with a mean knowledge score of 1.92, chose MRI to investigate CVI, irrespective of their professional background as ophthalmologists or optometrists. ERG was chosen by 4% of respondents, while VEP was selected by 3%. None of the respondents opted for FFA. Nevertheless, the Chi-square goodness-of-fit test did not yield a statistically significant result (c^2=163; df=1; p£0.01), indicating that the frequency of choosing MRI as the preferred investigation method among eye care professionals was not significantly different from other procedures.

Discussions

In developing countries, childhood blindness due to CVI has been reported at 0.3% in India, 0.4% in China, 6.1% in Indonesia, and 2.5% in Malaysia, respectively[8,14,22,23]. Results of the distributed survey showed that more than half of the respondents had moderate general knowledge regarding CVI in children. A previous pilot study discovered that ophthalmologists possess limited knowledge regarding clinical manifestations, diagnostic methods, differential diagnoses, and visual outlook of CVI in children[12]. It is crucial for eye care professionals to have an initial understanding of CVI in children before proceeding with further investigations. Early detection and preventive measures are essential components of effective strategic management. A previous study of low vision services in Klang Valley indicated that 380 optometrists working in Klang Valley faced challenges due to limited public awareness[24], similar to the need for a greater understanding of CVI among eye care professionals in Selangor and Kuala Lumpur. Interestingly, a mixed method study showed that a psycho-educational program significantly increased knowledge of CVI, emphasising the role of education in improving understanding[25]. Thus, initiatives to raise awareness and education among eye care professionals regarding CVI are crucial for better management and support.

A child with CVI may have variable visual field defects, which is one of the clinical features of CVI. When the dorsal stream, which connects fibers from the occipital cortex to the parietal lobe and is responsible for deciding an object in a visual environment, is involved, children with CVI may have variable vision loss or visual field defects. This can be attributed to abnormalities in the optic radiations or occipital cortex, manifesting as observable abnormal behaviour[26].

Children may experience related neurological symptoms, such as cerebral palsy, when hypoxia injury affects other parts of the brain[27]. Depending on the location of the disease, any one of these symptoms may appear alone or in any combination. The most challenging cases to diagnose in children are those with abnormal visual behavior alone because they may have normal visual acuity on the Snellen chart, pupillary responsiveness, and routine eye examination[1]. They may attend a regular school and get misdiagnosed. However, they still risk suffering due to atypical visual behaviour.

In the distributed questionnaire, more respondents knew the right way to investigate a problem than were aware of the common risk factors. It suggests that we might need more time to grasp the true nature of the problem entirely. The majority of the respondents choose MRI as the procedure. MRI is the preferred test for identifying CVI in children primarily because of its capability to identify brain lesions and damage potentially responsible for visual impairment, especially in the retro-geniculate pathway[28]. Besides, a brain injury from hypoxia is the primary pathophysiology of CVI in children. Perinatal hypoxia in premature infants damages the periventricular deep white matter, including the ocular radiations that induce CVI[29]. Brain MRI confirms this as periventricular leukomalacia[30]. Besides, other less frequent causes of CVI in children include meningitis, hydrocephalus, and brain trauma, all of which have distinct symptoms that also can be seen on a brain MRI. Consequently, brain MRI is the preferred test for identifying CVI in children[31].

Another important outcome of the questionnaire is that only a few respondents provided accurate answers regarding the differential diagnosis of CVI and the need for eye examination for children with CVI. Children with CVI typically do not reach normal development until they are one year old. In contrast, children with delayed visual maturation achieved normal by that age. Until the age of one, delayed visual development is considered one of the differential diagnoses of CVI in children[29]. In particular, it is important to consider autism as a differential diagnosis in children with CVI who exhibit unusual visual behavior despite having normal vision[32]. Fortunately, brain MRI can help differentiate between autism and CVI. Segmenting brain tissues such as grey matter, white matter, and cerebrospinal fluid, for example, can show variations in intensity values; autism images showed a markedly higher concentration of white matter than normal images[33]. Additionally, amblyopia can sometimes be mistaken for CVI in children during routine eye examinations due to lower visual acuity. However, it is crucial to note that amblyopia can affect one eye, while CVI typically affects both eyes[12]. Therefore, conducting a thorough eye examination is vital for children with CVI.

Children with CVI typically experience varying vision improvement over time, although most never regain normal vision[34]. Additionally, depending on the severity and scope of the condition, the care of CVI in children necessitates a multidisciplinary rehabilitative strategy that involves a pediatric ophthalmologist, pediatrician, radiologist, otorhinologist, neurologist, and physiotherapist[12]. The Ministry of Health Ophthalmology Department, special schools for visually impaired students, and non-government organisations like the Malaysian Association for the Blind and the Society for Blind Malaysia offered services related to the multidisciplinary management of visual impairment in Malaysia[35]. Besides, occupational therapists in Malaysia employed both objective and subjective visual performance measures to help patients with their everyday activities and skills[36]. Most respondents correctly indicated that the care of these children necessitates a multidisciplinary approach.

However, the percentage of respondents who accurately indicated how the management would turn out was substantially lower than the visual prognosis. One important contributing reason is the high utilisation of complementary and alternative medicine among Malaysians[37], which may lead to a lack of awareness or understanding of conventional medical management strategies for CVI. Moreover, the unequal distribution of experienced experts and healthcare resources in Malaysia, as highlighted in the literature, can impair the quality and accessibility of care for patients with CVI[8].

A previous study emphasises the significance of diagnoses and rehabilitation for children with CVI[38]. It focuses on novel techniques, such as the "visual ladder" approach, which aids in quantifying visual impairment and evaluating the effectiveness of rehabilitation strategies, particularly for patients with poor verbal abilities[38]. Interventions that focus on individualised visual training have demonstrated promising outcomes, with gains in functional vision found in children after such programs[39]. Hence, the studies highlight the importance of early intervention, interdisciplinary collaboration, and tailored rehabilitation strategies to optimise outcomes for children with CVI. In addition, knowing the outcomes of the management would be crucial for carefully planning the patient's future course[34].

Further analysis of the relationship between years of experience and CVI knowledge among eye care professionals revealed no significant relationship between the two variables in this study. Cormier's research in 2006 indicated that senior-level baccalaureate nursing students in Louisiana state universities have limited chances to apply health literacy, and there is minimal correlation between their knowledge of health literacy and its practice[40]. A limited study highlighted the relationship between years of experience and knowledge of CVI among eye care professionals. However, a knowledge-based study in India revealed limited awareness among ophthalmologists, with half of them showing limited knowledge and failing to achieve a total score, indicating a lack of comprehensive understanding across different levels of experience[16]. In other words, these findings reinforce that a person's experience level does not necessarily determine their knowledge in this context. These findings emphasise the importance of target training and education initiatives to enhance CVI knowledge among eye care professionals, regardless of their years of experience.

It is evident from this study that most eye care professionals in the survey were familiar with CVI in children. They recognized the importance of eye examination and the potential benefits of a multidisciplinary approach to rehabilitation for these children. In addition, for ophthalmologists and optometrists, it is critical to acknowledge the important roles of nurses and rehabilitation officers in the care of patients with eye diseases. Although these experts did not participate in this survey, their knowledge and actions are critical in patient management and recovery, emphasising the value of a collaborative approach in eye management. However, nearly half of the respondents expressed uncertainty about various aspects of CVI in children, including risk factors, clinical characteristics, differential diagnosis, need for an eye test, and visual prognosis. This limited knowledge may result from a lack of exposure to the CVI term. The study's limitations include the use of online methods and the distribution of the questionnaire through diverse social media platforms. This introduces the possibility of bias as respondents may consult online sources for answers during or before completing the questionnaire, deviating from relying solely on their own knowledge. Another limitation is the overrepresentation of optometrists in the sample, with only 28 ophthalmologists participating. This raises concerns about the generalizability of the findings, emphasizing the need for a more systematic and inclusive sampling approach to enhance representativeness.

Conclusion

This study revealed that more than half of the eye care professionals in Selangor and Kuala Lumpur had moderate general knowledge regarding CVI in children. The findings suggest that most eye care practitioners had acceptable knowledge of CVI but still had some gaps to fill. Advances in the medical field will promote an increase in the survival rate of children with CVI, eventually increasing the demand for eye care professionals to provide their services in dealing with this health condition. There is a need to raise CVI awareness among eye care professionals. Even so, consistent activities such as seminars regarding CVI are key to aiding children's knowledge and understanding of CVI.

The eye care professionals must be familiar with symptomatology, differential diagnosis, and diagnostic methods. Because unusual visual behavior is the most common symptom of CVI, eye care professionals should become acquainted with CVI guidelines, as early detection is critical for effective rehabilitative treatment.

Author contributions

Conception and design: Ibrahim WNA, Data analysis: Ibrahim WNA, Ahmad Razlan NAH, Writing: Ibrahim WNA, Ahmad Razlan NAH, Woi PJ, Data collection: Ahmad Razlan NAH, Ibrahim WNA, Woi PJ.

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Conflict of interest

All authors have no conflict of interest to declare.

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