BJMS
Borneo Journal of Medical Sciences

ORIGINAL ARTICLE

Prevalence and Causes of Low Vision and Blind in Ophthalmology Department, Miri Hospital, Sarawak

Ruby Huong Yeng Ting*, Chung Lee Sean, Filzah Rahilah Hussain, Anushia Raman, Chieng Lee Ling

Ophthalmology Department, Miri Hospital, Sarawak, Malaysia

*Corresponding author's email: rubyhyt@gmail.com

Received: 13 March 2022

Accepted: 8 September 2022

Published: 30 September 2022

DOI: https://doi.org/10.51200/bjms.v16i3.3732

Keywords: *low vision, blind, irreversible, permanent, visual impairment, ophthalmology*

ABSTRACT

Prevalence and causes of low vision and blind have been studied nationally and globally. However, similar studies have not been conducted locally in Sarawak. This study aims to identify the prevalence and causes of low vision and blind patients of different gender, age, and race in the Ophthalmology Department, Miri Hospital, Sarawak, for five years from 2016 to 2020. This study is a retrospective observational study. A total of 17,868 patients' clinical records were screened. The clinical records with fulfilled inclusion criteria will be extracted and reviewed. In this study, 269 (1.50%) patients were diagnosed with irreversible visual impairments. The prevalence of low vision and blindness was 0.78% and 0.72%, respectively. Most subjects (187, 69.5%) were more than 50 years old. Furthermore, 151 (56.13%) subjects were male, while 118 (43.87%) were female. Race Iban has a higher prevalence of low vision and blind (88, 32,7%), followed by Chinese (81, 30.1%), Malay (53, 19.7%), and other local natives (17, 5%). The four leading causes of low vision and blind were diabetic retinopathy (68, 25.3%), glaucoma (62, 23.0%), retinitis pigmentosa (26, 9.7%), and age-related macular degeneration (17, 6.3%). Low vision and blind due to diabetic retinopathy, glaucoma, and age-related macular degeneration could be avoided if eye health screening is conducted as early as age

40. For patients diagnosed with low vision and blind, integrated low vision and blind rehabilitation training should be accessible in all public healthcare systems. For the stakeholder, enforcing low vision and blind registry, fortifying low vision rehabilitation services, and precise mechanism of welfare intervention are the measures for more holistic low vision and blind management.

INTRODUCTION

Vision impairment is a major global public health issue affecting individuals, households, and communities, from reduced quality of life and employment to poverty (Marques et al., 2021). National Eye Survey 1996 revealed a prevalence of 2.44% of low vision and 0.29% of blindness in Malaysia (Zainal et al., 2002). In National Eye Survey II, Chew et al. (2018) reported that East Malaysia, which comprises Sabah and Sarawak, has the highest prevalence of visual impairment with poor access to eye care services in Malaysia. Despite ample evidence that primary prevention and early detection may have a better visual prognosis, geographical and logistic limitations remain the barriers affecting patients seeking healthcare services in Sarawak (Alyana et al., 2018; Rahman et al., 2017). Although previous researchers focused on visual impairment amongst preschool and school children in southern Sarawak districts, no study was conducted in northern districts of Sarawak (Bakar et al., 2012; Leng et al., 2021; Premsenthil et al., 2013). Thus, more epidemiological data are needed to understand these regions' vision impairment burden better.

This study is conducted to obtain insight into statistics and profiles of low-vision and blind patients in the Ophthalmology Department of Miri Hospital. Being the only secondary hospital in Northern Sarawak (Latar Belakang, 2022), the Ophthalmology Department of Miri Hospital is the main centre providing 24 hours comprehensive ophthalmology eye care services. The centre accepts patients' referrals from various healthcare professionals, from optometrists, opticians, and physicians, both in the public and private sectors in the northern districts of Sarawak. These northern districts include Lawas, Limbang, Batu Niah, Marudi, and all the suburban towns such as Subis, Beluru, and Telang Usan.

MATERIALS AND METHODS

This study is a retrospective observational study. Five years of clinical records of all Malaysian patients who had undergone eye assessments in the Ophthalmology Department of Miri Hospital from 1st January 2016 till 31st December 2020 were screened and reviewed. Data of subjects who fulfilled inclusion criteria were recorded in an adapted version of the MOH Low Vision and Blind Registry form. The data included age of notification of low vision and blind, gender, race, best corrected visual acuity (BCVA), visual field, ophthalmology diagnosis, and presence of associated systemic diseases. In addition, the patient who was referred for low vision and blind management & rehabilitation from 1st January 2016 till 31st December 2020, a patient with irreversible and permanent visual impairment, and the patient who fulfilled low vision and blind definition according to World Health Organization (WHO) were included in this study. However, patients' clinical records with incomplete eye assessments, patients with reversible and treatable visual impairment, and patients with unexplained or undetermined visual impairment were excluded from the study.

The definition of low vision and blind in this study was based on the World Health Organization (WHO) categories of visual impairment (WHO, 2021). Low vision is defined as visual acuity less than 6/18, but equal to or better than 3/60 or visual field less than 20°, and blind is visual acuity less than 3/60 or visual field less than 10°, in the better eye, with the best correction. Best corrected visual acuity (VA) was measured using Snellen Chart,

Sheridan Gardiner, or Kay Pictures Test. The visual field was assessed using Humphrey Visual Field Analyzer. For patients with multiple ophthalmic diseases, the disease with the most significant effect causing irreversible, permanent visual impairment was recorded and verified by the ophthalmologist. The causes of low vision and blind were classified according to the International Classification of Diseases (ICD), 10th Edition (WHO, 2010). Collected data were analysed using Microsoft Excel and Statistical Package for the Social Sciences (SPSS) version 21. The study was performed by the principles of the Declaration of Helsinki and was approved. It was the Medical Research and Ethics Committee (MREC) of the Ministry of Health Malaysia (MOH) [NMRR-21-394-58440 (IIR)].

RESULTS

Out of 17,868 patient records screened, 269 (1.50%) patients were diagnosed with irreversible, permanent vision impairment. The prevalence of low vision and blind in our sample population was 0.78% (139) and 0.72% (130), respectively. Figure 1 shows notifications of low vision and blindness from 2016 to 2020.

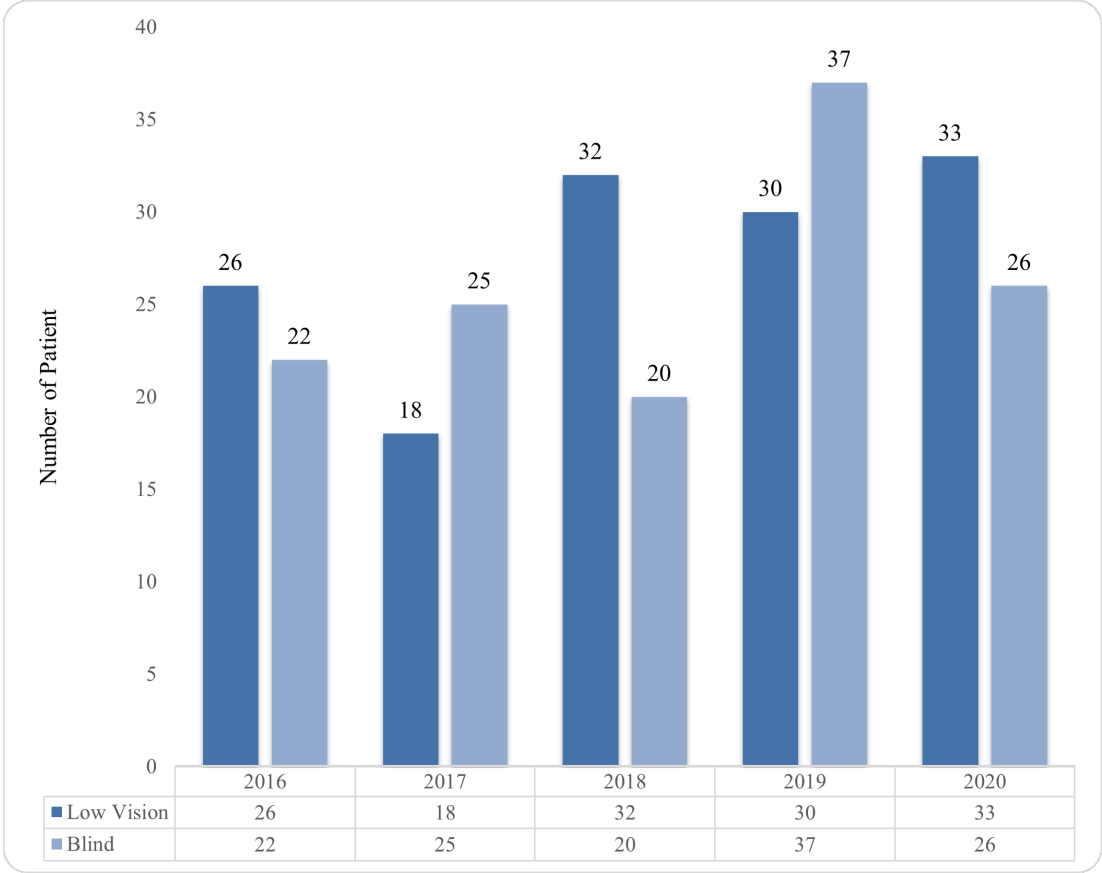

Figure 1 Notification of low vision and blind from 2016 to 2020 (n = 269)

Data were analysed using descriptive and inferential statistics using SPSS version 21 (Table 1). There is a bimodal peak in low vision, with the first peak in the group of ≤10 years old and the second peak in the group of 51 – 60 years old. However, for the patients in the blind category, there was only one peak at the age of 61 – 70 years old. We found that 69.5 % (187) of our permanent visually impaired population were more than 50 years old (Figure 2). The low vision was found more among the Chinese race (47), and blind was found more among the Iban population (44) (Figure 3).

Table 1 Age distribution of low vision and blind in the Ophthalmology Department, Miri Hospital

Age	Low Vision		Blind		Total	
	Number (%)	Mean age (95% CI)	Number (%)	Mean age (95% CI)	Number (%)	Mean age (95% CI)
≤10	10 (7.2)	5.7 (4.2 – 7.3)	0 (0.0)	–	10 (3.7)	5.7 (4.2 – 7.3)
11 – 20	3 (2.2)	12.7 (11.2 – 14.1)	0 (0.0)	–	3 (1.1)	12.7 (11.2 – 14.1)
21 – 30	1 (0.7)	25.0 (–)	8 (6.2)	26.0 (24.0 – 28.0)	9 (3.3)	25.9 (24.2 – 27.6)
31 – 40	12 (8.6)	36.0 (34.2, 37.8)	14 (10.8)	36.1 (34.5 – 37.6)	26 (9.7)	36.0 (35.0 – 37.1)
41 – 50	18 (12.9)	46.2 (44.5, 47.8)	16 (12.3)	46.4 (44.7 – 48.1)	34 (12.6)	46.3 (45.1 – 47.4)
51 – 60	30 (21.6)	55.0 (54.0, 56.0)	25 (19.2)	56.0 (54.7 – 57.3)	55 (20.4)	55.4 (54.7 – 56.2)
61 – 70	29 (20.9)	65.3 (64.3 – 66.3)	27 (20.8)	65.4 (64.2 – 66.6)	56 (20.8)	65.3 (64.6 – 66.1)
71 – 80	23 (16.5)	75.9 (74.8 – 77.0)	24 (18.5)	74.3 (73.1 – 75.4)	47 (17.5)	75.0 (74.3 – 75.8)
≥81	13 (9.4)	84.2 (82.8-85.6)	16 (12.3)	84.9 (83.0-86.8)	29 (10.8)	84.6 (83.4-85.7)
Total	139 (100.0)	55.9 (52.3-59.4)	130 (100.0)	59.7 (56.7-62.6)	269 (100.0)	57.7 (55.4-60.0)

CI: Confidence interval; –: No data available

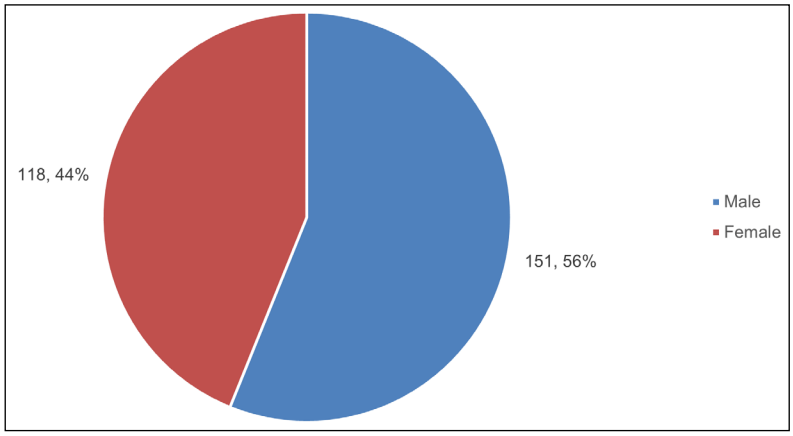

Figure 2 Distribution of gender in low vision and blind (n = 269)

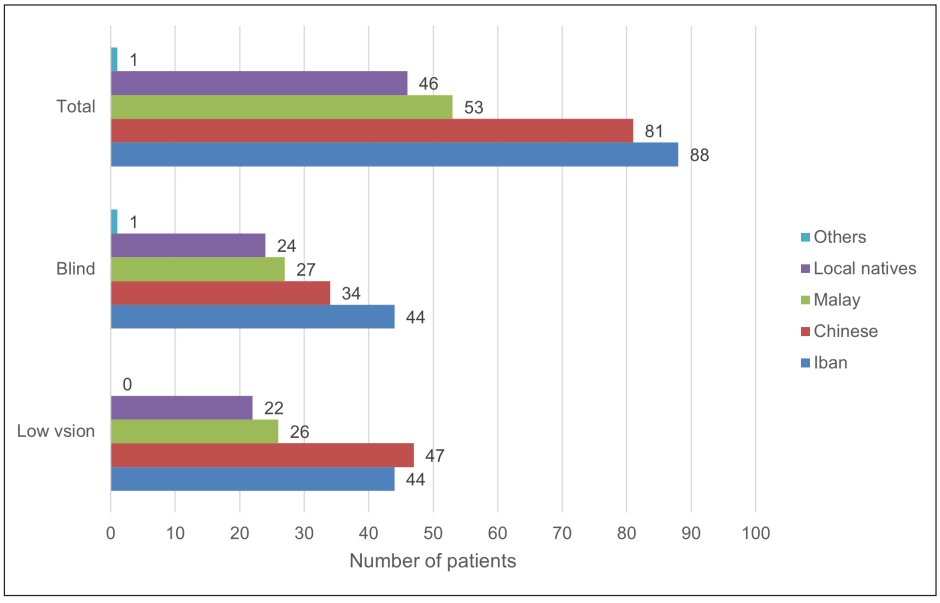

Figure 3 Distribution of races in low vision and blind (n = 269). Local natives: Orang Ulu (Includes Kayan, Lun Bawang, Kelabit, Kenyah, Penan, Sebop, Bisaya, and Berawan), Kedayan, Bidayuh (Includes Salako and Lara) and Melanau; Others: Other races not in the list.

The causes of low vision and blind were divided into three age groups 0 to 29 years old, 30 to 59 years old, and 60 years old and above. In the age group of 0 to 29 years, the most common causes of low vision and blind were congenital nystagmus (18.0%) and albinism (14.0%). In the 30 to 59 years age group, the most common cause of low vision and blind was diabetic retinopathy (37.0%), followed by retinitis pigmentosa (18.0%) and glaucoma (13%). For 60 years old and above, the most common cause of low vision and blind was glaucoma (34.0%), followed by diabetic retinopathy (19.0%) and age-related macular degeneration (12.0%) (Table 2).

Table 2 Main causes of low vision and blindness in different age groups (n = 269)

Age group	Diagnosis/ Causes	Low vision		Blind		Total	
		Number	Percentage (%)	Number	Percentage (%)	Number	Percentage (%)
0 – 29	Congenital nystagmus	5	22.7	0	0.0	5	22.7
	Albinism	3	13.6	0	0.0	3	13.6
	Retinopathy of prematurity	1	4.5	1	4.5	2	9.1
	Other congenital malformations of the eye	2	9.1	0	0.0	2	9.1
	Retinal detachment and breaks	0	0.0	2	9.1	2	9.1
	Chronic uveitis	0	0.0	2	9.1	2	9.1
	Diabetic retinopathy	0	0.0	1	4.5	1	4.5
	Glaucoma	0	0.0	1	4.5	1	4.5
	Corneal scars and opacities	1	4.5	0	0.0	1	4.5
	Amblyopia	1	4.5	0	0.0	1	4.5
	Others	1	4.5	1	4.5	2	9.1
	Subtotal	**14**	**63.6**	**8**	**36.4**	**22**	**100.0**
30 – 59	Diabetic retinopathy	29	26.9	11	10.2	40	37.0
	Retinitis pigmentosa	6	5.6	13	12.0	19	17.6
	Glaucoma	6	5.6	8	7.4	14	13.0
	Degenerative myopia	5	4.6	1	0.9	6	5.6
	Retinal detachment and breaks	0	0.0	4	3.7	4	3.7
	Toxic optic neuropathy	2	1.9	1	0.9	3	2.8
	Stargardt disease	1	0.9	1	0.9	2	1.9
	Rieger anomaly	0	0.0	2	1.9	2	1.9
	Corneal scars and opacities	1	0.9	0	0.0	1	0.9
	Injury of the eye and orbit	1	0.9	0	0.0	1	0.9
	Others	8	7.4	8	7.4	16	14.8
	Subtotal	**59**	**54.6**	**49**	**45.4**	**108**	**100.0**

≥60	Glaucoma	22	15.8	25	18.0	47	33.8
	Diabetic Retinopathy	17	12.2	10	7.2	27	19.4
	Age-related macular degeneration	9	6.5	8	5.8	17	12.2
	Corneal scars and opacities	3	2.2	4	2.9	7	5.0
	Injury of the eye and orbit	5	3.6	2	1.4	7	5.0
	Retinitis pigmentosa	1	0.7	6	4.3	7	5.0
	Degenerative myopia	1	0.7	5	3.6	6	4.3
	Retinal detachments and breaks	2	1.4	3	2.2	5	3.6
	Macula scars on the posterior pole	2	1.4	1	0.7	3	2.2
	Radiation retinopathy	1	0.7	2	1.4	3	2.2
	Others	3	2.2	7	5.0	10	7.2
	Subtotal	**66**	**47.5**	**73**	**52.5**	**139**	**100.0**

Others: Diagnoses not on the list

From the study, the four leading causes of low vision and blind in the Ophthalmology Department at Miri Hospital were diabetic retinopathy (68, 25.2%), glaucoma (62, 23.0%) and followed by retinitis pigmentosa (10.04%) and age-related macular degeneration (6.32%) (Figure 4).

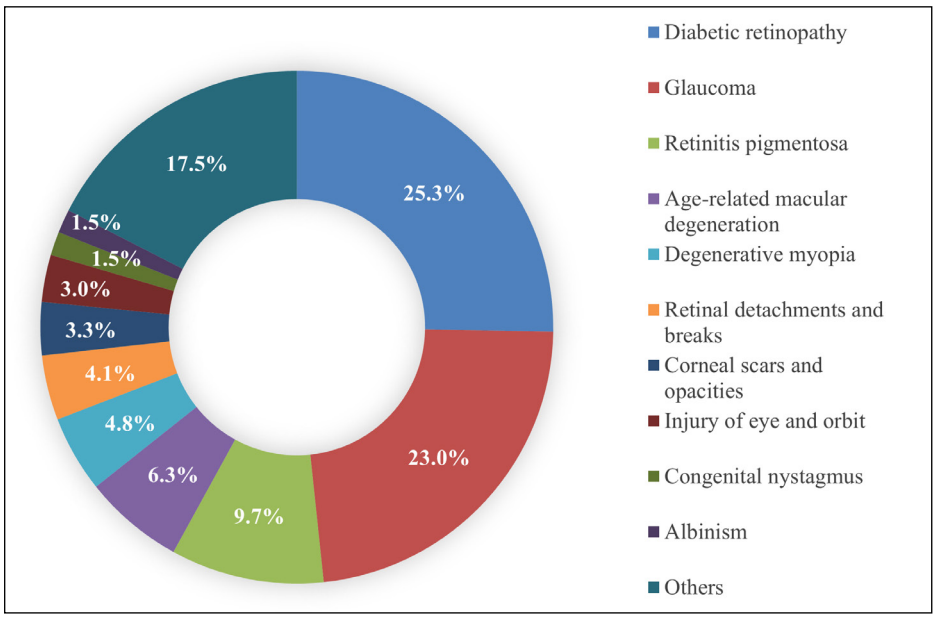

Figure 4 10 Main causes of low vision and blind in Ophthalmology Department, Miri Hospital
Others: Other diagnoses in the list

DISCUSSION

Prevalence of the Visual Impairment in Our Study Population

The prevalence of blindness in our study population was 0.78% which was close to the study reported in another hospital-based population at Universiti Malaysia Medical Centre (UMMC) (0.9%) by SC Reddy (2008) but with a lower prevalence of low vision with 0.72% compared to 9.8% in the study in UMMC. This significant difference in low vision diagnosis could be attributed to underdiagnosed and higher referral thresholds by local practitioners.

Understanding the Profile of the Permanent Visual Impairment in Our Population

In all the population studies in general, the prevalence of low vision and blind would naturally escalate with age, but in our study, there were two peaks of the low vision in our study population, namely in children < 10 years old age group and the adult group at 51 – 60 years of age. This resembles the age profile during the first consultation among the 10 years low vision clinic population (UKM-MAB) in the National University of Malaysia by Mohidin et al. (1998) but with the first peak at 10 to19-year-old and second at 50 to 69-year-old. After the first peak, there was a slope followed by a gradual rise from 3.0% in the 11 – 20 age group, reaching a peak of 21.6% in the 51 – 60 age group. We believe the first peak could be explained by the excellent coverage of the Ministry of Health Malaysia children's active screening initiatives. These initiatives include e child home-based health record programme for 0 to 6-year-old, a student health record book throughout education years, and school health team service activities. Children born in Malaysia are required to be examined at least three times 1-month-old, 18 months old, and four years old) by a medical health officer. As they grow older, they will receive school health services, including eye examinations at standard 1 (7 years old), standard 6 (12 years old), and form 3 (15 years old), as provided by KKM (Buang, 2013). Besides this, the Amblyopia and Visual Impairments Screening Ministry of Health Malaysia (AVIS) programme is another initiative by the Ophthalmology fraternity of the Ministry of Health Malaysia; starting in 2017, the Optometry Profession in the Ministry of Health Malaysia adopted the Prevention of Blindness Strategies Action Plan to target amblyopia and visual impairment among preschoolers through AVIS specifically. The project aims to identify and standardize the appropriate equipment, tests, and procedures for ideal preschool screening based on current literature (AVIS, 2017).

There was a gradual escalation of both low vision and blind populations with age to a second peak at 51 – 60 years, followed by a decline in the number at higher age groups. Our study's mean age of low vision and blind was 58 years old. The majority of low-vision and blind were diagnosed at 50 years old and above. This follows that most people with vision impairment and blindness are over the age of 50 years (WHO, 2021). The aetiologies of vision impairment in this age group were due to eye diseases such as diabetic retinopathy, glaucoma, and retinitis pigmentosa. Vision morbidity corresponds well to the duration of diseases (Wong, 2008). Therefore, the declining number of low-vision and blind patients diagnosed in higher age groups is undoubtedly a result of the natural distribution of the Gaussian curve in any population.

Gender and Race Among Low Vision and Blind

The low vision and blind among the gender and race were by the ratio of the subpopulation in the state. In Sarawak, the male-to-female ratio (1:1.28) was close to the population male-to-female ratio of 1.08:1. However, females were 1.2 times more than the based-on age-adjusted population in Malaysia (Zainal et al., 2002). Iban had the highest prevalence of low vision and blind (32.7%), followed by Chinese (30.1%), Malay (19.7%), and other local natives (17.4%). This result again was consistent with the number of the race population in the state,

with Iban being the majority race (26.5%), followed by Chinese (19.9%), Malay (18.7%), and other local natives (24.1%) (The official Portal of Sarawak Data, 2017). The prevalence of low vision and blindness in various studies too showed that they are race-independent (Rahman et al., 2020; Thevi et al., 2012; Wong et al., 2019; Zainal et al., 2002).

Aetiology of the Low-Vision and Blind

Based on the study, the four leading causes of low vision and blind in our study population were diabetic retinopathy (24.91%), glaucoma (24.54%), followed by retinitis pigmentosa (10.04%), and age-related macular degeneration (6.32%). In addition, other studies in Malaysia generally agreed that diabetic retinopathy, glaucoma, and age-related macular degeneration as the major irreversible causes of low vision and blind (Chew et al., 2018; Reddy et al., 2008; Zainal et al., 2002).

Diabetes retinopathy is the most common cause of low vision in our population, mainly due to the high prevalence of diabetes and prediabetes in the population. As reported in Malaysia National Morbidity Survey 2019, an estimated 3.9 million population over 18 years old (1 in 5 adults in Malaysia) have diabetes in Malaysia (Institute for Public Health, 2020). Another recent meta-analysis published in Jan 2022 also echoed the increased prevalence of diabetes and prediabetes in Malaysia (Akhtar, 2022). In addition, we reported a higher prevalence of low vision and blind among those more than 50 years old. Thus, baseline eye health screening should be conducted many years earlier. This is under the American Association of Ophthalmology (AAO) guideline that recommends eye health screening at the age of 40 in the average population and earlier if the individual has risk factors like diabetes mellitus, high blood pressure, or a family history of eye conditions (Turbert & Whitman, 2022).

Accessibility to eye care services is another important factor, as Miri is situated in the Northern division of Sarawak. Sarawak was one of the few regions with the worst access to eye clinics (Chew et al., 2002). About one-third of the patients in Sarawak need to travel more than 9 km to reach the nearest clinic (Risso-Gillet et al., 2015). Due to the remoteness, the nearest ophthalmology subspecialty like vitreoretinal, glaucoma, and cornea was more than 810 km drive away in Kuching, and the only government women and children hospital with a paediatric subspecialty is in Sabah. Poor access to treatment of diseases like diabetic retinopathy and glaucoma could be one of many factors contributing to the morbidity of these conditions.

Apart from the three leading causes of low vision and blind shared by reports by Zainal et al. (2002) and Reddy et al. (2008), we found a higher prevalence of low vision and blind due to retinitis pigmentosa in our study, which is incoherent with low vision population study by Mohidin (1998). Various studies from other countries like Nigeria, Thailand, Jordan, Pakistan and Turkey reported retinitis pigmentosa as one of the leading causes of low vision and blindness in young adults 15 years old and above (Bakkar et al., 2018; Chotikavanich et al., 2018; Iqbal et al., 2019; Küçük, 2019; Olusanya et al., 2012). In some studies, consanguineous marriage had been identified as one of the factors for the higher prevalence of retinitis pigmentosa (Baarah et al., 2018; Kumaramanickavel et al., 2002; Sheng et al., 2012). Nevertheless, we found no data on the incidence of consanguineous marriage in the region. Land Dayak customs (race Iban) prohibit any near relatives or consanguineous nuptials (Pantang, 2018). Prevention of genetic disease visual impairment could be achieved through pre-marriage medical counselling, implementation of molecular genetics, and management of genetic disease (Baarah et al., 2018).

Permanent Vision Impairment and Implications

Infants with visual impairment due to congenital disorders such as infantile glaucoma and refractive errors can experience

delays in motor, language, emotional, social, and cognitive development, as nearly 75% of learning comes from vision (Gogate, 2011). Therefore, it can directly affect their academic performance during school age (Taylor, 1999). Adults with functional vision loss have limited their choice of occupation. The severity of visual impairment is proportional to the unemployment rate. Thus, they are more likely to be excluded from the labour market. As employment helps visual impairment to be self-sufficient, reduce poverty, and improve physical and psychological health and quality of life (Nispen et al., 2020; Omar, 2010), there is necessary to expand further and improve low vision service in the region. By learning adaptive techniques and skills in the workplace, they will be able to stay in the labour market and thus increase the economic productivity of the country. As they age, especially the elderly with acquired visual impairment, they experience social isolation, difficulty with mobility, and a higher risk of falls and fractures (Wong et al., 2019).

This study is a hospital-based study regarding the prevalence and causes of low vision and blind in Miri Hospital, Sarawak. This study gives us an insight into the prevalence and causes of irreversible low vision and blind in Miri Hospital. It provides information concerning the socio-economic and accessibility of healthcare which will help in the future planning of public health policies, especially in allocating the budget for health services. However, this study has certain limitations. First, the hospital-based study may not represent the number of people with low vision and blind in the Miri population. Undiagnosed patients never present to a health clinic or hospital for eye assessment. Moreover, although not many, there are private hospitals with visiting ophthalmology services where patients can seek treatment and further management. Thus, this would lead to an underestimate of the prevalence of low vision and blindness in the Miri population. Second, patients with incomplete data were excluded in this retrospective study, which may result in lower prevalence. Third, as a secondary hospital with a tertiary ophthalmology setting, Miri Hospital receives a relatively high number of referrals from patients with complex and intransigent ocular conditions. Therefore, the study result may be indifferent if compared with primary care health clinics and other population-based studies, including treatable ocular disorders like cataracts and refractive error as causes of visual impairment.

During the COVID-19 pandemic, accessibility to eye care was compromised, and more low-vision and blind patients could be expected due to future delays in treatment and management. Different studies targeting low vision and blind children could be initiated as low childhood vision, and blind data is much lesser than adults. Aside from studying the prevalence of low vision and blindness, a multidisciplinary service could be conducted to evaluate the outcome of low vision and blind rehabilitation services in Miri Hospital.

CONCLUSION

Our population's leading causes of permanent vision impairment were diabetic retinopathy, glaucoma, retinitis pigmentosa, and age-related macular degeneration. Diabetic retinopathy is the leading cause of low vision, while glaucoma is the leading cause of blindness. Eye health screening as early as age 40 is recommended for patients with systemic disease. With early detection and effective intervention available, morbidity from these conditions can be avoided. For patients diagnosed with low vision and blind, integrated low vision and blind rehabilitation training should be accessible in all public healthcare systems. For the stakeholder, enforcing low vision and blind registry, fortifying low vision rehabilitation services, and transparent mechanisms of welfare intervention are the measures for more holistic low vision and blind management.

CONFLICT OF INTEREST

The authors declare that they have no competing interests in publishing this article.

ACKNOWLEDGEMENTS

The authors would like to thank the Ministry of Health Malaysia Director General for his kind permission to publish this article.

REFERENCES

Akhtar, S., Nasir, J. A., Ali, A., Asghar, M., Majeed, R., & Sarwar, A. (2022). Prevalence of type-2 diabetes and prediabetes in Malaysia: A systematic review and meta-analysis. *PloS one*, *17* (1), e0263139. https://doi.org/10.1371/journal.pone.02631309

Alyana, N., Sahdi, H., Rasit, A. H., & Zabidah, P. (2018). Barriers affecting clubfoot treatment in Sarawak. *Journal of Health and Translational Medicine*, *21* (2), 15 – 22.

Amblyopia and Visual Impairment Screening Ministry of Health Malaysia (AVISKKM). (2017, October 10). https://web.facebook.com/AVISKKM/about

Baarah, B. T., Shatnawi, R. A., & Khatatbeh, A. E. (2018). Causes of Permanent Severe Visual Impairment and Blindness among Jordanian Population. *Middle East African Journal of Ophthalmology*, *25* (1), 25 – 29. https://doi.org/10.4103/meajo.MEAJO_202_16

Bakar, N. F., Chen, A. H., Noor, A. R., & Goh, P. P. (2012). Comparison of refractive error and visual impairment between native Iban and Malay in a formal government school vision loss prevention programme. *The Malaysian Journal of Medical Sciences*, *19* (2), 48 – 55.

Bakkar, M. M., Alzghoul, E. A., & Haddad, M. F. (2018). Clinical characteristics and causes of visual impairment in a low vision clinic in northern Jordan. *Clinical Ophthalmology (Auckland, N.Z.)*, *12*, 631 – 637. https://doi.org/10.2147/OPTH.S153754

Buang, S. N. (2013, September 27). School Health Service. PORTAL MyHEALTH. http://www.myhealth.gov.my/en/school-health-service/

Chew, F., Salowi, M. A., Mustari, Z., Husni, M. A., Hussein, E., Adnan, T.H., Ngah, N. F., Limburg, H., & Goh, P. P. (2018). Estimates of visual impairment and its causes from the National Eye Survey in Malaysia (NESII). *PloS one*, *13* (6), e0198799. https://doi.org/10.1371/journal.pone.0198799

Chotikavanich, S., Chanvarapha, N., Loket, S., Yingyong, R., Dongngam, S., Nujoi, W., Sangsre, P., Maneephagaphan, K., Rungsiri, K., & Krutthong, W. (2018). A 5-year retrospective record review of hospital-based low-vision rehabilitation in Thailand. *Clinical Optometry*, *10*, 41 – 50. https://doi.org/10.2147/OPTO.S160103

Department of Statistics Malaysia Official Portal. (2020, July 10). Household Income and Basic Amenities Survey Report 2019. https://www.dosm.gov.my/v1/index.php?r=column/cthemeByCat&cat=120&bul_id=TU00TmRhQ1N5TUxHVWN0T2VjbXJYZz09&menu_id=amVoWU54UTl0a21NWmdhMjFMMWcyZz09

Gogate, P., Gilbert, C., & Zin, A. (2011). Severe visual impairment and blind in infants: Causes and opportunities for control. *Middle East African Journal of Ophthalmology*, *18* (2), 109 – 114. https://doi.org/10.4103/0974-9233.80698

Hussein, Z., Taher, S. W., Gilcharan Singh, H. K., & Chee Siew Swee, W. (2015). Diabetes Care in Malaysia: Problems, New Models, and Solutions. *Annals of Global Health*, *81* (6), 851 – 862. https://doi.org/10.1016/j.aogh.2015.12.016

Institute for Public Health. (2020). National Health and Morbidity Survey (NHMS) 2019: Non-communicable diseases, healthcare demand, and health literacy—Key Findings. National Institutes of Health (NIH) Ministry of Health Malaysia. https://iptk.moh.gov.my/images/technical_report/2020/4_Infographic_Booklet_NHMS_2019_-_English.pdf

Iqbal, F., Khalil, I., Khalil, H. A., Sadiq, M., Noor, H. A., & Zahid, M. (2019). Frequency of low vision patient and their causes presenting in Madinah Teaching Hospital, Pakistan. *Advances in Ophthalmology & Visual System*, *9* (6),151 – 154. https://doi.org/10.15406/aovs.2019.09.00368

Jaafar, N., Perialathan, K., Krishnan, M., Juatan, N., Ahmad, M., Mien, T. Y. S., Salleh, K. Z., Isa, A., Mohamed, S. S., Hanit, N. H. A., Hasani, W. S. R., Mohamad, E. M. W., & Johari, M. Z. (2021). Malaysian Health Literacy: Scorecard Performance from a National Survey. *International Journal of Environmental Research and Public Health*, *18* (11), 5813. https://doi.org/10.3390/ijerph18115813

Küçük, E., Zor, K. R. & Yilmaz, U. (2019). Causes of Blindness and Moderate-Severe Visual Impairment in Niğde, Central Anatolia, Turkey. *Erciyes Medical Journal*, *41* (4), 420 – 424.

Kumaramanickavel, G., Joseph, B., Vidhya, A., Arokiasamy, T. & Shridhara Shetty, N. (2002). Consanguinity and Ocular Genetic Diseases in South India. *Community Genetics*, *5* (3), 182 – 185. https://doi.org/10.1159/000066334

Latar Belakang Hospital Miri. (2022, August 18). Hospital Miri. https://hmiri.moh.gov.my/v2/latar-belakang-hospital-miri/

Leng, T. S., Saimon, R. Rahman, M. M., Safii, R., Lian, H. S., John, N., Thai, L. L., & Arsad, N. (2021). Visual health and its relation with screen time among school children: a cross-sectional study in Sarawak, Malaysia. *International Journal of Online and Biomedical Engineering*, *17* (08), 168 – 175. https://doi.org/10.3991/ijoe.v17i08.24607

Lim, H. P. (2020). Sarawak household income on the increase, latest survey finds. *Borneo Post Online*. https://www.theborneopost.com/2020/09/23/sarawak-household-income-on-the-increase-latest-survey-finds/

Marques, A. P., Ramke, J., Cairns, J., Butt, T., Zhang, J.H., Muirhead, D., Jones, I., Tong, B., Swenor, B. K., Faal, H., Bourne, R., Frick, K. D., & Burton, M. J. (2021). Global economic productivity losses from vision impairment and blindness. *EClinical Medicine*, *35*, 100852. https://doi.org/10.1016/j.eclinm.2021.100852

Mohidin, N., & Yusoff, S. (1998). Profile of a low vision clinic population. *Clinical and Experimental Optometry*, *81* (5), 198 – 202. https://doi.org/10.1111/j.1444-0938.1998.tb06735.x

Olusanya, B., Onoja, G., Ibraheem, W., & Bekibele, C. (2012). Profile of patients presenting at a low vision clinic in a developing country. *BMC Ophthalmology*, *12,* 31 (2012). https://doi.org/10.1186/1471-2415-12-31

Omar, R. (2010). Low vision rehabilitation can improve quality of life. *Social Welfare Journal*, *36* (6), 99 – 110.

Pantang Larang Adat Perkahwinan Kaum Iban Yang Anda Perlu Tahu. (2018, 22 January). https://kamekmiaksarawak.com/pantang-larang-adat-perkahwinan-kaum-iban-yang-anda-perlu-tahu/

Premsenthil, M., Manju, R., Thanaraj, A., Rahman, S. A., & Tan, A. K. (2013). The screening of visual impairment among preschool children in an urban population in Malaysia; the Kuching pediatric eye study: a cross sectional study. *BMC Ophthalmology, 13(*16). https://doi.org/10.1186/1471-3415-13-16

Rahman, M. H. A., Kee, Q. T., Mohammed, Z., Fadzil, N., Sahar, S. & Ahmad, M. (2020). Visual impairment among older adults in Selangor state of Malaysia: The grand challenge project. *Journal of Clinical and Diagnostic Research*, *14* (01).

Rahman, M., Rahim, N. A. & Arif, M. T. (2017). Barrier, weakness and utilization of pre-pregnancy clinic services. *Archives of Public Health*, *75*, 67. https://doi.org/10.1186/s13690-017-0236-2

Reddy, S., Tajunisah, I., Low, K. P., & Karmila, A. (2008). Prevalence of eye diseases and visual impairment in urban population - a study from university of malaya medical centre. *Malaysian Family Physician: The Official Journal of the Academy of Family Physicians of Malaysia*, *3* (1), 25 – 28.

Risso-Gill, I., Balabanova, D., Majid, F., Ng, K. K., Yusoff, K., Mustapha, F., Kühlbrandt, C., Nieuwlaat, R., Schwalm, J. D., Mccready, T., Teo, K. K., Yusuf, S., & Mckee, M. (2015). Understanding the modifiable health systems barriers to hypertension management in Malaysia: A multi-method health systems appraisal approach. *BMC Health Services Research*, *15*, 254. https://doi.org/10.1186/s12913-015-0916-y

Sheng, X., Rong, W., & Liu, Y. (2012). The inheritance mode and clinical characteristics of retinitis pigmentosa in Northwest China. *Investigative Ophthalmology & Visual Science Journal*, *53* (14), 4596.

Taylor Kulp, M. (1999). Relationship between visual motor integration skill and academic performance in kindergarten through third grade. *Optometry and Vision Science: Official Publication of the American Academy of Optometry*, *76* (3), 159 – 163. https://doi.org/10.1097/00006324-199903000-00015

The Official Portal of Sarawak Data. (2017). *Sarawak Population by District 2017*. https://data.sarawak.gov.my/home/data/resource/d8336af5-4667-463f-aa61-441edad63d08

Thevi, T., Basri, M., & Reddy, S. (2012). Prevalence of eye diseases and visual impairment among the rural population - a case study of temerloh hospital. *Malaysian Family Physician: The Official Journal of the Academy of Family Physicians of Malaysia*, *7* (1), 6 – 10.

Turbert, D., & Whitman, J. (2022, Apr. 08). Get an eye disease screening at 40. https://www.aao.org/eye-health/tips-prevention/screening

van Nispen, R. M., Virgili, G., Hoeben, M., Langelaan, M., Klevering, J., Keunen, J. E., &, van Rens, G. H. (2020). Low vision rehabilitation for better quality of life in visually impaired adults. *The Cochrane Database of Systematic Reviews*, *1* (1), CD006543. https://doi.org/10.1002/14651858.CD006543.pub2

Wong, T. Y., Chong, E. W., Wong, W. L., Rosman, M., Aung, T., Loo, J. L., Shen, S., Loon, S. C., Tan, D. T., Tai, E. S., Saw, S. M., & Singapore Malay Eye Study Team (2008). Prevalence and causes of low vision and blindness in an urban Malay population: The Singapore Malay Eye Study. *Archives of Ophthalmology (Chicago, Ill 1960)*, *126* (8), 1091 – 1099. https://doi.org/10.1001/archopht.126.8.1091

Wong, T. Y., Tham, Y. C., Sabanayagam, C., & Cheng, C. Y. (2019). Patterns and risk factor profiles of visual loss in a multiethnic Asian population: The Singapore epidemiology of eye diseases study. *American Journal of Ophthalmology*, *206*, 48 – 73. https://doi.org/10.1016/j.ajo.2019.05.006

World Health Organization. (2010). International Statistical Classification of Diseases and Related Health Problems 10th Revision. https://icd.who.int/browse10/2010/en

World Health Organization. (2021, 14 October). *Blindness and visual impairment*. https://www.who.int/news-room/fact-sheets/detail/blind-and-visual-impairment

Zainal, M., Ismail, S. M., Ropilah, A. R., Elias, H., Arumugam, G., Alias, D., Fathilah, J., Lim, T. O., Ding, L. M., & Goh, P. P. (2002). Prevalence of blind and low vision in Malaysian population: Results from the National Eye Survey 1996. *The British Journal of Ophthalmology*, *86* (9), 951 – 956. https://doi.org/10.1136/bjo.86.9.951