

Research Article

Referrals from an Optometric Practice to the Hospital Eye Services in Singapore – A Two-Year Pre- & During-Covid Retrospective Study

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Abstract

Purpose: This two-year retrospective study investigated the referral rate and eye conditions referred from an optometric practice in Singapore pre- and during-Covid.

Materials & Methods: Data collection (audit period) was done from Mar to May 2021. In total, 10582 patient records seen during the period of 14 Feb 2019 to 6 Feb 2021 were extracted. Five thousand three hundred and seventy-eight records were done in Year 1 (pre-Covid: 14 Feb 2019 to 31 Jan 2020) and 5204 records were done in Year 2 (during-Covid: 1 Feb 2020 to 6 Feb 2021). Data was then tabulated on patient's demography (age, gender, ethnicity), audit period, whether the patient was referred, Referral Reply Received (RRR) and the eye conditions being referred, that was categorized to anterior eye anomalies, posterior eye anomalies, glaucoma related eye anomalies and others eye anomalies.

Results: Total eye examination done pre-Covid was 5378 and 709 of them were referred (13.2%) with RRR at 42 (5.9%). Total eye examination done during-Covid was slightly lesser at 5204 and 645 of them were referred (12.4%) with RRR at 28 (4.3%). Majority of patients referred are Chinese and aged more than 60 years. 73% of the patients referred pre-Covid and 63% of the patients referred during-Covid were asymptomatic. The most commonly referred eye conditions were glaucoma, cataract/PCO, retinal and macular anomalies.

Discussion: High referral rate shown in this study does not represent the referral rate in the country as the data was collected in a single optometric practice. This study has demonstrated the role of optometrists in primary eye care through early detection of various eye conditions and save sight.

Keywords: Referral; Optometrists; Ophthalmologists; Hospital eye services; Pre-Covid; During-Covid

Introduction

In Singapore, optometrists' roles are limited compared to their counterparts elsewhere [6] as they are not licensed to use diagnostic pharmaceuticals. A survey on 230 optometrists in Singapore has shown that though their self-reported primary eye care knowledge is high, their confidence in screening and co-managing chronic eye conditions was low. There were evidence-based answers to issues revolving around optometrists' readiness for a role expansion [6]. The Optometrists & Opticians Board (OOB) is the regulating authority for optometrists and opticians in Singapore. According to OOB, optometrists are primary eye care providers who specialize in performing eye examinations and refer their patients to ophthalmologists when eye diseases is detected [10]. To date, there is no report on the optometrists' referral to Hospital Eye Services (HES) ophthalmologist in Singapore.

There have been few reports on referral rate in other countries. A paper in United States on 15 research studies over 33 years of research (1961-1993) has reported a referral rate of 3.83 - 5.5% by

optometrists to ophthalmologists and other providers. In the study, cataract and glaucoma were the most common conditions referred. Optometrists in private practice appear to be referring patients at rates consistent with referrals by optometrists who practice in more managed environments [1]. A study in Australia has reported an overall referral rate of 9% for all ages; where 2.4% were asymptomatic. There was a similar number of asymptomatic patients referred in the adult (20 to 64 years) age group compared to all ages (2.5%) [3]. Studies in the UK reported a referral rate ranged from 3.6% to 8.7% from community optometrists to HES [5,17]. On the other hand, El-Abiary et al. [4] reported an average referral rate from community optometry to HES that shown to have increased from 2.5% to 4.1% from 2010/11 to 2018/19 throughout Scotland with a 14.8% annual rise in optometry referrals to HES.

Covid-19 pandemic in Singapore is part of the worldwide pandemic of coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The first case in Singapore was confirmed on 23 January 2020. Early cases were primarily imported until local transmission began to develop

in February and March 2020 [2]. In this study, Feb 2020 was taken as a cut-off date for the start of Covid era in Singapore, in view of the surge in community cases. This study investigated the referral rate and eye conditions referred from a well equipped optometric practice in Singapore pre-Covid (a year before Feb 2020) and during-Covid (a year from Feb 2020 onwards) period.

Materials and Methods

This is a two-year retrospective study. Data collection (audit period) was done from Mar to May 2021 by three individuals (KK, KR and KY). In total, 10582 patient records seen in Pearl’s Optical Co. Pte Ltd. during the period of 14 Feb 2019 to 6 Feb 2021 were extracted. Five thousand three hundred and seventy-eight of the records were done in Year 1 (pre-Covid: 14 Feb 2019 to 31 Jan 2020) and 5204 of the records were done in Year 2 (during-Covid: 1 Feb 2020 to 6 Feb 2021). Data was then tabulated on patient’s demography (age, gender, ethnicity), audit period, whether the patient was referred, Referral Reply Received (RRR) and the eye conditions being referred, that was categorized to anterior eye anomalies, posterior eye anomalies, glaucoma related eye anomalies and others eye anomalies (Table 1). This study was granted exempt status by the Institutional Review Board of Singapore Polytechnic.

Pearl’s Optical Co. Pte Ltd. is a fully licensed private practice with eight registered optometrists under OOB. It started in 1975. Other than refractometer, Slit Lamp biomicroscope and Keratometer, the practice is well equipped with various diagnostic instruments such as OCT/OCTA; Optos Daytona (Ultra-wide field) with Fundus Autofluorescence; non-contact tonometer/pachymeter; Humphrey Visual Field, ocular biometer and Corneal Topographer. All patients visiting the Pearl’s Optical Co. Pte Ltd. undergone comprehensive eye examination workflow as shown in Figure 1.

Results

At pre-Covid period, total eye examination done was 5378 and 709 of them were referred (13.2%) with relatively low referral reply received (RRR) at 42 (5.9%). In contrast, during-Covid period, total

eye examination done was slightly lesser at 5204 and 645 of them were referred (12.4%) and again, the RRR was low at 28 (4.3%). During the two-year study period (pre- & during Covid), total eye examination was 10582 and 1354 of them were referred (12.8%) and the RRR was 70 (5.0%) (Table 2).

Table 3 shows the demography of the 1354 patients that being referred. Six-hundred and ninety-three of them are males and 661 are females. Majority of them are Chinese (1280 of them), followed by Malay (25), Indian (18) and other ethnicity (31). 625 of them were aged > 60 years, 290 of them were aged 51-60 years, 253 of them were aged 41-50 years, 66 of them aged 31-40 years, 59 of them aged 21-30 and 61 of them aged <= 20 years.

Are The Patients Referred Symptomatic or Asymptomatic?

Majority of the patients referred were asymptomatic. At pre-Covid period, 73% (517 out of the 709) of the patients referred were asymptomatic. Reasons for visiting optometrists for these asymptomatic patients were for regular eye check, making a pair of spectacles or merely for contact lens after care (498 of them); or with intention to replace their spectacles and/or contact lenses (19 of them). On the other hand, 27% were symptomatic (192 out of 709). Symptoms presented were blur vision (151 of them), red eyes (2 of them), pain/irritation/discomfort (5 of them), diplopia (2 of them), floaters/floats (12 of them), and others (20 of them) such as headache (8), migraine (3), watery eyes (2), hazy/shadow vision (2), sudden metamorphopsia (1), asthenopia (1), giddiness (1), eye itiness/tearing (1), and membrane blocking vision (1).

During-Covid period, 63% (406 out of 645) of the patients were asymptomatic. They visited optometrists for the same reasons as above, for regular eye check, making a pair of spectacles and merely for contact lens after care (385 of them); or with the intention to replace their spectacles and/or contact lenses (21 of them). On the other hand, 37% (239 out of 645) were symptomatic. Symptoms presented were blur vision (190 of them), red eyes (3 of them), pain/irritation/discomfort (10 of them), diplopia (5 of them), floaters/floats (10 of them), and others (21 of them) such as headache (16),

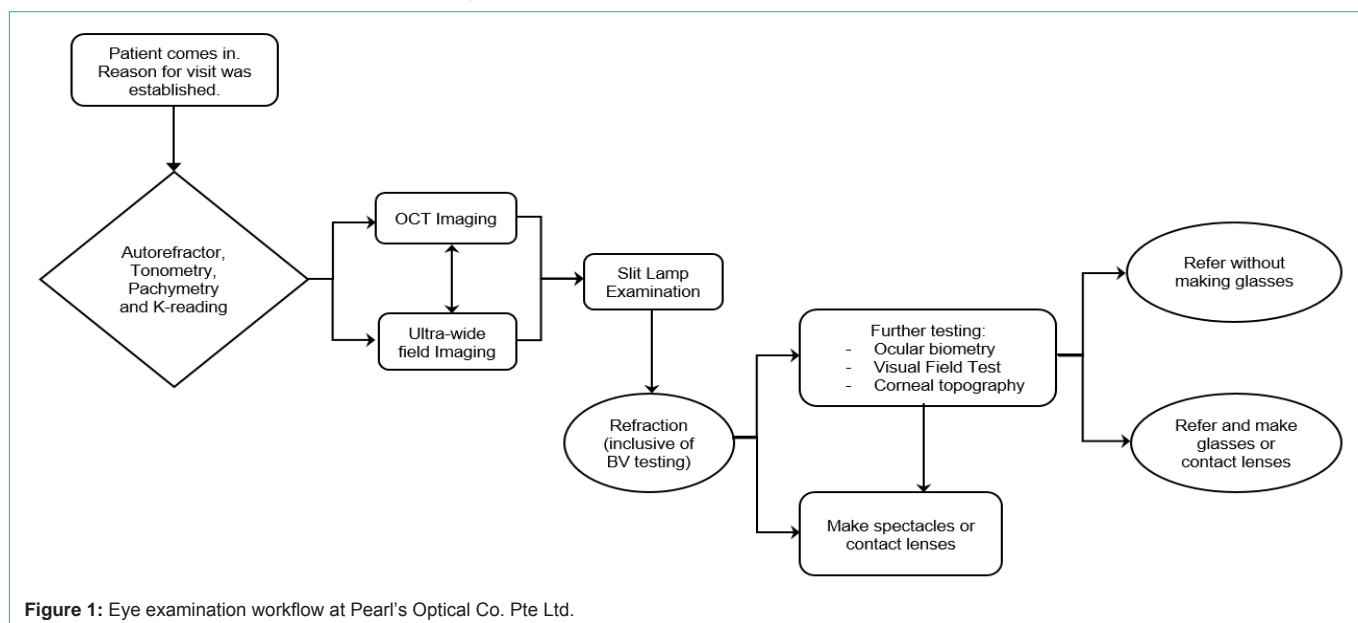


Figure 1: Eye examination workflow at Pearl's Optical Co. Pte Ltd.

Table 1: Data extracted and tabulated.

Data	Remarks
Subject's demography	Age, gender, ethnicity
Audit period	Month/year data was audited.
Whether the patient was referred and if yes, to where?	Hospital eye services (HES)
Categories of eye conditions	Anterior eye anomalies, posterior eye anomalies, glaucoma-related eye anomalies, others eye anomalies.
RRR	Referral reply received
Eye conditions	Neurological, ocular motor anomalies/orthoptic, macular lesions, retinal lesions, lid anomalies, tear film anomalies, corneal/conjunctival lesions, PCO, other conditions, etc.

Table 2: Audit period - Mar to May 2021.

Year	Px visit date	Total eye exam	Total referral (a)	% referral	Total RRR (b)	% RRR (% b/a)	
Year 1	pre-Covid	14 Feb 2019 - 31 Jan 2020	5378	709	13.2	42	5.9
Year 2	during Covid	1 Feb 2020 - 6 Feb 2021	5204	645	12.4	28	4.3
Total (pre- & during-Covid)		10582	1354	12.8	70	5.0	

Table 3: Subject demography - total number of patients being referred according to age, gender and ethnicity.

Gender	Ethnicity	Age (years)
Male	Chinese	> 60
Female	Malay	51-60
	Indian	41-50
	Others	31-40
		21-30
		<=20

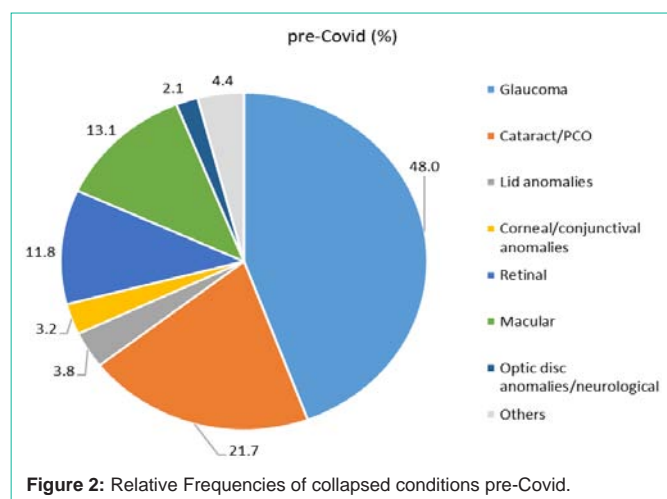


Figure 2: Relative Frequencies of collapsed conditions pre-Covid.

loss of peripheral vision (1), stye (1), eye injury (1), photophobia (1) and asthenopia (1).

Eye Conditions Referred Pre- vs During-Covid

The eye conditions referred pre- and during-Covid are summarized in Table 4 to 7. The eye conditions were categorized as anterior eye anomalies (Table 4), posterior eye anomalies (Table 5), glaucoma-related anomalies (Table 6) and others eye anomalies (Table 7).

As shown in Table 4, total number of anterior eye anomalies referred pre-Covid was 208 (29.3%), almost similar to those referred

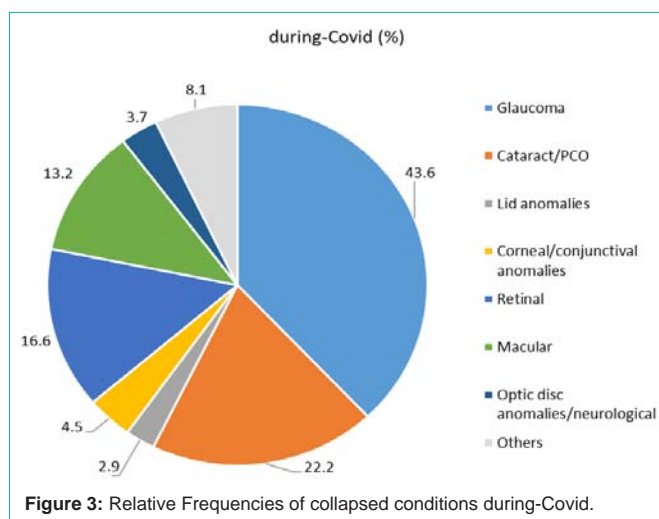


Figure 3: Relative Frequencies of collapsed conditions during-Covid.

during-Covid, 192 (29.8%). Percentage (%) in this report represents the percentage of eye conditions referred based on total referral (709 for pre-Covid and 645 for during-Covid). Majority of the anterior eye anomalies referred were lens anomalies (Cataract/PCO/IOL subluxation) with 154 cases (21.7%) pre-Covid and 143 cases (22.2%) during-Covid, followed by lid anomalies (ptosis, lid papilloma, trichiasis, hordeolum, etc) with 27 cases (3.8%) pre-Covid and 19 cases (2.9%) during-Covid and corneal/conjunctival anomalies (Cornea lesions such as guttata/abrasion/odema/endothelial dystrophy/polymegathism, keratoconus, conjunctivitis, allergic limbitis etc) with 23 cases (3.2%) pre-Covid and 29 cases (4.5%) during-Covid.

As shown in (Table 5), total number of posterior eye anomalies referred during-Covid was 216 (33.5%), more than those referred pre-Covid, 192 (27.1%). This applied to both retinal anomalies and optic disc/neurological anomalies. Retinal anomalies (retinal tear/hole/dark lesion/peripheral retinal degeneration/retinal detachment/Retinoschisis/ Retinoschisis, etc) contributed to about 107 cases (16.6%) during-Covid and 84 cases (11.8%) pre-Covid and optic disc/neurological anomalies (non-glaucoma-related optic neuropathy/papilloedema/optic neuritis/indistinct optic nerve head, etc) contributed to about 24 cases (3.7%) during-Covid and 15 cases

Table 4: Anterior eye anomalies referred pre-Covid vs during-Covid.

Anterior Eye Anomalies	pre-Covid	%	during-Covid	%
Lens anomalies				
Cataract (CC and NS)	123	17.3	122	18.9
Posterior capsular opacification	29	4.1	21	3.3
IOL Subluxation	2	0.3	0	0.0
Total	154	21.7	143	22.2
Tear film anomalies				
Dry eyes	3	0.4	0	0.0
Lacrimal blockage	1	0.1	0	0.0
Punctal stenosis	0	0.0	1	0.2
Total	4	0.6	1	0.2
Lid anomalies				
Ptosis	20	2.8	9	1.4
Hordeolum	1	0.1	1	0.2
Melanoma	1	0.1	0	0.0
Lid wiper epitheliopathy	1	0.1	0	0.0
Lid papilloma	2	0.3	1	0.2
Trichiasis	2	0.3	1	0.2
Epiblepharon (upper lid)	0	0.0	1	0.2
Stye	0	0.0	2	0.3
Palpehral conjunctiva granuloma	0	0.0	1	0.2
Lid Laceration	0	0.0	1	0.2
Entropion	0	0.0	2	0.3
Total	27	3.8	19	2.9
Corneal/conjunctival anomalies				
Cornea lesions (guttata, abrasion, odema, endothelial dystrophy, polymegathism)	15	2.1	15	2.3
Keratoconus	4	0.6	5	0.8
Corneal graft	0	0.0	2	0.3
Keratopathy	1	0.1	0	0.0
Conjunctivitis	2	0.3	2	0.3
Allergic Limbitis	0	0.0	3	0.5
Adenoviral infection	0	0.0	2	0.3
Total	23	3.2	29	4.5
Grand Total of Anterior eye anomalies	208	29.3	192	29.8

% = percentage of eye conditions referred based on total referral

(2.1%) pre-Covid. For macular conditions (wet & dry AMD/epiretinal membrane/macular pucker/maculopathy/macular hole/CSR/PED/macular oedema/ vitreomacular traction, etc), it was slightly more pre-Covid, 93 cases (13.1%) than during-Covid, 85 cases (13.2%)

Glaucoma-related anomalies made the highest referral rate in this study. As shown in (Table 6), cases referred pre-Covid was 340 (48.0%), more than those referred during-Covid, 281 (43.6%). Majority of them were ACG/ACG suspect, NTG/NTG suspect and POAG/POAG suspect and ocular hypertension, etc.

Others eye anomalies refers to eye conditions that do not fall into anterior/posterior/glaucoma-related anomalies, but include uveitis.

Table 5: Posterior eye anomalies referred pre-Covid vs during-Covid.

Posterior Eye Anomalies	pre-Covid	%	during-Covid	%
Retinal Anomalies				
Peripheral retinal degeneration (lattice, snail-track)	27	3.8	28	4.3
Retinal tear/hole/dark lesion	28	3.9	39	6.0
Retinal detachment	4	0.6	6	0.9
Retinoschisis	2	0.3	2	0.3
Retinitis pigmentosa	0	0.0	1	0.2
Retinal hyperfluorescence	17	2.4	13	2.0
Diabetic retinopathy (with dot-blot hemorrhage)	5	0.7	7	1.1
Hypertensive retinopathy	0	0.0	4	0.6
Arteriosclerosis of retinal arteries	0	0.0	1	0.2
Branch retinal vein occlusion	0	0.0	3	0.5
Caruncle raised lesion, flame haemorrhage	0	0.0	1	0.2
Retinoblastoma	0	0.0	1	0.2
Serous Retinopathy	1	0.1	0	0.0
Subretinal fluid	0	0.0	1	0.2
Total	84	11.8	107	16.6
Macular conditions				
Wet AMD	19	2.7	26	4.0
Dry AMD	13	1.8	6	0.9
Epiretinal membrane / macular pucker	14	2.0	17	2.6
Maculopathy	12	1.7	3	0.5
Macular hole (full or partial)	6	0.8	9	1.4
Central serous retinopathy	7	1.0	6	0.9
Pigment epithelial detachment	9	1.3	4	0.6
Macular swelling/oedema	6	0.8	3	0.5
Vitreomacular traction	3	0.4	4	0.6
Cystoid macular oedema	2	0.3	6	0.9
Best disease	1	0.1	0	0.0
Macular hyperfluorescence	1	0.1	1	0.2
Total	93	13.1	85	13.2
Optic disc anomalies/Neurological				
Optic neuropathy	7	1.0	9	1.4
Pale discs	4	0.6	0	0.0
Retinal nerve fiber thinning	1	0.1	0	0.0
RAPD	2	0.3	0	0.0
Enlarged blind spot	1	0.1	0	0.0
Migraine aura	0	0.0	1	0.2
Neurological lesions	0	0.0	1	0.2
Nerve palsy	0	0.0	1	0.2
Brain Tumor	0	0.0	1	0.2
Papilloedema	0	0.0	2	0.3
Optic neuritis	0	0.0	3	0.5
Indistinct optic nerve head	0	0.0	4	0.6
Marcus Gunn pupil	0	0.0	1	0.2
Melanocytoma (dark raised lesion at optic disc)	0	0.0	1	0.2
Total	15	2.1	24	3.7
Grand Total of Posterior eye anomalies	192	27.1	216	33.5

% = percentage of eye conditions referred based on total referral

Table 6: Glaucoma-related anomalies referred pre-Covid vs during-Covid.

Glaucoma-related anomalies	pre-Covid	%	during-Covid	%
ACG/ACG suspect	137	19.3	126	19.5
NTG/NTG suspect	130	18.3	109	16.9
POAG/POAG suspect	63	8.9	32	5.0
Ocular hypertension	9	1.3	12	1.9
Pigment dispersion syndrome	1	0.1	1	0.2
Posner-schlossman syndrome	0	0.0	1	0.2
Total	340	48.0	281	43.6

% = percentage of eye conditions referred based on total referral

Table 7: Others eye anomalies referred pre-Covid vs during-Covid.

Others	pre-Covid	%	during-Covid	%
Unexplained blur/lost of vision	9	1.3	10	1.6
Atropine therapy for myopia control	1	0.1	22	3.4
Posterior vitreous detachment	7	1.0	5	0.8
Diplopia	3	0.4	6	0.9
Floater/Dilated fundus examination	2	0.3	2	0.3
Steroid responder	1	0.1	1	0.2
Raised iris	1	0.1	0	0.0
Raised choroidal nevus	3	0.4	0	0.0
Cycloplegic refraction	1	0.1	0	0.0
Amblyopia with exotropia	0	0.0	1	0.2
Amaurosis Fugax	1	0.1	0	0.0
Contact lens implant	0	0.0	1	0.2
Mild RG deficiency	0	0.0	1	0.2
Discomfort, pain due to stitch post-cataract surgery	0	0.0	1	0.2
Choroidal dark lesion	0	0.0	1	0.2
Viral infection	1	0.1	0	0.0
Uveitis	1	0.1	0	0.0
Grand total of others eye anomalies	31	4.4	51	7.9

% = percentage of eye conditions referred based on total referral

There were 51 cases (7.9%) during-Covid, more than those recorded pre-Covid, 31 cases (4.4%). Cases referred include atropine therapy for myopia control/unexplained blur/loss of vision/unexplained diplopia/simplely for dilated fundus examination, etc (Table 7).

The Most Commonly Referred Eye Conditions

The most commonly referred eye conditions were collapsed into eight categories: glaucoma, cataract/PCO, lid anomalies, corneal/conjunctival anomalies, retina/macular anomalies, optic disc/neurological anomalies and others (including uveitis). For these collapsed categories, the relative frequencies of the pooled data are shown in Figure 2 (pre-Covid) and Figure 3 (during-Covid). The results show that glaucoma, cataract/PCO, retinal and macular anomalies were the predominant reason for referral by optometrists at the Pearl's Optical Co. Pte Ltd. to ophthalmologists in HES.

Discussion

Referral rate from the optometric practice studied to the HES in Singapore has shown to be 13.2% pre-Covid and 12.4% during-Covid

with glaucoma, cataract/PCO, retinal and macular anomalies being the most commonly referred eye conditions. This is the first study on patient's referral by optometrists in the country. The figure is higher as compared to what has been reported in the United States (3.83 - 5.5%; Brin and Griffin [1]), Australia (9%; Dobbelsteyn et al. [3]) and UK (3.6 - 8.7%; Evans et al., Swystun and Davey [5,17]) but quite similar to the referral rate reported in Scotland (14.8% annual rise; El-Abiary et al. [4]). Majority of the patients referred are Chinese and aged > 60 years. This was in agreement with the report by Swystun and Davey [17] that older patients above the age of 60 were four times more likely to be referred than children; as well as the report by Wang et al. [18] that Chinese ethnicity was more prone to have narrow anterior chamber angles and required referrals. According to the Optometrists & Opticians Board (OOB) advisory guide, patients with anterior chamber angles of less than 1/4th (25%) regardless of visual acuity must be referred to ascertain his/her risk for glaucoma [10]. Furthermore, there were patients referred for more than one eye conditions (eg. cataract with retinal/macular anomalies). The above factors could have contributed to the high referral rate in this study. As the data was collected in a single practice, it does not represent a figure in the country. To reflect the referral rate for optometrists in Singapore, a population/multicenter study is required. Another limitation of this study is that the outcomes of the referral was not captured.

As optometrists in Singapore are not licensed to use diagnostic pharmaceuticals [6], this has caused limitation in the examination techniques eg. dilated fundus examination, contact tonometry and gonioscopy. However, with the advancement of technologies, the legislation does not stop the optometrists to practice primary eye care and that includes the examination of the anterior & posterior eye health as well as glaucoma detection and neurological anomalies. For examples, posterior eye anomalies can be detected by fundus camera and more peripheral retinal anomalies can be detected using ultra-wide field camera coupled with Fundus Auto-Fluorescence function. On the other hand, anterior eye anomalies can be detected by slit lamp biomicroscopy and glaucoma-related anomalies can be detected through non-contact tonometry, pachymetry, visual field assessment and Optical Coherence Tomography (OCT/OCTA).

Anterior Eye Anomalies

From this study, the cases referred by optometrists to HES due to anterior eye anomalies such as lens anomalies (cataract/PCO/IOL subluxation), lid anomalies and corneal/conjunctival anomalies did not differ much during- and pre-Covid. These cases were less acute and urgent and therefore Covid did not affect them much.

Posterior Eye Anomalies, Glaucoma-Related Anomalies and Others Eye Anomalies

More referral were done by optometrists to HES on cases that is more acute and urgent such as retinal tears/holes/detachments and wet Age-related Macular Degeneration (AMD) during-Covid. There were 6.4% more cases referred during-Covid compared to pre-Covid for posterior eye anomalies include retinal anomalies and optic disc/neurological anomalies. For such conditions, patients have chosen to see the optometrists than visiting the public hospitals. This could be due to the concerns of the Covid infections that were higher in the hospitals, having trouble adhering to the Safety Management Measures

(SMM) of simply difficult to get an appointment in the hospitals. Likewise, for others eye anomalies such as uveitis, unexplained blur/loss of vision/unexplained diplopia, these acute and urgent cases has caused patients to visit optometrist more during-Covid season as patients were seeking for a more urgent eye care service. We have observed that 37% patients were symptomatic (239 out of 645) during-Covid compared to 27% pre-Covid (192 out of 709), more patients experience symptoms related to their eyes during-Covid and have driven them to visit optometrists. The opposite has happened for glaucoma-related anomalies such as NTG/NTG suspect and POAG/POAG suspect, whereby fewer cases were referred during-Covid. As these were less urgent and had no symptoms, patients preferred to wait and seek for medical advice later.

The Most Commonly Referred Eye Conditions

This study shows that glaucoma, cataract/PCO, retinal and macular anomalies were the predominant reason for referral by optometrists at the Pearl's Optical Co. Pte Ltd. to ophthalmologists in HES. Prior studies conducted in UK have reported cataract as a predominant reason of referral [8,9,12,13]. Cataract usually co-existed with another condition. This could be detrimental as cataract develops relatively slowly compared to other eye conditions, such as retinal/macular anomalies, and thus may be considered less urgent. Ophthalmological appointment may be delayed if a patient be solely referred for cataract while there is other underlying condition, and that could lead to serious deterioration of the patient's condition. In another report, optometrists had demonstrated a higher accuracy compared to general practitioners when referring patients for retinal conditions (75% compared to 68%) and glaucoma (76% compared to 56%) respectively [14]. The study also shows that optometrists and general practitioners has generally good agreement with the ophthalmological diagnoses [14].

Referral Reply Received

The Referral Reply Received (RRR) shown in this study was low pre- and during-Covid. It was only 5.9% pre-Covid and 4.3% during-Covid. The low RRR can be due to the followings:

- (i) The GPs in the polyclinics did not refer patients to the ophthalmologists. The GPs in the polyclinics are not obligated to reply to optometrists in the private practice.
- (ii) The ophthalmologists in the public hospitals replied to the GPs in the polyclinics but it was not cascaded to the optometrists in private practice.
- (iii) Reply to the GPs by ophthalmologists may not be required as both ophthalmologists and GPs in the polyclinics can access the centralized medical record system.

Shah et al. [15] studied 905 de-identified referral letters collected from six optometric practices in an audit period ranging from 12 to 23 months. From the study, the apparent referral reply rate (aRRR) and modified referral reply rate (mRRR) were calculated. The referral was to the appropriate professional in at least 90% of cases for Scotland and > 95% for England and the referral was considered necessary in > 90% of cases for both Scotland and England. The study demonstrated the importance of referral replies that could help maintain high standards of patient care, avoid unnecessary re-referral and close the feedback loop, thereby raising the standard of referrals. In the

next generation of online referral platforms alongside electronic patient record systems, it would be ideal if the record could be made accessible to both the referring optometrist and HES in Singapore. With this, the RRR could be elevated and likewise the standard of eye care in Singapore.

Singapore Primary Care System and Role of Optometrist in Public Eye Health Care

Singapore's primary care system has received an average score of 10.9/30, where "health system characteristics" scored an average of 6.3/18 and "practice characteristics" score and average of 4.6/12 [7]. The study suggests that Singapore's primary care system standard can be further improved in order to adapt to the needs of the population and make the overall healthcare system in Singapore more efficient. A study assessed by an independent panel of four optometrists has documented that optometrists provide a substantial range of eye care, and their individual scope of practice is influenced not only by legal boundaries, but also by financial and organizational factors found within managed care organizations [16].

In a report by George et al. [6], optometrists in Singapore have been reported as an underutilized group of professional medical workers, with high potential in alleviating the stress from hospital specialist outpatient clinics. Optometrists in that study have responded that their current roles were limited to diagnostic refraction (92%), colour vision assessment (65%), contact lens fitting and dispensing (62%) [6]. The current study, however, has shown that comprehensive primary eye care services including anterior and posterior eye health examinations can be carried out in an optometric practice. As such, optometrists' readiness for a role expansion is possible. In Singapore, optometrists may refer their patients to GPs in the community polyclinics for subsidized rate or to private eye clinics (non-subsidized). For the channel through polyclinics, GPs in the polyclinics will then refer the patients to ophthalmologists in the HES. There could be delay in medical consultation by ophthalmologists in the HES due to congested patient pool and a longer waiting time at the HES. As such, urgent or deteriorating cases may be missed and the situation could be worse during-Covid period. Though this study was derived from a single optometric practice, the data has shown that optometrists can play an important role in the primary eye care through early detection of many eye conditions. This will also raise public awareness on the role of optometrists as well as reducing workload for the ophthalmologists at the HES.

From this study, many patients were asymptomatic (73% pre-Covid and 63% during-Covid). They were not aware of their eye conditions as they were at an early stage and asymptomatic. They visited optometrists merely for regular eye check or just getting a pair of spectacles/contact lenses. Through primary eye care, eye conditions such as glaucoma and retinal/macular anomalies can be detected early and save sight. The increasing ageing population in Singapore has led to greater eye care demands and hence the eye health care system. The current study presents evidence about the readiness of optometrists as primary eye care professionals in Singapore.

Conclusion

Majority of the patients referred were asymptomatic but subsequently found to have a degree of pathology or risk thereof requiring referral for ophthalmological consultation. Although the

referral rate shown in this study was a representation of data collected in a single optometric practice, it has demonstrated the role of optometrists in primary eye care through early detection of various eye conditions and save sight.

Declaration of Interest Statement

The first author declares no conflicts of interest and received no financial support for this study. This study does not represent the views from Singapore Polytechnic.

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