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Strengthening keratoconus management systems in South African public sector facilities

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Background: Provision of comprehensive eye care remains a challenge in low to medium income countries including South Africa. The recent surge of keratoconus (KC) is exacerbating this challenge especially in terms of the need for specialised equipment, optical devices, and quality knowledgeable eyecare workforce necessary for KC management.

Aim: This study aimed to analyse the capacity of the public sector facilities in the provision of eyecare service to KC patients in view of developing strategies for strengthening systems for efficiency and effectiveness of KC patient care.

Setting: Public sector hospitals of Capricorn District, Limpopo Province, South Africa.

Methods: Concurrent mixed methods triangulation which included document review of clinical reports on patient headcount, cross-sectional survey of available equipment, working space and eyecare workforce, and key stakeholder and focus group interviews for exploring the perspectives of optometrists on eyecare service provision was conducted.

Results: A significant patient headcount of consulting patients and well-established outreach programmes were reported. Limited knowledge of KC and severe shortages of basic equipment, consumables, and optical devices associated with financial constraints were commonly reported barriers to service provision to KC patients.

Conclusion: The district has made progress in setting up systems for eyecare provision though gaps were identified in the service offered to KC patients. More efforts are required to strengthen the systems in this district for improvement of this service.

Contribution: This article seeks to highlight the capacity of the public sector as the main contributor to eyecare and to strengthen systems for KC patient care.

Keywords: Capricorn District of Limpopo Province; capacity; eyecare service provision; management of keratoconus; optometrist.

Introduction

An estimated 400 million people, globally, have visual impairment (VI), and an additional 36 million live with blindness.[1] Various regions are affected differently.[1] Poor health systems, socio-economic factors, and the burden of HIV and/or AIDS and tuberculosis which are more common in low- and middle-income countries (LMICs) than high-income countries contribute to the burden of VI and blindness.[2] With this burden, there is diminished quality of life (QoL) and the survival expectancy is reduced.[3]

The comprehensive eye care (CEC) strategy of the World Health Organization (WHO) was adopted worldwide to address burden with healthcare service provision. It does not only focus on treatment of the eye conditions but also encompass prevention, promotion, and rehabilitation of incurable blindness.[3] This strategy further integrates community-based stakeholders for broader participation to address VI and blindness.[3] Key issues highlighted in the CEC strategy include: provision of access to eye care services to communities at different stages of life, and prevention, treatment and rehabilitation of visual ailments.[3]

An analysis of the South African National Health and Nutrition Examination Survey (SANHANES-1) suggests a 9.2% prevalence of vision loss in South Africa, where the rural provinces are mostly affected.[4] In Limpopo Province, as an example, in a population of 3400 consulting patients, a 28.0% prevalence of VI was detected. Uncorrected refractive errors, cataract, glaucoma, and corneal anomalies were the leading causes at 56.7%, 20.9%, 9.0% and 7.5%,

respectively.[5] Though this is alarming, recent global studies suggest a likelihood of a rise in keratoconus (KC) prevalence, corneal ectasia characterised by the presence of myopia and astigmatism which result in severe VI in children and young adults.[6,7]

Keratoconus presents as ectasia of the cornea characterised by thinning and protrusion resulting in high myopia and irregular astigmatism.[8] It usually presents as a bilateral and asymmetrical condition.[7] Onset of KC is usually at pubescent years with the condition spanning through life until the fourth decade.[7] Recent studies show KC to have onset in much younger persons than those at pubescent ages.[9,10] In recent reviews of global prevalence of KC, Hashemi et al.[6] estimated 1.38 persons per 1000 for a total population of 50.4 billion people, while Santodomingo-Rubido and colleagues[7] estimated a prevalence of 0.2 to 4790 per 100 000 persons. In Africa, the KC prevalence was estimated at 7.9% in a population of 15 312 persons.[11] Keratoconus prevalence is higher in areas with warmer climates than those with colder climates.[12]

With the presumed increase in KC prevalence globally,[6,7] including in South Africa, a study conducted in the KwaZulu-Natal province of South Africa found deficiency in provision of the minimum optometric care and service patients with KC.[13] This study by Gcabashe and colleagues[13] alluded to lack of equipment and resources as barriers to provision of service to KC patients and suggested a need for improvement in quality of this service. This is the only study, known to the authors, which analysed the practices on the management of KC in South African public facilities. A larger proportion of South Africans, about 62.7%, rely on the public health system as the primary source of health and eye care.[14]

This current study, therefore, aimed to analyse the capacity of the public sector facilities in Capricorn District of Limpopo Province in providing services to KC patients, and to further develop strategies for strengthening systems for efficiency and effectiveness in caring for KC patients. The focus of the study was on optometry service as optometrists are regarded the primary providers of eyecare in South Africa. Optometry service is offered consistently across all selected hospitals, and optometrists play a critical role in screening, examination, diagnosis, treatment and management of KC in these facilities as compared to other forms of service like ophthalmic nursing and ophthalmology services.

Methods

Concurrent triangulation mixed method was applied in the study to combine the strengths of the quantitative and the qualitative research methods. The quantitative methods enabled the measurements of constructs and their operationalisation, the comparison of data from various groups of participants, and highlighting how the variables are associated with one another.[15] The qualitative methods, on the other side, enabled the researchers to document human experiences and their narrative accounts of managing keratoconus in the contexts of their environments.[15] Qualitative methods further allowed an in-depth analysis of complex human, family systems, and cultural experiences of participants that could not be achieved with quantitative methods.[16] The data that were collected from the two sets of research approaches, the quantitative and the qualitative approach, were then triangulated to enhance meaning.[17]

Study setting

Capricorn District has a population of 1 372 355 and is sparsely populated with a density of 63.23 people/km^2.[18] A total of 84.0% of people depend on public health services.[14] Of this population, 52.0% were female, 49.6% live beyond the poverty line, and 48.0% were unemployed.[18] A total of 51% of the people were between the ages of 18 to 65 years.[18]

Sampling

The study was conducted across seven public hospitals in the Capricorn District of the Limpopo Province of South Africa. Polokwane hospital did not grant gatekeeper permission to allow inclusion in the study and was therefore excluded. Monthly and yearly clinic reports for patient headcount in all seven hospitals for a 3-year period, between 01 May 2017 and 31 April 2020, were sampled for the document review part of the study.

Purposive expert sampling technique was used to select participants regarded to have superior knowledge on the items under investigation.[19] A total population of 25 optometrists were purposively sampled to participate in the study as the primary providers of comprehensive eyecare. From this population, seven optometrists who are eye unit managers (EUMs) from each of the seven hospitals, were sampled to participate in the cross-sectional descriptive survey which evaluated the capacity of the district in terms of the eyecare workforce, equipment and the working space. This was conducted over 3 months, between 01 July and 31 September 2020. They further participated in one-on-one key stakeholder interviews. Sixteen other optometrists participated in focus group interviews (FGIs) that aimed to explore their perspectives on the capacity of the district to provide eyecare service to KC patients. Provincial coordinator for eyecare (PCE) and the district coordinator for eyecare (DCE) were also included as participants in key stakeholder interviews.

Data collection

An excel database was developed to capture data on the number of patients who consulted, those examined, those refracted, and those who received spectacles at respective hospitals. Data on the outreach activities at catchment areas including the community-based clinics and schools were also captured.

A self-administered online questionnaire which surveyed the availability of eyecare workforce, equipment and working space was completed by the EUMs in each hospital. The questionnaires were developed using Google Forms and were distributed via email and WhatsApp.

One-on-one stakeholder interviews with the PCE, DCE and EUMs were conducted. These structured interviews were conducted in the offices of the key stakeholders at their respective workplaces lasting for a period of between 42 and 95 min. Additionally, three FGIs were conducted with optometrists who shared their insights and experiences of eyecare service in the district. These structured interviews were conducted online using Zoom Meetings platform, and they lasted between 65 and 73 min. All interviews were recorded and transcribed for analysis.

All coronavirus disease 2019 (COVID-19) protocols were observed in the process to reduce the surge of the pandemic.

Ethical considerations

Ethical clearance to conduct this study was obtained from the University of KwaZulu-Natal (UKZN) Biomedical Research Ethics Committee (BREC) (No. BREC/00001223/2020) and the gatekeeper permission (LP-202005-002) from the Limpopo Department of Health (LDoH). The study observed the Declaration of Helsinki.

Data analysis

Quantitative and qualitative data were analysed, and the findings were presented separately using descriptive and inductive approaches of analysis. Descriptive analysis was performed on patient headcount data collected from document review and data on eyecare workforce, equipment and workspace. These findings were presented in the form of means and percentages. For analysis of the capacity of the workforce, the WHO matrix for Human Resources for Eye Health (HReH)[20,21] was used. In terms of equipment, the Health Professions Council of South Africa (HPCSA) guidelines on minimum equipment list were used as the benchmark for analysis.

For qualitative data analysis, data-driven inductive thematic analysis was used to analyse the qualitative data. This is a widely used and heavily touted method of qualitative data analysis[22] which is characterised by theme development and the interpretation of realities as narrated by the participants.[22] It is preferred for its flexibility and accessibility.[22] The inductive thematic analysis was followed by the deductive thematic analyses from where the themes were grouped and aligned based on the WHO six pillar framework. Atlas.ti qualitative data analysis software version 9 of 2021 was used for analysis of the data.

The qualitative and quantitative methods were concurrently used to gather information and triangulation performed at the discussion stage to enrich the meaning of the findings.

Validity and reliability of the study

Validity of the study

The data collection instruments were developed by the primary author and reviewed by the secondary authors. The tools were developed from extensive literature review process. They were thereafter validated by a panel of six experts in the field of optometry who were drawn from the academic sector, public hospital and private practice sector.

Reliability of the study

A clearly defined study protocol was developed to guide the study. The investigators further selected time frames that were more applicable for the cross-sectional and the retrospective chart reviews to ensure the reliability of the study. A 3-year period was considered appropriate for chart reviews, while a 3-month time was used for the cross-sectional surveys. Additionally, a purposive total population sampling technique was also employed to ensure increase in the reproducibility of the study.

Trustworthiness and rigour of the qualitative research process

To ensure the rigour and trustworthiness of the study, several measures were taken. Multi-methods including focus groups and key stakeholder interviews were conducted to ensure ***dependability***.[23] The investigator conducted an audit trail of the findings against the participants to ensure that the interpretations are made from the data in the context of each participant. This ensured ***confirmability***.[23,24] The investigators also continuously asked themselves about the context of each question about the study, the facility, and the individual being studied to ensure ***transferability***.[23,24,25] The member checks were done immediately after the interviews to validate the supposed themes coming out of the interview data.

In the context of the participants, repeat interviews could not be performed but triangulation was conducted from the narrations of the participants in one-on-one and FGIs to reduce ***investigator bias***.[23,24,25,26] In addition, the research process followed a defined research design, data collection, analysis, and interpretation of the guidelines as defined in the study protocol.[23] A pilot study was undertaken to enhance the interviewing skills of the investigator such as to avoid the use of leading questions and to identify and limit potential harm to the main project.

Results

Service provision within the district

Headcount for patients consulting at the hospitals

A total of 63 157 patients consulted the eyecare department in the hospitals within the data collection period. Of the total patients that consulted, 31 366 (49.7%), an average of 9022 per hospital, were examined by optometrists. Refraction was performed in 13 470 (43%), an average of 1924 patients per hospital of those examined. There were 2239 (17% of those refracted) pairs of spectacles, average of 320 per hospital, and 92 (0.7% of those refracted) pairs of contact lenses ordered, all at Mankweng hospital.

Outreach to community clinics

There were 100 community clinics within the district and each hospital provided outreach services to an average of

12.5 clinics (100 clinics and 8 hospitals). Across all clinics, a total of 542 clinic visits were made from which 4046 persons were examined with 1636 referred (40.4%) to the hospital for further assistance during the study period.

Outreach to schools

Each hospital provides outreach services to the surrounding schools around the hospital. A total of 285 school visits were conducted, during which 12 750 children were screened and 1391 were referred for further assistance at the hospitals during the period of study. There was a referral rate of 10.9% with the number of referrals at 198.7 patients per hospital.

Contact lenses fitting and management of keratoconus patients

Keratoconus patients consulting peripheral hospitals were managed with spectacles. All KC patients requiring management by contact lenses and surgical interventions were referred to optometrists and ophthalmologists, respectively, at the tertiary hospital. Contact lenses were only fitted and dispensed at the tertiary hospital because of a lack of equipment and consumables at the peripheral hospitals. Additionally, aftercare of contact lenses wear was conducted at the tertiary hospital. There was therefore a backlog of patients requiring the contact lenses fitting, dispensing or aftercare resulting in increased waiting times to receive a service.

Patient education

The optometrists reported that the patients showed poor or lack of knowledge regarding the use of medication which affected patient care. The medication which was expected to be discarded in 30 days were often kept until the condition recurred in the following year:

> 'Patients say they have eye drops at home and when the next season comes in September they go back and use the same medication of the previous year. Severe VKC develops because the medication is no longer effective.' (Optometrist at a tertiary hospital)

Eyecare workforce

Availability of eyecare workforce in the hospitals

Table 1 presents the eyecare workforce component in the public eyecare facilities. A total of 41 eye-care practitioners were employed across the seven hospitals. There were 25 (61%) optometrists, 12 (29%) ophthalmic nurses and 4 (10%) ophthalmologists. A total of 5 (62.5%) ophthalmologists were females. All 8 (100%) ophthalmologists and ophthalmic medical officers, 8 (32%) optometrists, and 4 ophthalmic nurses (33%) were employed at the tertiary hospital. Zebediela hospital did not have an ophthalmic nurse. There was an average of 3.6 optometrists, 1.7 ophthalmic nurses, and 1.1 ophthalmologists per hospital. There were no other professions servicing eyecare. As presented in Table 1, the CEC guidelines suggested the appointment of 27 optometrists, 14 ophthalmic nurses, and 5.5 ophthalmologists and ophthalmic medical officers in line with a population estimated at 1.5 m. The district, therefore, had 92% compliance on the rate of optometrists, 71% compliance for ophthalmic nurses, and 145% compliance for ophthalmologists.

Generally, a minimum of three vacancies are allocated per hospital though some had only two filled and cannot fill the existing vacancy.

Cooperation between professionals

At the community clinics, the optometrists often experienced a lack of cooperation from some nurses who could not provide adequate information, proper working space and resources to optometrists to efficiently and effectively examine and manage patients. During outreach programmes at schools, some teachers were less cooperative and intolerant of optometrists who required time and working space to assist school children. Some would complain that the examinations took their time for teaching.

There was no protocol for cooperation and patient-centred care; hence, there were inconsistent approaches across various hospitals.

Knowledge of staff about keratoconus and other eye ailments

Most optometrists self-reported to have limited knowledge concerning screening, examination and management of KC patient. They also suggested that nurses at clinic also lacked basic knowledge and literacy in eye and vision care. In their view, they require upskilling programmes to help them develop their knowledge and skills.

Infrastructure and equipment

Table 2 shows the infrastructure and equipment that was available at each of the hospitals.

TABLE 1: The distribution of eyecare personnel in the Capricorn district per hospital.

Workforce	Capricorn district eyecare workforce distribution per hospital									Staffing analysis in line with Vision 2020				
	Ses	Zeb	HFr	WFK	Bot	Leb	Man	Total	Average	Ideal rate per 1 million pop.	Ideal rate for CD (pop = 1.5 m)	Available No (Rate) per	%	Staff shortage
Opt	3	3	3	2	2	4	8	25	3.6	20	27	25	92	2
ON	1	0	2	1	2	2	4	12	1.7	10	14	12	71	2
Oph & OMO	0	0	0	0	0	0	8	8	1.1	8	5.5	8	145	0
Total	**4**	**3**	**5**	**3**	**4**	**6**	**16**	**41**	**5.8**	**38**	**46.5**	**-**	**-**	**-**

ON, Ophthalmic nurse; OMO, Ophthalmic Medical Officers; OPH, Ophthalmologist; OPT, Optometrist; Bot, Botlokwa; HFr, Helen Franz; Leb, Lebowakgomo; Man, Mankweng; Ses, Seshego; WFK, WF Knobel; Zeb, Zebediela.

TABLE 2: Equipment available in each hospital.

Variables	Bot	HFr	Leb	Man	Ses	WFK	Zeb
Pre-consulting room	1	0	1	2	0	1	1
Refraction room	1	1	1	2	1	1	1
Ophthalmologists' examination stations	0	0	0	3	0	0	0
Refraction unit (chair, stand & phoropter)	1	1	2	1	1	1	1
Trial case & frame	2	2	2	4	2	1	2
Retinoscopy & Ophthalmoscopy	2	2	1	4	1	1	1
Slit Lamp	0	1	0	2	1	0	1
Keratometer	0	0	0	2	1	0	1

Bot, Botlokwa; HFr, Helen Franz; Leb, Lebowakgomo; Man, Mankweng; Ses, Seshego; WFK, WF Knobel; Zeb, Zebediela

Equipment

The basic consulting rooms had an examination chair and stand, a phoropter, a trial case and frame, a chart projector, and diagnostic sets. Only six (86%) hospitals had a tonometer, four (57%) of the seven hospitals had slit lamp biomicroscopes and three (44%) of the seven hospitals had keratometers.

Available working space

The Lebowakgomo and Mankweng hospitals had two patient examination (refraction) rooms each, and all other hospitals had one each. None of the hospitals had consulting rooms dedicated for either contact lenses or specialised clinical service such as paediatrics or binocular vision. The Mankweng hospitals had two pre-consulting rooms for ophthalmic nurses and three ophthalmologist consulting rooms.

According to the informants, most hospitals had limited working spaces dedicated for patient examination. They were also used as offices and staff rooms which then compromised privacy and the confidentiality for consulting patients:

> 'We have only 1 consulting room which is also an office. the problem is that if you have many patients, you still have to help one at a time … previously we would compromise and take more than one patient at a time, but *due to* COVID-19 we have to take only one at a time.' (Eye unit manager at a district hospital)

The optometrists further suggested that the working space should be proportionate to the number of staff members per hospital:

> 'We don't have space, but we have the equipment and staff … ideally, we would need "one clinician" – one consulting room setup.' (Optometrist at the tertiary hospital)

Mankweng hospital had acquired a Pentacam and was awaiting its delivery. A KC patient clinic has been established at Mankweng hospital and more equipment was awaited such that this clinic could be set up.

Information and technology

Patients' records

Hospitals used online patient record filing system which mainly generated file numbers for new patients, served as a reference when locating patient files from the physical storage and was also used to generate invoices for patients' consultations. The key challenges noted were that patient files were stored as physical copies, was unable to generate electronic backup files, was not centralised and interactive across hospitals. Hence, the system was not interactive and therefore, did not allow tracking and tracing of patients as they consult or to book appointments because files were not backed up, and only summaries of each consultation were recorded manually in the daily patient register book:

> 'We don't do tracking, we only emphasize on treatment when they consult … if they decide to return.' (Eye unit manager at a district hospital)

One of the weaknesses of this was that it could not trace allocation of resources and hence the public healthcare system was vulnerable to abuse because some patients were able to acquire treatment resources such as optical devices from multiple sites:

> 'We have a patient that goes to hospital 1 to get spectacles and move to hospital 2 to get another pair … and unfortunately you cannot pick them up …' (District coordinator for eyecare)

Considering these key challenges, the system could not therefore generate sufficient or reliable data for research and planning.

Funding

There was no specific budget dedicated to eyecare, but rather allocations were made to a fund pool for all professional units. Most of the budgets were then prioritised and channelled towards managing conditions regarded as 'life-threatening'. In addition, each year, there were budget cuts and they worsened with each coming year. Hospitals were therefore unable to acquire equipment, consumables, optical devices and/or fill the vacant posts:

> 'No, it does not help at all because the money is getting reduced … like last year we were allocated R250 000 [*for equipment*] for the whole hospital …'

> 'Main challenge is budgets … budget for appointment of staff … budget for procurement of resources …' (Eye unit manager at a district hospital)

Patient care was therefore affected:

> '… patients keep on going to the local hospital and continuously not getting medication where VKC gets worse.' (Optometrist at a tertiary hospital)

> 'A lot of people lose their vision waiting to come to Mankweng … because intraocular pressure was not done … you find a patient who is referred for cataract surgery but still has glaucoma … it's November and the patient is booked for May the following year …' (Optometrist at a tertiary hospital)

The district hospitals were reported to lack some critical resources such as consumables for patient examination and isolated incidences of medications for patients:

'I couldn't get fluorescein strips, the last time [*I got them*] was in 2005.' (Eye unit manager at a district hospital)

Initiatives to obtain donations

The key informants reported that they recently received assistance from NGOs and international donors to purchase equipment and devices for the patients:

' ... there is inconsistency with the provision of spectacles … currently spectacles provided are donated ...' (Eye unit manager at a district hospital)

Governance

The eyecare services in the Limpopo Province were coordinated in line with the national, provincial, district, and hospital policies and guidelines. However, there was no dedicated directorate for eyecare at the provincial government as with other professions such as medical services, nursing, and pharmacy. Optometry was classified and clustered under the allied health professions together with physiotherapy, dietetics, and occupational therapy. This classification, according to the PCE, DCE, and EUMs, did not provide a platform to mobilise resources and funding specifically for eyecare:

'We have a problem in the way it is structured … when somebody is in charge, they must have powers … in pharmacy they have a directorate, the nurses have a directorate, but eyecare is still clustered together with allied professions … it hinders a lot of progress …' (Eye unit manager of a district hospital)

'… there is no section that focuses on eyecare in the provincial office. Even if you have challenges no one attends to them …' (Eye unit manager of a district hospital)

Optometry services were offered at the same level across all hospitals, including in district and tertiary hospitals, though the services provided were more dependent on the availability of equipment, consumables, and staff. Accordingly, there was a distinction between the optometry services offered at the district level and the tertiary level, because the tertiary hospitals had more resources compared to the district hospitals:

'Optometry service across the hospitals is the same whether you are at a district, regional or tertiary hospital, the service is the same … A referral is only when the patient has to see an ophthalmologist …' (District coordinator for eyecare)

The district had developed protocols for generic patient care for patient screening, examination, diagnosis, and the management of visual as well as ocular abnormal conditions. There were, however, no protocols for screening, examination, and diagnosis of KC patients:

'Protocol is generic and outlines the process to manage conditions … There is no protocol for contact lenses fitting yet …' (District coordinator for eyecare)

The district had no defined protocols for the allocation of optical devices and medication. The practitioners used their autonomy and discretion to allocate resources.

Discussion

The study aimed to analyse the capacity of the Capricorn district public sector facilities to manage KC patients and suggest strategies to strengthen systems for efficiency and effectiveness of care to these patients. This investigation that was conducted followed the WHO's six pillar capacity model that defines capacity in terms of service delivery, eyecare workforce, infrastructure and medical products, health information, financing systems, and governance.[3,27]

Findings of the study revealed that hospitals provided comprehensive eyecare service to consulting patients and an extensive outreach programme, although enormous gaps were identified on service provided when managing KC patients. The lack of resources severely affected the quality of the service provided and peripheral hospitals did not have adequate equipment and consumables for early detection and examination of KC patients. Besides patient examination, they further did not have adequate equipment for contact lenses fitting and to perform other procedures for management of KC, and rather the patients were mostly managed with spectacles. The study also found that medication and optical devices could not be acquired because of a lack of funding, hence affecting the service to patients. Equally, critical vacant posts could not be filled which compromised the capacity of the eyecare workforce. In terms of governance, eyecare was coordinated and governed based on the national, provincial and district policies and guidelines. There were available protocols for general patient examination though no protocols for KC patient examination and management were evident. The study also found no protocols for allocation of optical devices to patients in general.

Service delivery

There was a high patient headcount for consultations. Of the total of 63157 patients who consulted, 31366 (49.7%) were examined by optometrists from which 13470 (43%) were refracted and 2239 pairs of spectacles were prescribed. The patient headcount was significant and represented about 4% of the Capricorn District populace.[18] About 10% of the populace had some form of VI;[18] hence, there was a need to develop campaigns to develop awareness and raise headcount for persons seeking eyecare. The HPCSA guidelines on minimum procedures mandated for patient examination include refraction[28] though refraction in this study was performed in only 43% of consulting patients and spectacles were ordered in mere 17% of the cases. In comparison to a similar investigation done by Maake and Moodley in the KwaZulu-Natal, the rate of refraction and spectacle prescriptions were lower although the province had a higher patient turnover. These percentages are lower and need to be increased to improve the vision QoL for consulting patients.

Contact lenses fitting was performed only at the tertiary hospital because of a lack of equipment, consumables and

working space that are needed for such service at peripheral hospitals. This may be the reason why contact lenses were ordered for only 92 (0.7%) consulting patients within the 3-year period. This low number of patients should be regarded as an anomaly given the observed rising prevalence of KC. Although district hospitals did not have capacity to fit contact lenses, the available resources could enable them to conduct aftercare visits for patients wearing contact lenses. This could reduce inconvenience and costs of patients travelling to tertiary hospitals for such a follow-up service.

Besides contact lenses and spectacles, no other form of service was performed as part of management for KC patients. Ideally, surgical procedures such as corneal cross-linking may be performed to strengthen the corneal collagens in highly progressive KC cases,[8] and corneal crafts may also be performed in severely progressed cases where contact lenses no longer provide significant improvement on the vision of patients.[29] There was no evidence of such capacity being available; efforts should be made to acquire resources such that there is capacity to perform the full spectrum of KC clinical and non-clinical management strategies.[29] As suggested by Buthelezi and van Staden,[27] there is a need for scaling to increase the prescription rate and also to improve the quality of care by acquiring adequate and relevant equipment for a comprehensive eye exam.

Findings of the study revealed that the district conducted efficient and effective outreach programme at community clinics and schools. Over 4046 patients and 12750 children were examined at the community clinics and schools, respectively. This is highly commendable because outreach programmes provide an opportunity for early detection of eye conditions before they become apparent.[30] According to Burnett and colleagues,[31] outreach programmes have been effectively used as a strategy for early detection of diseases in LMICs and can assist early detection of KC which will, in turn, improve its prognosis.[29]

For clinics, nurses may be offered basic training on common presenting and/or priority conditions such as KC in terms of how they can conduct screening of these patients, their presentations and procedures to be followed in assisting the patients.[32] At schools, teachers play an important role in identifying children with vision problems. Teacher education may be conducted to equip teachers with relevant skills to identify such children.[3,32] Several indicators are present in a learner having visual or eye health challenges and these may include, but are not limited to, the gradual drop in academic performance, the inability to see on the white and/or black board in the classroom, reading at a close distance, eye rubbing, red eyes, watery eyes, and swollen eyelids.[32] Eye health talks may also be done to introduce parent education and self-screening for children with vision and eye health challenges.[32]

Almost half (40.4%) of the patients screened at the community clinics were referred for further assistance at the hospitals. This referral rate is too high and may suggest that clinics were not adequately resourced with either equipment for examination or medication for pathological conditions, hence patients had to be referred to hospitals. Providing such resources may enable better service at the clinics such that fewer patients require referral.

According to the informants, level of offerings for optometry service was supposed to be the same at all hospitals though it differed from tertiary to district hospitals based on how they were resourced. Furthermore, patients were supposed to be referred to tertiary hospitals mainly to receive ophthalmology services. The high inter-hospital referral rate from peripheral to tertiary hospitals contributed to increasing backlog at the tertiary hospitals resulting in increased waiting times for patients to receive services and optical devices. Most viable strategies to reduce waiting times which can be applied to address this challenge in this district include increased working space such that there is a consulting room for all optometrists on duty, improve scheduling such that it is easier for patients to honour sessions, and to be on time given their proximity or remoteness to these referral hospitals and also rescheduling of late arrivals.[33]

Patient education was reported as a challenge in the study. Patients were either not compliant or not adequately educated about their eye conditions and consequently some used medication beyond their shelf life. Ethically, patients should participate in their own care and consent to their perceived best options towards their treatment.[34] This improves their self-care and leads to self-efficacy.[34] Keratoconus is a progressive condition[29] which requires self-efficacy; therefore, patients will likely take medication to relieve symptoms and accept use of optical devices to improve vision.

Eyecare workforce

The district employed about four (3.6) optometrists, two (1.7) ophthalmic nurses, and one (1.1) OMOs per hospital which, based on the WHO's HReH model, achieved 92% compliance rate for optometrists, 71% for ophthalmic nurses, and 145% for ophthalmologists. Some hospitals did not have ophthalmic nurses while others have fewer optometrists than normal and hence several appointments were required such as to reach full compliance for improving service provision. Two optometrists could be appointed at WF Knobel and the Botlokwa hospitals each and two ophthalmic nurses could be appointed at Zebediela hospital and at Seshego and/or the WF Knobel hospitals to improve the capacity. These hospitals had vacant optometry and ophthalmic nurse positions that could not be filled because of financial constraints.

Generally, three to four optometrists were employed per hospital where one was the EUM and the other two conducted most of the clinical work. In some hospitals, only two optometrists were available like WK Knobel and Botlokwa hospitals; hence, it could be assumed that it was difficult to provide patient care service at the specific hospital, conduct office administration for the unit and to fulfil the responsibilities for outreach projects at the same time. In

addition, normal human resources requirement like taking leave could not be fulfilled.[35,36] This has possible consequences such as burnout, brain drain and it has been the cause of staff turnover elsewhere in healthcare.[35,36] The staff shortage challenges are not peculiar to this district, Limpopo Province and South Africa as a country, but rather a general problem also in other developing and developed countries.[37] It consequently contributes to longer working hours with possible immediate effects such as stress, lack of sleep, fatigue, and possible alcohol and substance use.[37]

The financial constraints were touted as limitations in the filling of vacancies. While this is a challenge, it should be noted that South Africa is far ahead with compliance to the HReH model in sub-Saharan Africa, and there is evidence that this district has higher rates of compliance than others in South Africa.[38] Continuous efforts to mobilise funds to curb the challenge of staffing should be made. Financial resources remain a challenge, but other efforts such as scheduling can be explored to rotate staff to where there is a dire need. Examples can be moving one staff member from one hospital to the nearby hospital to cover for needs when one staff member is on leave or when they go on outreach.

The rise in prevalence of KC has been observed in the past decade or two with the introduction of advanced equipment like the ocular coherence tomography (OCT) and corneal topographers; hence, attention has shifted towards this condition only recently. Limited practitioner knowledge, therefore, including that of ophthalmologists[39] and optometrists[31] in different settings, has been observed. Participants in this study acknowledged to have limited knowledge on KC patient care. Structured and unstructured periodical continuous professional development programmes should be implemented to upskill optometrists on the theory and practice of KC patient care across various hospitals or nurses in the clinic settings.[31] Mentorship programmes, regular case study meetings, and volitional peer support groups have been found to be effective and to have higher impact in upskilling professionals in a clinical setting and may equally be implemented in the district.[31]

Infrastructure and equipment

All the hospitals had limited working space, and most did not have the requisite equipment and consumables for patient examination. The availability of staff, equipment and working space are the greatest contributors to increased waiting times.[37,38] The waiting times are a barrier to the provision of healthcare and also they are the cause of stress for many patients.[40] This usually brings about challenges, such as increased daily waiting times especially for contact lens, in a setting that does not have a separate room and no separate schedule for patients requiring such a service.[33,41] A study by Buthelezi and van Staden[27] found challenges with the provision of optometry speciality care of patients, hence it can be suggested that it is not an isolated case to this district and therefore needs immediate attention as it is a minimum requirement and should be a regular practice in line with the professional standards.[42] Some optometrists suggested that there should be a proportionate allocation of equipment to the number of staff members such as a 'one practitioner for one cubicle' principle. Implementation of such an initiative will curb challenge of working space where advanced patient care in optometry like fitting of contact lenses, binocular vision and low vision care are daily activities of the service provision.

Fitting KC patients with contact lenses requires more time than that of a regular patient and allocating specific working rooms may be beneficial. Findings in this study suggest that there were no rooms that were specific for speciality care such as for KC or contact lenses fitting, hence the same refraction room was used for fitting. Fully equipped and specialised rooms for contact lenses or KC patient care should be made available to increase efficiency and improve the quality of the service to these patients. The consultation rooms for KC patients should have, among other standard equipment, keratometers, slit lamp biomicroscopes, pachymeters, OCT and a corneal topographer.[7,43] It was concerning that a number of these basic equipment were not available at some of the hospitals and therefore there was a likelihood of misdiagnosing or underdiagnosing the KC patients if the corneal thickness and the curvature are not confirmed. [43,44]

The district should further create specific staff and/or office space to allow practitioner private space for debriefing and separate them from the patients' consulting rooms. This equally has benefits for their mental health and promotes privacy and confidentiality while consulting patients.[45,46]

Information technology

Record keeping was found to be challenge where only manual files were kept without digital copies as backup; the online system was used to generate file numbers and retrieve patient files and for invoicing of patients. Good record keeping, especially the use of online medical files, reduces errors when storing files, improves access to practitioners and patients, facilitates easier and prompt access, and patient history may be created after the visit.[47] From literature, the challenges of such a system include that it will poorly support patient care.[48] Functions such as patient tracking and tracing enable the systematic pre-booking of patients with fewer errors and enhance compliance of patients[49] though respondents in this study reported not to do any tracking and tracing. Accordingly, it is believed that the costs of a tracer far outweigh the complications and the cost that comes with patients' dropout.[50] This may be important to reduce patient dropouts in contact lens wear for KC patients.

In the current system, there was no backup of files kept and hence, had poor security. Fully-fledged online storage system enables the interconnectedness where records of patients are accessed at any facility that the patient visits within the organisation.[48,51] The other benefits may include the efficient allocation, control and inventory management of resources like optical devices and medication to curb abuse in the

district.[51,52] The respondents in this study alluded to the latter occurring in public hospitals currently. Online systems store information in the mainframe hence serving as a backup in case the physical copies are lost across hospitals.[53] When using paper-based files, many unauthorised persons may access patients' files as compared to when they are kept online as that requires monitored and tracked access.[53]

Besides these challenges, which are mainly experienced between the patient-clinician-facility, the studies highlight the non-availability or the inaccurate information to reduce the capacity planning at each level of governance. When the data are generated and kept manually, such as is the case in our study, it is bound to have inaccuracies. Hence, an integrated, interactive online system is required.

Funding

Findings of the study showed gross financial constraints which affected the appointment of staff, the purchasing and maintenance of equipment, as well as the sourcing of optical devices and consumables for patient examination. These are common challenges facing South Africa today[54] and it was further evident that these financial woes were worsening annually. As in the study at the KwaZulu-Natal Province, there were no clear guidelines on budget allocations as some areas of healthcare were prioritised over others. Anecdotal information provides that eye conditions are usually defined as 'non-life threatening', hence, receive less preference irrespective of the dire consequences that come with their neglect. Poor policy implementation, cumbersome monitoring, corruption, poor budgeting, salary inducement policies such as occupation-specific dispensation and remuneration work outside of the public service, and the inequitable allocations of budgets are some of the contributory factors to the experienced challenges.[54] In a public health system riddled with budget constraints, there is usually the reprioritisation of resources for life-threatening or critical programmes such as HIV and/or AIDS, tuberculosis and cancer management,[55] which is the case in the current study.

Governance

Eyecare services in the Capricorn district were governed based on the national, provincial and district guidelines. It can be conceded that there was some level of efficiency and effectiveness given the number of achievements where projects such as outreach activities were conducted. The absence of a portfolio for eye health in the LDoH proved to be a barrier to provision of eyecare according to informants. The PCE, DCE and the EUMs conceded the absence of the portfolio as a setback to eyecare service provision and it was therefore advocated for. Its absence limited the mobilisation of resources which is better achieved in professions that have this portfolio such as in nursing, clinical services and pharmacy. The same challenge was also reported at the KwaZulu-Natal-based study, where respondents advocated for access to the decision-makers and for open channels of inquiry.[27] According to Akuffo et al.,[56] introduction of portfolios for eyecare services across all the provincial health departments in South Africa was debated and agreement was reached to introduce this by the year 2000, although there was not any implementation.

There were no defined protocols for KC patient care, allocation of optical devices and medication. Availability of such protocols provides benefits to patients, healthcare professionals, and the healthcare systems. When defined, patients are likely to benefit because it brings consistency of care across the hospitals for the same conditions, and the patients are assisted in the same manner irrespective of who is providing the service.[57] Further, the quality of clinical decisions, the consistency of care and the methods of patient care improve.[57] They guide decision-making, especially on cases with a likely thin line between harm and benefit to patients. The healthcare systems benefit from the protocols mainly because the standardised approach to patient care is adopted. There is an optimisation of the value for money and adherence to quality, thereby improving public image.[57] The introduction of protocols for KC patient care, allocation of optical devices and medication should be implemented to improve the quality of the service and guide the purchasing decision in the public facilities within the district.

Conclusion

Having sufficient capacity to provide service is critical and is one of the initiatives that WHO is striving to achieve especially in LMICs which commonly have challenges with resources necessary for eyecare provision. The district was found to offer adequate services to general consulting patients although gaps were identified in the provision of service to KC patients. Efforts should be made to improve KC patient management with contact lenses and other surgical intervention strategies such as to improve the outcome of vision correction. The outreach programmes and inter-facility referrals are excellent platforms for that be used to reach more persons that require eyecare within the district and for early detection of KC especially in children and young adults in schools. Availability of funding and budget constraints remain a huge challenge and limit acquisition of equipment and other resources necessary for patient care. Governments should develop and improve better funding models to enable quality service provision through appointment and upskilling of quality eyecare workforce, and acquisition and maintenance of sufficient equipment and other resources required in eyecare service.

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Competing interests

The authors declare that they have no financial or personal relationship(s) that may have inappropriately influenced them in writing this article.

Authors' contributions

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Data availability

Data used to support the findings of the study are available from P.M.W.N., the corresponding author, upon reasonable request.

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