

## Availability of eye care infrastructure and human resources for managing diabetic retinopathy in the western province of Sri Lanka

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**Purpose:** Blindness and visual impairment due to diabetic retinopathy (DR) are avoidable by early screening and timely treatment. The western province of Sri Lanka has the highest prevalence of diabetes mellitus (18.6%) in the country. DR had been given less attention in services expansion because of lack of evidence. The aim of this study was to assess the availability of human resources (HR) and infrastructure for DR in eye care facilities. **Methods:** A cross-sectional survey was conducted in 51 health care institutions by administering a validated questionnaire schedule and through semi-structured interviews. The data on infrastructure, HR and level of training, and skills were collected during the site visits by observation, frequency counting, and interviewing. Key findings of the interviews were recorded using categorical responses. Data analysis was done using MS-Excel<sup>®</sup> and STATA/IC<sup>®</sup>-Version 2-13.0 packages. **Results:** The response rate of the survey was 84.3% (43/51). There were 40 board-certified ophthalmologists and 6 vitreo-retinal surgeons in the region, of whom 77.5% (31/40) were in Colombo district. The highest population-adjusted DR-related infrastructure ratios were recorded from Colombo district. Mid-level cadres such as medical officers' mean skill score of DR screening and treatment was low (0.37, 95% CI 0.32-0.40). **Conclusion:** There is no systematic DR screening program, and HR and infrastructure distribution was not aligned to the population need in the western province. Urgent attention should be paid to expand the service delivery and mid-level HR training for DR screening and treatment in this region.

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Diabetes mellitus (DM) is an epidemic in most parts of the world, with a significant impact on health systems.<sup>[1]</sup> The International Diabetes Federation estimated that there will be 629 million people with diabetes (PwDM) by the year 2045.<sup>[2]</sup> The percentage of increase (69%) affected by DM will be much higher in developing countries.<sup>[3]</sup> South Asian countries have shown a dramatic swift in the prevalence of DM over the last 20 years.<sup>[4]</sup> Sri Lanka has one of the fastest aging populations, and the disease patterns have changed from communicable to non-communicable, doubling the burden of the health sector.<sup>[5-7]</sup> In addition, changes in lifestyle and behavior has resulted in an increase in the prevalence of non-communicable diseases such as DM.<sup>[8]</sup>

The overall prevalence of DM in Sri Lanka has been estimated to be 10.3% (95% CI 9.4-11.2%) among those aged >20 years and it has been projected that the prevalence for 2030 will be 13.9%.<sup>[9]</sup> One systematic review showed a "high epidemicity index" of DM (52.8%) in Sri Lanka compared to other countries in the region.<sup>[4]</sup> The western province of Sri Lanka has the highest reported prevalence of DM in Sri Lanka, which is 18.6% (95% CI 15.8-21.5%, age >20 years).<sup>[10]</sup>

Diabetic retinopathy (DR) is a common microvascular complication of DM, caused by chronic hyperglycemia.<sup>[11]</sup> It is

associated with the duration of DM, hypertension, and high lipids.<sup>[11]</sup> Many studies have shown that control of risk factors and DR screening (DRS) and early treatment can reduce the risk of blindness and visual impairment due to DR.<sup>[12-14]</sup> In Sri Lanka, the prevalence of DR among type 2 PwDM was 31.3% (95% CI 28.0-31.6%) and 4.1% of them were identified as blind due to advanced DR.<sup>[15]</sup> One study on self-reported PwDM found that the prevalence of any form of DR was 27.4%, whereas another study reported a prevalence of DR of 52.6% among the PwDM who had the disease for 15-20 year.<sup>[16,17]</sup>

There was no scientific evidence base to draw the attention of decision-makers toward problems such as DR in Sri Lanka. Skilled human resources (HR) and infrastructure are pre-requisites for the development of a DRS program.<sup>[18]</sup> There is no documented evidence on the current situation on HR and infrastructure for DR services in this province. The aim of this study was to identify the inputs for a systematic DRS program for prevention of DR associated visual impairment and blindness in Sri Lanka. The primary objective was to conduct a survey on the availability of HR and infrastructure for DRS and management in the health care institutions of the western province of Sri Lanka. The secondary objective was

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to assess training, professional qualifications, and skills of eye staff with regard to DR and management.

## Methods

The study design was a descriptive cross-sectional survey. Eligible institutions (both public and private) listed using the information available with the Ministry of Health-Sri Lanka and the governing bodies. The institutions, where a specialist general ophthalmologist (Gen Oph) or a vitreo-retinal surgeon (VRS) was available were included in the survey (Population size  $N=51$ ) and all were included because of the uneven distribution of variables was anticipated. A semi-structured questionnaire schedule was designed to collect quantitative and categorized qualitative data on HR.<sup>[19,20]</sup>

Ethical approval was obtained from the ethics review committee of the National Eye Hospital-Colombo and from the research ethics committee of the London School of Hygiene and Tropical Medicine-United Kingdom. Written informed consent was obtained from the key personnel participating in the interview, after explaining the objectives of the survey.

### Data collection

Survey was conducted from June 2014 to August 2014 in the western province of Sri Lanka. The questionnaire schedule was validated before using for the data collection. Data were collected on the validated questionnaire schedule at the site. The data were obtained from the head of the institution or a key informant (i.e., head of the unit - Gen Oph) identified at the eye clinic, on availability of HR and infrastructure by interviewing the key informant and by frequency counting. In addition, interviewing of members of each staff category (i.e., postgraduate trainee in ophthalmology, medical officer, nursing officer, optometrist, and attendant) was done depending on the availability to assess the training and skills.

The curriculum and training programs of the eye care staff were assessed according to the inclusion of a training module on DRS and management. The health care cadres are trained under the training centers of the Ministry of Health - Sri Lanka. The training programs are developed by the government sector institutions such as postgraduate institute of medicine, nursing schools, and school of optometry. The skill level of eye care health workers was assessed in terms of their ability to perform a specific task-related to DRS or treatment independently. These interviews responses were documented using categorical response scoring system. Observational checklists were used to assess infrastructure available for DRS and management during the site visit. The consistency of the numerical data was checked with the available inventories and records of the institution. The validity of the training and skills data were assessed by cross-checking the overall responses with a trainer responsible of training a particular HR category.

### Data analysis

Qualitative data on training and skills were categorized according to a numerical scoring system. Data were entered in Microsoft Excel®2013 (Version 1), where the double entry method was followed to minimize errors. Cleaned and finalized data sheet was then transferred into a STATA/IC-13.0® (Version 2) analytical package for detailed analysis.

## Results

Western province was home to 51 institutions at various service delivery levels in both public and private sectors, providing eye care services. There were 9 (18%) tertiary level, 25 (49%) secondary level, and 17 (33%) primary level institutions included in the survey; across three districts of Colombo (65%, 33/51), Gampaha (21%, 11/51), and Kalutara (14%, 7/51). Overall, 69% ( $n=35$ ) were in the private sector and 31% ( $n=16$ ) in the public sector. A total of 43 institutes gave permission to conduct the survey. (Response rate 84.3%, 43/51). Eight institutions (1 tertiary, 3 secondary, and 4 primary levels) refused consent and did not participate in the survey. These institutions also deliver the same level of services according to the level of service delivery.

### Human resources

Main participants of the interview were heads of the institution, Gen Oph, and VRS. There were 40 board certified Gen Oph (including one senior VR trainer) and 6 VRS in the region. 77.5% (31/40) of the consultant Gen Oph and 83% (5/6) of the VRS were based in the Colombo district. There were no VRS in Gampaha and Kalutara region public sector. It was observed that the majority (72%, 91/126) of the medical officers (MO) (72%, 91/126), nursing officers (NO) (72%, 46/71), and optometrists/ophthalmic technologists (OT) (64.8%, 46/71) were in Colombo. There were only 3 low-vision optometrists for the whole region.

Although there was no specific category as ophthalmic photographers, 5 eye care workers were trained and employed in this task. There were 159 clinic assistants/attendants in the province of whom 68% (108/159) were in Colombo district. Seventeen counselors were available in the province, their involvement in DR counseling was very low. The district wise distribution of HR is described in Table 1.

We considered the number of Gen Oph and VRS by considering the number of meeting points because the same specialist could work in several institutions i.e., both in private and public sector simultaneously according to the current health system in Sri Lanka. Of the Gen Oph, 21.4% (23/107) were in the public sector. The private sector ophthalmologists number was as high as 84 (78.5%) because the same ophthalmologists were working in different institutes. Similarly, 14% (3/22) of the VRS were in the public sector. The employment of MO in an eye care unit in the private sector was low (11%, 14/126). The distribution of the other categories was more or less equal in both sectors (45% vs. 54%). Fifty-seven percent (61/107) of the Gen Oph and 45% (10/22) of VRS were

**Table 1: District wise human resources ratios per 100,000 population**

Category	Colombo	Gampaha	Kalutara
Ophthalmologists	1:74,000	1:380,000	1:400,000
VR surgeon	1:460,000	1:2,290,000	0
Medical officer	1:25,000	1:104,000	1:93,000
Optometrist	1:50,000	1:127,000	1:173,000
Clinic nurse	1:52,000	1:176,000	1:304,000
Operation theater nurse	1:18,000	1:49,000	1:48,000
Attendants	1:21000	1:63000	1:81000

in secondary level centers. There were no NOs at primary level eye clinics. Forty-eight percent of the OTs were in secondary level eye units.

**Human resources-curriculum development and training**

We assumed that the best level of training and skills are with Gen Oph/VRS, deriving a maximum mean of 1. VRS (mean 0.98, 95% CI 0.9-1.0) and Gen Oph (mean 0.81, 95% CI 0.78-0.84) had the highest score in training with a comprehensive curriculum in DR management. Score of training for postgraduate (PG) trainees (95% CI 0.48-0.96) and MO (Junior MO - <4 years in eye care, 95% CI 0.17-0.29; Senior MO - >4 years in eye care 95% CI 0.23-0.41) was significantly different ( $P=0.0005$ ) [Fig. 1] Optometrists mean training score (0.48) was higher than the mean training score of MO (0.32) and this was statistically significant ( $P = 0.0002$ ) [Fig. 2].

**Human Resources-skills in DR screening and management**

Vitreo-retinal surgeon's skills score was the highest (mean 1.00). Medical officer's mean skill score was 0.37 (95% CI 0.32-0.40), which was lower than the average of 0.50. Optometrist's mean skills score was 0.36 (95% CI 0.32-0.34), and there was no statistical difference when compared with the medical officers ( $P = 0.0712$ ) [Fig. 3].

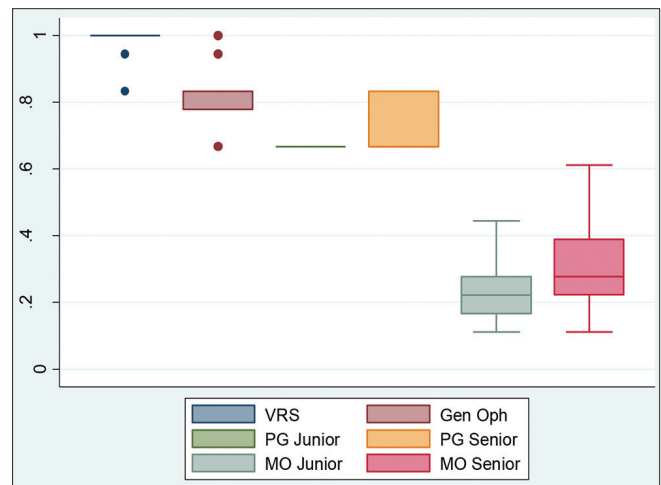
**Infrastructure**

DRS was an opportunistic screening in western province. There were two main types of eye care units involved in this process. First, the Gen Oph unit, which has the first contact with the patient, and second, the VR units, which handle the advanced DR, complications, and rehabilitation following a referral. Out of 43 institutions, there were 49 Gen Oph clinics (because some institutions had facilities for more than 1 clinic) and 8 VR clinics in the province. Thirty-one Gen Oph (mainly cataract) and 10 VR operating theater facilities were seen. However, there were only 13 eye units with DR laser treatment facilities.

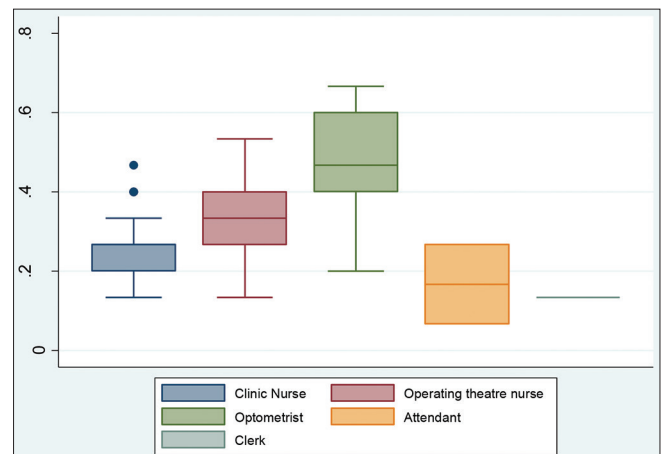
All eye units (n = 57; as some institutions have more than one unit, without sharing the infrastructure) were using bio-microscope (slit lamp) and 90D/78D digital lens to view the fundus after pharmacological dilatation of the pupil as the DRS method. In some institutions, this was further assisted by fundus photography, ocular angiography, and two/three-dimensional ocular coherence tomography (OCT), where available and necessary. Main decision-makers of the DR grading, diagnosis, and treatment were Gen Oph, VRS, and PG trainees.

In the management of DR, laser treatment and intra-vitreous injections were given at the general eye care unit level. Medical officers were involved in basic screening by direct ophthalmoscopes/slit lamp bio-microscopes, and most of the time patients were referred to the next level for decision-making. Patients were referred to a VRS if found to have advanced DR.

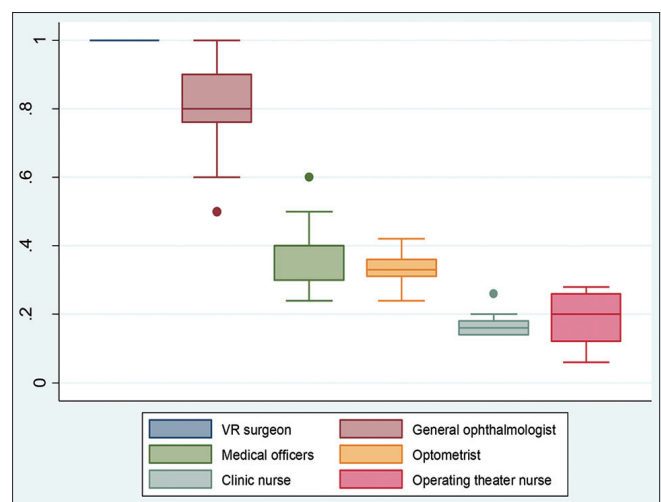
Most of the infrastructure was concentrated in the Colombo district. Of the equipment necessary for DRS, 67% (89/132) of bio microscopes, 91% (10/11) of fundus photography instruments, and 89% (8/9) of ocular angiography facilities were available in the Colombo district. Further, 85% (11/13) of the laser machines were in the Colombo district, whereas Kalutara did not have any. Eighty percent (8/10) of VR major operating theater facilities were also located in Colombo. Most ocular



**Figure 1:** Score in training of clinical staff and supportive staff. \*VRS-Vitreo retinal surgeon, Gen oph-General ophthalmologist, PG-Post graduate trainee, MO-Medical officer



**Figure 2:** Score on training of supportive staff



**Figure 3:** Diabetic retinopathy screening and management skills score of clinical staff

imaging facilities were in the private sector (81% of fundus photography and 89% of ocular angiography). Seventy-seven

**Table 2: Population adjusted (per 100,000) district wise distribution of infrastructure**

	Colombo	Gampaha	Kalutara
Total population	2,309,809	2,294,641	1,217,260
Slit lamp examination	3.853	1.35	0.985
Refraction	2.25	1.08	0.657
Fundus imaging	0.432	0.043	0
Ocular angiography	0.346	0.043	0
OCT macular imaging	0.216	0	0
Laser treatment	0.476	0.087	0
VR Minor surgical facility	0.649	0.261	0.246
VR Major surgical facility	0.346	0.087	0
Phacoemulsification	0.779	0.348	0.41

percent of the laser treatment facilities and 80% VR major theater facilities were also provided by the private sector. Overall, only 7 out of the 22 (31.8%) secondary level institutes had laser treatment facilities [Table 2].

When the population-adjusted (per 100,000) rates of infrastructure were evaluated, it was observed that the highest infrastructure rates were reported from the Colombo district. There was no infrastructure in ocular imaging, laser, and VR major surgical facilities in Kalutara district. Most DR management infrastructure was in tertiary level institutions.

Eighty-three percent (36/43) of the institutions had manual record systems; 16.3% (7/43) of the institutes had electronic health information system and only 11.6% of the institutes used telephone calls as reminders for follow-up. However, there is no documentation of follow-up rates or failures. Further, there was no institution keeping the patient records as fundus images in DRS.

## Discussion

This survey shows that there was no systematic DRS in the western province, whereas there was adequate capacity to deliver services. There is ample scientific evidence to show that preventive measures are beneficial to decrease the progression of DR and controlling blindness and visual impairment.<sup>[12,14,21]</sup> One study concluded that sight loss due to DR is associated with significant decline in patient's quality of life.<sup>[22]</sup> Further surveillance on equity should be a component of a standard DRS program.<sup>[23]</sup> Most of these aspects were not observed in this region.

Human resourced development is a fundamental concept in a health system.<sup>[24]</sup> However, the distribution of HR was not according to the population needs where three-fourth of the eye care facilities were in Colombo city. Ophthalmologists are unevenly distributed in the province, where most peripheral needy populations do not have accessibility. World Health Organization recommended ophthalmologist ratio of 1:100,000 and this was not achieved in Gampaha and Kalutara.<sup>[25]</sup> There were no VRS in Kalutara district. The majority of MOs were also located in Colombo district and this ratio was also below the WHO recommendation of 1:50,000.<sup>[25]</sup> Further, NOs, OTs, and ophthalmic attendant ratios were below the recommended norms in Gampaha and Kalutara districts.

HRs capacity building strategies should be built on the community requirements.<sup>[26]</sup> Training of VRS as a subspecialty was adequate according to the population needs, however, distribution was not even. Senior PG trainees were as competent as Gen Oph in terms of DRS and treatment which reflects that senior PG trainees can be utilized in conducting a DRS program as a team leader especially at a peripheral secondary level hospital on an outreach basis. Nurses and MOs do not have a proper curriculum on DR and even eye care in general at present, which shows the need of competency-based training on DR. Absence of continuous medical education may have impeded their active participation in DRS. Further, OT's role in DR management is not defined and is vague at present.

The western province of Sri Lanka has highly skilled VRS and Gen Oph with up-to-date knowledge and skills in screening and treatment of DR. However, there is imbalance and mal-distribution of these skillful professionals in the province leading to an artificial shortage.<sup>[26]</sup> Although PG trainees and MOs are competent in DR management, their productive participation in the process is low as observed in other studies.<sup>[27]</sup> Besides the sufficient numbers in HR, the inputs from other categories in DRS and management are inadequate in the western province. In addition, the required skill mix should be assessed in further studies.<sup>[28]</sup> Capacity building of mid-level personnel is a vital requirement in achieving blindness elimination targets in a country.<sup>[29]</sup> Medical officers and OTs may be the potential categories for a DRS skill development training program using task shifting for this region. We can recommend training mid-level human resources at all level of service delivery to improve the DRS services in the region. This can be regularized by allocating a dedicated trainee at each level of service delivery, especially for DRS.

Sustainable and standard infrastructure is an indispensable component in an eye care program.<sup>[30]</sup> Infrastructure development should be according to population needs, maintaining equitable access. The western province had a satisfactory level of infrastructure to conduct an organized screening program. All the institutions had the essential equipment for performing the dilated fundoscopic examination, with refraction services. Besides this infrastructure, it was underutilized for DRS services.<sup>[31]</sup> Therefore, it is apparent that resources are unevenly distributed in the region with less accessibility for the PwDM in the peripheral divisional secretariat levels.

## Conclusion

There is no systematic DRS program in the eye care institutions of the western province of Sri Lanka. However, western province has adequate HR and infrastructure to conduct a DRS program, which has been mal-distributed at present. Training and skills development in DRS and grading is especially required for mid-level cadres such as medical officers and optometrists. The western province of Sri Lanka needs immediate attention on the development of a systematic screening program.

### Strengths and limitations of the study

This survey would not reflect the trend of DR services over time. Structured and closed nature of the questionnaire limited the inclusion of general ideas that were raised in the interview. Further, some answers were biased by the perceptions and

attitudes of the key participants. There were 8 institutions who did not participate in the survey. This may lead to an underestimation of actual picture. In addition, erroneously one secondary level public institution was not included in the main enumeration. Further, probable opportunistic DRS or case finding out of eye care units (e.g., medical and endocrinology units) were not considered in this survey.

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### Contributions

Dr. M.M.P.N. Piyasena conducted this study as part of a Masters' dissertation at London School of Hygiene and Tropical Medicine in the year 2014. M.M.P.N. Piyasena conducted the study in the western province of Sri Lanka and collected the primary data. Prof. G.V.S. Murthy supervised the student project. Both authors were involved in the concept development, study design, data analysis, and manuscript preparation.

### Declarations

A part of this study has been published in Ceylon Medical Journal that described the situation of service delivery output with regard to diabetic retinopathy screening and treatment in the western province. However, the data on availability of eye care infrastructure and human resources have not been submitted/published elsewhere.

### Ethics approval

The ethics approval was granted by ethics review boards of National Eye Hospital – Colombo and London School of Hygiene and Tropical Medicine – UK.

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### Conflicts of interest

There are no conflicts of interest.

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