

Health system dynamics analysis of eyecare services in Trinidad and Tobago and progress towards Vision 2020 Goals

Abstract

Avoidable blindness is an important global public health concern. This study aimed to assess Trinidad and Tobago's progress towards achieving the Caribbean, "Strategic Framework for Vision 2020: The Right to Sight," indicators through comprehensive review of the eyecare system, in order to facilitate health system priority setting. We administered structured surveys to six stakeholder groups, including eyecare providers, patients, and older adult participants in the National Eye Survey of Trinidad and Tobago. We reviewed reports, registers and policy documents, and used a health system dynamics framework to synthesise data. In 2014, the population of 1.35 million were served by a pluralistic eyecare system, which had achieved 14 out of 27 Strategic Framework indicators. The Government provided free primary, secondary and emergency eyecare services, through 108 health centres and 5 hospitals (0.26 ophthalmologists and 1.32 ophthalmologists-in-training per 50,000 population). Private sector optometrists (4.37 per 50,000 population), and ophthalmologists (0.93 per 50,000 population) provided 80% of all eyecare. Only 19.3% of the adult population had private health insurance, revealing significant out-of-pocket expenditure. We identified potential weaknesses in the eyecare system where investment might reduce avoidable blindness. These included a need for more ophthalmic equipment and maintenance in the public sector, national screening programmes for diabetic retinopathy, retinopathy of prematurity, and neonatal eye defects, and pathways to ensure timely and equitable access to subspecialised surgery. Eyecare for older adults was responsible for an estimated 9.5% (US\$ 22.6 million) of annual health expenditure. This study used the health system dynamics framework and new data to identify priorities for eyecare system strengthening. We

recommend this approach for exploring potential health system barriers to addressing avoidable blindness, and other important public health problems.

Introduction

Blindness and vision impairment affect an estimated 223.4 million people globally (Stevens et al., 2013). Vision loss is an important public health issue, because over 65% is potentially avoidable through cost-effective interventions to prevent, treat or cure eye disorders (Bourne et al., 2013b). Populations of lower and middle-income countries are particularly affected. Approximately 0.5% of the Caribbean population are blind, and an additional 2.9% have moderate or severe vision impairment (MSVI), resulting predominantly from cataract, glaucoma, uncorrected refractive error, diabetic retinopathy and macular degeneration (Leasher et al., 2014). The World Health Organization and partners launched a global initiative to eliminate avoidable blindness in 1997 (WHO, 1997). A Caribbean Region specific ‘Strategic Framework for Vision 2020: The Right to Sight’, was developed by the Pan American Health Organisation with multiple partners and Member States in 2002, and updated in 2010 (PAHO, 2010). This strategic framework proposed 80 actions for Member States and stakeholders, and 27 progress indicators, to support individualised priority setting and objective development within each country.

Comprehensive, accessible, equitable systems are necessary to address avoidable vision loss (WHO, 2013). Whilst over 243 surveys have estimated the prevalence of blindness (Bourne et al., 2013a), a paucity of relevant health systems research limits understanding of contributing factors (Blanchet et al., 2014). Such research is especially important in highly pluralistic health care systems in which public stewardship may be under-developed (WHO, 2000).

In 2013-2014, a National Eye Survey of Trinidad and Tobago (NESTT) was completed, to estimate the prevalence of vision loss and eye disease in the

population aged 5 years and above (*citation in press, masked*) . The current study aimed to address the absence of published literature on the health care system relating to eyecare in Trinidad and Tobago, and to identify potential areas for health system strengthening to reduce avoidable blindness.

Methods

We sought structured feedback from six stakeholder groups in Trinidad and Tobago: all optometrists, all ophthalmologists and ophthalmologists-in-training, all public hospital eye department administrators, all public health centres, all public sector primary care physicians (PCPs), and a sample of out-patients attending the public hospital eye clinics. The content of the surveys was based on several pre-existing tools including the Vision 2020 situation analysis (WHO, 2002), essential equipment for a functional eye unit (IAPB, 2011, Hornby, 2013, Bailey, 2011), healthcare costs (Clarke et al., 2003), with modifications to better suit the local context following stakeholder focus group feedback. The surveys included information about services, human resources, training, equipment, referral pathways, access to guidelines and protocols, administrative support, types and volume of services, fees, patient satisfaction, and feedback on the eyecare system. Trainee ophthalmologists were invited to complete a survey on their clinical learning environment (Boor et al., 2007). (See Table 1).

We collected details of all eyecare professionals and practices in mid-2013 from various sources. These included: lists published by newspapers and the telephone directory; lists held by professional registration bodies including the Medical Board of Trinidad and Tobago (MBTT) (MBTT, 2013) and Trinidad and Tobago Optometry Registration Council (TTORC) (TTORC, 2013); lists of active practitioners held by professional societies including the Ophthalmological Society of Trinidad and Tobago (OSTT) and the Trinidad and Tobago Optometry Association (TTOA); and lists of

professionals-in-training held by University and Hospital departments. Twelve ophthalmologists on the MBTT register were excluded; 2 were deceased, 1 was retired, and 9 were working in the UK. The MoH supplied details of all health centres and public hospitals containing eye departments.

We circulated electronic surveys to eyecare providers and PCPs using an online platform (Smart Survey©). The Chief Nursing Officer distributed hard copies to the Head Nurse in every health centre. Interviewers visited each hospital eye clinic to meet administrators, review equipment, and survey a convenience sample of out-patients attending over a ten-day period, aiming for a quota of 100 in each clinic in Trinidad, and 50 in Tobago. We utilised survey methods known to improve response rates, including pre-notification about the study, university sponsorship, use of a white background, and reminders with notification that others had responded (Edwards et al., 2009).

In addition, we obtained new data on eye care utilisation over the preceding 12 months, and unit costs for eyecare services, collected from older adults (aged 40 years and above) who participated in the National Eye Survey of Trinidad and Tobago (NESTT, 2013-2014). The study rationale and methods are detailed elsewhere (*citation masked*). In brief, randomised multistage cluster sampling, with probability-proportionate-to-size methods, was used to select 9913 eligible people from the population aged 5 years and above. 4263 older adults were invited to attend a regional clinic for comprehensive assessment and structured interview.

Finally, we reviewed reports and policy documents offering insight into the health and eye care system in Trinidad and Tobago.

Ethics Committee Approvals

The authors obtained ethical approval from their institutions (*masked*) and from the Ministry of Health of the Government of Trinidad and Tobago.

Statistical analysis

We used standard statistical software for descriptive data analysis (StataCorp. 2013. Stata Statistical Software: Release 13.1. College Station, TX: StataCorp LP).

Analytic frameworks

We used the Health System Dynamics Framework to synthesise data (Russell et al., 2013, van Olmen et al., 2012). This systems model promotes consideration of the broader social determinants of health (Russell et al., 2013), and has been used previously to review eye care services in Zambia (Bozzani et al., 2014). The framework incorporates eight components and their interactions to facilitate a comprehensive analytical overview of the system, its constituent parts and functioning at national, regional and individual levels (See Figure 1). In addition, we integrated the 27 Vision 2020 Strategic Framework Indicators for the Caribbean (PAHO, 2010), to review Trinidad and Tobago's progress.

Results

We collected data between May 2013 and November 2014. Amongst providers, response rates ranged from 83% of health centres (n = 90), to 15% of ophthalmologists (n = 5) and 14% (n=5) of ophthalmologists-in-training. Amongst the general population aged > 40, who were sampled as part of the National Eye Survey of Trinidad and Tobago, 59% (n = 2520) responded to the demographic and socioeconomic questionnaires (See Table 2). The characteristics of the latter were broadly similar to the 2011 population census (Citation masked). We also surveyed 454 patients attending eye clinics in all 5 hospitals. Responder characteristics are summarised in Table 3.

Health System Dynamics Analytical Framework

The Context

Trinidad and Tobago is a twin-island democratic state, and former British colony that has been independent since 1962. It is the fifth largest Caribbean country, with a landmass of 5,128 km² (CIA, 2015). It became a high-income nation in 2005, on account of large reserves of oil and natural gas, which contribute 40% to Gross Domestic Product (GDP). The Gross National Income per capita is \$US 18,380 (GNI at Atlas Method) (World Bank, 2014). However, monthly household income was reported as less than TT\$ 9999 (US\$ 1562) by 79.7% (n = 1985) at an exchange rate of 6.4086 TT\$ = 1 US\$ in 2014 (Central Bank of Trinidad and Tobago, 2017) (See Table 2). This discrepancy may reflect a bias in self-reported income, but also a skewed income distribution, with substantial inequality. 1.7% of the population are considered poor, based on the multidimensional poverty index, and an additional 0.5% are living near poverty (UNDP, 2015). The Human Development Index (HDI) gauges a country's level of human development, taking into account how income is turned into education and health opportunities. Trinidad and Tobago had an HDI of 0.760 in 2012, ranking 67th out of 187 countries, approaching the threshold for designation as an "advanced economy" by the International Monetary Fund (≥ 0.788) (UNDP, 2015). Unemployment is low, at 3.2% (Central Bank of Trinidad and Tobago, 2015). Literacy is very high (99%) (CIA, 2015), but 19% (n=475) of older adults report only basic literacy (See Table 3).

The eyecare system, like the general health system, faces multiple challenges. Internationally, there have been significant advances in imaging technology and treatments. These facilitate improved screening, diagnosis and management of eye disease, but at significant cost. Health care expectations are also changing, with potential impact on health-seeking behaviour. Factors driving these changes include improved education and computer literacy; 61% of adults over 40 years (n = 1537) report internet use.

The Population

Trinidad and Tobago had a population of 1.35 million people in 2014 (6th largest in the Caribbean), with life expectancy at birth of 70 years for men and 76 years for women (Central Statistical Office, 2014). The maternal mortality rate was 63 deaths per 100,000 live births (112th in world), and the infant mortality rate was 24 deaths per 1000 live births (72nd in the world) (CIA, 2015). These metrics indicate a good level of development of the population, its health system and its interaction with the social determinants of health. The population was ethnically diverse, with 34% of African origin, 35% of South Asian origin, 23% of mixed ethnicity and 1% of other ancestral origins (CSO, 2011). This is of interest because some diseases, such as glaucoma (Tham et al., 2014) and diabetes (Spanakis and Golden, 2013) are more prevalent in these ethnic groups. The population size was static but demographically transitioning rapidly towards a more aged population, with 9.8% of the population aged over 65 years (CSO, 2011). Advancing age is a risk factor for many eye diseases, including glaucoma, macular degeneration and cataract (Bourne et al., 2013b). The larger island of Trinidad was residence to 95% (CSO, 2011), with the greatest population density along two major highways. Large areas of rainforest and swamp were sparsely populated, with limited transport infrastructure.

The Global Burden of Disease Study estimated that in 2010, 6727 people in Trinidad and Tobago were blind and 39,014 had moderate or severe vision impairment, a burden more typical for a middle-income country (Leasher et al., 2014). The burden of chronic non-communicable diseases (NCDs), associated with nutrition and lifestyle transition, is the highest of any Caribbean nation (Ministry of Health, 2012a). NCDs may cause vision loss, and account for over 60% of premature loss of life (Ministry of Health, 2012a). Approximately 55.7% of adults are overweight or obese, 26.3% are hypertensive, 5.1% are diabetic and 20.5% have pre-diabetes (Ministry of Health, 2012a), and poor glycaemic control is common (Apparico et al., 2007). Childhood obesity affects 23% and 25% of primary and secondary school children, respectively

(Traboulay and Hoyte, 2015), but the prevalence of childhood type 2 diabetes is currently only 10 per 100,000 children (Batson et al., 2013).

THE EYECARE SYSTEM

Leadership and Governance

The MoH in Trinidad and Tobago devolved responsibility and funding for health care provision to six autonomous Regional Health Authorities (RHAs) in 1994 (Rutten et al., 2002). These were subsequently reduced to five. The MoH sets regional policies, goals and targets based on needs assessment, and indirectly governs the health system (Ministry of Health, 2015). Facilities are operated by the Northwest, Northcentral, Southwest, and Eastern RHAs in Trinidad, and by the Tobago RHA. Regulatory bodies include the MBTT and the TTORC. Key professional societies include the OSTT, the TTOA, and the Opticians Association of Trinidad and Tobago, who set professional and ethical standards.

Analysis of the effectiveness of the leadership and governance of the health and eye care sector in Trinidad and Tobago was beyond the scope of this study. However, Van Olmen and colleagues (Van Olmen et al., 2012) have observed that strong capacity and strategic oversight are needed within a Ministry of Health and its decentralised structures to steer pluralistic health care systems into satisfactory balance. Governance is also important, to engage all stakeholders and ensure their interests are made explicit. Furthermore, mechanisms of population accountability are needed, with fair and transparent decision-making processes, to prioritise short, medium and long-term goals. Governments have an important role in monitoring health systems, intervening to correct market failures, and redistributing resources among the population where necessary, to ensure that health care is accessible to all according to need (Van Olmen et al, 2012). Mills and Ranson (Mills and Ranson, 2006) caution that a lack of monitoring, insufficient knowledge of the health system,

insufficient resources, diverging priorities or insufficient political commitment may cause gaps between rules and their enforcement.

Values and Principles: Review of key stakeholder mission statements

The MoH's (Ministry of Health, 2015) vision was to be a, *“people-centred, caring, proactive institution that assures standards of excellence are achieved by all stakeholders that promote, protect and improve the health status of the people of Trinidad and Tobago”*. Its mission was, *“to provide effective leadership for the health sector by focusing on evidence-based policy making, planning, monitoring, evaluation, collaboration and regulation,”* and, *“to establish national priorities for health and ensure an enabling environment for the delivery of a broad range of high quality, people-centred services from a mix of public and private providers”*. The MoH explicitly recognised the importance of the social determinants of health and their effect on individuals and the population, and fully endorsed the WHO Charter of Patients' Rights and Obligations (Ministry of Health, 2011). Mission statements were readily available online for the TTOA, the Trinidad and Tobago Blind Welfare Association (BWA), and The Caribbean Council for the Blind's member agency in Trinidad and Tobago, Persons Associated with Visual Impairment (PAVI).

Infrastructure for the delivery of health and eyecare services

Over the ten-year period leading up to 2013/4, substantial investments were made in the public and private health sectors. In 2014 there were 20 hospitals, with 406 beds and 27 operating theatres in 11 private hospitals, and 2,862 beds (including 1093 mental health patient beds) and 31 operating theatres in 9 public hospitals, and 146 outpatient facilities, of which 32 were private (PAHO, 2014). The health system also included four cardiac catheterisation facilities, 9 magnetic resonance imaging (MRI) facilities and 10 computerised tomography (CT) imaging facilities.

The public infrastructure for primary eyecare, offering basic universal access, included 112 health centres, 84 in Trinidad and 18 in Tobago, and the accident and emergency (A&E) departments of the regional hospitals (See Figure 2). Diabetic eyecare was provided on an ad hoc basis in 2014, without systematic integration into primary care. However, diabetic retinopathy screening, modelled on the service in Wales, had been piloted in the southwest RHA in 2012-2013, and plans to continue and extend this nationwide were being considered.

Secondary eyecare was provided in 5 regional public hospitals. Port of Spain General (PoSG) hospital served northwest Trinidad (22.1% population), Mount Hope (MH) hospital served northcentral Trinidad (18.4% population), Sangre Grande (SG) hospital served eastern Trinidad (8.3% population), San Fernando General (SFG) hospital served southwest Trinidad (46.6% population), and Scarborough hospital served Tobago (4.6% population) (See Figure 2). Hospital records from 4 hospitals identified that 2010 cataract operations were performed in 2013-2014, giving a public sector cataract surgical rate of at least 1489 per year per million population (Table 4). Subspecialised ophthalmic services, such as vitreoretinal surgery and corneal surgery, were generally unavailable. There were 3 neonatal high dependency units (PoSG, MH and SFG; none in the private sector), but no screening programme for retinopathy of prematurity, and only one private vitreoretinal surgeon offering laser therapy for identified cases. Eye examination for congenital cataract was not routinely included in neonatal health checks.

Public hospitals were fairly accessible to the population (See Figure 2). Patients attending the five eye clinics (n=453) reported a median travel time from home of 30 minutes (IQR 20-60), ranging from 1 to 240 minutes, and a median cost for the return journey of TT\$16 (IQR \$8 to \$22, range \$0 to \$300) (US\$2.50). Median travel times were shortest in Tobago (15 minutes, IQR 15-30), and longest in southwest Trinidad (60 minutes, IQR 30-90). The majority of patients travelled using public transport

(58.2%, n=262), or private car (33.8%, n=152). Referrals between health centres and eye clinics were mostly paper based, requiring hand delivery by the patient (98%, n=88 health centres), with referral by phone in the remainder. Feedback from the eye clinics to the referring professional was infrequent, with 75% of health centres, and 80% of optometrists reporting 'never' receiving it. By comparison, only 2.6% optometrists reported 'never' receiving feedback from private ophthalmologists.

In the private sector, primary eyecare was provided by optometrists located in 44 practices and by PCPs. Spectacles were available from 20 dispensing optician practices. 31 private ophthalmology clinics, located in the larger cities and towns, offered services, including subspecialised surgery (See Figure 2). The number of cataract operations undertaken in the private sector in 2013-2014 could not be reliably ascertained on account of a low response rate to the ophthalmologist survey.

Within the public system, the population could self-refer to health centres to see a nurse or PCP, or to A&E, who in turn referred to the regional eye department. The insured population were able to self-refer to private optometrists or PCPs, who referred to private ophthalmologists. The population also had the option to pay out-of-pocket to access private care directly.

Data on eyecare service utilisation in a 12-month period was collected from the population-representative sample of adults over 40 years in the NESTT survey (n=2520) (Citation masked). This revealed that 18.2% (n=454) used the public sector, 63.7% (n=1586) used both sectors (paying out-of-pocket), and 18.1% (n=451) were insured for private eyecare. Out of 1020 eyecare episodes reported in one year in this sample, 19.8% (n=202) were public sector, and 80.2% (n = 818) were private sector, indicating a preference for the latter, and a willingness by the uninsured population to pay out-of-pocket for eyecare. Private optometrists provided 44.3% (n=452) of episodes, private ophthalmologists provided 34.7% (n=354) and private

PCPs provided 1.2% (n=12). Within the public sector, health centres provided 2.8% (n=29) of episodes, A&E departments provided 0.6% (n=6), and hospital clinics provided 13.6% (n=139). An additional 1.5% (n=15) involved overnight admission, and 1.3% (n=13) involved day case surgery (See Figure 3).

This infrastructure was supplemented by a low vision clinic offering limited free refractions at the University Optometry Department during term time. The BWA offered services to clients on the blind register, including general and vocational counselling, rehabilitation, leisure activities, library services, social welfare assistance, and courses on daily living skills, mobility, social and communication skills (BWA, 2015). PAVI offered additional rehabilitation services in mobility, communication skills, social adjustment, daily living skills, and vocational guidance (CCB, 2014).

Organisation of health and eyecare resources

Financing

Trinidad and Tobago's GDP in 2014 was US\$ 27.8 billion (Central Bank of Trinidad and Tobago, 2015) and 5.5% was spent on health (world rank 131st) (CIA, 2015). Public and private sector expenditure contributed equally to total health expenditure (PAHO, 2012). Government spending on pharmaceuticals and medical supplies was stable in 2012-2014, and totalled US\$ 83 million (\$69M was for pharmaceuticals and \$14M for medical supplies). There was no data on eyecare expenditure. The surveys for optometrists, ophthalmologists, and hospital administrators estimated typical unit costs associated with eyecare services (See Table 5). Public sector unit costs were provided by the MoH (Personal Communication, 2016). The total cost, from a health service perspective, associated with 1020 eyecare episodes utilised over 12 months by the NESTT population sample, was TT\$ 691,413 (Figure 3). Extrapolating to all adults over 40 years (39.2% of the total population) suggested an eyecare service

expenditure of TT\$ 144.7 million (US\$ 22.6 million), equivalent to 9.5% of total healthcare expenditure.

The NESTT survey found that 18.9% (n = 471) of the population had health insurance, which was provided by approximately 20 companies. Most private sector employees had insurance cover including healthcare. Government employees received a medical plan, 'Unimed', valued at TTD\$300 per month. Co-payments were typically 80/20 or 70/30 for vision needs. Policies did not include subsidised sight tests (TTD\$120), but covered some or all the cost of spectacles (typically TTD\$1000 to 3000).

The MoH had a permanent External Patient Program to reduce waiting times for surgery in the public sector, and sporadically entered public-private partnerships for subspecialised surgery on a case-by-case basis (Ministry of Health, 2012b).

Human resources

The Ministry of Health estimated that there were 20 physicians per 10,000 people (16.2 PCPs and 3.8 specialists) in 2012/13. This compares favourably with the unweighted average for the Latin America Region of 16.1 (in 2012), and the USA of 26 (in 2011) (PAHO, 2014).

The 2013-2014 eyecare workforce included: 115 private optometrists, and 1 in the public sector (TTORC, 2013), with 90 optometrists-in-training; 54 dispensing opticians; 34 active ophthalmologists (eye surgeons), of whom 23 worked in the private sector, 10 in both, and one in the public sector; and 35 ophthalmologists-in-training in the public sector. The ophthalmologists had mostly obtained postgraduate qualification in the UK (n=31/34) (MBTT, 2013). The optometrists (n=50) had obtained qualification in the UK (41%) or USA (30%), and had been in practice for between 2 and 65 years, with an average time since qualification of 17 years. The optometrists reported an average 36-hour week (sd 15, range 1 to 70), spending

77.2% of their time refracting, 9.0% on management/business, 8.3% teaching, and the remainder doing research (1.5%), fulfilling a role in a professional organisation (1.8%), or undertaking charity work locally (2.2%) or abroad (0.02%). Optometry capacity was not fully utilised; only 54% reported having over 75% of their available appointments filled on a typical day.

Trinidad and Tobago's eyecare workforce comfortably exceeded the Vision 2020 Goal to have at least one ophthalmic surgeon, one optometrist able to refract, and one ophthalmic-trained nurse or ophthalmic medical assistant per 50,000 population (WHO, 2007). Overall, per 50,000 population, there were 4.37 optometrists, 2.03 dispensing opticians, 0.93 private sector ophthalmologists, 0.26 public sector ophthalmologists, and 1.32 public sector ophthalmologists-in-training (See Table 6). These estimates reveal an unequal distribution of independent ophthalmologists between the public and private sectors, and highlight a significant dependence within the public sector on service provision by trainee eye surgeons. Furthermore, the workforce distribution was not evenly matched to the population distribution, with a higher concentration of eyecare providers in northwest Trinidad, and a paucity in eastern Trinidad (see Table 6 and Figure 2). Low income countries typically have 0.45 ophthalmologists per 50,000 population, compared to 4.0 per 50,000 in high income countries (Resnikoff, et al. 2012). Significant geographic variability in ophthalmologist distribution has also been reported in the USA (Gibson, 2015), and in France, where it ranges from 5.5 to 13.5 per 100,000 population (Lafuma et al., 2006). The eyecare workforce in Trinidad and Tobago was significantly underestimated previously, at 16 (Resnikoff et al., 2012), illustrating the value of health system studies undertaken within country.

Technical support and maintenance of specialised ophthalmic equipment in the hospitals was provided by supply companies, whose technicians were located abroad but sporadically visited.

The public health centres made a small contribution to the eyecare workforce. Health centres (n=90) included a median 1.9 district health visitors, 0.6 district nurses, 0.9 registered nurses, 2.2 enrolled nursing assistants, 1.8 PCPs and 0.9 school health screeners. However, competence in the measurement of visual acuity was estimated to range from 25.0% amongst district nurses to 76.5% amongst PCPs. Only 20.5% (n=17) of health centres had protocols for the triage and management of eye or vision problems. A School Health Project, including hearing and vision screening for all 1st year primary school children, was in the process of being implemented nationwide in 2014. This resulted from collaboration between the Ministries of Health, Education, and Social Development, and NGOs including PAHO, and the United Nations Children's Fund. A scheme to enable free access to spectacles was in the process of being extended to meet demand.

Infrastructure

Equipment and supply of pharmaceuticals

The optometry survey confirmed that the majority of private practices were appropriately equipped for primary eyecare (IAPB, 2011, Hornby, 2013). The following services were included by at least 80% of optometrists in a standard sight test with a mean cost of TT\$113 (sd 28): distance visual acuity (100%, n=50), near acuity or reading assessment (98.0%, n=49), refraction (98.0%, n=49), direct ophthalmoscopy (92.0%, n=46), slit lamp examination of the anterior segment (80.0%, n=40), and air puff tonometry (86.0%, n=43). Less frequently included components were slit lamp examination of the fundus (58.0%, n=29) and Goldman Tonometry to measure intraocular pressure (20.0%, n=10). Visual field testing, essential for the diagnosis and monitoring of glaucoma and other conditions, was offered by 76%, but for a mean additional fee of TT\$178 (sd 30). However, optometry practices were concentrated in more affluent areas, leaving large rural areas without

geographically proximate access (Figure 2). Optometrists reported a desire to increase the scope of their practice by dilating eyes to enable more thorough examination, and this became legal in December 2014, although professional indemnity cover exclusions still limited its application.

In contrast, health centres were within easy reach of all communities nationwide, but they were often not adequately equipped to offer primary eyecare. Only 58% had a distance visual acuity chart, 19% had a near acuity or reading chart, and whilst 85% had a direct ophthalmoscope, only 5% had dilating eye drops to facilitate fundus examination. None had a visual field analyser. In the preceding 3-month period, 2% had offered ophthalmology outreach clinics, and 1% (all in the ERHA) had offered optometry outreach clinics for patients with chronic disease, via the Shared Community Ophthalmology Primary Eyecare (SCOPE) program.

The equipment available for ophthalmic service delivery in the 5 public hospital eye departments did not meet minimum requirements (Bailey, 2011) in some cases (see Table 4), but Scarborough was in the process of ordering new equipment.

Scarborough and MH Hospital did not have a visual field analyser. This equipment, considered essential for even a primary care eye service (Hornby, 2013), is needed for the safe management of glaucoma patients. Scarborough, PoSG, and MH hospitals did not have a fundus camera to facilitate monitoring of retinal disease. Only SG hospital had fluorescein angiography, but reported seldom using it on account of inadequate availability of trained staff. 4 hospitals had corneal topography and 3 had advanced biometry devices, considered desirable but not essential for secondary eyecare (Bailey, 2011). Laser treatment was available in all hospitals. However, maintenance problems were reported by three hospitals, leading to periods of unavailability lasting weeks or months. Delayed laser treatment, for example in patients with proliferative diabetic retinopathy, may result in irreversible vision loss. All five were equipped for a modern cataract surgical service, with biometry and

phacoemulsification machines. Vitrectomy equipment, which is used most frequently to repair retinal detachments, was available in two hospitals, but expertise to use it in only one. Availability of other investigations was reasonable. Four hospitals had access to CT imaging and two to MR imaging, which are valuable for the investigation of certain ophthalmic emergencies and complex cases. All hospitals had access to serological investigations.

Access to essential medicines is a crucial commodity in any health system (IAPB, 2011). From 2005, a Chronic Disease Assistance Programme provided 47 prescription medicines for 11 chronic conditions, including diabetes, hypertension, and glaucoma, in all public health facilities. These drugs were dispensed through over 250 public and private pharmacies (PAHO, 2012).

Training of eyecare providers

A 4-year BSc degree in optometry commenced at the University of the West Indies in Trinidad in 2009, and had 90 students enrolled. Training of ophthalmologists occurred under each autonomous RHA. A postgraduate ophthalmology training program commenced in 2009 at UWI, but had been suspended in 2013. There was no rotation of ophthalmology trainees between RHAs and no national organisational structure to oversee training standards and competency progression, or to issue postgraduate qualifications. Ophthalmology trainees reported self-funding postgraduate qualifications abroad, via examination systems in the UK, USA and Jamaica.

Public Education in eyecare

The eyecare community hosted annual events for World Sight Day, and intermittent Glaucoma community awareness programs. The MoH led intermittent public education initiatives on eyecare, and general healthcare, for example, a “Fight the Fat” initiative, promoting healthy lifestyles (Ministry of Health, 2012a). PAVI

organised fund-raising events, and an International Day for Persons with Disabilities (CCB, 2014).

Information and knowledge

There was no existing literature on the prevalence, causes and risk factors for avoidable blindness in Trinidad and Tobago, and NESTT (*citation masked*) was designed to address this. Health systems also need data for monitoring, evaluation and quality assurance, and to support clinical decision-making. In many countries, but not currently in Trinidad and Tobago, routine administrative and clinical data, including data on cataract surgical outcomes, hospital episodes statistics including diagnostic classification codes, and patient safety incidents, are collated nationally by computer-based information systems.

Outcomes

Eye clinic outpatients (n = 453) were generally satisfied (55.8%, n = 250) or very satisfied (21.7%, n = 97) with the quality of care received in the 5 public hospitals. The median waiting time for a new patient appointment was 2.8 months (IQR 0.5-9, range 0 to 36). Suggestions for improvement included reducing clinic waiting time (n = 148), improving staff communication skills (n = 26) and the quality of explanations given to patients about their condition and management (n = 9), more physical space (n = 28), improved wheelchair access (n = 12, in POSG hospital), more eye doctors (n = 26), more nurses (n = 14), improving the referral, appointments and medical records systems (n = 14), reducing the waiting time for appointments (n = 14), reducing the waiting time for operations (n = 6), improving availability of drugs in pharmacy (frequently out of stock) (n = 8), investment in more equipment (n = 5), and government support for the cost of transport to clinic (n = 4), and spectacles (n = 2).

Eyecare providers also provided feedback on current eyecare services. Optometrists (n = 50) highlighted the lack of availability in the public hospitals of key investigations

(e.g. visual field analysis in 2 hospitals) and services (e.g. low vision assessment, refraction, contact lens fitting, keratoconic assessment and orthoptics). They also reported that government financial assistance for the cost of eye tests and spectacles was only available to parents of children with visual impairment who were in receipt of welfare grants, leaving many families unable to afford spectacles. They highlighted the need for orthoptists and more paediatric ophthalmologists in Trinidad and Tobago. Some suggested that, *“more union and harmony between all levels of eye care professionals is needed.”* There were also reports of a lack of enforcement of professional standards in optometry, and a risk of missed diagnoses in some optometry practices lacking a slit lamp. PCPs (n = 22) suggested systematic screening for diabetic retinopathy, training and employing more ophthalmologists in the public sector, developing public sector optometry services, and offering ophthalmology outreach services in health centres. Ophthalmologists (n=5) working in public and private sectors provided feedback on access to consumables and specialised equipment in clinic and theatre, and availability of supporting administrative and allied health professionals. Ophthalmologists-in-training (n=5) provided feedback on their training environment. Whilst these provided interesting insights into the eyecare system, we have not reported this data on account of the risk of bias from such small samples.

Eyecare Goals

In 2014, Trinidad and Tobago had made good progress towards the prevention of avoidable blindness, with the achievement of 14/27 (51.9%) indicators in the Caribbean region's, *“Strategic Framework for Vision 2020: The Right to Sight”* (PAHO, 2010) (Table 7). In addition, a further three were imminently achievable. Two indicators relating to the introduction of a diabetic retinopathy screening and

treatment program, integrated with primary care. This had been piloted in southwest Trinidad in 2013 and there was political commitment to introduce this nationally. The Ministry of Health had also invested in a National Eye Survey to generate an evidence-base on the magnitude and causes of avoidable blindness. This evidence-base will support stakeholders and policy makers in developing and implementing a National Vision-2020 plan, as well as providing a baseline against which progress towards preventing avoidable blindness can be measured.

Linkages between health system elements

Linkage between different elements in a highly pluralistic system is important to ensure integration and coordination between public and private sectors, and primary, secondary and tertiary levels, to prevent gaps in access and care. Ideally, the tiers should operate in a complementary way to ensure the optimal flow of patients and the optimal management for each individual at the most appropriate level, rather than competition (van Olmen et al., 2012). This study identified a dominant role of the private sector in the provision of eyecare services in Trinidad and Tobago, but uneven geographic distribution of private optometry and ophthalmology services, and high costs for some services relative to household income. In contrast, the geographic distribution of public sector primary care facilities was good, but staffing and equipment were inadequate for a primary eyecare service, and utilisation data identified that the population seldom seek eyecare via that route. Relationships between different tiers of the eyecare system were governed by some formal arrangements, but predominantly by market forces.

Discussion

This study provides the first comprehensive overview of the health system in Trinidad and Tobago, and focuses specifically on its capacity to deliver eyecare. The strengths of this study include its attempted inclusivity, and obtaining qualitative

feedback from providers, users and the general public, on aspects of the quality, affordability, and acceptability of eyecare in 2014. Investigators included senior local ophthalmologists, optometrists and academics, who were able to provide important external validation of the study findings. Direct engagement to understand different stakeholders' perspectives is essential, because intervening in health systems may change power dynamics, and sustainable development is likely to depend on the alignment of goals and interests (van Olmen et al., 2012). In addition, we present quantitative data on the public and private eyecare system infrastructure, human resources, equipment, referral pathways, unit costs, and utilisation in a 12-month period, which will be of value in future economic analyses. To our knowledge, this study is also the first in a Caribbean nation to report on progress towards the PAHO Vision 2020 Strategic Framework Indicators.

In common with many other countries, the major challenge facing the Trinidad and Tobago health system is rising health care demand linked to the rapid emergence of chronic diseases and an aging population, with associated rising health care expenditure. Health systems need to be prepared to respond to these challenges (Atun et al., 2013). We estimate that eyecare for older adults may be responsible for as much as 9.5% of all health care expenditure in Trinidad and Tobago, and this may increase in the future. This study identified several weaknesses in the eyecare system, which could result in avoidable blindness. Firstly, there were no co-ordinated national screening programmes to identify and treat sight-threatening conditions, including diabetic retinopathy, retinopathy of prematurity, and congenital cataract. Secondly, potential patient safety issues relating to equipment were identified. Specifically, two public hospitals lacked automated visual field equipment essential for the management of glaucoma, a leading cause of avoidable blindness, and three hospitals had laser equipment maintenance issues with delayed treatment of sight-threatening diabetic retinopathy. Thirdly, some subspecialised surgery was

unavailable in the public sector, including surgery for urgent or blinding conditions including retinal detachment and corneal scarring. This highlights the importance of central governance of the eyecare system and on-going coordination with the private sector to avoid sight-threatening gaps in access to timely diagnosis and treatment. Similar public-private partnerships have been used effectively to strengthen eyecare systems in other countries (Blanchet and Patel, 2012). Finally, the referral, medical records, and appointment systems were paper-based, with limited capacity for information gathering, integration or audit, and accountability between levels and sectors.

An important limitation of this study was the suboptimal response rate to the ophthalmologist survey. Given the potential non-response bias, we only presented data that could be objectively verified from other sources, including the Medical Board registration list, Ministry of Health reports, Newspaper and Directory listings. We have not reported qualitative feedback obtained from ophthalmologists or ophthalmologists-in-training, or estimated private sector ophthalmic equipment ownership, as this could not be corroborated. We presented private sector unit costs reported by ophthalmologists for different services and procedures because the fees reported by responding ophthalmologists were similar to the costs reported by patients selected to participate in the national eye survey. These data, allowing for uncertainty in the true mean values, will be important for future health economic modelling of cost-effective health system interventions. Seeking potentially sensitive financial information may have been one factor influencing non-response. In addition, low participation in this eyecare system study may have been influenced by a contemporaneous national eye survey (citation masked), to which some local ophthalmologists were publically opposed on account of the inclusion of a genetic epidemiology component (citation masked).

Low response rates to health provider surveys have been reported elsewhere (McLeod et al., 2013), and may result in data from non-representative samples of different groups. In addition, most of the data in this study was based on self-report, which is subject to potential recall bias. We sought to mitigate bias by gathering information on key parameters, such as waiting times, human resources, infrastructure, and service fees, from multiple sources. This study did not include a survey of private patients, and a follow-up study should seek to address this.

Conclusions

The most recent WHO global eye health strategy advocates research into, and strengthening of, health systems to address the existing burden of avoidable blindness (WHO, 2013). Countries have diverse, unique, and frequently pluralistic health service delivery models, and obtaining a detailed overview can be challenging. By undertaking a comprehensive in-country situation analysis, and describing the function and inter-relation of each element using the health system dynamics framework, we have taken a systematic approach to identify strengths and limitations of the eyecare system. However, there is little research on how eyecare systems should respond effectively and sustainably to the challenges identified, highlighting the need for more research in this area (Blanchet et al., 2012). Through exploring the context in which potentially avoidable blindness develops, we have sought to provide decision-makers with important insights with which to interpret the NESTT blindness prevalence estimates in due course (citation masked). This evidence-base will support the development of a national eyecare strategy and the priorities for future resource allocation. We recommend the survey instruments developed for use in this study, and the health system dynamics analytic framework, as useful tools for country-level health systems research elsewhere in the Caribbean and beyond.

References

- APPARICO, N., CLERK, N., HENRY, G., SEALE, J., SEALY, R., WARD, S. & MUNGRUE, K. 2007. How well controlled are our type 2 diabetic patients in 2002? An observational study in North and Central Trinidad. *Diabetes Res Clin Pract*, 75, 301-5.
- ATUN, R., JAFFAR, S., NISHTAR, S., KNAUL, F. M., BARRETO, M. L., NYIRENDA, M., BANATVALA, N. & PIOT, P. 2013. Improving responsiveness of health systems to non-communicable diseases. *Lancet*, 381, 690-7.
- BAILEY, C. 2011. Ophthalmic Imaging. *Ophthalmic Services Guidelines*. London, UK: Royal College of Ophthalmologists.
- BATSON, Y. A., TEELUCKSINGH, S., MAHARAJ, R., SINGH, V., BALKARAN, S. & COCKBURN, B. 2013. Screening for diabetes in schoolchildren in Trinidad, West Indies. *Paediatr Int Child Health*, 33, 37-41.
- BLANCHET, K., GILBERT, C. & DE SAVIGNY, D. 2014. Rethinking eye health systems to achieve universal coverage: the role of research. *Br J Ophthalmol*, 98, 1325-8.
- BLANCHET, K., GORDON, I., GILBERT, C. E., WORMALD, R. & AWAN, H. 2012. How to achieve universal coverage of cataract surgical services in developing countries: lessons from systematic reviews of other services. *Ophthalmic Epidemiol*, 19, 329-39.
- BLANCHET, K. & PATEL, D. 2012. Applying principles of health system strengthening to eye care. *Indian J Ophthalmol*, 60, 470-4.
- BLIND WELFARE ASSOCIATION OF TRINIDAD AND TOBAGO, BWA. 2015a. *The Objectives of the T&T Blind Welfare Association* [Online]. <http://www.bordeglobal.org/blind/index.php>. [Accessed January 2015].
- BOOR, K., SCHEELE, F., VAN DER VLEUTEN, C. P., SCHERPBIER, A. J., TEUNISSEN, P. W. & SIJTSMA, K. 2007. Psychometric properties of an instrument to measure the clinical learning environment. *Med Educ*, 41, 92-9.
- BOURNE, R., PRICE, H., TAYLOR, H., LEASHER, J., KEEFFE, J., GLANVILLE, J., SIEVING, P. C., KHAIRALLAH, M., WONG, T. Y., ZHENG, Y., MATHEW, A., KATIYAR, S., MASCARENHAS, M., STEVENS, G. A., RESNIKOFF, S., GICHUHI, S., NAIDOO, K., WALLACE, D., KYMES, S., PETERS, C., PESUDOV, K., BRAITHWAITE, T., LIMBURG, H. & DISEASE VISION LOSS EXPERT GROUP, O. B. 2013a. New systematic review methodology for visual impairment and blindness for the 2010 global burden of disease study. *Ophthalmic Epidemiol*, 20, 33-9.
- BOURNE, R. R., STEVENS, G. A., WHITE, R. A., SMITH, J. L., FLAXMAN, S. R., PRICE, H., JONAS, J. B., KEEFFE, J., LEASHER, J., NAIDOO, K., PESUDOV, K., RESNIKOFF, S. & TAYLOR, H. R. 2013b. Causes of vision loss worldwide, 1990-2010: a systematic analysis. *Lancet Glob Health*, 1, e339-49.
- BOZZANI, F. M., GRIFFITHS, U. K., BLANCHET, K. & SCHMIDT, E. 2014. Health systems analysis of eye care services in Zambia: evaluating progress towards VISION 2020 goals. *BMC Health Serv Res*, 14, 94.
- CARIBBEAN COUNCIL FOR THE BLIND, CCB. 2014. *Persons Associated with Visual Impairment (PAVI): Mission, Vision and Main Activities* [Online]. <http://www.eyecarecaribbean.com/our-member-in-trinidad-and-tobago>. [Accessed 16 April 2014].
- CENTRAL BANK OF TRINIDAD AND TOBAGO. 2015. 2015 Annual Economic Survey: Review of the National Economy. In: CENTRAL BANK OF TRINIDAD AND TOBAGO(ed.). Available: [https://http://www.central-bank.org.tt/sites/default/files/Annual Economic Survey 2015.pdf](https://http://www.central-bank.org.tt/sites/default/files/Annual%20Economic%20Survey%202015.pdf).
- CENTRAL BANK OF TRINIDAD AND TOBAGO. 2017. Data Centre Exchange Rates Annual for 2014. Available: <http://www.central-bank.org.tt/statistics/data-centre/annual-data.php> [Accessed 22 May 2017]

- CENTRAL INTELLIGENCE AGENCY 2015. The World Factbook: Central America and the Caribbean: Trinidad and Tobago.
<https://http://www.cia.gov/library/publications/resources/the-world-factbook/geos/td.html>. [Accessed 16 April 2014].
- CENTRAL STATISTICAL OFFICE. 2011. Trinidad and Tobago 2011 Population and Housing Census Demographic Report. Port of Spain, Trinidad: The Government of The Republic of Trinidad and Tobago Ministry of Planning and Sustainable Development.
- CENTRAL STATISTICAL OFFICE. 2014. *Population Mid Year Estimates* [Online]. Port of Spain, Trinidad: The Government of The Republic of Trinidad and Tobago Ministry of Planning and Sustainable Development. Available:
<http://cso.gov.tt/data/?productID=31-Population-Mid-Year-Estimates>. [Accessed 14 December 2016 2016].
- CLARKE, P., GRAY, A., LEGOOD, R., BRIGGS, A., HOLMAN, R. 2003. The impact of diabetes-related complications on healthcare costs: results from the United Kingdom Prospective Diabetes Study (UKPDS Study No. 65). *Diabetic Medicine: a journal of the British Diabetic Association*. 20(6):442-50.
- EDWARDS, P. J., ROBERTS, I., CLARKE, M. J., DIGUISEPI, C., WENTZ, R., KWAN, I., COOPER, R., FELIX, L. M. & PRATAP, S. 2009. Methods to increase response to postal and electronic questionnaires. *Cochrane Database Syst Rev*, MR000008.
- GIBSON, D. M. 2015. The geographic distribution of eye care providers in the United States: Implications for a national strategy to improve vision health. *Prev Med*, 73, 30-6.
- HORNBY, S. 2013. Primary Care Ophthalmology Care. *Ophthalmic Services Guidelines*. London, UK: Royal College of Ophthalmologists.
- INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF BLINDNESS. 2011. Standard List of Equipment, Drugs and Consumables for VISION 2020 Eye Care Service Units 2010/2011. London, UK: London School of Hygiene & Tropical Medicine.
- LAFUMA, A. J., BREZIN, A. P., FAGNANI, F. L., MESBAH, M. & BERDEAUX, G. H. 2006. Prevalence of visual impairment in relation to the number of ophthalmologists in a given area: a nationwide approach. *Health Qual Life Outcomes*, 4, 34.
- LEASHER, J. L., LANSINGH, V., FLAXMAN, S. R., JONAS, J. B., KEEFFE, J., NAIDOO, K., PESUDOV, K., PRICE, H., SILVA, J. C., WHITE, R. A., WONG, T. Y., RESNIKOFF, S., TAYLOR, H. R. & BOURNE, R. R. 2014. Prevalence and causes of vision loss in Latin America and the Caribbean: 1990-2010. *Br J Ophthalmol*, 98, 619-28.
- MEDICAL BOARD OF TRINIDAD AND TOBAGO 2013. Medical Board of Trinidad and Tobago: National Electronic Register of Board Members who have registered Higher (Specialist) Qualifications. Trinidad. [Accessed 16 May 2013].
- MCLEOD, C. C., KLABUNDE, C. N., WILLIS, G. B. & STARK, D. 2013. Health care provider surveys in the United States, 2000-2010: a review. *Eval Health Prof*, 36, 106-26.
- MILLS, A.J., RANSON, M.K. 2006. The design of health systems. In: MERSON, M. H., BLACK, R.E., AND MILLS, A.J. (ed.) *International public health: diseases, programs, systems, and policies*. Second Edition ed. Sudbury: Jones and Bartlett Learning.
- MINISTRY OF HEALTH, Government of Trinidad and Tobago. 2011. Health Report Card for Trinidad and Tobago 2011. Port of Spain, Trinidad. Available:
<http://www.health.gov.tt/downloads/DownloadDetails.aspx?id=223>
- MINISTRY OF HEALTH, Government of Trinidad and Tobago. 2012a. Panamerican STEPS Chronic Non-communicable disease risk factor survey Final Report. Port of Spain, Trinidad. Available:
http://www.who.int/chp/steps/TrinidadAndTobago_2011_STEPS_Report.pdf
- MINISTRY OF HEALTH, Government of Trinidad and Tobago. 2012b. Address by the Honourable Dr Fuad Khan, Minister of Health, Trinidad and Tobago, at the Opening Ceremony. In: MINISTRY OF HEALTH(ed.) *Congress of the Ophthalmological Society*

- of the West Indies. Hyatt Regency Hotel, Trinidad:
<http://www.health.gov.tt/downloads/DownloadDetails.aspx?id=276>.
- MINISTRY OF HEALTH, Government of Trinidad and Tobago. 2015. *Ministry of Health - Overview: Our Vision and Our Mission* [Online]. Port of Spain, Trinidad: Government Online. Available: <http://www.health.gov.tt/sitepages/default.aspx?id=38>.
- PAHO 2010. Pan American Health Organization Strategic Framework for Vision 2020: The Right to Sight. Caribbean Region. In: PAHO Regional Office of the World Health Organization. (ed.). Barbados. Available:
http://www.iapb.org/sites/iapb.org/files/Caribbean%20V2020%20Committees%20Meeting_Dec2012.pdf
- PAHO 2012. Pan American Health Organization: Health in the Americas 2012: Trinidad and Tobago Country Volume. In: Pan American Health ORGANIZATION(ed.). Available: http://www.paho.org/Saludenlasamericas/index.php?option=com_docman&task=doc_view&gid=149&Itemid= [Accessed 14 December 2016].
- PAHO 2014. Pan American Health Organization *Trinidad and Tobago Indicator Profile, Group of Resources, Services and Coverage Indicators* [Online].
<http://ais.paho.org/phis/viz/indicatorprofilebydomain.asp>: Pan American Health Organization. [Accessed 14 December 2016].
- PATRICK, H. A., PAUL, R. & NALDER, S. 1991. A health situation analysis in Trinidad and Tobago, 1990. The local health systems approach. *West Indian Med J*, 40, 105-8.
- PERSONAL COMMUNICATION. 1 June 2016. RE: *Personal communication with the Ministry of Health, Office of the Chief Medical Officer*.
- RESNIKOFF, S., FELCH, W., GAUTHIER, T.M., SPIVEY, B. 2012. The number of ophthalmologists in practice and training worldwide: a growing gap despite more than 200,000 practitioners. *British Journal of Ophthalmology*, 96, 783-7.
- RUSSELL, E., JOHNSON, B., LARSEN, H., NOVILLA, M. L., VAN OLMEN, J. & SWANSON, R. C. 2013. Health systems in context: a systematic review of the integration of the social determinants of health within health systems frameworks. *Rev Panam Salud Publica*, 34, 461-7.
- RUTTEN, F., LAPRE, R., ANTONIUS, R., DOKOUI, S., HAQQ, E., ROBERTS, R. & MILLS, A. 2002. Financing of health care in four Caribbean territories: a comparison with reforms in Europe. *Health Policy*, 62, 103-13.
- SPANAKIS, E. K. & GOLDEN, S. H. 2013. Race/ethnic difference in diabetes and diabetic complications. *Curr Diab Rep*, 13, 814-23.
- STEVENS, G. A., WHITE, R. A., FLAXMAN, S. R., PRICE, H., JONAS, J. B., KEEFFE, J., LEASHER, J., NAIDOO, K., PESUDOV, K., RESNIKOFF, S., TAYLOR, H. & BOURNE, R. R. 2013. Global prevalence of vision impairment and blindness: magnitude and temporal trends, 1990-2010. *Ophthalmology*, 120, 2377-84.
- THAM, Y. C., LI, X., WONG, T. Y., QUIGLEY, H. A., AUNG, T. & CHENG, C. Y. 2014. Global prevalence of glaucoma and projections of glaucoma burden through 2040: a systematic review and meta-analysis. *Ophthalmology*, 121, 2081-90.
- TRABOULAY, E. A. & HOYTE, O. P. 2015. Mini-review: Obesity in Caribbean Youth. *West Indian Med J*, 64, 250-62.
- TTORC 2013. Trinidad and Tobago Optometry Registration Council: Gazette Listing of Registered Optometrists, Dispensing Opticians, and Practices in Trinidad and Tobago (2013). [Accessed 30 April 2013]
- UNDP 2015. United Nations Development Report: Human Development Report 2015: Work for human development - Trinidad and Tobago. Available:
http://hdr.undp.org/sites/all/themes/hdr_theme/country-notes/TTO.pdf. [Accessed 1 November 2016]

- VAN OLMEN, J. C., B.; BHOJANI, U.,; MARCHAL, B.; VAN BELLE, S.; CHENG M.F.; HOEREE, T.; PIRARD, M.; VAN DAMME, W.; KEGELS, G. 2012. The Health System Dynamics Framework: The introduction of an analytical model for health system analysis and its application to two case-studies. *Health, Culture and Society*, 2.
- WHO 1997. Global Initiative for the Elimination of Avoidable Blindness: Vision 2020 The Right to Sight. Geneva: World Health Organisation. Available: http://whqlibdoc.who.int/hq/1997/WHO_PBL_97.61_Rev.1.pdf
- WHO 2000. World Health Report 2000. Geneva: World Health Organisation.
- WHO 2002. A framework and indicators for monitoring VISION 2020-The Right to Sight: The global initiative for the elimination of avoidable blindness. Geneva: World Health Organisation.
- WHO 2007. World Health Organisation Global initiative for the elimination of avoidable blindness - action plan 2006-2011. Geneva: World Health Organisation.
- WHO 2013. Universal eye health: a global action plan 2014-2019. Geneva, Switzerland:World Health Organisation. Available: <http://www.who.int/blindness/actionplan/en/>
- WORLD BANK 2014. The World Bank Data: Trinidad and Tobago. Available: <http://data.worldbank.org/indicator/NY.GNP.PCAP.CD?locations=TT>: World Bank Group.