

Increasing Access to  
Eyeglasses in Low- and  
Middle-Income Countries



PRODUCT NARRATIVE:  
**EYEGLASSES**



**ATscale**  
GLOBAL PARTNERSHIP FOR  
ASSISTIVE TECHNOLOGY  
[atscale2030.org](https://atscale2030.org)

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# ACRONYMS

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AT	Assistive technology
BRAC	Bangladesh Rural Advancement Committee
CE	CE marking (compliance with EU legislation)
CHAI	Clinton Health Access Initiative, Inc.
CHW	Community health worker
CSO	Civil society organisation
DPO	Disabled persons' organisation
EUR	Euro (currency)
FDA	US Food and Drug Administration
HIC	High-income country
IAPB	International Agency for the Prevention of Blindness
ISO	International Organization for Standardization
LMIC	Low- and middle-income country
NGO	Non-governmental organisation
SEH	School eye health
UHC	Universal health coverage
UK	United Kingdom
US	United States of America
USD	United States Dollar
WHO	World Health Organization

# EXECUTIVE SUMMARY

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**GLOBALLY, AT LEAST 1 BILLION PEOPLE HAVE A VISION IMPAIRMENT** that is uncorrected or could have been prevented. Refractive error is the most common cause of vision impairment. Refractive error occurs when the shape or length of the eye prevents light from focusing directly on the retina, resulting in blurred vision. Globally, myopia and presbyopia, the two most common refractive errors, affect 2.6 billion and 1.8 billion people respectively. These numbers will continue to increase due to population growth, ageing, and lifestyle changes: for example, 3.4 billion people – or 40% of the global population – are projected to have myopia by 2030.

Correcting refractive error with eyeglasses is a simple and effective intervention. At least 826 million people suffer from vision impairment due to uncorrected refractive errors and can benefit from eyeglasses. Some estimates that include milder vision loss place this number at more than 2 billion. The unmet need is concentrated in low- and middle-income countries (LMICs), yet demand for eyeglasses in LMICs remains low due to lack of awareness around vision impairment and stigma towards the wearing of eyeglasses. Uncorrected refractive errors cause an approximately USD270 billion annual loss in productivity to the global economy. Uncorrected refractive errors also have a negative impact on the health, education, quality of life, and general wellbeing of affected individuals.

The global eyewear market focuses primarily on developed markets or high-value market segments in LMICs, such as wealthier, often urban populations with expensive prescription eyeglasses. Reading eyeglasses are relatively affordable. The supply chain for prescription eyeglasses is complex due to the level of customisation required to meet a prescription. The leading global supplier of lenses and frames controls the full value chain, from manufacturing of components to retail sales. In LMICs, markets are small with limited public provision of eyeglasses, even though the World Health Organization (WHO) recommends that eyeglasses should be provided within the context of comprehensive eye care, and integrated within the healthcare system and national health plans.

Key market barriers that perpetuate the current situation of low access to eyeglasses in LMICs include: low levels of investment by governments; high costs to the end-users; complex in-country supply chains; a service delivery model that requires high levels of resources in terms of personnel and infrastructure; limited number of points of services and sales; and low awareness and acceptance of eyeglasses. Innovations in identification of refractive errors, refraction devices, service delivery, and eyeglasses themselves may provide opportunities to address some of these barriers.

Increasing access to eyeglasses to eliminate the burden of uncorrected refractive errors in LMICs will require a multisectoral approach that brings together the public and the private sector, multilateral organisations, and donors. This will require an approach that increases demand for eyeglasses, raises the number of access points for screening and provision, and accelerates the availability of affordable products. To achieve this, we propose five strategic objectives that can strengthen the market in both the short and longer term:

- **STRATEGIC OBJECTIVE 1:** Mobilise key stakeholders, including donors, multilaterals, NGO implementers, and the private sector, around reliable data and scalable proven models to accelerate efforts against vision impairment caused by refractive errors.
- **STRATEGIC OBJECTIVE 2:** Strengthen global policy guidance around service delivery standards for low-resource settings to accelerate the adoption of innovative models, devices, and products that support a simplified service delivery.
- **STRATEGIC OBJECTIVE 3:** Support governments to develop comprehensive eye care plans integrating validated models of vision screening and provision within the public health system, and facilitate scale-up of those models.
- **STRATEGIC OBJECTIVE 4:** Engage the private sector to expand delivery of affordable, quality eyeglasses and related services in LMICs.
- **STRATEGIC OBJECTIVE 5:** Build and drive awareness and consumer demand for eyeglasses.

# INTRODUCTION

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## 1. Assistive Technology and Market Shaping

Assistive technology (AT) is an umbrella term covering the systems and services related to the delivery of assistive products such as wheelchairs, eyeglasses, hearing aids, prostheses, and digital devices and software. Today, over 1 billion people require AT to achieve their full potential, but 90% do not have access to the AT that they need. This unmet need for AT is driven by a lack of awareness of this need, discrimination and stigma, a weak enabling environment, lack of political prioritisation, limited investment, and market barriers on the demand and supply side. Narrowing in on the market shortcomings that limit the availability of assistive products, market shaping is proposed to address the root causes that limit availability, affordability, and access of appropriate AT, with the wider aim of ensuring improved social, health, and economic outcomes for people who require AT. Increased access to AT is critical to achieve many global commitments, including universal health coverage (UHC), the ideals of the United Nations Convention on the Rights of Persons with Disabilities, and the ambitious Sustainable Development Goals. To accelerate access to AT, the global community needs to leverage the capabilities and resources of the public, private, and non-profit sectors to harness innovation and break down market barriers.

Whether by reducing the cost of antiretroviral drugs for HIV by 99% in 10 years, increasing the number of people receiving malaria treatment from 11 million in 2005 to 331 million in 2011,<sup>1</sup> or doubling the number of women receiving contraceptive implants in 4 years while saving donors and governments USD240 million,<sup>2</sup> market shaping has addressed market barriers at scale. Market-shaping interventions can play a role in enhancing market efficiencies, improving information transparency, and coordinating and incentivising the numerous stakeholders involved in both demand- and supply-side activities. Examples of market-shaping interventions include: pooled procurement, de-risking demand, bringing lower cost and high-quality manufacturers into global markets, developing demand forecasts and market intelligence reports, standardising specifications across markets, establishing differential pricing agreements, and improving service delivery and supply chains.

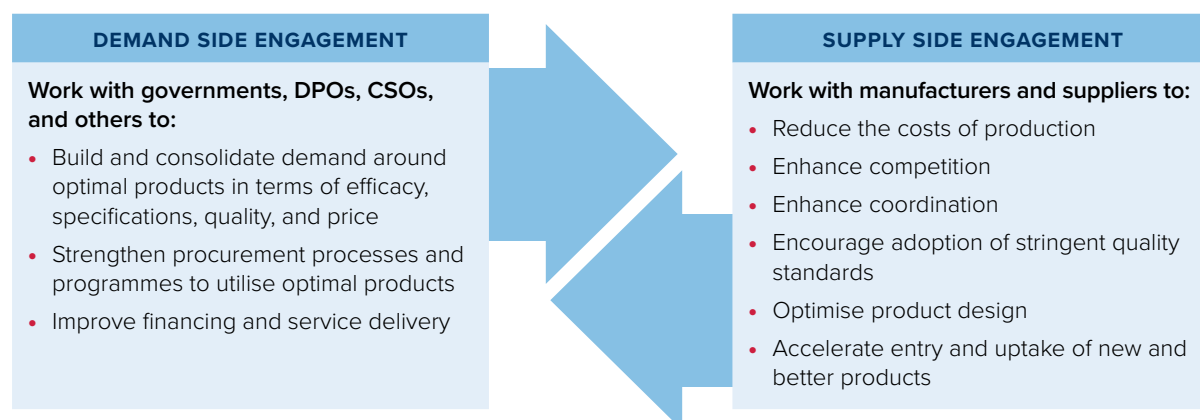
Market-shaping interventions often require coordinated engagement on the demand and supply side (see Figure 1). Successful interventions are tailored to specific markets after robust analysis of barriers and look to coordinate action on both the demand and supply side. These interventions are catalytic and time-bound, with a focus on sustainability, and are implemented by a coalition of aligned partners providing support where each has comparative advantages.

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<sup>1</sup> UNITAID and World Health Organization. UNITAID 2013 annual report: transforming markets saving lives. UNITAID; 2013. Available from: [http://unitaid.org/assets/UNITAID\\_Annual\\_Report\\_2013.pdf](http://unitaid.org/assets/UNITAID_Annual_Report_2013.pdf).

<sup>2</sup> Suzman, M. Using financial guarantees to provide women access to the modern contraceptive products they want to plan their families. Bill & Melinda Gates Foundation and World Economic Forum; 2016 May. Available from: [http://www3.weforum.org/docs/GACSD\\_Knowledge%20Hub\\_Using\\_Financial\\_Guarantees\\_To\\_Provide\\_Women\\_Access\\_To\\_Modern\\_Contraceptives.pdf](http://www3.weforum.org/docs/GACSD_Knowledge%20Hub_Using_Financial_Guarantees_To_Provide_Women_Access_To_Modern_Contraceptives.pdf).

**FIGURE 1: ENGAGING BOTH DEMAND AND SUPPLY SIDE FOR MARKET SHAPING**



Historically, AT has been an under-resourced and fragmented sector and initial analysis indicated that a new approach was required. ATscale, the Global Partnership for Assistive Technology, was launched in 2018 with an ambitious goal to provide 500 million people with the AT that they need by 2030. To achieve this goal, ATscale aims to mobilise global stakeholders to develop an enabling ecosystem for access to AT and to shape markets to overcome supply- and demand-side barriers, in line with a unified strategy (<https://atscale2030.org/strategy>). While the scope of AT is broad, ATscale has focused on identifying interventions needed to overcome these barriers for five priority products: wheelchairs, hearing aids, eyeglasses, prosthetic devices, and assistive digital devices and software.

Clinton Health Access Initiative (CHAI) is delivering a detailed analysis of the market for each of the priority products under the AT2030 programme (<https://at2030.org/global-partnerships/>), funded by UK aid from the UK government, in support of the ATscale Strategy. The AT2030 programme is led by the GDI Hub. What follows is a detailed analysis of eyeglasses, one of the five priority products to be evaluated.

## 2. Product Narrative

The product narrative defines the approach, identified by CHAI, to sustainably increase access to high-quality, low-cost AT in LMICs. The goals of this narrative are to: 1) propose long-term strategic objectives for a market-shaping approach; and 2) identify immediate opportunities for investments to influence the accessibility, availability, and affordability of eyeglasses.

This report has been informed by desk research, market analysis, key informant interviews, and site visits with relevant partners and governments to develop a robust understanding of the market landscape and the viability of the proposed interventions. A list of all individuals interviewed or consulted during the development process can be found in Appendix A. This document is divided into two chapters:

- **CHAPTER 1:** Market Landscape, including market context, the current product landscape, state of access and provision, supply chain analysis, and stakeholders' current engagement, as well as key market challenges and barriers to access on both the demand and supply side.
- **CHAPTER 2:** Strategic Approach to Market Shaping, including strategic objectives highlighting the long-term outcomes required to shape the market. A series of immediate next steps or actions to support achieving each strategic objective are proposed. For any given objective, the interventions are discrete testable opportunities that support the development of longer-term scalable interventions and investments.

*Note: The use of the terms 'spectacles' and 'eyeglasses' varies regionally as well as according to context: whether the term is being used in academic writing or by providers, suppliers, or manufacturers, amongst others. In Europe and by manufacturers, 'spectacles' is commonly used when referring to a complete pair of frames and lenses. This document uses 'eyeglasses' throughout to refer to the complete product of frames and lenses (both ready-made and prescription) for distance and near vision correction.*



# MARKET LANDSCAPE

## 3. Market Context

### 3.1 At least 1 billion people worldwide have a vision impairment that is uncorrected or could have been prevented

Globally, at least 1 billion people have a vision impairment that is uncorrected or could have been prevented.<sup>3</sup> Myopia and presbyopia, the two most common causes of vision impairment, affect 2.6 and 1.8 billion people respectively.<sup>4</sup> These numbers will continue to increase due to population growth, ageing, and lifestyle changes.

Refractive error is the most common cause of vision impairment. Vision impairment occurs when an eye condition affects the visual system and one or more of its vision functions.<sup>5</sup> Various eye conditions can cause vision impairment, including refractive error, cataracts, age-related macular degeneration, glaucoma, diabetic retinopathy, corneal opacity, and trachoma (see Appendix B). Refractive error occurs when the shape or length of the eye prevents light from focusing directly on the retina, resulting in blurred vision.<sup>6</sup> Table 1 presents the four types of refractive error.

**TABLE 1: TYPES OF REFRACTIVE ERROR**

	MYOPIA	HYPEROPIA	ASTIGMATISM	PRESBYOPIA
<b>Type of condition</b>	<ul style="list-style-type: none"> <li>Imperfection of the eye, whether it is its length or shape, or curvature of the cornea.</li> </ul>			<ul style="list-style-type: none"> <li>Hardening of the lens over time.</li> </ul>
<b>Description</b>	<ul style="list-style-type: none"> <li>Distant objects appear blurry.</li> </ul>	<ul style="list-style-type: none"> <li>Near objects appear blurry.</li> </ul>	<ul style="list-style-type: none"> <li>Blurred vision at all distances.</li> </ul>	<ul style="list-style-type: none"> <li>Near objects appear blurry.</li> </ul>
<b>Cause</b>	<ul style="list-style-type: none"> <li>Mix of genetic and environmental factors such as intensive near work activities (e.g. doing homework, reading books, using smartphones) or reduced time spent outdoors.<sup>7</sup></li> </ul>	<ul style="list-style-type: none"> <li>Mainly genetic factors.</li> </ul>	<ul style="list-style-type: none"> <li>Mainly genetic factors.</li> <li>Frequently occurs in addition to myopia or hyperopia.</li> </ul>	<ul style="list-style-type: none"> <li>Age: eye unavoidably loses the ability to focus on nearby objects.</li> <li>Typically affects both eyes similarly.</li> <li>Adds to any existing refractive error.</li> </ul>
<b>Typical age of onset</b>	<ul style="list-style-type: none"> <li>Around 8-12 years old.</li> <li>Onset can be as early as 5 years old in some regions.</li> </ul>	<ul style="list-style-type: none"> <li>Childhood.</li> <li>Children naturally compensate for it if mild or moderate.</li> </ul>	<ul style="list-style-type: none"> <li>Childhood or can develop throughout life.</li> </ul>	<ul style="list-style-type: none"> <li>Around 40 years old.</li> <li>May develop up to 5 years earlier due to environmental conditions, most prominently in the southern hemisphere.<sup>8</sup></li> </ul>

<sup>3</sup> World Health Organization. World report on vision. WHO; 2019.

<sup>4</sup> Fricke TR, Tahhan N, Resnikoff S, Papas E, Burnett A, Ho SM, Naduvilath, T, Naidoo KS. Global prevalence of presbyopia and vision impairment from uncorrected presbyopia. Ophthalmology. 2018;125(10):1492-1499.

<sup>5</sup> World Health Organization. World report on vision. WHO; 2019.

<sup>6</sup> Ibid.

<sup>7</sup> Morgan IG, Ohno-Matsui K, Saw SM. Myopia. The Lancet. 2012;379(9827):1739-1748.

<sup>8</sup> Jain IS, Ram J, Gupta A. Early onset of presbyopia. Am J Optom Physiol Opt. 1982;59(12):1002-1004.

Visual acuity is the typical measure for vision impairment severity (see Figure 2).

Distance visual acuity is assessed using a vision chart at a fixed distance, commonly 6 metres / 20 feet. The smallest line read on the chart is written as a fraction, where the numerator refers to the distance at which the chart is viewed, and the denominator is the distance at which a “healthy” eye is able to read that line of the vision chart. For example, a visual acuity of 6/18 means that at 6 metres from the vision chart, a person can read a letter that someone with normal vision would be able to see at 18 metres. “Normal” vision is taken to be 6/6 or otherwise referred to as 20/20.<sup>9</sup> A ‘tumbling E’ chart, which contains rows of the letter E in various kinds of rotation, is used for illiterate populations.

Near visual acuity is measured according to the smallest print size that a person can discern at a given test distance. Near vision impairment is commonly classified as a near visual acuity less than N6 at 40cm, where N6 refers to a font size equivalent to newspaper print.<sup>10</sup>

**FIGURE 2: VISION ACUITY DEFINITIONS ACCORDING TO WHO<sup>11</sup>**

	<b>MILD VISION IMPAIRMENT</b>	<b>MODERATE VISION IMPAIRMENT</b>	<b>SEVERE VISION IMPAIRMENT</b>	<b>BLINDNESS</b>	<b>PRESBYOPIA</b>
<b>Presenting visual acuity in the better eye</b>	Worse than 6/12 but equal to 6/18 or better	Worse than 6/18 but equal to 6/60 or better	Worse than 6/60 but equal to 3/60 or better	Worse than 3/60	Near vision worse than N6 at 40 cm

Myopia and presbyopia affect 2.6 billion<sup>12</sup> and 1.8 billion<sup>13</sup> people respectively. About 66% of people with myopia live in Asia, and prevalence of myopia is as high as 52% in East Asia.<sup>14</sup> In Sub-Saharan Africa, myopia prevalence is lower at approximately 9%.<sup>15</sup> Myopia is the most common type of refractive error in children: estimates suggest that 312 million children suffer from myopia worldwide.<sup>16</sup> On the other hand, prevalence of presbyopia reaches approximately 70% in populations over 50 years old worldwide.<sup>17</sup> Since a person can have more than one eye condition, it is difficult to estimate the total number of people with refractive errors as the figures for presbyopia and myopia cannot simply be summed to derive a global estimate (see Appendix C)<sup>18</sup>.

The number of people with refractive errors is projected to grow significantly in the next decade. 3.4 billion people are projected to have myopia by 2030, due to population growth and lifestyle changes such as reduced time spent outdoors, increased near work, and increased rates of urbanisation as children in urban areas spend less time outdoors, among other factors.<sup>19</sup> The number of people with presbyopia is projected to increase to 2.1 billion by 2030 due to population growth and aging.<sup>20</sup>

<sup>9</sup> World Health Organization. World report on vision. WHO; 2019.

<sup>10</sup> Ibid.

<sup>11</sup> Ibid.

<sup>12</sup> Holden BA, Fricke TR, Wilson DA, Jong M, Naidoo KS, Sankaridurg, P, Wong, TY, Naduvilath, TJ and Resnikoff, S. Global prevalence of myopia and high myopia and temporal trends from 2000 through 2050. Ophthalmology. 2016;123(5):1036-1042.

<sup>13</sup> Fricke TR, Tahhan N, Resnikoff S, Papas E, Burnett A, Ho SM, Naduvilath, T, Naidoo KS. Global prevalence of presbyopia and vision impairment from uncorrected presbyopia. Ophthalmology. 2018;125(10):1492-1499.

<sup>14</sup> Holden BA, Fricke TR, Wilson DA, Jong M, Naidoo KS, Sankaridurg, P, Wong, TY, Naduvilath, TJ and Resnikoff, S. Global prevalence of myopia and high myopia and temporal trends from 2000 through 2050. Ophthalmology. 2016;123(5):1036-1042.

<sup>15</sup> Ibid.

<sup>16</sup> Rudnicka AR, Kapetanakis VV, Wathern AK, Logan NS, Gilmartin B, Whincup PH, Cook, DG and Owen, CG. Global variations and time trends in the prevalence of childhood myopia, a systematic review and quantitative meta-analysis: implications for aetiology and early prevention. Br J Ophthalmol. 2016;100(7):882-890.

<sup>17</sup> Fricke TR, Tahhan N, Resnikoff S, Papas E, Burnett A, Ho SM, Naduvilath, T, Naidoo KS. Global prevalence of presbyopia and vision impairment from uncorrected presbyopia. Ophthalmology. 2018;125(10):1492-1499.

<sup>18</sup> World Health Organization. World report on vision. WHO; 2019.

<sup>19</sup> Holden BA, Fricke TR, Wilson DA, Jong M, Naidoo KS, Sankaridurg, P, Wong, TY, Naduvilath, TJ and Resnikoff, S. Global prevalence of myopia and high myopia and temporal trends from 2000 through 2050. Ophthalmology. 2016;123(5):1036-1042.

<sup>20</sup> Fricke, TR, Tahhan, N, Resnikoff, S, Papas, E, Burnett, A, Ho, SM, Naduvilath, T and Naidoo, KS. Global prevalence of presbyopia and vision impairment from uncorrected presbyopia: systematic review, meta-analysis and modelling. Ophthalmology. 2018;125(10):1492-1499.

### 3.2 Unaddressed vision impairment has a profound negative effect on individuals and society.

Negative outcomes on education, the economy, and health are associated with unaddressed vision impairment, both for individuals and society:

- **HIGH PRODUCTIVITY LOSS:** uncorrected myopia and presbyopia cost the global economy approximately USD270 billion in lost productivity per year due to diminished educational and job prospects, and reduced on-the-job efficiency.<sup>21</sup>
- **INCREASE IN ROAD ACCIDENTS:** several studies demonstrate a correlation between road accidents and unaddressed vision impairment. For example in India, drivers with poor vision have up to 30% higher incidence of road accidents.<sup>22</sup> In the UK, it is estimated that poor vision leads to over 2,800 traffic-related casualties and costs over USD50 million per year.<sup>23</sup>
- **LOWER QUALITY OF LIFE:** adults with unaddressed vision impairment are more likely to suffer from a lower quality of life, including higher rates of depression and anxiety, social isolation, higher risk of falls and fractures, limited mobility, higher rates of bullying, and cognitive decline.<sup>24</sup>
- **LOWER EDUCATION OUTCOMES:** in LMICs, children with unaddressed vision impairment are less likely to enrol in school, complete primary education, and be literate.<sup>25</sup> The probability of enrolling in school, completing primary school, or being literate are estimated between 5 to 7.3 percentage points below average for children with vision impairment, depending on the indicator and sample of countries. In addition, students with vision impairment tend to have lower academic performance.<sup>26</sup>

### 3.3 Refractive errors could be easily addressed with eyeglasses, but at least 826 million people worldwide live with uncorrected refractive errors.<sup>27</sup>

Correcting refractive errors with eyeglasses is a simple and effective intervention. As the most common corrective intervention, eyeglasses are included on the WHO Priority Assistive Products List.<sup>28</sup> Other interventions include contact lenses and laser eye surgery. Peer-reviewed research revealed that correcting presbyopia with eyeglasses increased productivity of tea-pickers by 22%, and up to 32% for those aged over 50 years old.<sup>29</sup> Research in China also showed that providing eyeglasses to primary school students has a significant positive impact on academic tests.<sup>30</sup> Eyeglasses are considered functioning interventions, which means that they do not eliminate refractive errors by treating their causes, but rather provide compensation for them.<sup>31</sup> Three types of eyeglasses exist:

- **PRESCRIPTION EYEGLASSES** are used to treat all types of refractive errors – myopia, hyperopia, astigmatism, and presbyopia. Prescription eyeglasses are customised products made to the specific need of each individual eye. In most countries they are sold in optical shops or vision centres, and users need a prescription from an accredited eye care professional (see Appendix D).

<sup>21</sup> World Health Organization. World report on vision. WHO; 2019.

<sup>22</sup> World Economic Forum. Eyeglasses for global development: bridging the visual divide. WEF; 2016.

<sup>23</sup> Ibid.

<sup>24</sup> World Health Organization. World report on vision. WHO; 2019.

<sup>25</sup> World Bank. Looking ahead: visual impairment and school eye health programs. World Bank; 2019.

<sup>26</sup> Ibid.

<sup>27</sup> Fricke TR, Tahhan N, Resnikoff S, Papas E, Burnett A, Ho SM, Naduvilath T, Naidoo KS. Global prevalence of presbyopia and vision impairment from uncorrected presbyopia. *Ophthalmology*. 2018;125(10):1492-1499.

<sup>28</sup> World Health Organization. World report on vision. WHO; 2019.

<sup>29</sup> Reddy, PA, Congdon, N, Mackenzie, G, Gogate, P, Wen, Q, Jan, C, Clarke, M, Kassalow, J, Gudwin, E, O'Neill, C, Jin, L, Tang, J, Bassett, K, Cherwek, DH and Ali, R. Effect of providing near glasses on productivity among rural Indian tea workers with presbyopia (PROSPER): a randomised trial. *Lancet Glob Health*. 2018;6(9):e1019-e1027.

<sup>30</sup> Ma, X, Zhou, Z, Yi, H, Pang, X, Shi, Y, Chen, Q, Meltzer, ME, Le Cessie, S, He, M, Rozelle, S, Liu, Y and Congdon, N. Effect of providing free glasses on children's educational outcomes in China: cluster randomized controlled trial. *BMJ*. 2014;349(sep23 7):g5740-g5740.

<sup>31</sup> While interventions aimed at inhibiting or slowing the progression of myopia in children exist, they are not the focus of this product narrative. These interventions show promising outcomes, but evidence is currently mixed and they should be considered as more evidence becomes available. Interventions include: increasing time spent outdoors; pharmacological agents, such as atropine eye drops; multifocal contact lenses; orthokeratology; and light stimulation via digital devices.

- **READING EYEGLASSES** – also known as near vision eyeglasses or ready-made readers – are used to treat presbyopia only. Reading eyeglasses are generic products that have the same corrective power on both lenses. Individuals put them on to do near tasks and take them off to look into the distance. In most HICs they can be purchased over the counter without a prescription from an accredited eye care professional. In some cases, a prescription is still required to buy reading eyeglasses – e.g. due to regulation or when individuals have presbyopia combined with myopia, hyperopia, or strong astigmatism – these cases will be considered as prescription eyeglasses in this report.
- **MULTIFOCAL EYEGLASSES** are used to treat patients with both myopia/hyperopia and presbyopia. The lenses are divided into two (bifocals) or three (trifocals) parts, or into a continuum of different corrective powers (progressive lenses). Individuals can look through the top part to see into the distance and look through the bottom part to see up close – therefore removing the need for taking reading eyeglasses on and off. They follow a similar supply chain as prescription eyeglasses but are not a focus of this report.

An appropriate pair of eyeglasses is defined as one that matches the person's prescription for both eyes while being comfortable to look through, fits the face of the user, and is durable, but also acceptable in terms of style. At a minimum, eyeglasses procured in a country should meet ISO quality standards or their equivalent.<sup>32</sup> Additionally, eyeglasses are often considered by users as a fashion accessory rather than a medical device. Therefore, it is important to ensure choice of frames to support longer-term compliance and provide dignity of choice to end users.

WHO estimates that **at least** 1 billion people have a vision impairment that is unaddressed or could have been prevented, including **at least** 826 million people suffering from vision impairment due to unaddressed presbyopia and **at least** 124 million people suffering from moderate to severe distance vision impairment or blindness due to unaddressed myopia or hyperopia.<sup>33</sup> Others estimate that this could be closer to 2.7 billion people with uncorrected refractive errors when including those with milder vision loss.<sup>34,35</sup> Rates of unaddressed presbyopia are estimated to be greater than 85% in Sub-Saharan Africa, while comparative rates in high-income regions like North America and Western Europe are reported to be around 1% (see Figure 3).<sup>36</sup>

<sup>32</sup> Lenses: ISO 8980 focuses on anti-reflective and anti-abrasion coating properties, lens optical power, positioning, geometric size, thickness tolerance and robustness, and luminous transmittance, among other aspects. Frames: ISO 12870 focuses on general frame construction (e.g. smooth surfaces, rounded edges), stability in elevated temperatures, and resistance to sweat and fire, among other aspects. Ready-made reading eyeglasses: ISO 16034 focuses on frame stability, resistance to sweat and fire, nickel release, lens surface quality and strength, optical power, and luminous transmittance, among other aspects.

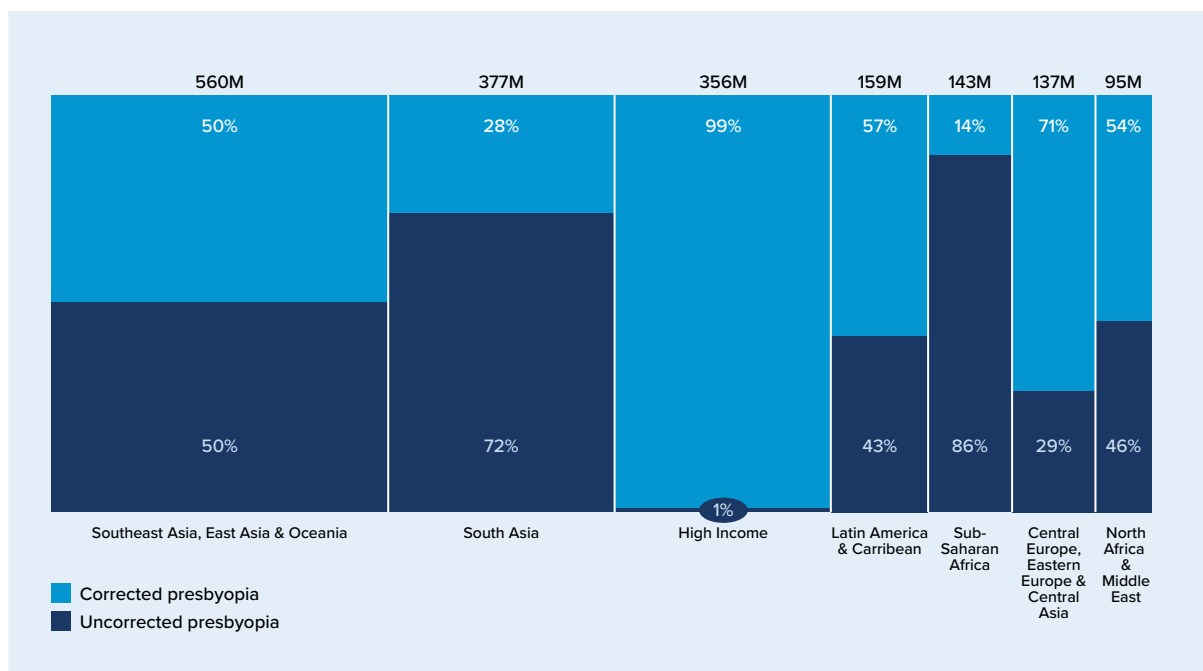
<sup>33</sup> World Health Organization. World report on vision. WHO; 2019.

<sup>34</sup> This estimate uses a lower threshold for visual acuity (worse than 6/9) than that used by WHO (worse than 6/12), and therefore estimates a much higher refractive error prevalence and assumes a higher number of individuals with uncorrected refractive errors as well.

<sup>35</sup> Essilor See Change. Eliminating poor vision in a generation: What will it take to eliminate uncorrected refractive errors by 2050? Essilor; 2019.

<sup>36</sup> Holden BA, Fricke TR, Wilson DA, Jong M, Naidoo KS, Sankaridurg, P, Wong, TY, Naduvilath, TJ and Resnikoff, S. Global prevalence of myopia and high myopia and temporal trends from 2000 through 2050. Ophthalmology. 2016;123(5):1036-1042.

**FIGURE 3: PERCENTAGE OF PEOPLE WITH CORRECTED AND UNCORRECTED PRESBYOPIA BY REGION (TOTAL 100% = 1.8 BILLION)<sup>37</sup>**



### 3.4 Eyeglasses should be provided within the context of comprehensive eye care and integrated within the healthcare system and national health plans.<sup>38</sup>

Providing eyeglasses is only one component of comprehensive eye care. As previously mentioned, vision impairment can be caused by a variety of eye conditions that in some cases require more specialised care. For example, cataracts, which are treated surgically, account for approximately 25-35% of moderate and severe vision impairment for people above 50 years old in Sub-Saharan Africa.<sup>39</sup> Health personnel trained for vision screening or refraction should be able to conduct a basic eye health assessment, identify signs and symptoms of common eye diseases, and refer patients to the relevant level of care. In addition, refraction services are often required as a component of rehabilitation services following eye surgeries such as cataract surgery.<sup>40,41</sup>

The WHO recommends an integrated approach to public eye care with services delivered across all levels of a health system in its 2019 *World Report on Vision*.<sup>42</sup> Countries are encouraged to integrate eye care into national health plans and health service delivery, rather than through a separate vertical programme approach. This aims to ensure eye care is integrated into health system planning and included across all service delivery platforms.<sup>43</sup> While many LMICs have developed national eye health plans leveraging WHO's most recent action plan, most have not yet integrated eye health into the national health plan, leading to a lack of appropriate strategic planning and budgeting.<sup>44</sup> Beyond healthcare, integrating eye care with other sectors such as education is also key to delivering high quality, cost-effective interventions such as school eye health programmes (see section 4.9).<sup>45</sup>

<sup>37</sup> Fricke TR, Tahhan N, Resnikoff S, Papas E, Burnett A, Ho SM, Naduvilath, T, Naidoo KS. Global prevalence of presbyopia and vision impairment from uncorrected presbyopia. *Ophthalmology*. 2018;125(10):1492-1499.

<sup>38</sup> World Health Organization. *World report on vision*. WHO; 2019.

<sup>39</sup> Flaxman SR, Bourne RR, Resnikoff S, Ackland P, Braithwaite T, Cicinelli MV et al. Global causes of blindness and distance vision impairment 1990–2020: a systematic review and meta-analysis. *Lancet Glob Health*. 2017;5(12):e1221-e1234.

<sup>40</sup> Mulley, AG, Goroll, A. *Primary care medicine: Office evaluation and management of the adult patient*. Wolters Kluwer; 2009.

<sup>41</sup> Vanneste, G. Community based case-finding and rehabilitation: detection of cataract patients and post-operative follow-up. *Community Eye Health*; 1998.

<sup>42</sup> World Health Organization. *World report on vision*. WHO; 2019.

<sup>43</sup> Ibid.

<sup>44</sup> Ibid.

<sup>45</sup> Ibid.

### 3.5 Capacity to deliver services for refractive errors in LMICs is limited due to the high cost of equipment and human resources required.

Guidelines for provision of eyeglasses are generally developed at the country level by professional associations and follow a common process in HICs (see Figure 4). In the US for example, the Optometric Clinical Practice Guidelines are defined by the American Optometric Association.

**FIGURE 4: OVERVIEW OF THE PROVISION PROCESS FOR PRESCRIPTION AND READING EYEGLASSES**

#### Four steps to provision of prescription eyeglasses

1. **VISION SCREENING:** distance visual acuity is tested using a distance vision chart, which is commonly available at low cost and is easy to use.
2. **OBJECTIVE REFRACTION:** an eye professional determines the severity of the refractive error and identifies the starting/initial lens power required to compensate for it using a device, either a retinoscope or an autorefractor (see Appendix E).
3. **SUBJECTIVE REFRACTION:** the eye professional tests corrective lenses with either a phoropter or a universal frame with trial lenses (see Appendix E) and makes adjustments based on the user's feedback. Subjective refraction aims to take into account the user's preferences and comfort.
4. **PROVISION OF PRESCRIPTION EYEGLASSES:** users select a frame, and uncut lenses matching the prescription for each eye are edged and mounted onto the frame in an optical assembly lab. Users typically receive their customised pair of eyeglasses a few days later (see section 4.4).

In clinical settings, other visual functions are also assessed, such as measurement of interpupillary distance, binocular vision assessment, measurement of field of vision, contrast sensitivity, or colour vision.<sup>46</sup>

Following the distance vision assessment, additional near vision tests are conducted to prescribe reading or multifocal eyeglasses.

#### Two steps to provision of reading eyeglasses

*(available over-the-counter and recommended where there is no service to do both a distance and near vision prescription)*

- **VISION SCREENING:** near visual acuity is tested using a near vision chart, which is typically available at low cost and is easy to use.
- **PROVISION OF READING EYEGLASSES:** users test reading eyeglasses with different corrective powers and select the ones that best accommodate their sight.

In most HICs, the provision process for reading eyeglasses can be completed with minimal training. Users can self-identify a vision loss and buy reading eyeglasses at retail points, such as pharmacies, without a prescription. On the other hand, the provision process for prescription eyeglasses relies on trained professionals. Traditional refraction devices are complex to operate, expensive, and stationary. The estimated cost for setting up an optical assembly lab is approximately USD200,000-USD250,000 in LMICs, with the highest costs allocated to lab equipment (approximately USD75,000, e.g. for lens centring, lens edger, and frame heater machines), and personnel training (approximately USD50,000). Due to the high cost of equipment and human resources required, points of access for eye care services in LMICs are scarce and principally located in urban areas.<sup>47</sup> Limited service points contribute to high drop-out rates when individuals are referred to a vision centre after being screened in more remote locations. Direct costs to access eye care, such as transport to appointments, are primary barriers to accessing care in LMICs.<sup>48</sup> Indirect costs of care, including the loss of productivity and foregone earnings for the patient and caregiver, are also common reasons to skip eye care appointments.<sup>49</sup>

<sup>46</sup> Ibid.

<sup>47</sup> Ibid.

<sup>48</sup> Ibid.

<sup>49</sup> Ibid.

Limited policy documents guide the provision of refraction services and eyeglasses in LMICs. Recent efforts to support LMICs include the *Standard School Eye Health Guidelines for Low and Middle-Income Countries*<sup>50</sup> (see section 4.9) and the International Agency for the Prevention of Blindness's (IAPB)<sup>51</sup> Standard List / Valued Supplier Scheme for refraction services and eyeglasses. The Standard List provides information on where to source the most cost-effective and appropriate equipment, including a comprehensive list of different products from tried and tested global manufacturers. The list is focused on LMIC settings and is a free source.<sup>52</sup>

### 3.6 There is a general shortage of ophthalmologists and optometrists in LMICs, and mid-level eye care workers are not effectively deployed.

LMICs lack trained personnel to deliver refraction services. In many countries, highly trained ophthalmologists are the only personnel legally allowed to prescribe eyeglasses. Ophthalmologists are responsible for performing eye surgery and treating all common eye conditions, including providing refraction services. They are medical doctors who have completed at least 7 years of medical study. There is a shortage of ophthalmologists in LMICs: for example, there are only 2.5 ophthalmologists per million population in Sub-Saharan Africa, below the WHO recommended ratio of 4 per million population.<sup>53,54</sup> Most importantly, the distribution of ophthalmologists is unequal, with most concentrated in urban areas and secondary or tertiary health facilities in LMICs.<sup>55</sup>

Optometrists and mid-level eye care workers are involved in the management of refractive error worldwide, but are often not accredited to carry out eye care services independently. Optometrists provide diagnosis, management, and treatment services for eye conditions. At a minimum, an optometrist has completed a bachelor's degree and is licensed or registered.<sup>56</sup> They are not medical doctors. The acceptance of optometrists remains an issue in many countries, either because optometry is not recognised as a profession or because there is no established educational requirement for optometrists.<sup>57</sup> There is also a shortage of optometrists in most LMICs, with for example only 7.5 optometrists per million population in Sub-Saharan Africa, which is below the WHO recommended ratio of 10 per million population.<sup>58</sup> A disparity in distribution between rural and urban areas also exists. Mid-level eye care workers are a heterogeneous group of staff with specialist ophthalmic training, but who can perform fewer competencies than an optometrist. The cadre name, time spent in training, and competencies may vary by country, based on regulations, but may include opticians, refractionists, orthoptists, optometric/ophthalmic technicians and assistants, ophthalmic nurses, etc. (this list is non-exhaustive).<sup>59</sup> They diagnose and treat some eye conditions, and refer patients with conditions beyond their scope of practice. In contrast to ophthalmologists and optometrists, they often serve in rural areas and provide a bridge between ophthalmologists and primary or community-level workers<sup>60</sup> (see Appendix F).

Task-shifting to optometrists and mid-level eye care workers can support the detection and treatment of refractive errors and other eye conditions in LMICs.<sup>61</sup> The LV Prasad Eye Institute, an Indian NGO, developed a pyramid model of eye care delivery relying on a large network of primary health workers and a strong referral network between the tiers of care to address the lack of available highly trained

<sup>50</sup> London School of Hygiene and Tropical Medicine, Sightsavers and Brien Holden Vision Institute. *Standard school eye health guidelines for low and middle-income countries*. IAPB; 2018.

<sup>51</sup> The IAPB is a coordinating umbrella organisation representing over 150 NGOs, eye care professional organisations, and corporate entities committed to the elimination of avoidable blindness. It works closely with WHO through a formal partnership to advocate for the need for scaling-up efforts to address avoidable blindness and vision impairment in the context of strengthening health services and integrating eye health into universal health coverage.

<sup>52</sup> IAPB Standard List [Internet; cited 2020 February 5]. Available from: <https://iapb.standardlist.org>.

<sup>53</sup> Resnikoff, S, Lansingh, VC, Washburn, L, Felch, W, Gauthier, T, Taylor, HR, Eckert, K, Parke, D and Wiedemann, P. Estimated number of ophthalmologists worldwide: will we meet the needs? *Br J Ophthalmol*. 2019;104(4):588-592.

<sup>54</sup> Palmer, JJ, Chinanayi, F, Gilbert, A, Pillay, D, Fox, S, Jaggernath, J, Naidoo, K, Graham, R, Patel, D and Blanchet, K. Mapping human resources for eye health in 21 countries of sub-Saharan Africa: current progress towards VISION 2020. *Hum Resour Health*. 2014;12(1).

<sup>55</sup> WHO Regional Office for Africa. *Core competencies for the eye health workforce in the WHO African region*. WHO; 2019.

<sup>56</sup> World Council of Optometry. *Global competency model*. WCO; 2015.

<sup>57</sup> World Health Organization. *World report on vision*. WHO; 2019.

<sup>58</sup> Graham, R. *Facing the crisis in human resources for eye health in sub-Saharan Africa*. Community Eye Health; 2017.

<sup>59</sup> WHO Regional Office for Africa. *Core competencies for the eye health workforce in the WHO African region*. WHO; 2019.

<sup>60</sup> Ibid.

<sup>61</sup> World Health Organization. *World report on vision*. WHO; 2019.



personnel (see Case study 1).<sup>62,63</sup> Standardisation of accreditation mechanisms for optometrists and mid-level eye care workers is needed to support task-shifting. WHO recommends moving from a pre-defined set of eye health workers to a competency-based approach, where ‘competencies’ refer to the specific tasks an individual must be able to perform to a specified standard to qualify as a professional.<sup>64</sup> Several core competency frameworks were published by the International Council of Ophthalmology,<sup>65</sup> the World Council of Optometry<sup>66</sup> and the WHO Regional Office for Africa.<sup>67</sup> However, there is no common understanding of how to translate these competencies into training programmes – e.g. steps to learn a competency, expected level of quality, programme length, trainer background, practice on users – leading to a lack of uniformity of both training programmes and service quality across the world. More research is also needed to assess how the additional workload related to refractive errors is impacting mid-level eye care workers’ current scope of practice and the risks around potentially over-burdening them.

### CASE STUDY 1: LV PRASAD EYE INSTITUTE

The LV Prasad Eye Institute currently operates 183 vision centres, 19 service centres, 3 tertiary centres, and 1 centre of excellence in India (note: this structure is separate from the public healthcare system). In 2018, it reached 533,186 people through community eye health initiatives and rehabilitated 18,686 visually impaired people with eyeglasses or surgery.<sup>68</sup> Key success factors in this model are the institute’s ability to recruit, train, and retain the staff and the quality of services offered. The delocalised model, leveraging vision guardians and vision centres, increases awareness of vision issues and accessibility to eye care in remote areas.

TIER	NAME	POPULATION SERVED	SERVICES PROVIDED	STAFF AND TRAINING
1	Vision Guardians	5,000	Community awareness, vision screenings, provision of reading eyeglasses, and referrals for more advanced care to the nearest Vision Centre.	Volunteers trained locally for 2 weeks in primary eye care.
2	Vision Centres	50,000	Comprehensive eye exams, provision of prescription eyeglasses, and referrals to the nearest Service Centre for surgeries and other conditions. Eye exams are free of charge, and operational costs are covered through the sales of eyeglasses.	Managed by Vision Technicians, a high school graduate with 1 year of basic training in optometry.
3	Service Centres	500,000	Comprehensive eye care, including diagnosis and treatment of all eye conditions, surgical services, low vision, and rehabilitation services. Tiered system of payment for services and revenues generated from the sales of eyeglasses.	Run by one or two ophthalmologists, with a technical staff of 10-12 and support staff of 10-12.
4	Tertiary Centres	5 million	Complete eye services including subspecialty care. Serve as training centres.	Team of subspecialists.
5	Centre of Excellence	50 million	Advanced tertiary care centre that treats complex diseases, offers train the trainer modules in subspecialties and rehabilitation, and engages in advocacy.	Team of top subspecialists.

<sup>62</sup> Rao, GN, Khanna, RC, Athota, SM, Rajshakar, V and Rani, PK. Integrated model of primary and secondary eye care for underserved rural areas: the L V Prasad Eye Institute experience. *Indian J Ophthalmol*. 2012;60(5):396.

<sup>63</sup> LV Prasad Eye Institute. Website [Internet; cited 2020 February 5]. Available from: <https://www.lvpei.org..>

<sup>64</sup> World Health Organization. World report on vision. WHO; 2019.

<sup>65</sup> International Council of Ophthalmology, International Joint Commission on Allied Health Personnel

<sup>66</sup> Ophthalmology. International Core Curriculum for Refractive Error. ICO; 2011.

<sup>67</sup> World Council of Optometry. Global competency model. WCO; 2015.

<sup>68</sup> WHO Regional Office for Africa. Core competencies for the eye health workforce in the WHO African region. WHO; 2019.

<sup>69</sup> LV Prasad Eye Institute. 2018-2019 Activity report. LV Prasad Eye Institute; 2019.



### 3.7 Donor funding to address uncorrected refractive errors in LMICs is only a fraction of the funding spent on eye health and comes from a limited number of donors.

NGOs play a critical role in the provision of refraction services and eyeglasses in LMICs.<sup>69,70</sup> The spending per year addressing uncorrected refractive errors is not typically tracked, but EYEalliance, a coalition of multi-sector stakeholders looking to address the unmet need for eyeglasses, estimated that USD37 million was spent across fewer than 50 NGOs on uncorrected refractive errors in 2015.<sup>71</sup> This represents a small fraction of the funding spent on overall eye health: for example, trachoma eradication is supported by a USD105 million philanthropic fund<sup>72</sup> and also receives multi-million funding as part of neglected tropical diseases programmes.<sup>73</sup> Funding for uncorrected refractive errors remains insufficient to address the gap: with USD37 million, NGOs could only reach 7.8 million people,<sup>74</sup> addressing less than 1% of the need for eyeglasses.

The donor landscape for uncorrected refractive errors is limited: the largest donors include the Standard Charter Bank, Lions Club International, L'Occitane Foundation, and corporate social responsibility programmes – mostly from leading eyeglasses manufacturer EssilorLuxottica. Institutional donors account for only approximately 10% of the funding dedicated to uncorrected refractive errors. For example, uncorrected refractive errors benefit from funding through USAID's Child Blindness Program, which currently offers grants for projects focused on preventing and treating blindness among children. In-kind donations also account for an important part of NGO funding as there is a preference from a number of donors on providing eyeglasses to individuals instead of building a sustainable provision system.<sup>75</sup>

Essilor estimates that approximately USD14 billion is needed over the next 30 years to eliminate uncorrected refractive errors globally – a significant portion of which is allocated for demand creation activities.<sup>76</sup> Recent momentum has been gained for uncorrected refractive errors with a few large initiatives being announced:

- **THE VISION CATALYST FUND:** was announced in 2018. It aims to launch in 2020 and to allocate over USD1 billion in funding over 30 years. Although it is unclear how much will be allocated to uncorrected refractive errors, the fund aims to work directly with governments to accelerate systems change and expand universal eye health services. The fund gathers together public and private sector partners.<sup>77</sup>
- **VISION FOR LIFE:** In 2015, Essilor launched a EUR30 million social impact fund, dedicated to supporting sustainable vision care infrastructure and programmes to eradicate uncorrected refractive errors.<sup>78,79</sup>

<sup>69</sup> Essilor See Change. Eliminating poor vision in a generation: What will it take to eliminate uncorrected refractive errors by 2050? Essilor; 2019.

<sup>70</sup> World Economic Forum. Eyeglasses for global development: bridging the visual divide. WEF; 2016.

<sup>71</sup> Fiscutean, A. A smart solution to vision problems. Nature [Internet]. 2019. Available from: <https://www.nature.com/articles/d41586-019-01110-z> doi: 10.1038/d41586-019-01110-z.

<sup>72</sup> Sightsavers [Internet]. \$105 million fund to eliminate trachoma launched at star-studded concert in South Africa. 2018. Available from: <https://www.sightsavers.org/news/2018/12/105-million-fund-to-eliminate-trachoma>.

<sup>73</sup> International Coalition for Trachoma Control [Internet]. USAID launches program to end neglected tropical diseases in West Africa. 2018. Available from: <https://www.trachoma-coalition.org/news-blogs/usaids-launches-program-end-neglected-tropical-diseases-west-africa>.

<sup>74</sup> EYEalliance. Internal study on funding for uncorrected refractive errors. 2015.

<sup>75</sup> Ibid.

<sup>76</sup> Essilor See Change. Eliminating poor vision in a generation: What will it take to eliminate uncorrected refractive errors by 2050? Essilor; 2019.

<sup>77</sup> Ibid.

<sup>78</sup> Essilor [press release]. Essilor creates the Vision For Life program dedicated to eliminating poor vision. 2015.

<sup>79</sup> Essilor See Change. Eliminating poor vision in a generation: What will it take to eliminate uncorrected refractive errors by 2050? Essilor; 2019.

## 4. Market Assessment

### 4.1 The global eyewear market is valued at USD130 billion, has a clear market leader and caters to HIC markets.

The global eyewear market is estimated at approximately USD130 billion with lenses accounting for approximately 39% of the market and frames for approximately 37%.<sup>80,81</sup> EssilorLuxottica is the leading global provider of lenses and frames, following the merger of Essilor and Luxottica in 2018. Essilor (France) is the leading lenses supplier, with an estimated 45% of the lenses market.<sup>82</sup> Other lenses suppliers, such as Hoya (Japan) and Carl Zeiss (Germany) have each less than 10% market share.<sup>83</sup> Luxottica (Italy) is the top frames manufacturer, with an estimated 25% market share,<sup>84</sup> also well ahead of other market players such as Safilo (Italy) which have less than 10% market share.<sup>85</sup>

The global eyewear market is largely focused on high-income markets. Europe and North America accounted for approximately 80% of Luxottica net sales<sup>86</sup> and approximately 75% of Essilor revenue<sup>87,88</sup> in 2018. In LMICs, expensive branded eyeglasses are often the only available products.<sup>89</sup> Private optical companies target high-income urban customers with prices of prescription eyeglasses ranging from approximately USD50 to more than USD200. Pricing differs considerably, depending on the mark-ups in the value chain (see section 4.4). Reading eyeglasses are less expensive, with prices ranging from approximately USD3 to approximately USD20.

Manufacturing of lenses and frames is concentrated in four regional clusters within China, with over 3,000 business enterprises involved in the manufacturing of eyeglasses and related products. Most Chinese manufacturers produce unbranded products or serve as contract manufacturers for international brands. Only recently have Chinese manufacturers begun marketing their own brands, backed by in-house research and development.<sup>90</sup>

Lenses and frames manufacturers control the value chain to the end user. For example, Luxottica owns almost 9,000 stores and contracts with a further 100,000 opticians around the world.<sup>91</sup> Essilor owns optical assembly labs and supplies between 300,000 and 400,000 optical stores worldwide.<sup>92</sup> EssilorLuxottica continues to expand its control over the chain through the acquisition of retail networks.<sup>93</sup>

### 4.2 Demand for eyeglasses in LMICs remains low due to low awareness around vision impairment and stigma around wearing eyeglasses.

In LMIC, demand generation for eyeglasses is an under-funded area due to the misconception among donors that individuals are aware of their poor vision and will seek treatment when they can. In reality, even with a well-established supply in an area, demand for eyeglasses remains low due to poor awareness of vision issues and available treatments, and low acceptability of available eyeglasses.

<sup>80</sup> Sunglasses (including luxury sunglasses) account for the remaining approximately 24% of the eyewear market.

<sup>81</sup> Credit Suisse. Eyewear industry. Credit Suisse; 2017.

<sup>82</sup> Knight, S. The spectacular power of big lenses. The Guardian. 2018.

<sup>83</sup> Credit Suisse. Eyewear industry. Credit Suisse; 2017.

<sup>84</sup> Knight, S. The spectacular power of big lenses. The Guardian. 2018.

<sup>85</sup> Credit Suisse. Eyewear industry. Credit Suisse; 2017.

<sup>86</sup> Luxottica. Annual report 2018. Luxottica; 2018.

<sup>87</sup> Essilor [press release]. First-half 2018. 2018.

<sup>88</sup> First half of 2018, share consistent with 2017.

<sup>89</sup> World Economic Forum. Eyeglasses for global development: bridging the visual divide. WEF; 2016.

<sup>90</sup> HKTDRC Research. China's spectacles market. HKTDRC; 2019.

<sup>91</sup> Knight, S. The spectacular power of big lenses. The Guardian. 2018.

<sup>92</sup> Ibid.

<sup>93</sup> Blamont, M. EssilorLuxottica sets sights on retail dominance with \$8 billion GrandVision deal. Reuters 2019

- **LOW AWARENESS:** Many individuals either do not know they have a problem with vision or are not aware that simple and affordable treatments exist. For example, older people often consider a reduction in vision as part of normal ageing and are unaware that it can be corrected with eyeglasses.<sup>94</sup> A study in Ghana determined that primary reasons for not correcting near vision loss among adults aged 35 years and older were 'lack of felt need for near vision correction' (26%) and being 'unaware of available interventions/correction' (22%).<sup>95</sup>
- **STIGMA AND LOW ACCEPTABILITY:** When individuals are provided with eyeglasses, wearing compliance remains an issue due to style, cultural stigma, or misconceptions around eyeglasses. Among adults, a study in East Timor found that the primary reasons for unwillingness to use eyeglasses were cosmetic (41%) and embarrassment (38%).<sup>96</sup> Children can also be reluctant to wearing eyeglasses due to the fear of being victimised at school: in the UK, children wearing eyeglasses are indeed 35% to 37% more likely to be bullied.<sup>97</sup> Caregivers also play a role in wearing compliance of children: in China, parents and teachers commonly believe that wearing eyeglasses will worsen children's vision.<sup>98</sup>

### 4.3 LMIC markets generally lack effective public procurement systems for eyeglasses; NGOs have traditionally aimed to fill the gap by distributing refurbished donated eyeglasses.

Procurement and provision of eyeglasses by the public sector is low to non-existent. Vision impairment straddles health, education, and social welfare agencies that address disability, but it is rarely a priority for any of these ministries, due to limited budgets, competitive priorities, a focus on mortality and morbidity indicators, and low awareness around the burden of uncorrected refractive errors. When procurement occurs, it is poorly coordinated across different ministries and no singular ministry has complete oversight on procurement and provision. When the product is procured, this may be done at sub-national levels where capacity is lacking. In South Africa, provision of eyeglasses is the responsibility of each province. In Zambia and Sierra Leone, each district has their own procedures around procurement. Some districts lack the capabilities and capacity to procure and stock products, or some wait to order until volume thresholds for lenses and frames are met, which contributes to products being out of stock and long waiting lists.

For a long time, NGOs aimed to fill the gap in public procurement through in-kind donations. Provision would take place through one-off vision camps where eyeglasses were distributed without establishing sustainable provision points. These provision models often relied on recycled eyeglasses, whereby a beneficiary's prescription was matched to the best available donated eyeglasses. But the practice of recycling donated eyeglasses is expensive, costing approximately USD21 per pair.<sup>99</sup> Recognising the limitations within this model and following IAPB recommendations on this topic,<sup>100</sup> many NGOs and inclusive businesses now focus on capacity building for the provision of appropriate eyeglasses within the public sector or through the sale of affordable or subsidised eyeglasses, often with eyeglasses available for less than USD20. These models are explored in the following sections.

<sup>94</sup> World Health Organization. World report on vision. WHO; 2019.

<sup>95</sup> Ntodie, M. Abu, SL, Kyei, S, Abokyi, S and Abu, EK. Near vision spectacle coverage and barriers to near vision correction among adults in the Cape Coast Metropolis of Ghana. *Afr Health Sci*. 2017;17(2):549.

<sup>96</sup> Ramke, J, du Toit, R, Palagyi, A, Brian, G and Naduvilath, T. Correction of refractive error and presbyopia in Timor-Leste. *Br J Ophthalmol*. 2007;91(7):860-866.

<sup>97</sup> Horwood, J, Waylen, A, Herrick, D, Williams, C and Wolke, D. Common visual defects and peer victimization in children. *Invest Ophthalmol Vis Sci*. 2005;46(4):1177.

<sup>98</sup> Jan, C, Congdon, N. Chinese national policy initiative for the management of childhood myopia. *Lancet Child Adolesc Health*. 2018;2(12):845-846.

<sup>99</sup> World Economic Forum. Eyeglasses for global development: bridging the visual divide. WEF; 2016

<sup>100</sup> International Agency for the Prevention of Blindness. IAPB position paper on recycled spectacles. IAPB; 2014.

#### 4.4 The supply chain for prescription eyeglasses is complex due to the level of customisation required which adds cost to the user; reading eyeglasses are easier and cheaper to obtain.

Prescription eyeglasses sold in the traditional private optical sector in LMICs have a costly and complex supply chain (see Table 2).

**TABLE 2: PRESCRIPTION EYEGLASSES SUPPLY CHAIN STEPS**<sup>101</sup>

SUPPLY CHAIN	(1) LENSES AND FRAMES MANUFACTURING	(2) SHIPPING	(3) IMPORT	(4) DISTRIBUTION	(5) OPTICAL ASSEMBLY LAB	(6) RETAIL
Prescription eyeglasses	Uncut lenses and frames are manufactured.	Lenses and frames are shipped to LMICs.	Lenses and frames go through customs at the port of entry.	Lenses and frames are stocked in a warehouse and distributed to optical labs or points of sale.	Uncut lenses are edged and assembled onto the frame.	Eyeglasses are sold to users in optical shops or vision centres.

**(1 & 2) SOURCING PRODUCTS:** uncut lenses and frames are manufactured and shipped to ports of import for less than USD1.50 altogether. Most is mass production and situated in China.

**(3) IMPORT:** eyeglasses are often considered as cosmetic products rather than medical devices by authorities, leading to long clearing processes at customs and higher import duties.<sup>102,103</sup> For example, import duties reach 76% for frames and 32% for corrective lenses in Bangladesh.<sup>104</sup>

**(4) DISTRIBUTION:** in-country delivery costs are typically high and options limited, especially to reach remote areas. Often users do not leave points of sale with their prescription eyeglasses on the day of refraction assessment as the order needs to be sent to an optical lab, which is often centrally located. Once assembled, eyeglasses are sent to the point of sale where the user returns to pick them up.

**(5) OPTICAL ASSEMBLY LAB:** in LMICs, optical shops typically contract out to private optical assembly labs, which can add significant margins to the sale price.

**(6) RETAIL:** optical shops often have high infrastructure and overhead costs – including brand licensing fees – and charge a significant margin. Branded frames, such as those supplied by Luxottica under the Ray-Ban, Vogue, or Prada brands, carry a significant price premium and can lead to a final price 40 times higher than the cost of the frame.<sup>105</sup> Customer preferences related to frame style also play an important role in the purchase of eyeglasses. Retail points must create product assortments that offer choice in sizes, colours, and shapes of frames. This makes ordering and stock management complex and can lead to small volume orders spread across various frame models.

The following cost reduction opportunities exist along the supply chain:

- **DISINTERMEDIATING THE SUPPLY CHAIN** – commonly known as ‘cutting out the middleman’ – by handling distribution and optical assembly lab activities. A hub-and-spoke model can be a cost-effective option where the hub is the optical assembly lab and the spokes are the shops of a retail optical chain or the vision centres in different hospitals. In North America, vertically integrated e-commerce player Warby Parker disrupted the eyewear industry by designing, manufacturing,

<sup>101</sup> Credit Suisse. Eyewear industry. Credit Suisse; 2017.

<sup>102</sup> World Economic Forum. Eyeglasses for global development: bridging the visual divide. WEF; 2016.

<sup>103</sup> Essilor See Change. Eliminating poor vision in a generation: What will it take to eliminate uncorrected refractive errors by 2050? Essilor; 2019.

<sup>104</sup> Bangladesh customs duty calculator [Internet; cited 2020 January 10]. Available from: [http://www.bangladeshcustoms.gov.bd/trade\\_info/duty\\_calculator](http://www.bangladeshcustoms.gov.bd/trade_info/duty_calculator).

<sup>105</sup> Portella, A. Ver de verdad, una óptica sin fines de lucro. Forbes Mexico; 2019.

and selling their eyeglasses directly to customers. They were able to offer eyeglasses for less than USD100, significantly below the average cost in the US.<sup>106</sup>

- **ELIMINATING OR REDUCING IMPORT DUTIES** on low-cost, non-branded frames and ready-made reading eyeglasses.<sup>107</sup> In Pakistan, NGOs successfully lobbied the Ministry of Commerce and saw import duties lowered from 11% to 3% on low-cost, non-branded eyewear.<sup>108</sup>

Reading eyeglasses have a simpler supply chain compared to prescription eyeglasses as they are generic and have the same prescription on both lenses. They are shipped to LMICs as ready-made eyeglasses and therefore can be purchased directly at points of sale without requiring an in-country optical assembly lab.

#### 4.5 Ready-to-assemble eyeglasses can alleviate supply chain challenges for 80% of the need for eyeglasses.

A new model of eyeglasses adapted to low-resource settings, called ready-to-assemble eyeglasses, entered the market in 2015. Pre-edged lenses are clipped into the frame. Lenses are interchangeable between right and left and allow eyeglasses to be adapted to the specific left- and right-eye prescription. Two main suppliers of ready-to-assemble models are: 1) Essilor, through its inclusive business arm 2.5 New Vision Generation (Ready2Clip model); and 2) VisionSpring, a social enterprise. Ready-to-assemble eyeglasses have a limited range of corrective power, from -6.00D to +6.00D, do not correct for astigmatism and offer limited interpupillary distance adjustment compared to customised eyeglasses. Despite those limitations, they can still address 80% of the population need while alleviating supply chain challenges:<sup>109</sup>

- **FASTER, SIMPLIFIED DELIVERY:** ready-to-assemble eyeglasses can, with limited training, be mounted on the spot in less than 5 minutes. On-the-spot delivery is more cost-effective than custom eyeglasses because it does not require an optical assembly lab and reduces referral and loss to follow-up barriers. Users in low-resource settings are significantly more likely to acquire a pair of eyeglasses when delivered on the spot compared to when issued by prescription only.<sup>110</sup>
- **APPROPRIATE DESIGN:** ready-to-assemble eyeglasses come with different styles and models adapted to different face shapes. For example, Ready2Clip offers over 30 different styles. Products are certified according to European quality standards (CE marking) and/or ISO standards, and are durable, with spring hinges allowing for flexibility, lightweight resin for frames, and scratch-resistant lenses. Studies show no difference in satisfaction and wearing compliance compared with traditional custom-made eyeglasses.
- **AFFORDABLE:** the price offering for ready-to-assemble eyeglasses typically ranges between approximately USD5 for a basic model to approximately USD15 for more specialised lenses, such as photochromatic.<sup>111</sup> This price point is lower than the price of the majority of customised eyeglasses currently available in LMICs.

Ready-to-assemble eyeglasses are considered by experts as an appropriate solution for LMICs: Ready2Clip and VisionSpring ready-to-assemble eyeglasses are listed on the IAPB list of recommended products for LMICs.<sup>112</sup> However, they have received pushback from optometric professional associations in various countries, mainly due to concerns around poor fitting<sup>113,114</sup> and inequality of treatment between people receiving ready-to-assemble eyeglasses and those receiving fully customised eyeglasses, thereby limiting their uptake.

<sup>106</sup> Lisa. Warby Parker: disrupting the eyewear industry. HBS Digital Initiative; 2015.

<sup>107</sup> World Economic Forum. Eyeglasses for global development: bridging the visual divide. WEF; 2016.

<sup>108</sup> Sightsavers.

<sup>109</sup> World Bank. Looking ahead: visual impairment and school eye health programs. World Bank; 2019.

<sup>110</sup> Ramasamy, D, Joseph, S, Valaguru, V, Mitta, VP, Ravilla, TD and Cotch, MF. Cluster randomized trial to compare spectacle delivery systems at outreach eye camps in south India. *Ophthalmic epidemiol.* 2013;20(5):308-314.

<sup>111</sup> Photochromic lenses darken in the sun and lighten when UV exposure decreases.

<sup>112</sup> IAPB Standard List [Internet; cited 2020 February 5]. Available from: <https://iapb.standardlist.org>.

<sup>113</sup> Poorly fitting eyeglasses can cause induced prismatic effects when users do not look through the optical centres of their lenses. Rays entering a lens at any point other than the optical centre will be deviated, thus inducing prismatic effects. These prismatic effects may lead to visual complaints such as asthenopia, blurry vision, and headaches. However, research supports the premise that the fear of visual discomfort because of induced prismatic effects should not preclude the use of ready-to-assemble eyeglasses (du Toit, R, Ramke, J and Brian, G. Tolerance to prism induced by readymade spectacles: setting and using a standard. *Optom Vis Sci.* 2007;84(11):1053-1059).

<sup>114</sup> Moodley, VR, Kadwa, F, Nxumalo, B, Pencilliah, S, Ramkalam, B and Zama, A. Induced prismatic effects due to poorly fitting spectacle frames. *African Vision and Eye Health.* 2011;70(4).

Other social enterprises are trying to enter this space. DOT Glasses similarly offers ready-to-assemble eyeglasses with a unique model and an adjustable bridge. DOT Glasses further simplifies the supply chain by providing only 5 different corrective powers, matching the refractive error to the best available lenses. OneDollarGlasses and TwoBillionEyes offer on-the-spot production of handcrafted eyeglasses. In the OneDollarGlasses model, a flexible spring steel is bent on the spot to create a frame where pre-edged lenses are inserted. However, these products have varying levels of quality, limited customisation options, and have also not been tested for acceptance by end users.

## 4.6 New technologies for vision screening and refraction create opportunities to reach more people.

The new technologies mentioned below represent some of the most promising changes to the delivery landscape:

- **SMARTPHONE-BASED VISUAL ACUITY TESTS:** visual acuity apps offer an alternative to the traditional paper-based eye chart. Among providers, Peek Vision (UK) offers a smartphone-based vision screening app called Peek Acuity which enables data-driven health programmes. The app has shown to be as accurate as conventional paper-based vision tests.<sup>115</sup> It is integrated with data capture tools – called Peek Solutions – for visualising patient flow along the health system. One of the features is text message reminders of follow-up appointments, which are sent to the care giver in the local language. In a school screening programme in Kenya, the use of Peek Acuity nearly tripled the number of children who attended follow-up appointments compared to conventional eye health screening.<sup>116</sup> Peek Solutions enables the analysis of population-based data, which allows health services to identify challenges along the pathway to care and to optimise programme designs. Peek Vision partners with governments, NGOs or major eye hospitals and provides consulting support to improve programme design based on best practices. Peek Vision provides partners with training and consulting on use of the data generated to identify programme gaps and optimise the impact in an iterative process, and to achieve continuous improvement.
- **HANDHELD, EASY-TO-USE REFRACTION DEVICES ADAPTED TO LOW-RESOURCE SETTINGS:** these devices can be operated by a technician with minimal training, can be taken to the field, and typically require less time to do the refraction compared to traditional refraction devices. They vary by technology, cost, and accuracy (see Appendix G).
  - Promising handheld autorefractors perform objective refraction using wavefront aberrometry technology, which makes them as accurate as top traditional desktop autorefractors, but they cost 2 to 3 times less. Prices are from approximately USD4,000 to USD7,000. A few options exist that are adapted to LMICs, such as the Plenoptika ‘QuickSeeFlip’ or ‘e-see’, the Smart Vision Lab ‘SVOne’, or the Ovitz ‘EyeProfiler’.
  - Other refraction devices are offered at prices starting from approximately USD50 to around USD1,300, but they do not meet the accuracy levels of traditional desktop autorefractors. Promising innovations include the Essilor ‘ClickCheck’ and EyeNetra ‘Netra’. They rely on a self-refraction technique where the user looks into a mechanical or mobile-powered device and turns a knob or a dial to align bars or bring an image into focus. The device then allows a prescription to be determined by comparing the user’s assessment with the ideal alignment.

Depending on the accuracy of the device and the regulations in place, these devices can help reach more people in different ways. One way is to increase the efficiency of existing optometrists or ophthalmologists – by using handheld autorefractors, existing eye professionals can see more patients and travel more easily to remote communities. These devices also support task-shifting as they allow mid-level eye care workers to perform refraction. Mid-level eye care workers can triage patients, identify complicated cases to

<sup>115</sup> Bastawrous, A, Rono, HK, Livingstone, IAT, Weiss, HA, Jordan, S, Kuper, H and Burton, MJ. Development and validation of a smartphone-based visual acuity test (Peek Acuity) for clinical practice and community-based fieldwork. JAMA Ophthalmology. 2015;133(8):930.

<sup>116</sup> Rono, HK, Bastawrous, A, Macleod, D, Wanjala, E, Di Tanna, GL, Weiss, HA and Burton, MJ. Smartphone-based screening for visual impairment in Kenyan school children: a cluster randomised controlled trial. Lancet Glob Health. 2018;6(8):e924-e932.

be referred to an eye professional, and provide eye professionals with an initial starting point for refraction, or even prescribe the eyeglasses themselves if they are using a reliable handheld autorefractor and if national regulations allow. Some studies show a good alignment between the prescription determined with wavefront aberrometry and subjective refraction, potentially opening the way for objective refraction using this technology to be sufficient to prescribe eyeglasses.<sup>117</sup>

- **SELF-REFRACTION DEVICES INTEGRATED WITH THE DELIVERY OF EYEGLASSES:** this self-refraction technique allows the user to self-adjust the lens power they need to arrive at an adequate level of vision.<sup>118</sup> Global Vision 2020 has developed a simple portable mechanical self-refraction device – the ‘USee’ – which can determine a prescription based on subjective refraction only. Concerns were raised among vision experts about the fact that using only subjective refraction could lead to over-correction among children, and these concerns are currently being addressed by GV2020.<sup>119</sup> The device is used in combination with ready-to-assemble eyeglasses that can be delivered on the spot (see Case study 2). Other examples of self-refraction innovations include adjustable eyeglasses, such as the Adlens and Adspects eyeglasses, but these products have had limited success in the vision space, mainly due to unsatisfactory cosmetic appearance.<sup>120</sup>
- **PHOTOSCREENERS:** these devices rely on a camera to estimate refractive error. They are used to triage patients and provide an initial diagnostic for young children or uncooperative patients as they can be used from a 1 metre distance and take less than 1 minute to complete. Cost is similar to handheld autorefractors, from approximately USD5,000 to around USD8,000, but they have a lower level of accuracy than refraction devices. Examples of photoscreeners include the ‘plusoptiX A12R and S12R’ by plusoptiX – listed on the IAPB standard list – ‘Spot’ by Welch Allyn, ‘iScreen’ by iscreen Vision, or the ‘GoCheckKids’ app by Gobiquity.
- **TELEOPTOMETRY/OPHTHALMOLOGY:** mid-level eye care workers send eye images to an accredited eye care professional who can then confirm the initial diagnosis and prescription remotely. Teleophthalmology has the same desired clinical outcome as the traditional system, especially for eye conditions where a digital imaging system is useful.<sup>121</sup> Teleophthalmology can be useful in countries where regulations require ophthalmologists or optometrists to write the prescription, and it has the potential to engage established eye care professionals to support the development of mid-level eye care workers in countries where capacity is constrained. Forus Health – an Indian medical equipment company – developed a handheld autorefractor called ‘3nethra aberro’ integrated with a teleophthalmology platform. Images collected from ‘3nethra aberro’ are sent to the platform and can be accessed by an eye care professional remotely. Essilor’s EyeMitra programme (see section 4.11) is currently using this platform where an EyeMitra – a mid-level eye care worker trained by Essilor – can connect to an available optometrist in a (peri-)urban area. The optometrist accesses the details of the refraction and guides the EyeMitra to prescribe the eyeglasses. Users are charged on a per-screening basis for platform usage.

Uptake of these technologies has been limited by a lack of standards around implementation evidence, low acceptance by optometric professional associations, and price. Consensus around clinical, economic, and implementation evidence is needed to demonstrate that these technologies support a cost-effective, simplified service delivery model versus traditional refraction devices, and that they can be used in low-resource settings at scale. Optometric professional associations may identify innovative devices allowing for delegation of tasks to lower-skilled workers as a threat to their scope of practice. Core competency frameworks currently do not consider innovative devices to support task-shifting. In addition, handheld autorefractors, based on their current price, still represent a significant investment in LMICs, in particular if they are meant to be operated by the larger pool of mid-level eye care workers.

<sup>117</sup> Durr, NJ, Dave, SR, Lage, E, Marcos, S, Thorn, F, Lim, D. From unseen to seen: tackling the global burden of uncorrected refractive errors. *Annu Rev Biomed Eng.* 2014;16(1):131-153.

<sup>118</sup> Gudlavalleti, VS, Allagh, KP and Gudlavalleti, AS. Self-adjustable glasses in the developing world. *Clinical Ophthalmology.* 2014;405.

<sup>119</sup> The clinical trial found that ‘USee’ resulted in an over-correction of 0.31D compared to gold-standard refraction methods.

<sup>120</sup> Gudlavalleti, VS, Allagh, KP and Gudlavalleti, AS. Self-adjustable glasses in the developing world. *Clinical Ophthalmology.* 2014;405.

<sup>121</sup> Sreelatha, OK, Ramesh, SV. Teleophthalmology: improving patient outcomes? *Clinical ophthalmology.* 2016;285.



## CASE STUDY 2: GLOBAL VISION 2020<sup>122</sup>

Global Vision 2020 (GV2020, US) developed a portable mechanical screening device for low-resource settings called 'USee device'. This self-refraction device allows the user to dial the lens bars up or down to find the most comfortable correction while viewing a vision chart. The lens bars have a coloured index to indicate the power correction required (+6.00 to -6.00D in steps of 0.25D).<sup>123</sup>

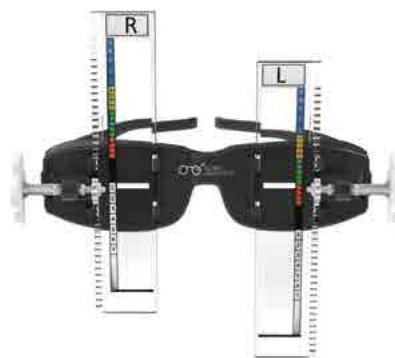


Photo used with permission: Global Vision 2020

'USee device' is sold as part of a vision kit for on-the-spot provision of both prescription and reading eyeglasses. This kit includes 250 frames and 540 pop-in lenses of various corrective powers (ready-to-assemble eyeglasses) and 250 pairs of reading eyeglasses.<sup>124</sup> The vision kit is listed on the IAPB Standard List for refraction services and is sold at approximately USD1,600 – resulting in an initial provisioning cost of approximately USD3 per pair of eyeglasses. Using this method, eyeglasses can be delivered by mid-level health workers with 3 to 6 hours of training.

A peer-reviewed clinical trial conducted at Johns Hopkins University Hospital recommended the use of the 'USee device',<sup>125</sup> and field testing was conducted in 4 high schools in Mozambique and rural villages in several countries. GV2020 is looking to facilitate large-scale distribution of the 'USee' vision kit in LMICs through various distribution models and partners.

## 4.7 Successful and sustainable public sector procurement and delivery models exist.

Proven models exist to increase access to refraction services and eyeglasses within the public sector. One of these models is to establish vision centres within existing public health facilities, operated and managed by the Ministry of Health (see Case study 3). Vision centres offer refraction and general eye care services, and sell affordable prescription and reading eyeglasses. Setting up a vision centre requires significant upfront investments in terms of infrastructure, equipment, supply chain setup, and human resources training. A public-private partnership approach can help spread the costs across the different stakeholders (see Table 3) and build technical capacity at the Ministry of Health for eyeglasses procurement and supply chain management. Vision centres represent a sustainable solution for public sector provision of affordable eyeglasses:

- **SELF-SUSTAINING:** vision centres operate as stand-alone businesses, with revenue from eyeglasses sales covering operational costs, ensuring long-term sustainability. In some settings, profits from vision centres are transferred to public health facilities.
- **GOVERNMENT OWNERSHIP:** vision centre operations and product procurement and distribution are handled by the Ministry of Health, ensuring operations are sustained after NGOs or private partners exit the programme.
- **CATERING TO BASE OF THE PYRAMID CUSTOMERS:** different tiers of pricing and product offering enable a cross-subsidy type of model, with higher-income users paying higher rates based on a sliding scale or purchasing higher-tiered products that may carry higher margins, thereby subsidising lower-priced options for those less able to pay.
- **PROXIMITY WITH A LOCAL HOSPITAL:** referral networks are strengthened to treat other types of eye conditions, such as cataracts requiring surgery.

<sup>122</sup> Global Vision 2020 [Internet; cited 2020 February 5]. Available from: <https://gv2020.org>.

<sup>123</sup> Ibid.

<sup>124</sup> Grace, R. Making a charitable vision come into focus. Prospector; 2019.

<sup>125</sup> Annadanam, A, Varadaraj, V, Mudie, LI, Liu, A, Plum, WG, White, JK, Collins, ME and Friedman, DS. Comparison of self-refraction using a simple device, USee, with manifest refraction in adults. PLoS One. 2018;13(2):e0192055.



**TABLE 3: EXAMPLE OF PUBLIC-PRIVATE PARTNERSHIP: SHARING OF COSTS ACROSS STAKEHOLDERS**

SHARE OF COSTS	INFRASTRUCTURE	EQUIPMENT	PROCUREMENT AND LOGISTICS	HEALTH WORKFORCE
Ministry of Health	Refurbish or provide space in existing public facilities.			Pay salaries of workforce (supported by vision centre revenue).
NGO or private sector partner		Donate new and refurbished equipment.	Set up supply chain and long-term purchase agreements.	Provide training on refraction and business management.

### CASE STUDY 3: ONESIGHT<sup>126</sup>

OneSight is an NGO engaged in setting up sustainable vision centres in existing public facilities in cooperation with governments. It follows a replicable model to set up centres in different parts of the world, including The Gambia, Zambia, Rwanda, South Africa, China, and Bangladesh.

OneSight prioritises countries based on prevalence of refractive error and other eye conditions, infrastructure in place, and partnership opportunities with the government and other NGOs, among other factors. Once a country is identified, OneSight runs a pilot and tracks key performance indicators (e.g. traffic, sales, costs). If the pilot is successful, permanent vision centres are implemented throughout the country. OneSight oversees setting up management systems, distribution, training the local workforce on refraction, edging, marketing, IT, finance, manufacture and dispensing of products, and training the government on procurement and supply chain management. Management of the vision centre is then transitioned to the government, with OneSight keeping a monitoring and evaluation role.

OneSight opened its first vision centre in The Gambia in 2013. In 6 years, OneSight, in partnership with the government, set up 7 vision centres and 1 optical assembly lab. More than 15,000 eyeglasses were sold and 84 jobs created locally. In 2019, operations were officially transitioned to the government. OneSight continues to monitor key performance indicators through quarterly check-ups and an annual audit. The government is responsible for continued staffing, finance, inventory, logistics, supply chain, operations, etc.

Sustainability depends on sales and appropriate supply management. To ensure sufficient eyeglasses sales, outreach activities are needed to draw traffic due to low awareness around vision impairment and available interventions (see section 4.2). Long-term sustainability of this model also relies on the correct management of the supply chain process by the government to ensure a continuous supply of eyeglasses, and the availability of donor support to replace the donated equipment in the long term.

Other initiatives to support provision of eyeglasses within the public sector include setting up local optical assembly labs. The Ministry of Health of Uganda, jointly with the Australian NGOs Light for the World and the Brien Holden Vision Institute, established a national optical lab to assemble prescription eyeglasses.<sup>127</sup> Assembled eyeglasses are delivered by local transport within 3 working days to users, who pay approximately USD12. Eyeglasses are free for children. About 2,500 eyeglasses are ordered per year. One of the main challenges of the project is to find a sustainable way to procure frames and lenses, which are currently donated products. In South Africa, the KwaZulu Natal province identified the setup of a local optical lab integrated into government systems as a cost-effective and sustainable solution to provide eyeglasses. So far, the province has relied on the Brien Holden Vision Institute to compliment the manufacture and supply of eyeglasses at subsidised cost. The project aims to create a hub-and-spoke model that establishes an on-site optical assembly lab at one of the provincial eye care hospitals. It is expected that eyeglass manufacturing costs will be lowered, turnaround times will be reduced to same-day delivery in some instances, and KwaZulu Natal will be able to provide services to its marginalised

<sup>126</sup> OneSight [Internet; cited 2020 February 5]. Available from: <https://onesight.org>.

<sup>127</sup> Light for the World. Impact evaluation findings and lessons learned: Universal access to refractive services within the national health system in Uganda. Light for the World; 2014.

poor population. In parallel, the province and National Department of Health are working on setting up a provincial and national tendering system for the procurement of eyeglasses.

#### **4.8 Most users in LMICs pay out-of-pocket for services, but public financing mechanisms can be leveraged to ensure better access and quality.**

In many LMICs, especially in Asia and Africa, provision of eyeglasses is not integrated into the benefits package of public health services or national health insurance schemes.<sup>128</sup> A WHO survey among 29 countries reported that more than 20% of them did not provide coverage for any eye care services. If coverage does exist, it often only covers the vision assessment and diagnosis, but excludes the eyeglasses themselves. Other countries in the WHO survey reported that eye care services were only minimally covered or restricted to some categories, such as children.<sup>129</sup> Potential users without health insurance have lower rates of use of eye care services or rely on lower-quality options.<sup>130</sup> As mentioned previously, most prescription eyeglasses are unaffordable or lead to high out-of-pocket costs. As a result, users rely on offerings from lower-quality and unregulated private sector optical services. For instance, there has been a proliferation of small private optical shops in Asia that have limited government oversight and clinical regulation.

WHO recommends including eye care provision in public financing. Countries should shift from out-of-pocket payments towards mandatory prepayments with pooling of funds.<sup>131</sup> This should ensure that the inability to pay is not a barrier to coverage, and therefore makes eye care an integral part of universal health coverage.<sup>132</sup> To support countries in implementing eye care within universal health coverage, WHO is currently developing costing tools and recommendations within the OneHealth tool to support the inclusion of eye care interventions in a health benefits package.<sup>133</sup>

Coverage and financing decisions will impact uptake, access, quality, and cost efficiency of eyeglasses provision, but more research is needed to support decision-makers. Countries will need to decide whether and at what level of coverage they will finance eyeglasses as part of emerging insurance schemes, often based on cost efficiency and effectiveness thresholds. Countries may choose to cover the full cost of eye exams, lenses, and frames up to a capped amount for different portions of the population, or may only cover a subset of the provision. For example, the Philippines insurance programme PhilHealth provides reimbursement for services and eyeglasses up to a set amount for children under 18, and the community-based insurance programme in Rwanda covers the exam and the first tier of eyeglasses (ready-to-assemble) for all members, but then further subsidises services by selling additional tiers of eyeglasses through the public vision centre. Some public vision centres and financing schemes cover the exam only, with eyeglasses sold through the public institution. Governments may also choose to leverage the already existing private sector to support financing and delivery of services. Indonesia's national scheme, Jaminan Keshatan Nasional, provides for a mix of public and private services, whereby members receive an initial assessment and prescription from a public hospital eye clinic and then eyeglasses are provided by contracted private optical shops.

Similar to the Indonesian model, novel financing mechanisms that leverage the private sector exist. A voucher-based model that provides government reimbursement to a private provider can support increased access to quality services. Such a model has been explored as part of the school health programme in Trinidad and Tobago. In other health areas, vouchers have successfully been used to increase access, limit out-of-pocket expenses, and drive quality for family planning services.<sup>134</sup> Coverage under UHC often assumes that the public sector provides the service; however in many LMICs, refraction services are primarily available in the private sector. Vouchers are paper or electronic referral coupons that are provided to beneficiaries for free

<sup>128</sup> World Health Organization. World report on vision. WHO; 2019.

<sup>129</sup> Ibid.

<sup>130</sup> Ibid.

<sup>131</sup> Ibid.

<sup>132</sup> Ibid.

<sup>133</sup> Ibid.

<sup>134</sup> Bellows, B, Bulaya, C, Inambae, S, Lissner, CL, Ali, M and Bajracharya, A. Family planning vouchers in low and middle income countries: a systematic review. *Stud Fam Plann.* 2016;47(4):357-370.

or at a highly subsidised cost. Voucher holders can then choose when and where they seek care from a contracted government-accredited provider. The provider then receives payment from the government once services are delivered in accordance with the voucher programme standards and guidelines.

#### 4.9 School eye health (SEH) is an effective delivery platform for eyeglasses and opportunities exist to expand across LMICs.

With a shortage of eye care professionals and infrastructure in LMICs, school-based eye health programmes are cost-effective interventions that leverage existing institutions to screen and deliver eye care services. School-age children are a key target group for eye care services; children with vision impairment lag behind in school enrolment, learning outcomes, and completion of primary school as 80% of all learning during a child's first 12 years occurs through vision.<sup>135</sup> NGOs and governments have proven that SEH can safely and accurately identify children with vision impairment. SEH is based on three main activities: 1) teachers, school nurses, or other trained personnel screen children for vision problems on-site at schools; 2) children identified with vision problems are examined by an eye health professional who determines an eyeglasses prescription or refers them for more advanced care; 3) children who are in need of eyeglasses are provided with a pair. Evidence shows that teachers can adequately identify children with vision impairment.<sup>136</sup> The Disease Control Priorities (DCP-3) considers school vision screenings to be an essential and cost-effective intervention, with a cost of USD3.6 per child who benefits.<sup>137</sup> The World Bank declared the intervention low cost and affordable for many governments in December 2019.<sup>138</sup> Governments are increasingly recognising that SEH is possible, but only few LMICs are implementing it (see Case study 4).

A set of best practices and guiding principles were published to ensure the long-term sustainability and success of school-based eye health interventions:<sup>139</sup>

- **INTEGRATION OF SEH:** integrate SEH into existing school health or inclusive education programmes, e.g. combine vision screening and basic eye care training with existing school health training, such as deworming, and leverage existing school health budgets.
- **COLLABORATION BETWEEN MINISTRIES OF HEALTH AND EDUCATION:** agreements between ministries need to be in place to allow teachers to screen school children and to take time away from work to be trained in vision screening and basic eye health. The Ministry of Health remains in charge of the quality of health interventions in school.
- **ENGAGEMENT OF SCHOOL LEADERSHIP:** teachers or school nurses – in settings where screening can be performed by these two cadres – need to be trained to screen children and identify those with vision issues.
- **EDUCATION OF TEACHERS AND PARENTS ON EYE HEALTH AND TREATMENT:** teachers and parents play an important role in eyeglasses wearing compliance for children.
- **SUFFICIENT TRAINED EYE PROFESSIONALS, INFRASTRUCTURE, AND REFERRAL SYSTEMS IN PLACE:** sufficient eye exam professionals and a continuous supply of eyeglasses in the country is needed to ensure eyeglasses can be replaced when needed, and strong referral systems should be in place to connect children in need of specialist assistance to the correct level of care.

Task-shifting, using new screening or diagnostic devices, and ready-to-assemble eyeglasses can help programmes reach further cost-effectiveness. Scaling existing initiatives to a national scale can also help achieve economies of scale (mainly due to absorption of coordination costs).

<sup>135</sup> World Bank. Looking ahead: visual impairment and school eye health programs. World Bank; 2019.

<sup>136</sup> World Economic Forum. Eyeglasses for global development: bridging the visual divide. WEF; 2016.

<sup>137</sup> Bundy, DAP, de Silva, S, Horton, S, Jamison, DT and Patton, GC. Optimizing education outcomes: high-return investments in School Health for increased participation and learning. World Bank; 2018. Disease Control Priorities.

<sup>138</sup> World Bank. Looking ahead: visual impairment and school eye health programs. World Bank; 2019.

<sup>139</sup> London School of Hygiene and Tropical Medicine, Sightsavers and Brien Holden Vision Institute. Standard school eye health guidelines for low and middle-income countries. IAPB; 2018.

#### CASE STUDY 4: LIBERIA SCHOOL EYE HEALTH

The Liberia National SEH Initiative was launched in 2018 to demonstrate that proven models of eye health delivery can be taken to national scale within a short period of time. The goal is to reach all public schoolchildren in primary and secondary schools in 12 of the country's 15 counties with school-based vision screening and free eyeglasses within four years.

At the request of the government, EYElliance assembled an ecosystem of eye health players, bringing them together with the Ministries of Health and Education to develop a national plan based on three broad principles: 1) national systemisation; 2) government ownership; 3) filling technical gaps with external expertise. EYElliance now coordinates a collaborative consortium of partners who have relevant expertise (the LV Prasad Eye Institute, Sightsavers, OneSight, Essilor's 2.5 New Vision Generation, and Our Children's Vision) and the government ministries who have the national mandate for service delivery (the Ministries of Health and Education) to deliver the work over four years.

In the first year, nearly 50,000 children were screened across three counties. During the second year, three more counties will be included, reaching 200,000 additional students; while the final six counties will be covered in the final year reaching more than 480,000 total students.

Partner NGOs provided direct cost support during the pilot phase. SEH has already been included in the next national education sector plan, positioning the Ministry of Education to assume financial responsibility for the national initiative, starting in 2022 with support from the Ministry of Health, the Global Partnership for Education, and other development partners.

#### 4.10 Models to distribute reading eyeglasses through the public or private sector have been explored but their sustainability has not yet been proven.

Despite reading eyeglasses having a simplified supply chain, last mile delivery models have encountered many challenges and struggle to be sustainable. The following represent promising models to deliver reading eyeglasses, but more testing is needed to identify key sustainability factors:

- **COMMUNITY HEALTH WORKERS (CHW):** pilot models show that an individual with no prior health training can learn in a few hours to conduct basic vision screenings and dispense reading eyeglasses. This approach has been implemented for over 10 years as part of private CHW initiatives, initially proven in Bangladesh (see Case study 5) and replicated by multiple NGOs in China, Kenya, Uganda, and Pakistan. It shows there is an opportunity to integrate basic vision screenings and delivery of reading eyeglasses as a new service offering in government-managed CHW programmes. Evidence needs to be generated on the inclusion of eyeglasses in supply chains and the incremental cost involved with adding this new service to the existing system. There are also concerns that adding reading eyeglasses to CHW portfolio of products and services would stretch their capacity.
- **LAST MILE RETAILERS:** reading eyeglasses are sold in kiosks, pharmacies, or other last mile retail outlets. More operational evidence needs to be generated on what is needed to incentivise retailers to carry reading eyeglasses, given that they take up shelf space with low profit margins. The profit margin of a pair of reading eyeglasses is equivalent to that of a bar of soap, but individuals only need to buy eyeglasses every couple of years versus the frequent need for soap. Demand generation interventions are key to support sales of reading eyeglasses at last mile retailers and pharmacies.
- **SALE OF AFFORDABLE OR SUBSIDISED EYEGLASSES BY SMALL ENTREPRENEURS:** local entrepreneurs are trained to conduct near vision screenings and sell reading eyeglasses in remote areas to underserved populations. Several pilots of this model showed that entrepreneurs struggle to create a sustainable income when relying on reading eyeglasses only. They typically run out of territory after approximately 18 months and margins are low. As stand-alone entrepreneurs, they are also not well integrated with higher levels of care, with weak referral networks for other eye conditions.
- **WORKPLACE SCREENING:** companies organise regular vision camps to screen their employees for vision loss, provide them with reading eyeglasses if needed, and refer them to specialised

care when relevant. VisionSpring established a Clear Vision Workplace alliance to promote workplace screenings, partnering with companies from the textile, transport, and tea industries. VisionSpring selects ‘Vision champions’ from the workforce to run the vision camps and trains them in near vision screening, reading eyeglasses dispensing, and counselling. For example, VisionSpring announced a partnership with Shell India and the New Mangalore Port Trust – owned by the Ministry of Shipping – to provide free vision screenings to truck drivers, deliver low-cost eyeglasses, and refer those who need it to specialised care. Sustainability of the programme beyond VisionSpring’s engagement and integration of the cost of reading eyeglasses in employees’ health benefits has not yet been fully validated and would benefit from further research.

## **CASE STUDY 5: COMMUNITY HEALTH WORKERS IN BANGLADESH AND PAKISTAN**

### **Lady Health Workers in Pakistan**

In 1994, Pakistan’s Ministry of Health implemented the Lady Health Worker Programme as part of a national strategy to bring primary health care to underserved communities.<sup>140</sup> Each Lady Health Worker services around 1,000 people and is associated with a government health facility within the community, where she receives training, a stipend, and medical supplies. In 2018, there were 125,000 Lady Health Workers deployed by the Ministry of Health.<sup>141</sup>

In recent years, the curriculum of Lady Health Workers was revised to strengthen primary eye care.<sup>142</sup> They receive 3 to 5 days’ training in primary eye care as part of their comprehensive classroom training, followed by 2 days of in-the-field training in community eye care.<sup>143</sup> On completion of their primary eye care training, Lady Health Workers are able to deal with conjunctivitis and foreign body injuries, screen patients for cataract, trachoma, low vision, and childhood blindness, and when necessary they refer community members to nearby eye care services.<sup>144</sup>

Following the integration of primary eye care, the number of people with eye problems examined by Lady Health Workers increased by 27% between 2005 and 2009, and upgraded district eye units demonstrated a 279% increase in eye outpatient attendances.<sup>145</sup>

### **BRAC Shasthya Shebikas community health workers in Bangladesh**

Since the early 1980s, the Bangladesh Rural Advancement Committee (BRAC) NGO has trained CHWs in Bangladesh, also known as Shasthya Shebika, to be responsible for treating essential diseases such as anaemia, colds, fevers, and diarrhoea, and sell medications for these ailments for a nominal fee. Each Shasthya Shebika is responsible for approximately 300 households and visits about 15 households each day.<sup>146</sup>

In 2006, BRAC and VisionSpring partnered through the project Reading Glasses for Improved Livelihoods to train Shasthya Shebika to provide free basic vision screenings and sell reading eyeglasses to the individuals who need them, alongside other basic healthcare services and products provided by Shasthya Shebika. Reading eyeglasses are sold at a subsidised price of approximately USD1.50.<sup>147</sup>

By 2017, over 37,000 Shasthya Shebika had been trained in vision screening. More than 1 million reading eyeglasses were provided, representing the first pair of eyeglasses for 90% of customers. In addition, 610,000 users were referred for higher levels of care.<sup>148</sup> The programme resulted in USD450,000 in supplemental income for Shasthya Shebika since 2006.<sup>149</sup> Since launch, this model has been replicated by NGOs in China, Kenya, Uganda, and Pakistan.

<sup>140</sup> Zhu, N, Allen, E, Kearns, A, Caglia, J and Atun, R. Lady health workers in Pakistan: improving access to health care for rural women and families. Harvard School of Public Health; 2014.

<sup>141</sup> Adil, H. The plight of Pakistan’s lady health workers. Al Jazeera [Internet]. 2018 April 10. Available from: <https://www.aljazeera.com/indepth/features/plight-pakistan-lady-health-workers-180410085710330.html>.

<sup>142</sup> Khan, AA, Khan, NU, Bile, KM and Awan, H. Creating synergies for health systems strengthening through partnerships in Pakistan - a case study of the national eye health programme. East Mediterr Health J. 2010;16(Suppl.):61-68.

<sup>143</sup> Khan, NU, Khan, AA, Awan, HR. Women health workers: improving eye care in Pakistan. Community Eye Health. 2009; 22(70): 26.

<sup>144</sup> Ibid.

<sup>145</sup> Khan, AA, Khan, NU, Bile, KM and Awan, H. Creating synergies for health systems strengthening through partnerships in Pakistan - a case study of the national eye health programme. East Mediterr Health J. 2010;16(Suppl.):61-68.

<sup>146</sup> Bhutta, ZA, Lassi, ZS, Pariyo, G and Huicho, L. Global experience of community health workers for delivery of health related millennium development goals: A systematic review, country case studies, and recommendations for integration into national health systems. WHO Global Health Workforce Alliance; 2010.

<sup>147</sup> BRAC. BRAC, VisionSpring expand new eyeglasses market for BD poor [Internet]. BRAC. 2017 February 13. Available from: <https://www.brac.net/brac-in-the-media/item/1023-brac-vision-spring-expand-new-eyeglasses-market-for-bd-poor>.

<sup>148</sup> Ibid.

<sup>149</sup> Ibid.

#### 4.11 Inclusive businesses exist that provide quality eyeglasses to base of the pyramid customers and are economically viable, but they require upfront investment to be replicated and scaled.

Different models of inclusive optical businesses exist and have proven successful:

- **URBAN MODEL:** Private optical businesses have managed to set up profitable stores in urban areas selling high-quality eyeglasses in a range of prices, including affordable eyeglasses. These inclusive businesses manage to offer eyeglasses starting at approximately USD10 for prescription lenses and frames by relying on: 1) rapid scale; 2) a tiered pricing model targeting the large and underserved market of middle- to low-income customers with a range of margins based on product category; 3) establishing a repeat customer base through innovative marketing strategies; 4) selling directly to customers, cutting out the middlemen for distribution and optical assembling activities; and 5) developing house brands, thereby avoiding branding fees. Successful examples in LMICs include Lenskart in India and Ver de Verdad in Mexico (see Case Study 6). Further research needs to be conducted to understand the replication potential of such initiatives and mobilise private sector investment to support scale-up in less dense areas.
- **MIXED MODEL:** High throughput volume is rare in LMICs; therefore, social entrepreneurs and start-ups are looking into other models to generate demand and reach middle-income and base of the pyramid customers, especially in remote areas. In Uganda, Wazi Vision relies on a cross-subsidy business model to sell eyeglasses made with frames locally manufactured from recycled plastic. Sales of USD20-USD25 eyeglasses to middle-income customers can subsidise outreach programmes in remote communities where they sell eyeglasses at USD2-USD3. As demand and volume grows, Wazi Vision is hopping to offer a tiered pricing model and increase the number of delivery points.
- **RURAL/LAST MILE ENTREPRENEURIAL MODEL:** Setting up a rural network of optical shops selling affordable eyeglasses appears more challenging, due to the lower population density and reduced customer mix. Models do exist, where un(der)-employed youth are trained to become primary eye care providers and run an optical shop (see Case Study 7) or an entrepreneurial 'vision-in-a-box' type of business. In the latter, individuals are equipped with a vision kit which contains the necessary screening tools and materials (e.g. lenses, frames) to deliver prescription eyeglasses on the spot. For example, Vision Vijana, a Kenyan social enterprise, equips each pair of entrepreneurs with the innovative handheld autorefractor 'QuickSee Flip' by Plenoptika and the TwoBillionEyes eyeglasses assembly kit. Vision Vijana currently works in partnership with truck companies offering eye care coverage for their employees.

This rural/last mile entrepreneurial model requires start-up capital that entrepreneurs may not be able to cover alone. Required capital may cover: 1) training in basic eye health assessment, refraction, referrals for non-refractive issues, and edging of and mounting of eyeglasses; 2) business training around stock management, marketing, or brand-building; 3) set up of the supply chain, procurement and distribution systems and processes; and 4) investment in medical equipment and infrastructure. Novel financing mechanisms, such as development impact bonds or blended finance, may represent an opportunity to crowd in private funding to support the early-stage investment of entrepreneurs and contribute to the expansion of these models. Different mechanisms can ensure that other eye conditions are detected, and patients referred to the relevant level of care. This may include ensuring regular meetings with the local hospital or providing entrepreneurs with compensation – such as a commission for each referral. An important consideration of any of these models is how they are connected into referral systems for more complex eye care needs.



### CASE STUDY 6: VER DE VERDAD

Ver de Verdad is a private optical chain targeting middle- and low-income customers in Mexico. Founded in 2011, by February 2019 it had a network of more than 100 stores and 539 employees.<sup>150</sup>

Ver de Verdad sources low-cost quality frames and lenses from China and sells them at affordable price. To offer prices as low as approximately USD10, Ver de Verdad relies on: 1) tiered pricing, allowing for premium products sold at higher margin to balance sales of entry-price products; 2) control over the supply chain, with for example in-house optical labs where lenses and frames are assembled; and 3) economies of scale, targeting a potential untapped market of 10 million people in Mexico.<sup>151</sup>

Ver de Verdad offers a large choice of frames – approximately 500 on average. A free eye exam is offered to attract new clients: in 2018, approximately 50% of sales were to first-time users. Ver de Verdad has sold 280,000 eyeglasses in 7 years.<sup>152</sup> To sustain sales, optical shops are strategically located in areas with sufficient population to serve. Ver de Verdad reported annual growth rates of 14% per store in 2018.<sup>153</sup>

### CASE STUDY 7: EYEMITRA

The EyeMitra programme was founded in 2013 by Essilor through its inclusive business models division '2.5 New Vision Generation'. The programme trains un(der)-employed individuals living in rural areas to become primary eye care providers and establish an optical shop selling quality affordable eyeglasses to base of the pyramid customers.

Participants are trained for one year in refraction services and visual health, and obtain government-recognised certification to provide primary eye care. With this certification, they are able to screen and refract patients for a small fee, sell prescription eyeglasses, and refer people to higher levels of the health care system for non-refractive issues. EyeMitra candidates are selected based on their entrepreneurial spirit, and willingness to invest their own funds in equipment and infrastructure to start their business. Training costs and supply chain setup are supported by Essilor.

This model benefits both remote communities by creating a sustainable channel to access vision care, and entrepreneurs by providing them with a livelihood. In 2016, 2/3 of the approximately 1,300 EyeMitra opticians were earning a higher living than previously.<sup>154</sup>

Identified barriers to scale are the long-term financing of the training programme and the replicability of the model in territories with low population densities.

<sup>150</sup> Portella, A. Ver de verdad, una óptica sin fines de lujo. Forbes Mexico; 2019.

<sup>151</sup> Pallares, M. Pais, con potencial para colocar 27 millones de lentes. El Universal. 2017.

<sup>152</sup> García Fuentes, M. Este emprendedor quiere que todos puedan ver y paguen menos por sus lentes. Entrepreneur. 2018.

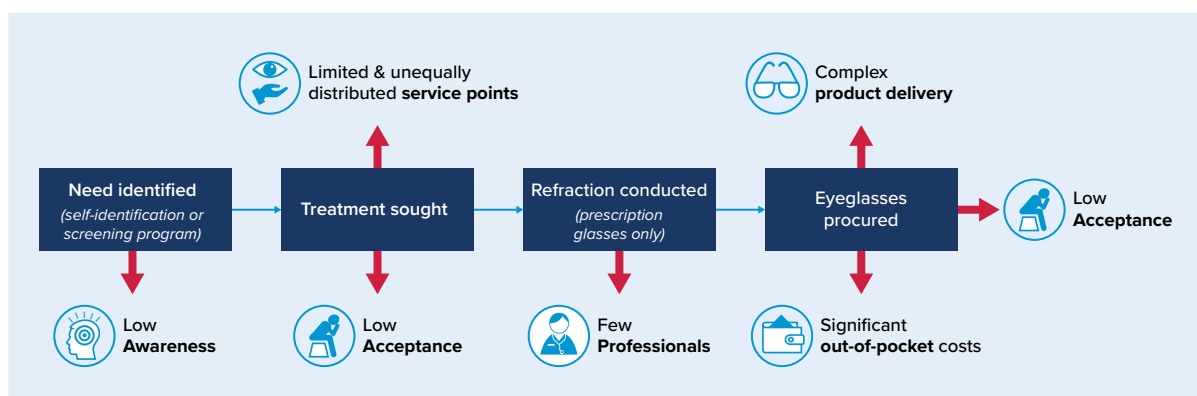
<sup>153</sup> Ibid.

<sup>154</sup> World Economic Forum. Eyeglasses for global development: bridging the visual divide. WEF; 2016.

## 5. Market Challenges

The market landscape identified a number of demand and supply dynamics that have challenged the development of a low cost, high-quality, high-volume market. Figure 5 identifies where some of these challenges lie on the user pathway to care.

**FIGURE 5: CHALLENGES ALONG THE CARE PATHWAY FOR PEOPLE WITH UNCORRECTED REFRACTIVE ERRORS**



### 5.1 Demand

<b>Awareness</b>	<p><b>There is a lack of awareness around the need for and importance of eyeglasses among donors, policymakers, service providers, and users.</b></p> <p><b>At the policy level:</b> Donors and policymakers lack awareness and data on the prevalence of uncorrected refractive errors and on the need, importance, and impact of eyeglasses. Donors need more data on what components of the system are in place and what needs to be augmented at the country level, and which scaling pathways can absorb significant resources. This negatively affects prioritisation in policy, programmatic, personnel training, and financing decisions.</p> <p><b>At the provider level:</b> Teachers, elder care providers, health care professionals, parents, and others who would be well-equipped to identify vision impairment are either not well informed about the potential signs of vision loss, about the need to have vision screened, or how to potentially compensate it with eyeglasses.</p> <p><b>At the user level:</b> Many individuals either do not recognise they have a problem with vision or are not aware that simple corrective treatments exist.</p>
<b>Acceptance/ Stigma</b>	<p><b>Low acceptance and stigma around eyeglasses can prevent individuals from seeking treatment or wearing eyeglasses.</b></p> <p>Individuals wearing eyeglasses may face stigma, preventing or limiting their use. When individuals are provided with eyeglasses, compliance remains an issue due to style, attractiveness, cultural biases, and stigma. Misconceptions around eyeglasses and their benefit may prevent individuals from seeking treatment. For example, teachers and parents may believe that eyeglasses cause vision to worsen and therefore do not seek treatment for children with vision impairment.</p>



<b>Financing</b>	<p><b>Due to a lack of public, private, and donor financing for the provision of eyeglasses, users experience high out-of-pocket costs.</b></p> <p>Governments lack policies or insurance schemes that allocate funds for eyeglasses procurement and provision. There are very low levels of government procurement of eyeglasses in LMICs. Refraction services, and provision of eyeglasses in particular, are typically not integrated into national health insurance schemes, resulting in high out-of-pocket expenses for patients. Therefore, users must turn to the private sector, which in LMICs has not been geared towards low-income clients, so sales are limited to wealthier, urbanised populations. For many people who need them, eyeglasses are priced above the ability to pay.</p> <p>There is currently limited donor financing available for uncorrected refractive errors. Donors are primarily focused on other eye conditions such as trachoma.</p>
<b>Political Will</b>	<p><b>Government involvement is low due to lack of awareness and competing priorities.</b></p> <p>Most LMICs have developed national eye care plans, but these are often not integrated into national health strategic plans or funded, leading to a lack of appropriate planning and budgeting.</p> <p>Vision impairment straddles health, education, and social welfare agencies that address disability, and are rarely a priority for any of these, due to limited budgets, relatively low awareness of vision impairment, and advocacy towards other issues. Low prioritisation from governments results in limited to no financing for the purchase and provision of eyeglasses.</p>
<b>Provision</b>	<p><b>The limited number of service points for refraction and eyeglasses provision, a shortage of trained eye professionals, and limited adoption of models to simplify provision limit access to eyeglasses.</b></p> <p>Existing standards of care propose a service delivery model that requires highly skilled providers and expensive and/or technical equipment, which therefore makes it difficult to scale. Limited consensus on and availability of guidelines on the provision of refraction services and eyeglasses in low-resource settings prevents the adoption of simplified models of provision. Innovative service delivery models, such as task-shifting models, where mid-level eye care workers are enabled to deliver a range of eye care services, and new technology could help increase access in LMICs; but global guidelines driven by a consensus process have not been developed.</p> <p>Due to the high cost of equipment and human resources required, points of access for eye care services in LMICs are scarce and principally located in urban areas. There is a general shortage of ophthalmologists in LMICs, and technician-level support cadres are often not defined or effectively deployed. Traditional refraction devices are complex to operate, expensive, and stationary. Innovative refraction devices for screening and diagnosis currently have seen limited uptake due to limited efficacy evidence, reach, and cost, although this is coming down.</p> <p>Limited service points in LMICs contribute to high drop-out rates when individuals are referred to a vision centre (often located in large urban areas) after being screened in more remote locations.</p>

## 5.2 Supply

<b>Appropriate Design</b>	<p><b>Appropriate eyeglasses need to meet user frame preferences with customised lenses to meet user prescription.</b></p> <p>Eyeglasses are different from other assistive products as they are not entirely considered by individuals as a medical device, but also as fashion accessory. Ensuring choice of frames supports longer term compliance and provides dignity of choice to end users.</p>
<b>Competitive Landscape</b>	<p><b>Leading global suppliers primarily focus on high-income markets.</b></p> <p>Leading global suppliers have a limited investment in setting up supply systems in LMIC markets because they do not see the pathway to profitability. Where they do work in LMICs, they only target high-income customers. Regulatory and taxation barriers, high internal distribution costs, as well as restrictions as to who can prescribe eyeglasses, make LMIC markets less attractive to suppliers in terms of price, logistics, and availability of trained human resources. Distributors further increase cost in markets where there is limited ability to pay and opportunity for value creation.</p>
<b>Cost-Efficient Supply Chains</b>	<p><b>Prescription eyeglasses have a complex and costly in-country supply chain due to the level of customisation required.</b></p> <p>A customised pair of eyeglasses needs to be cut and assembled in an optical assembling lab. These labs require costly infrastructure and trained human resources. Using a hub-and-spoke-model for delivery of frames and lenses results in high in-country delivery costs where logistics management and shipping contribute to high overhead costs. Increased costs of eyeglasses are also driven by high import taxes as many countries tax eyeglasses as commercial products, which adds additional cost for the buyer.</p>

## 5.3 Enablers

<b>Quality</b>	<p><b>Lack of national regulation of the optical sector is common in LMICs.</b></p> <p>While ISO quality standards exist for frames, uncut lenses, and mounted lenses, LMICs often lack national regulations for both the product and its sale. For example, the quality of reading eyeglasses sold in small street optical shops remains an issue in South-East Asia.</p>
<b>Data</b>	<p><b>There is a lack of consistent data to inform on the burden of uncorrected refractive errors and the impact of eyeglasses.</b></p> <p>Policymakers lack awareness and data on the prevalence of uncorrected refractive errors. The economic benefits and outcomes of correcting vision impairment are also not well understood by both public and private stakeholders.</p>

# STRATEGIC APPROACH TO MARKET SHAPING

## 6. Strategic Approach to Market Shaping and Market Building

Ensuring that individuals with uncorrected refractive errors have access to the eyeglasses and services that they need will require a multisectoral approach that brings together the public sector with the private sector, multilateral organisations, and donors. This section proposes five strategic objectives that, when taken together, can help build and strengthen the market for eyeglasses in both the near- and longer-term:

- **STRATEGIC OBJECTIVE 1:** Mobilise key stakeholders, including donors, multilaterals, NGO implementers, and the private sector, around reliable data and proven scalable models to accelerate efforts against vision impairment caused by refractive errors.
- **STRATEGIC OBJECTIVE 2:** Strengthen global policy guidance around service delivery standards for low-resource settings to accelerate the adoption of innovative models, devices, and products that support a simplified service delivery.
- **STRATEGIC OBJECTIVE 3:** Support governments to develop comprehensive eye care plans integrating validated models of vision screening and provision within the public health system, and facilitate scale-up of those models.
- **STRATEGIC OBJECTIVE 4:** Engage the private sector to expand delivery of affordable, quality eyeglasses and related services in LMICs.
- **STRATEGIC OBJECTIVE 5:** Build and drive awareness and consumer demand for eyeglasses.

**STRATEGIC OBJECTIVE 1:** Mobilise key stakeholders, including donors, multilaterals, NGO implementers, and the private sector, around reliable data and proven scalable models to accelerate efforts against vision impairment caused by refractive errors.

<b>Barriers addressed</b>	<ul style="list-style-type: none"> <li>• Lack of global awareness and consistent data on the prevalence and impact of uncorrected refractive errors.</li> <li>• Lack of data on quality of eye care and eye care capacity in countries.</li> <li>• Fragmentation of efforts to address uncorrected refractive errors, often led by a variety of NGO implementers.</li> </ul>
<b>Rationale</b>	A coordinated effort that is informed by better data will ensure a more effective use of available resources and achieve better outcomes.

<b>Proposed activities</b>	<ul style="list-style-type: none"> <li>• <b>Standardise data collection</b> across countries – on the magnitude of refractive errors, uncorrected refractive errors, and the quality of eye care – to monitor progress to reduce the global burden of uncorrected refractive error and integrate indicators into health management information systems.</li> <li>• <b>Consolidate existing market intelligence and conduct further market research</b> around low-cost suppliers and demand in LMICs.</li> <li>• <b>Develop global cross-sector collaborations around proven delivery platforms – such as school eye health</b> – to 1) coordinate and accelerate global efforts; 2) mobilise political will; 3) increase donor commitment to address uncorrected refractive errors; and 4) enhance exchange of learning across countries.</li> </ul>
<b>Target outputs</b>	<ul style="list-style-type: none"> <li>• Increase in quality data to guide investment and prioritisation.</li> <li>• Cross-sector collaborations to accelerate national-scale solutions that have been proven at the district level.</li> <li>• Quality data influences activities under Strategic Objective 2.</li> </ul>
<b>Long-term outcome</b>	Governments and donors prioritise efforts to address uncorrected refractive errors and support scaling of proven models.

**STRATEGIC OBJECTIVE 2: Strengthen global policy guidance around service delivery standards for low-resource settings to accelerate the adoption of innovative models, devices, and products that support a simplified service delivery.**

<b>Barriers addressed</b>	<p><b>Refraction services (human resources)</b></p> <ul style="list-style-type: none"> <li>• Shortage of qualified professionals to provide refraction services.</li> <li>• Lack of standardisation of training standards, accreditation mechanisms, and clear legislation to allow for refraction and dispensing of eyeglasses across countries.</li> </ul> <p><b>Refraction services (devices)</b></p> <ul style="list-style-type: none"> <li>• Limited uptake of innovative devices for screening and diagnosis that are mobile, less expensive, and require less training.</li> </ul> <p><b>Customised eyeglasses</b></p> <ul style="list-style-type: none"> <li>• Complex and expensive supply chain for customised eyeglasses.</li> <li>• Limited uptake of ready-to-assemble solutions that can serve 80% of the need.</li> </ul>
<b>Rationale</b>	<ul style="list-style-type: none"> <li>• A simplified delivery model supported by global guidelines has the potential to standardise provision requirements at multiple levels and to resolve questions around the appropriate use of new screening and refraction devices.</li> <li>• Decentralising screening and refraction through task-shifting and new technology can lead to a reduction in barriers related to personnel, infrastructure, costs, and reach of services.</li> <li>• Evidence is needed to show that increasing trained mid-level eye care workers does not impact the business of current practitioners, who often lobby through professional bodies against task-shifting.</li> </ul>
<b>Proposed activities</b>	<ul style="list-style-type: none"> <li>• <b>Develop guidance on a simplified delivery model, and on minimum competencies and training standards</b> to refract, prescribe, and dispense eyeglasses in LMICs, leveraging a consensus-driven process with relevant stakeholders.</li> <li>• <b>Support uptake of innovative screening and refraction devices</b> that simplify service delivery by achieving consensus on research standards and generating additional implementation and cost-effectiveness evidence.</li> <li>• <b>Build partnerships with optometric professional associations</b> in various countries to promote uptake of ready-to-assemble eyeglasses, and new screening and refraction devices.</li> <li>• <b>Analyse impact of increasing the number of mid-level eye workers trained in refraction</b> on ophthalmologists/optometrists' existing demand.</li> <li>• <b>Develop advocacy tools to lobby governments</b> for tax exemption or lower import duties on low-cost unbranded lenses and frames.</li> </ul>

<b>Target outputs</b>	<ul style="list-style-type: none"> <li>• Global guidance on task-shifting and required training standards in service delivery for low-resource settings.</li> <li>• Accelerated adoption of innovative screening and refraction devices, and ready-to-assemble eyeglasses.</li> <li>• Advocacy points to support task-shifting with optometric professional bodies.</li> <li>• Global guidance influences activities under Strategic Objectives 3 and 4.</li> </ul>
<b>Long-term outcome</b>	<ul style="list-style-type: none"> <li>• Enhanced access to refraction services and eyeglasses for individuals, due to the broad adoption of simplified service delivery models that are more affordable and effective in addressing uncorrected refractive errors.</li> <li>• Global guidance is utilised by relevant bodies, such as Higher Education Commissions, to increase number of individuals who can refract, prescribe, and dispense eyeglasses.</li> </ul>

### **STRATEGIC OBJECTIVE 3:** Support governments to develop comprehensive eye care plans integrating validated models of vision screening and provision within the public health system and facilitate scale-up of those models.

<b>Barriers addressed</b>	<ul style="list-style-type: none"> <li>• Lack of planning, budgeting, and low levels of government procurement for vision services.</li> <li>• Limited service delivery points, due to high-cost equipment and limited number of trained personnel, leading to vision centres being concentrated in urban centres.</li> <li>• Limited public financing for eye care and provision of eyeglasses.</li> </ul>
<b>Rationale</b>	<ul style="list-style-type: none"> <li>• Use of eyeglasses has a measurable impact on education, literacy, road safety, and productivity.</li> <li>• Inclusion in UHC or insurance schemes can drive uptake and access.</li> <li>• Proven models to increase access to eyeglasses exist, such as school eye health and integration of vision centres into public facilities. Scaling up these models will require government leadership to create an enabling environment (e.g. regulation and logistics).</li> <li>• CHWs can serve as an access point for reading eyeglasses with minimal training, but more operational evidence is needed to prove this model is sustainable.</li> </ul>
<b>Proposed activities</b>	<ul style="list-style-type: none"> <li>• <b>Advise LMIC governments</b> on WHO-recommended eye care interventions and public financing schemes to promote coverage of part or total costs of screening, refraction, and eyeglasses provision in low-resource settings.</li> <li>• <b>Support LMIC governments to develop and implement a costed plan for eye care</b>, integrated in national health strategic plans and aligned with UHC objectives – the plan should incorporate proven cost-effective interventions, such as school eye health programmes and vision centres providing refraction services in public facilities.</li> <li>• <b>Build operational evidence on the role of government-managed CHWs</b> to serve as points of triage to dispense reading eyeglasses and identify individuals in need of more advanced eye care – in particular, generate evidence on integration of eyeglasses into government-managed supply chains, and analysis of the incremental cost of adding this service offering to existing programmes.</li> </ul>
<b>Target outputs</b>	<ul style="list-style-type: none"> <li>• National eye health programmes that include refraction services and eyeglasses.</li> <li>• Increased number of access points offering refraction services and eyeglasses.</li> <li>• New screening and service delivery models developed and implemented through the public sector.</li> <li>• Increased procurement of eyeglasses in the public sector.</li> </ul>
<b>Long-term outcome</b>	Increased access to refraction services and affordable eyeglasses through sustainable public sector programmes.

## STRATEGIC OBJECTIVE 4: Engage the private sector to expand delivery of affordable, quality eyeglasses and related services in LMICs.

Barriers addressed	<ul style="list-style-type: none"> <li>• Focus on high-income segments by private sector.</li> <li>• Lack of affordable products in LMICs.</li> <li>• Limited service points, especially in rural areas of LMICs.</li> </ul>
Rationale	<ul style="list-style-type: none"> <li>• Regulatory barriers (as addressed in Strategy Objective 2), especially around who can prescribe eyeglasses as well as high internal distribution costs, make LMIC markets less attractive to suppliers in terms of price, logistics, and availability of trained human resources.</li> <li>• Inclusive business models exist that show promise to reach the base of the pyramid and other market segments with affordable high-quality eyeglasses and appear economically viable.</li> <li>• Catalytic investment in pipeline development, refraction, and business training can increase the availability of a workforce to attract and support private sector businesses.</li> </ul>
Proposed activities	<ul style="list-style-type: none"> <li>• <b>Leverage existing last mile retail or pharmacy chains</b> to sell reading glasses, e.g. providing them with tools on procurement and inventory management, and market data around reading eyeglasses, such as pricing and regional style preference.</li> <li>• <b>Develop business cases</b> to replicate and scale successful inclusive optical business models to other regions.</li> <li>• <b>Set up blended finance vehicle</b> to support start-up of inclusive optical businesses and scaling of high potential innovators in LMICs.</li> </ul>
Target outputs	<ul style="list-style-type: none"> <li>• Create a competitive business environment that can drive prices down while maintaining high quality.</li> <li>• Increased access points through the private sector.</li> </ul>
Long-term outcome	A sustainable and inclusive private sector providing quality products and service at low cost to remote and/or low-income communities.

## STRATEGIC OBJECTIVE 5: Build and drive awareness on available treatments and consumer demand for eyeglasses.

Barriers addressed	<ul style="list-style-type: none"> <li>• <b>Low awareness:</b> Many individuals either do not recognise they have a vision problem or are not aware that simple corrective treatments exist.</li> <li>• <b>Low acceptance:</b> When individuals are provided with eyeglasses, compliance remains an issue due to style and attractiveness, cultural biases, stigma, or misconceptions around eyeglasses.</li> <li>• Lack of understanding of the economic benefits of correcting vision impairment by private stakeholders.</li> </ul>
Rationale	<ul style="list-style-type: none"> <li>• Demand generation is under-funded due to the misconception that individuals are aware of their poor vision and will seek treatment when they can.</li> <li>• Additional evidence is required to better understand the causes of and mechanisms to overcome compliance challenges.</li> </ul>
Proposed activities	<ul style="list-style-type: none"> <li>• <b>Develop an investment case and toolkit</b> for demand generation at the global level – this can include guidance on how funds could be deployed, lay out best practices, and consolidate the available evidence on behavioural change communication and compliance.</li> <li>• <b>Integrate and contextualise demand generation activities</b> into governments' national plans and mobilise funding around them.</li> <li>• <b>Engage with regional industry federations</b> (e.g. in textiles and transport) to include workplace vision screening in employee health programmes, provide technical support, and understand how workplace vision screenings generate demand in the marketplace.</li> </ul>

<b>Target outputs</b>	<ul style="list-style-type: none"> <li>• Increased awareness and care-seeking for poor vision.</li> <li>• Increased compliance with eyeglasses wearing.</li> <li>• Demand generation activities supporting activities under Strategic Objectives 3 and 4.</li> </ul>
<b>Long-term outcome</b>	Decreased prevalence of uncorrected refractive errors as populations in need become aware of eyeglasses as a potential solution to vision problems, are care-seeking for eyeglasses, and are regularly wearing eyeglasses.

## 7. Next Steps

This document was developed to support the identification of activities that will support increased and sustainable access to appropriate and affordable AT. As an overall investment and implementation strategy is developed, some of these proposed activities will be undertaken in the immediate term by the UK aid-funded AT2030 programme, which is led by the GDI Hub, to test what works to increase access to affordable AT. Others will be complementary early investments that ATscale will take on or will become foundational to ATscale's long-term investment in the space.

As interventions are shown to be effective, the investment case outlining the magnitude and types of investment needed will be further refined and developed. It is expected that different large-scale investments and financial instruments will be needed to achieve long-term outcomes. For example, system-strengthening grants may be needed to support integration into the health system, while match funding or co-investments may catalyse government procurement and investment. On the supply side, donor investment may be leveraged to de-risk private investment in cost-effective supply mechanisms.

# APPENDICES

## APPENDIX A: INDIVIDUALS INTERVIEWED OR CONSULTED

ORGANISATION	NAME
Aravind	Dhivya Ravilla Ramasamy
Brien Holden Foundation	Tim Fricke
CBM	Babar Qureshi
CHAI	Melinda Stanley
	Tucker Bbosa
Devlyn Optical Mexico	Patrick Devlyn
DOT Glasses	Philip Staehelin
Essilor	Anurag Hans
	Laura Herman
	Kovin Naidoo
EYElliance	Elizabeth Smith
EyeNetra	Vitor Pamplona
Forus Health	K Chandrasekhar
Global Vision 2020	Kevin White
Helen Keller International	Nick Kourgialis
IAPB	Zoe Gray
	Philip Hoare
	Jude Stern
International Centre for Eye Health	Priya Morjaria
International Eye Foundation	John Barrows
Light for the World	Jess Blijkers
LV Prasad Eye Institute	Rohit C Khanna
M2S	Andrew Kim



ORGANISATION	NAME
One Dollar Glasses	Martin Aufmuth Antje Bonfield
OneSight	K-T Overbey
	Laurie Gerversman
	Mike Smith
	Dennis Norris
	Reshma Dabideen
Peek Vision	Andrew Bastawrous
Plenoptika	Shivang Dave
REAP	Nathan Congdon
	Xiaochen Ma
SightSavers	Imran Khan
	Sumrana Yasmin
	Iain Jones
The Fred Hollows Foundation	Debbie Muirhead
	Amanda Davis
The Vision Catalyst Fund	Andrew Cooper
Uganda Ministry of Health	Dr Bubikire Stanley
USAID Child Blindness Program	Chris Pearson
Vision Aid Oversees	Nicola Chevis
Vision for a Nation	Lara Sherwood
Vision Impact Institute	Kristian Gross
Vision Spring	Jordan Kassalow
	Ella Gudwin
	Nate Leichter
Vision Vijana	Ronald Mukanga
Wazi Vision	Brenda Katwesigye
WHO	Alarcos Cieza
	Stuart Keel
World Blind Union	Jose Viera

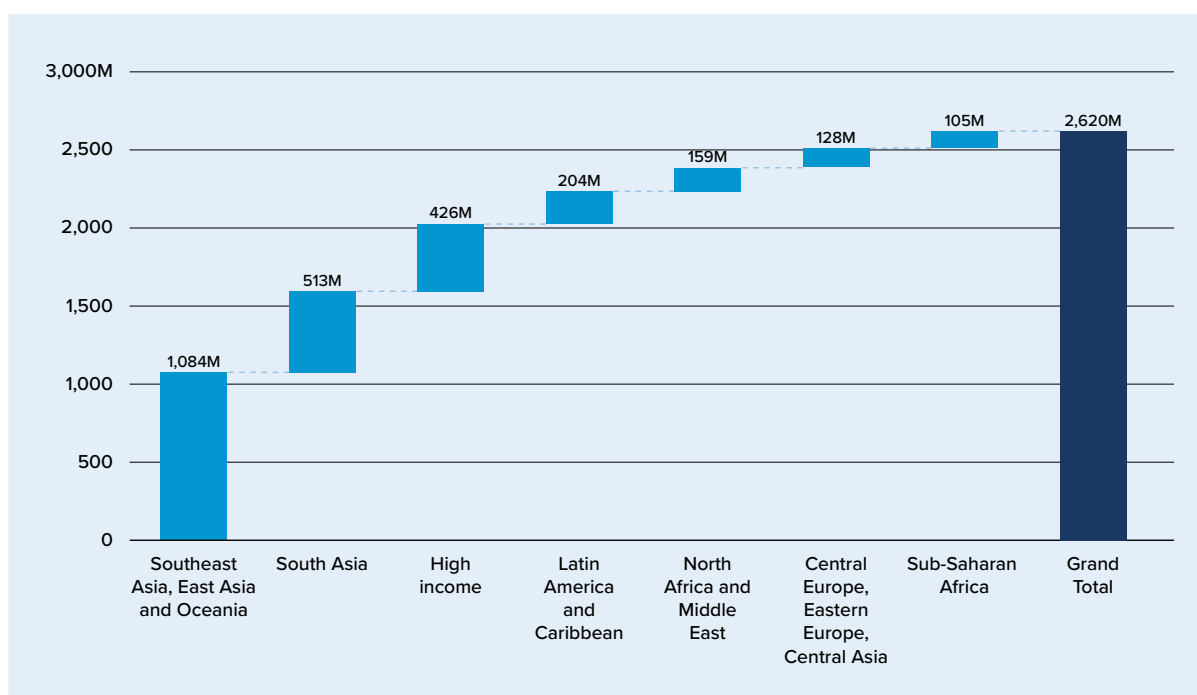
## APPENDIX B: COMMON EYE CONDITIONS (WHO)<sup>155</sup>

Does not typically cause vision impairment	<ul style="list-style-type: none"> <li>• <b>Blepharitis:</b> Inflammation of the eyelids near the base of the eyelashes characterised by redness and irritation of the eye and eyelid.</li> <li>• <b>Chalazion and hordeolum (stye):</b> Common eyelid disorders resulting from a blocked gland or localised infection that can cause pain.</li> <li>• <b>Conjunctivitis:</b> Inflammation of the conjunctiva (the clear membrane lining the inside of the eyelids and covers the white part of the eye), most commonly caused by allergy or infection.</li> <li>• <b>Dry eye:</b> Due to inadequate tear production that can result in irritation and blurred vision.</li> <li>• <b>Pterygium and pinguecula:</b> Abnormal growths on the conjunctiva that can cause pain. In advanced cases, pterygium can encroach on the cornea and cause vision loss.</li> <li>• <b>Subconjunctival haemorrhage:</b> Broken blood vessels underneath the conjunctiva.</li> </ul>
Typically causes vision impairment	<ul style="list-style-type: none"> <li>• <b>Age-related macular degeneration:</b> Damage to the central part of the retina responsible for detailed vision leads to dark patches, shadows, or distortion of the central vision. The risk of developing macular degeneration increases with age.</li> <li>• <b>Cataract:</b> Cloudiness in the lens of the eye, leading to increasingly blurred vision. The risk of developing cataracts increases with age.</li> <li>• <b>Corneal opacity:</b> A group of conditions causing the cornea to become scarred or cloudy. Opacity is most commonly caused by injury, infection, or by vitamin A deficiency in children.</li> <li>• <b>Diabetic retinopathy:</b> Damage to blood vessels in the retina which become leaky or blocked. Vision loss most commonly occurs due to swelling in the central part of the retina, which can lead to vision impairment. Abnormal blood vessels can also grow from the retina, which can bleed or cause scarring of the retina and blindness.</li> <li>• <b>Glaucoma:</b> Progressive damage to the optic nerve. Initially, loss of vision occurs in the periphery and can progress to severe vision impairment (known as open angle glaucoma, the most common type).</li> <li>• <b>Trachoma:</b> Caused by a bacterial infection. After many years of repeated infections, the eyelashes can turn inwards (known as trichiasis) which can lead to corneal scarring and, in some cases, blindness.</li> </ul>

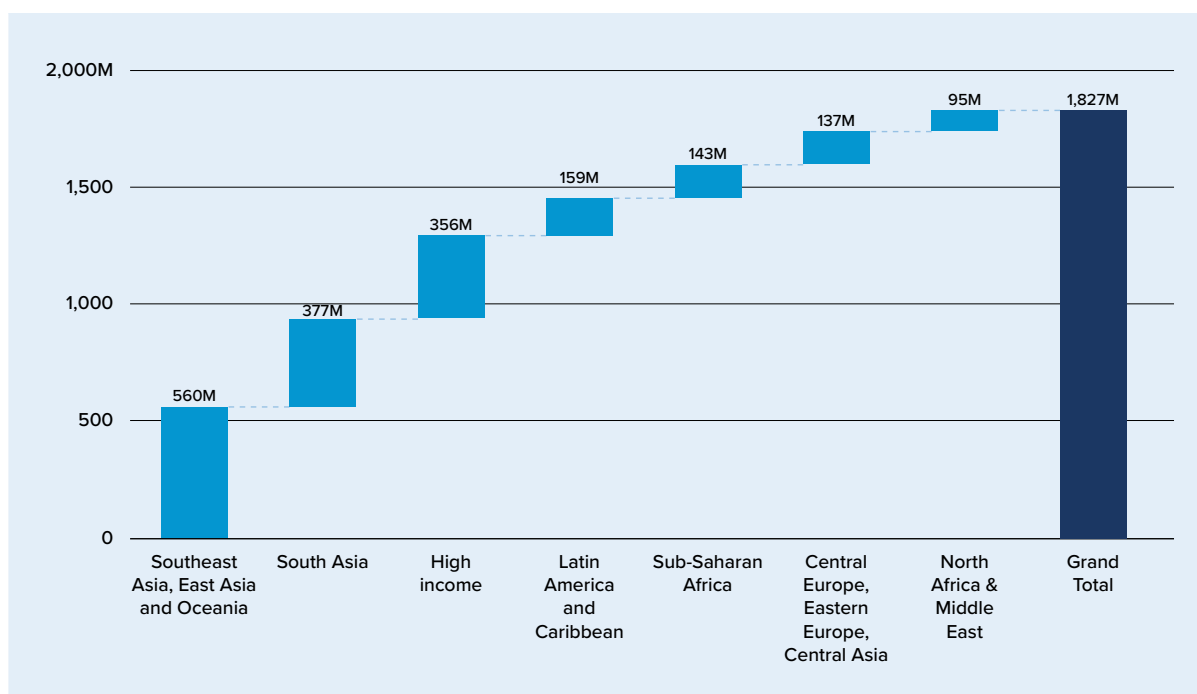
<sup>155</sup> World Health Organization. World report on vision. WHO; 2019.

## APPENDIX C: GLOBAL MAGNITUDE OF MYOPIA AND PRESBYOPIA

Number of people with myopia by region (estimated in 2020)<sup>156</sup>



Number of people with presbyopia by region (2015)<sup>157</sup>



<sup>156</sup> Holden BA, Fricke TR, Wilson DA, Jong M, Naidoo KS, Sankaridurg, P, Wong, TY, Naduvilath, TJ and Resnikoff, S. Global prevalence of myopia and high myopia and temporal trends from 2000 through 2050. *Ophthalmology*. 2016;123(5):1036-1042.





<sup>157</sup> Fricke TR, Tahhan N, Resnikoff S, Papas E, Burnett A, Ho SM, Naduvilath, T, Naidoo KS. Global prevalence of presbyopia and vision impairment from uncorrected presbyopia. *Ophthalmology*. 2018;125(10):1492-1499.

## APPENDIX D: PRESCRIPTION DETAILS

Prescriptions for eyeglasses include a variety of details to be fully customised to each individual.

- **Sphere** (SPH): indicates the amount of lens power, measured in dioptres (D), prescribed to correct short-sightedness (indicated with minus sign –) or long-sightedness (indicated with plus sign +). It is ideally determined to the nearest 0.25D.
- **Cylinder** (CYL): indicates the amount of lens power for astigmatism.
- **Axis**: indicates the orientation of the astigmatism. It is a number anywhere between 0 and 180 degrees.
- **Near Addition** (ADD): indicates the additional refractive power to be combined, or added, to the distance power to achieve the ideal near power.
- **Prism**: indicates the amount of prismatic power, measured in prism dioptres, prescribed to compensate for eye alignment problems.
- **Pupillary Distance** (PD) or **Interpupillary Distance** (IPD): indicates the distance between pupil centres.

## APPENDIX E: REFRACTION EQUIPMENT

OBJECTIVE REFRACTION		SUBJECTIVE REFRACTION	
			
<b>Retinoscope</b>	<b>Autorefractor</b>	<b>Universal frame with trial lenses</b>	<b>Phoropter</b>
The eye professional shines a light into the patient's eye and sees how the light is reflected from the retina. <sup>158</sup>	Automated machine which calculates the refractive error by detecting how the patient's eye influences infrared radiation sent into the eye. <sup>159</sup>	The eye professional inserts trial lenses into a frame that allows for variable adjustments such as interpupillary distance or side length.	Mechanical device combining many switchable lenses into a single system which allows the eye professional to quickly alternate lenses until the best is found. <sup>160</sup>
Around USD300-USD500	Around USD10,000-USD15,000	Around USD300-USD700	Around USD1,000-USD3,000

<sup>158</sup> Cordero, I. Understanding and looking after a retinoscope and trial lens set. Community Eye Health; 2017.

<sup>159</sup> Keirl, A, Christie, C. Clinical optics and refraction: a guide for optometrists, contact lens opticians and dispensing opticians. Elsevier Health Sciences; 2007.

<sup>160</sup> Durr, NJ, Dave, SR, Lage, E, Marcos, S, Thorn, F, Lim, D. From unseen to seen: tackling the global burden of uncorrected refractive errors. Annu Rev Biomed Eng. 2014;16(1):131-153.

## APPENDIX F: INTERNATIONAL STANDARD CLASSIFICATION OF EYE HEALTH PROFESSIONALS<sup>161</sup>

HEALTH CADRE	RESPONSIBILITIES	TRAINING
<b>Ophthalmologists</b>	<ul style="list-style-type: none"> <li>• Diagnose, treat (medically and surgically), and prevent eye diseases, ailments and injury, using specialised procedures and techniques, applying principles of modern medicine to deliver comprehensive eye care.</li> <li>• May also diagnose general diseases of the body and treat ocular manifestations of systemic diseases.</li> </ul>	<ul style="list-style-type: none"> <li>• Medical practitioner with at least 7 years of medical study and who has had specialised post-graduate training in ophthalmology.</li> <li>• Ophthalmologists may further train in subspecialties.</li> </ul>
<b>Optometrists</b>	<ul style="list-style-type: none"> <li>• Provide comprehensive eye and vision care, which includes refraction and dispensing, detection or diagnosis, and management of disease in the eye, and the rehabilitation of conditions of the visual system.</li> </ul>	<ul style="list-style-type: none"> <li>• At a minimum, has completed a bachelor's degree and is licensed or registered.</li> <li>• Optometrists are not medical doctors.</li> </ul>
<b>Mid-level eye care workers</b>	<ul style="list-style-type: none"> <li>• Heterogeneous group of staff with specialist ophthalmic training, but who can perform fewer competencies than an optometrist.</li> <li>• Diagnose and treat eye illnesses and refer patients with conditions beyond their scope of practice.</li> </ul>	<ul style="list-style-type: none"> <li>• Wide range of training varying across countries.</li> </ul>

<sup>161</sup> WHO Regional Office for Africa. Core competencies for the eye health workforce in the WHO African region. WHO; 2019.

## APPENDIX G: NEW REFRACTION DEVICES

COMPANY	PRODUCT/INNOVATION	COMMERCIAL STATUS
<b>Essilor</b> (Est. 1972)  <b>France</b>	<b>ClickCheck:</b> handheld tube where the patient can look through one end and turn a knob to bring the image into focus. A marking on the side then reports the user's prescription.  Adequate for an initial diagnosis.	<ul style="list-style-type: none"> <li>Field tested in India and Indonesia.</li> <li>Expected to be commercially available in 2020.</li> </ul>
<b>EyeNetra</b> (Est. 2009)  <b>Germany</b>	<b>Netra:</b> portable self-test refraction tool powered by a smartphone (fits Samsung S4 only). The user turns a dial to align the patterns and pushes a button to lock them in place. After 8 interactions, the app calculates the difference between what the user sees as "aligned" and the actual alignment of the patterns to provide a prescription.	<ul style="list-style-type: none"> <li>Clinically validated.</li> <li>Commercially available in 132 countries.</li> <li>Registered with US FDA.</li> </ul>
<b>ForusHealth</b> (Est. 2010)  <b>India</b>	<b>3nethra aberro:</b> monocular — i.e. each eye is refracted separately — handheld autorefractor using wavefront aberrometry technology.  Integrated with a telemedicine platform.	<ul style="list-style-type: none"> <li>Clinically validated and field-tested in hospitals in India.</li> <li>Available globally.</li> <li>Registered with US FDA.</li> </ul>
<b>GV2020</b> (Est. 2009)  <b>US</b>	<b>USee:</b> portable self-refraction device which allows the user to dial lens bars up or down to find the most comfortable correction while viewing a vision chart. The lens bars have a coloured index to indicate the power correction required (+6.00 to -6.00D in steps of 0.25D).  Device sold as part of a vision kit for on-the-spot provision of both prescription and reading eyeglasses.	<ul style="list-style-type: none"> <li>Clinically validated by Johns Hopkins University Hospital study.</li> <li>Field-tested in high schools in Mozambique and rural villages in several countries.</li> </ul>
<b>Ovitz</b> (Est. 2012)  <b>US</b>	<b>Eyeprofiler:</b> monocular — i.e. each eye is refracted separately— handheld autorefractor using wavefront aberrometry technology.	<ul style="list-style-type: none"> <li>Clinically validated by 6 tests worldwide.</li> <li>Field testing in South Korea, Bangladesh, and Vietnam.</li> <li>Registered with US FDA.</li> </ul>
<b>Plenoptika</b> (Est. 2014)  <b>US</b>	<b>QuickSee:</b> binocular - i.e. both eyes refracted at the same time - handheld autorefractor using wavefront aberrometry technology.  <b>QuickSee Flip:</b> monocular version of the Quicksee, i.e. each eye is refracted separately, targeting LMICs. Distributed under the 'e-See' brand by Aurolab - a subsidiary of the Aravind manufacturing company - in India and surrounding countries.	<ul style="list-style-type: none"> <li>Clinically validated by 1500+ patients across India, US, and Spain.</li> <li>Field tested with Aravind in India.</li> <li>QuickSee and QuickSee flip registered with US FDA and CE marked.</li> </ul>
<b>plusoptiX</b> (Est. 2001)  <b>Germany</b>	<b>plusoptiX A12R:</b> handheld binocular - i.e. both eyes refracted at the same time - autorefractor designed for babies, children, and uncooperative patients that measures baseline refraction from 1 metre distance in the context of an initial exam.  <b>plusoptiX S12R:</b> handheld vision screener that can be used on patients as young as 5 months old. Device takes a picture of the user's eyes, compares measurement with age-specific thresholds, and displays a "Pass" or "Refer" result.	<ul style="list-style-type: none"> <li>Clinically validated.</li> <li>Available in 60 countries.</li> <li>Recommended on IAPB Standard List.</li> <li>Registered with US FDA.</li> </ul>
<b>Smart Vision labs</b> (Est. 2013)  <b>US</b>	<b>SVOne:</b> monocular — i.e. each eye is refracted separately — handheld autorefractor using wavefront aberrometry technology.  Integrated with a telemedicine platform.	<ul style="list-style-type: none"> <li>Clinically validated.</li> <li>Telemedicine feature focused on US market.</li> <li>Registered with US FDA.</li> </ul>





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