Country guidance

Scaling-up spectacles provision using handheld autorefractors in low-resource settings

ATscale
GLOBAL PARTNERSHIP FOR ASSISTIVE TECHNOLOGY
Hosted by
UNOPS

Disclaimer

Suggested citation. Scaling-up Spectacles Provision Using Handheld Autorefractors in Low-resource Settings: Country Guidance. Geneva: ATscale, The Global Partnership for Assistive Technology and IQVIA; 2025.

Table of contents

Acknowledgements

This report was developed by ATscale, the Global Partnership for Assistive Technology, under the guidance of Anil Kashyap and Satish Mishra. The contributing authors were from IQVIA and LV Prasad Eye Institute, Hyderabad, India. ATscale and IQVIA are grateful to the contributors and to the members of the Technical Working Group for their invaluable contributions to the study's implementation and the finalization of findings and recommendations:

Members of the Technical Working Group:

- Dr Scott Mundle, International Agency for the Prevention of Blindness (IAPB)
- Ms Sumrana Yasmin, SightSavers International
- Dr Reshma Parmanand, Fred Hollows Foundation
- Dr Ving Fai Chan, University of Belfast, UK
- Mr Yudha Dhoj Sapkota, IAPB

Contributing authors from the Study Team:

- Dr Srinivas Marmamula, Principal Investigator, L V Prasad Eye Institute, Hyderabad, India
- Dr Santosh Moses, Co-Principal Investigator, IQVIA
- Dr Rohit Khanna, L V Prasad Eye Institute
- Hemant Chaudhry, IQVIA
- Dr Stephanie Berrada, IQVIA
- Dr Aneesha Ahluwalia, IQVIA
- Mr Winston Prakash, L V Prasad Eye Institute

Technical reviewers

- Stuart Keel, Technical Officer, Vision and Eye Care Programme, WHO
- Andreas Mueller, Technical Advisor, Vision and Eye Care Programme, WHO
- Mitasha Yu, Consultant, Vision and Eye Care Programme, WHO
- Simona Minchiotti, Technical Advisor, Eye and Vision Care, ATscale
- Dr. Dechen Wangmo, Technical Advisor, Eye and Vision Care, ATscale

We also acknowledge the support of our public and private sector partners across low—and middle-income countries.

Special thanks are due to the clinical study sites – Nepal Eye Hospital, University of Abuja (Nigeria), and Menelik II Comprehensive Specialized Hospital (Ethiopia) – for their commitment and collaboration.

Through the collective efforts of all stakeholders, this initiative marks a significant step toward expanding access to assistive technologies and improving eye care outcomes for underserved populations.

List of acronyms

D	Diopter
eREC	Effective Refractive Error Coverage
IAPB	International Agency for the Prevention of Blindness
LMICs	Lower Middle-Income Countries
SE	Spherical Equivalent
SER	Spherical Equivalent Refractive Error
URE	Uncorrected Refractive Error
WHO	World Health Organization

Executive summary

This document serves as a supplementary resource to the primary study on handheld autorefractor technologies. Uncorrected Refractive Errors (UREs) remain a significant global public health challenge, impacting over 88 million individuals worldwide. While traditional refraction techniques, such as retinoscopy and subjective refraction, are considered the gold standard, handheld autorefractors are emerging as viable, scalable alternatives, particularly in low-resource settings, to simplify the refractive error services and spectacles provision.

Since their inception in the 1970s, handheld autorefractors have undergone substantial technological evolution. Modern devices are compact, battery-operated, and designed for ease of use. Many devices now incorporate advanced features such as Wavefront Aberrometry, Artificial Intelligence (AI), and telemedicine integration, enhancing both diagnostic accuracy and operational scalability. These innovations enable frontline health workers to perform vision screenings in remote areas and transmit data to specialists for further evaluation, thereby supporting decentralized care models such as mobile eye clinics and reducing urban-rural disparities in access to vision services.

The global autorefractor market was valued at $1.9 billion in 2023 and is projected to reach $5.2 billion by 2032. Within this, the value of the handheld segment is expected to grow to $1.2 billion by 2033, driven by increasing demand, aging populations, and heightened awareness of eye health.

To assess the clinical effectiveness and scalability of spectacle provision using the handheld autorefractors, ATscale, the Global Partnership for Assistive Technology commissioned a multi-country study across Ethiopia, Nepal, and Nigeria. The study was carried out by IQVIA and the L V Prasad Eye Institute, with oversight from the Technical Working Group of technical partners set up for this work. The research aimed to compare handheld autorefractors with conventional refraction methods, evaluate prescription alignment, and determine the feasibility of integration into public health systems in low-resource settings.

The global autorefractor market was valued at $1.9 billion in 2023 and is projected to reach $5.2 billion by 2032. Handheld devices are expected to grow to $1.2 billion by 2033, driven by rising demand, aging populations, and increased awareness of eye health. Due to the scarcity of robust data on the existing handheld autorefractors, ATscale embarked on a study aimed at exploring their potential in expanding refractive services through task-shifting to mid-level providers. Specifically, the study examined whether these devices—by combining technology, portability, accuracy, and user-friendly interfaces—can reliably support a direct-to-dispense model, in which patients receive spectacles immediately without requiring confirmatory retinoscopy or subjective refraction by specialist personnel.

1. Background and context

Globally, more than two billion people experience vision impairment, with over one billion individuals having avoidable vision impairment.[1] It is a striking fact that 90% of people with vision impairment reside in low- and middle-income countries (LMICs), where service provision is weakest.[1] Uncorrected refractive errors (URE) are a leading cause of vision impairment in both children and adults[2] and are responsible for vision impairment in about 88.4 million people.[3] URE has far-reaching consequences across different age groups and is a crucial public health threat with widespread social implications.

WHO reports that two thirds of people in low-income countries who need spectacles do not have access to them,[4] highlighting how poor access to refractive services and affordable spectacle provision drives the disproportionate vision-impairment burden of LMICs. Effective refractive error coverage (eREC) shows substantial unmet need globally despite modest gains, again underscoring low access to refractive error services in LMICs, mainly in primary eye care, and gaps in the specialist workforce and spectacle provision in those countries.[5]

1. Burton, M. J., et al. (2021). The Lancet Global Health Commission on Global Eye Health: Vision beyond 2020. The Lancet Global Health, 9(4), e489–e551.
2. https://www.who.int/publications/i/item/9789241516570. Last accessed 24th November 2024.
3. Fricke T. R., Tahhan N., Resnikoff S., Papas E., Burnett A., Ho S.M., Naduvilath T., Naidoo K.S. Global prevalence of presbyopia and vision impairment from uncorrected presbyopia: systematic review, meta-analysis, and modelling. Ophthalmology. 2018;125(10):1492–1499. doi: 10.1016/j.ophtha.2018.04.013.
4. World Health Organization (2023), SPECS 2030: Improving Access to Spectacles. WHO.
5. Liu, Y., et al. (2025). Effective refractive error coverage (eREC): global and regional estimates, 2000–2020. The Lancet Global Health, 13(2).

Traditionally, refractive error correction has relied on conventional methods such as retinoscopy, subjective refraction, and cycloplegic refraction, which are considered gold standards. However, retinoscopy and subjective refraction examinations must be carried out by skilled optometrists or ophthalmologists, limiting the ability to scale services in resource-constrained settings. The major guidelines do not include cycloplegic drops in routine school/community screening due to issues of logistics, consent, side effects, and scope of practice (cycloplegia is reserved for diagnostic examinations after referral).

In recent decades, technological innovations such as autorefractors have offered the potential to significantly expand refractive services in LMICs and address the challenges mentioned above.

Autorefractors are devices that objectively measure refractive error. They have evolved from bulky tabletop units in the 1970s to modern handheld devices using advanced optics such as wavefront sensing. These portable models offer fast and accurate measurements, and are particularly suited for field settings.[6]

In many low-resource regions, a lack of ophthalmologists, optometrists, and the use of expensive equipment has left a massive gap in uncorrected vision care.[7] Handheld autorefractors can play a crucial role by bringing refractive error assessments to communities with little access. Simply put, these portable devices enable more widespread vision screening, helping to identify people who need spectacles and to facilitate correction in remote and underserved areas.

6. Agarwal A., Bloom D.E., deLuise V.P., Lubet A., Murali K., et al. (2019) Comparing low-cost handheld autorefractors: A practical approach to measuring refraction in low-resource settings. PLOS ONE 14(10): e0219501. https://doi.org/10.1371/journal.pone.0219501
7. ibid.

The autorefractor market is witnessing robust growth globally, propelled by the urgent need to address widespread vision impairment. Technological advancements, particularly the rise of portable, high-precision autorefractors, are transforming how and where eye examinations are conducted. Handheld autorefractors and novel refraction technologies are a growth segment of the market and a game-changer for delivering eye and vision care in both advanced and low-resource settings. The combination of strong demand (due to demographic and lifestyle trends) and continuous innovation (from industry players focusing on accuracy, affordability, and portability) suggests that autorefractors will play an increasingly vital role in global vision care in the coming years.

However, literature regarding the utility, scalability, and reliability of handheld autorefractors used in different geographies remains limited at present. With its mission to improve access to assistive technology in LMICs, ATscale, the Global Partnership on Assistive Technology, is committed to leveraging data and evidence to identify solutions that can accelerate and transform the provision of assistive technology. ATscale therefore commissioned a large-scale study to determine the clinical effectiveness and feasibility of using handheld autorefractors for immediate, "on-the-spot" prescription of spectacles, especially in countries with low-resource settings and limited availability of eye-care specialists and a high burden of uncorrected refractive errors.

The study was undertaken by IQVIA, a leading global provider of healthcare consulting, research, data analytics, and technology solutions, in collaboration with LV Prasad Eye Institute, a World Health Organization Collaborating Centre for the Prevention of Blindness, and with guidance from global experts in the eye-care sector.

Overview of study methodology

Scope of the study 2024	• Countries: Ethiopia, Nepal, and Nigeria; three study sites were selected, one per country, for implementation of the study. • Technologies: Six technologies were studied – Eccentric Photorefraction, Wavefront Aberrometry, Badal Optometer, Shack-Hartmann Wavefront Sensing, SynchroScan, and Auto Fogging. • Study Participants: The participants were recruited from the study site and met the following inclusion criteria: above five years of age, visual acuity improving to at least 6/12 with refraction, and absence of any other ocular pathology.
Sampling design	Six groups, each with 200 participants, took part in the study, with one group for each of the six technologies (devices). A total of 1200 participants were recruited for the study.
Data collection methods	Eligible participants underwent auto-refraction conducted by a community health worker using two handheld autorefractors. Following this, an ophthalmologist carried out a comprehensive eye examination, which included a fundus examination.
Data analysis	• The data analysis was conducted using Stata/SE 14 for Windows software (StataCorp LLC, TX, USA). • The Spherical Equivalent, which combines spherical and cylindrical power to estimate refractive error, was calculated. The Mean Spherical Equivalent Refractive error obtained by the gold-standard manual subjective refraction was compared with that of handheld autorefractors.
Stakeholder consultations	Industry experts, eye care specialists, and leading organizations in eye care and public health were interviewed. Stakeholder consultations took place in India, Indonesia, Kenya, and Pakistan to discuss the potential implications of the study findings.

Findings reveal high diagnostic accuracy and performance across all age groups (except children), portability and design features, as well as ease of use training non-specialized health workers to undertake refractive error operations. Handheld autorefractor technologies displayed sensitivity of over 70% and specificity range of 80–90% for refractive errors when compared with retinoscopy and subjective refraction. In low-resource settings, where mass screening is required, handheld autorefractor technologies can play a critical role in reducing the burden of uncorrected refractive error and increasing access to spectacles. The study demonstrated the potential of these technologies beyond screening. Three devices showed better alignment in prescription of spectacles when compared with subjective refraction. Such technologies, if used in combination with readymade or ready-to-clip spectacles, offer immense potential to simplify access to refractive error services and spectacles in resource-poor settings. Prescriptions should ensure that visual acuity improves to 6/6 or 6/9. , such prescriptions should not be made if the measured eye power exceeds ±3.00 diopters, as these cases may require personalized correction and further clinical assessment.

2. Findings from the autorefractor study

This study evaluated the performance of six handheld autorefractors, each based on a distinct optical principle, across three settings in low-and middle-income countries. Using retinoscopy as the gold standard, the study assessed agreement in Spherical Equivalent refraction (between subjective and objective refraction), diagnostic accuracy for myopia and hyperopia, and reliability across age groups vis-à-vis their clinical validity and practical utility.[8] The findings showed that while all of the devices and technologies demonstrated a certain degree of utility, there were notable differences in their accuracy, precision, and suitability for community-based screening programmes.

8. The process of assessing the eye's refractive status is called refraction. Retinoscopy is an objective refraction process that measures a person's refractive error (such as nearsightedness, farsightedness, or astigmatism) using a retinoscope and light. Subjective refraction, often carried out after objective refraction, involves manually evaluating refractive status using a combination of spherical and cylindrical lenses to find the best-corrected visual acuity for prescription of spectacles. In this study, retinoscopy and subjective refractions were taken to be the gold standard. A Spherical Equivalent (SE) is an estimate of the eyes' refractive error, calculated independently for each eye. It is calculated by merging the spherical (nearsightedness or farsightedness) and cylindrical (astigmatism, a common vision condition causing blurred vision) components of the refractive error. Spherical Equivalent Refractive Error (SER) is calculated by adding the sphere power to half of the cylinder power. For this study, there was no statistically significant difference in mean SER between both eyes. Data from the right eye was used for analysis. Diagnostic accuracy refers to how well a test identifies whether a condition is present or absent. Sensitivity (true positive rate) and specificity (true negative rate) are important components of diagnostic accuracy. Myopia is nearsightedness or shortsightedness. This is a common vision condition where close objects are seen clearly, but distant objects appear blurred. Hyperopia is known as farsightedness. It is a refractive error where distant objects are usually seen clearly, while close objects appear blurred.

DIAGNOSTIC ACCURACY AND ALIGNMENT TO THE GOLD-STANDARD PRESCRIPTION

Eccentric Photorefraction	Wavefront Aberrometer	Badal Optometer	Shack-Hartmann Wavefront Sensing	SynchroScan Technology	Auto Fogging Technology
Stronger precision but lesser diagnostic accuracy and higher false-positive rates (weaker specificity)	High precision and minimum measurement variability compared to findings from retinoscopy	Poor repeatability of results and limited agreement with gold-standard retinoscopy	Moderate agreement with retinoscopy, but greater measurement variability	Moderate measurement variability compared to retinoscopy; technological advantages that enhance accuracy	High degree of variability between measurements from the technology and subjective refraction

SUITABILITY FOR REFRACTIVE ERRORS

Eccentric Photorefraction	Wavefront Aberrometer	Badal Optometer	Shack-Hartmann Wavefront Sensing	SynchroScan Technology	Auto Fogging Technology
Better suited for myopia, but not hyperopia	Strong sensitivity for myopia detection and useful for hyperopia	Not well-suited for community or large-scale public health settings	Not suitable for detecting severe myopia, but useful for hyperopia	Best combination of sensitivity and specificity for both myopia and hyperopia	Can be used for hyperopia, but with limitations

AGE GROUPS

Eccentric Photorefraction	Wavefront Aberrometer	Badal Optometer	Shack-Hartmann Wavefront Sensing	SynchroScan Technology	Auto Fogging Technology
Suitable for all age groups above 17 years of age	Consistent findings across all age groups	Not useful across all age groups	Better for the younger age group	Suitable for all age groups; technological advantages for the younger age group	Not age-resilient

Key takeaways

CLINICAL ACCURACY & AGREEMENT

- Top-performing technologies:
  - Eccentric Photorefraction: Lowest mean difference in SER, narrow limits of agreement -> high precision.
  - Shack-Hartmann Wavefront Sensing and SynchroScan: Moderate agreement with the gold standard.
- Clinically acceptable range: ±0.50 D in SER is considered acceptable for spectacle prescriptions.

IMPLICATIONS FOR PROVISION OF SPECTACLES

- Manual refraction is complex and training-intensive.
- Handheld autorefractors offer a viable alternative for spectacle prescriptions, especially in low-resource settings.
- Devices must deliver:
  - Accurate SER values (±0.50 D).
  - Low variability (≤1.0 D).

PERFORMANCE ACROSS AGE GROUPS

- 5-16 years: large variability was noted for all the technologies, limiting their suitability for refractive error correction in this age group.
- 17-28 years: 3 out of 6 devices performed well.
- 29–39 years: 4 out of 6 devices performed well.
- 40+ years: 5 out of 6 devices performed well.
- Older age groups showed:
  - Less variability -> better suitability for refractive correction.
- SynchroScan Technology:
  - Most consistent across age groups above 17 years.
  - Recommended for scaling in community settings.

USE OF SER IN LOW-RESOURCE SETTINGS

- SER enables ready-made or clip-on spectacle provision for individuals aged 17 and above.
- Useful for mass screening and quick provisioning of individuals with final corrected visual acuity of 6/6 or 6/9, and eye power not exceeding ± 3D.

STUDY LIMITATIONS

- Astigmatism was not evaluated.
- Cycloplegic refraction was not performed.
- Small sample sizes in high refractive error groups -> results not generalizable.

FINAL RECOMMENDATIONS: SynchroScan (best overall), Shack-Hartmann Wavefront, and Eccentric Photorefraction

- SynchroScan Technology
  - Suitable for on-the-spot spectacle prescriptions in low-resource settings.
  - Can be operated by minimally trained allied health professionals.
  - Performs well in non-cycloplegic settings (necessary for mass screenings).
- Shack-Hartmann Wavefront
  - Portable.
  - Lower cost.
  - Can be operated by minimally trained allied health professionals.
- Eccentric Photorefraction
  - High precision.
  - Lower cost.
  - Can be operated by minimally trained allied health professionals.
  - Lightweight.
- Further research needed:
  - To assess patient acceptance and satisfaction with autorefractor-based prescriptions.
  - Comparison of SynchroScan with cycloplegic refraction in children.

KEY TAKEAWAYS

Handheld autorefractor technology fits into the task-sharing framework as a catalytic tool that lowers the skill barrier for a critical task (vision testing), enabling its delegation to less specialized health workers for on-the-spot provision of spectacles. Three of the tested technologies can play a critical role in simplifying access to refractive error services and on-the-spot provision of spectacles in low-resource settings for individuals aged 17 and above. Prescriptions should ensure that visual acuity improves to 6/6 or 6/9, and should not be made if the measured eye power exceeds ± 3D, as these cases require personalized correction and further clinical assessment.

Resource constraints in LMICs have driven interest in "task-shifting" and "task-sharing" strategies, empowering community health workers (CHW) or other lay personnel to perform basic vision screenings and refractions, which were once the sole domain of specialised workforce. Also, aligning with the World Health Organizations' (WHO) Eye care competency framework (ECCF) and Competency-based Refractive Error Team guidelines, handheld autorefractor technology fits into the task-sharing framework as a catalytic tool that lowers the skill barrier for a critical task (vision testing), enabling its delegation to less specialized health workers. The other factors such as user interface or ease of use, enabling environment for task-sharing, supplier-based knowledge, price point, integration with other IT-based platforms are also key determinants to scale-up adoption of such technologies and accelerate access to refractive error services and spectacle provision.

3. Recommendations for scaling up autorefractor technologies

Below are some broad recommendations from the perspectives of countries, suppliers, manufacturers, implementing partners, and other stakeholders for the potential scale-up of handheld autorefractive technologies, particularly in LMICs to accelerate refractive error and spectacle provision to the needy. The timeline includes three categories: short term (within 1 year); medium term (1-2 years); and long term (3-4 years).

1. Address information asymmetry
Demand and supply perspective to adopt most appropriate and cost-effective technology

2. Enabling policy environment for task-sharing
Competency-based refractive error team approaches

3. Coupling technology with spectacle provisioning
Proven handheld autorefractor with ready to clip spectacles

4. Enabling regulatory environment
Including procurement systems to ensure quality of products and after-sale services

5. Affordability
Multifaceted - market competition, transparent pricing, competitive standardization, support manufacturers

6. Research & development
Invest in technologies optimized that meet the physiological needs of children's eyes for pediatric refraction

1. Address information asymmetry

Addressing information asymmetry from demand and supply perspectives is critical in order to ensure that governments and health programmes in LMICs adopt the most appropriate and cost-effective handheld autorefractor technologies.

Although several technologies are available globally, procurement of the devices from buyers and reaching the market from the suppliers' side is particularly challenging. This is due to limited manufacturers' information around demand, sales channels, and country procurement announcements and portals. On the buyers' side, countries have to rely on distributors with limited exposure to various technologies available in the market. During the study implementation, it was also found that stringent import processes along with bureaucratic red tape, especially in low-resource settings such as the African region, often led to disruptions in procurement.

Key interventions	• Collaborate with manufacturers and suppliers to create a market intelligence platform/information guide that shows a list of devices, manufacturer details, sales focal points, specifications, prices, etc. • Countries should create a single-window clearance system for handheld autorefractor technologies to ease customs and other related barriers and should learn from the best practices established in other countries for the import of medical devices and equipment. • Countries should develop policy briefs and technical documents to support policy advocacy with the relevant local ministries and/or departments, enabling a simpler regulatory ecosystem for importing such devices.
Implementation timeframe	Medium to long term.
Key stakeholders	Manufacturers, customs and excise departments, national governments.

2. Enable policy environment for task-sharing

Adopting a competency-based refractive error team approach that facilitates task-sharing will greatly help to scale up the use of handheld autorefractor technology, thus accelerating access to refractive error services.

Stakeholder consultations revealed that at the present time handheld autorefractors are largely being operated by trained health workers, including optometrists, ophthalmic nurses, and ophthalmic clinical officers. Involvement of other healthcare staff, including community health workers and non-healthcare workers, is very limited or non-existent. However, the present study has demonstrated that community health workers and other healthcare staff in low-resource settings can be trained to use handheld autorefractor technologies. This fact highlights the potential of these devices for future scalability in lower-income countries.

Key interventions	• It is important to enable policy environments that promote task-sharing and to put in place continuous education programmes on the adoption and use of the new technologies. • Adoption of competency-based refractive error team approaches can facilitate the adoption of such technology and scale up refractive error services. • Development of curriculum and use of autorefractor technology by the primary healthcare workforce should be included as a part of the competency framework.
Implementation timeframe	Short to medium term.
Key stakeholders	Health ministries, national eye programmes, regional public hospitals, and national public hospitals.

3. Coupling with easy-to-deploy spectacle technology

Coupling the use of proven handheld autorefractors with "ready to clip" spectacles can pave the way for simplifying the provision of spectacles, especially in population-based programmes.

This study has established that devices with SynchroScan, Shack-Hartmann Wavefront Sensing technologies, primarily, and Eccentric Photorefraction, particularly with open-view designs, are effective in community settings and offer huge potential for on-the-spot provision of spectacles. Other studies have been carried out in different contexts and settings to establish the diagnostic accuracy of other autorefractor technologies.

Key interventions	• Global partners should develop an online and dynamic guide to inform countries about the technological advantages of different handheld devices, their design features, costs, and diagnostic accuracy in different settings. • Prior to large-scale adoption of the technologies in the programme, countries will need either to rely on evidence published in reputed journals or platforms/or facilitate pilot implementation of health technology assessment studies to explore the suitability of the technologies for their context. • Ease of use by mid-level providers and community health workers with minimal training, speed of measurement, portability (weight, battery life, ruggedness), language support, user interface, and integration with local workflows are the key technical specifications to be considered when selecting a handheld autorefractor technology. • Further research (behavioural studies) should be carried out to understand compliance and patient satisfaction with spectacles prescribed using handheld autorefractors.
Implementation timeframe	Short to medium term.
Key stakeholders	Global institutions, ministries, and eyecare programmes.

4. Regulatory environment and procurement system

Creating an enabling regulatory environment and procurement system to ensure that only quality products are introduced in the local market, with after-sales services for repair and maintenance.

An enabling regulatory environment will play a crucial role in facilitating access to and integration of appropriate handheld autorefractors within national health systems. Regulations influence not only the availability and import of devices but also their quality assurance, certification, and inclusion in public procurement, distribution systems, and service delivery frameworks.

Key interventions	• Develop a regulatory framework with key considerations such as ISO certifications, traceability, labelling, CE mark, etc., for safety (preferably non-invasive), technical performance, and clinical validity. • Countries' procurement practices should consider pooled procurements, total cost of ownership (not just purchase price), including consumables, spare parts, calibration, software updates, and electricity infrastructure. • Integrate the product flow for these devices into the existing supply chain management software. • Strengthen health product distribution networks. Focus should be on enhancing visibility, implementing robust inventory management, and fostering strong supplier relationships.
Implementation timeframe	Short to medium term.
Key stakeholders	National regulatory authorities, procurement authorities, professional and hospital associations.

5. Multi-faceted approaches to make the technology affordable

A multi-faceted approach based on the evolution of the medical device sector is crucial to address the issue of the high cost of autorefractors.

Key strategies to make autorefractors more affordable, especially in LMICs, could include fostering market competition for affordable models through transparent pricing, component standardization, and supporting manufacturers that are focused on low-resource settings.

Key interventions	• Foster greater market competition, particularly for "essential" or "basic" models that offer core functionality at a lower price point. • Promote transparent pricing, standardize certain technical specifications for interchangeable components, and support emerging manufacturers, especially those focused on designing devices specifically for low-resource settings. • Governments and public health organizations should leverage bulk procurement agreements and establish clear demand signals to incentivize manufacturers to produce more affordable devices. • Manufacturers should explore tiered pricing based on country income levels and leasing or pay-per-use models rather than outright purchase. • Focus on reducing the total cost of ownership, beyond the initial purchase price. This will ensure long-term sustainability by emphasizing durable designs, readily available spare parts, and accessible maintenance training.
Implementation timeframe	Medium to long term.
Key stakeholders	Manufacturers, procurement authorities, professional and hospital associations.

6. Research and development for paediatric refraction

Handheld autorefractor manufacturers should further invest in designing technologies optimized for the unique physiological characteristics of children's eyes in order to minimize the impact of accommodation.

This and previous studies have indicated that, though almost all the handheld autorefractor technologies (except the Badal Optometer) provided readings for refractive errors within the clinically acceptable limits, larger variability was noted for the paediatric age group (between 5 and 16 years). It is important to note that cycloplegia is not feasible in community health settings for large-scale eye and vision care programmes.

Key interventions	• Manufacturers should focus on technological enhancements that can minimize the need for cycloplegic refraction in children. • Explore the development of open-source or collaboratively designed autorefractor hardware and software, which could significantly reduce R&D costs. • Manufacturers/research institutions should continue to invest in publishing literature in peer-reviewed journals to disseminate knowledge and build a body of evidence around emerging technologies.
Implementation timeframe	Medium to long term.
Key stakeholders	Manufacturers.

ATscale
GLOBAL PARTNERSHIP FOR ASSISTIVE TECHNOLOGY
Hosted by UNOPS

atscalepartnership.org