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Delivering Refractive Care to Populations With Near and Distance Vision Impairment: 2 Novel Social Enterprise Models

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Abstract: Vision impairment due to refractive error affects crucial time periods across the life course—the educational years for children and working years for adults. Refractive error is easily and safely corrected with glasses, but many potential beneficiaries remain uncorrected due to various barriers, which can be addressed with innovative service delivery models. This review describes evidence-based initiatives from 2 social enterprises, Peek Vision and VisionSpring, addressing barriers to refractive error correction in children and working adults, particularly in low-resource settings. The reach, implementation challenges, adoption, and future development of these 2 novel models are described, and research evidence of program effectiveness is presented.

Key Words: low-middle income countries, near vision impairment, Peek Vision, presbyopia, refractive error, vision screening, VisionSpring

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Uncorrected refractive errors (URE) have profound implications across different stages of the life cycle. In children, URE can hamper a child's educational performance,[1–3] social interaction,[4,5] and future economic productivity.[6] In adults, uncorrected presbyopia can cause increased difficulties with activities of daily living[7,8] and reduce vision functioning[7] and quality of life.[8] Increasing trial evidence shows that correcting refractive error in children can improve academic achievement [2,9–12] and, in adults, it improves work productivity.[13] Unfortunately, those with URE and their families often continue to suffer unnecessary limitations due to poor access to high-quality, affordable eye care due to barriers of knowledge, geography, cost, and culture.[14] This article reviews initiatives from 2 social enterprises, Peek Vision and VisionSpring, designed to address these barriers and to improve the lives of children and adults.

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PEEK VISION

Peek Vision is a social enterprise that partners with organizations delivering eye care to extend the program's reach, efficiency, and equity. Peek has developed technology-enabled public health methodologies to determine eye health needs and support the continuous improvement of school and community eye health programs.

Peek Acuity is a validated,[16,18] certified (as a medical device) digital visual acuity (VA) test developed by Peek. Peek Acuity is available on Android devices and downloaded for use in more than 190 countries since its release in 2017. School and Community Eye Health programs powered by Peek have Peek Acuity embedded, and programs are in development or running in sub-Saharan Africa (Botswana, Ghana, Ethiopia, Kenya, Tanzania, Uganda, and Zimbabwe) and South Asia (India, Nepal, and Pakistan).

Peek Solutions use apps and other software to enable vision screening, eye health surveys, and community and school screening programs, connecting local services for clear referral pathways to treatment. Mobile data capture during these programs allows assessment of screening coverage, referral adherence, and treatment/intervention effectiveness. This can identify where in a pathway patient dropout occurs and whether a specific group is being underserved, making the unmet need visible. Peek's team of Program Managers and researchers work with the local implementing team to undertake a root cause analysis (evidence reviews). This helps identify at what point in a health system the change needs to be made to strengthen the patient pathway. These changes are made appropriately and iteratively. The software and survey tools developed at Peek and used in programs are validated in clinical trials and further developed to be suitable for partner use.

Evidence for Peek's Approach and Technology

The reliability of the digital distance acuity test, Peek Acuity, was initially demonstrated in a validation study in Kenya from 2013 to 2014, which was nested within the first cohort study of eye disease in sub-Saharan Africa.[15] The study compared the digital smartphone test results to those tested using a Snellen chart and back-illuminated Early Treatment Diabetic Retinopathy Study (ETDRS) logMAR charts in more than 270 adults.[16] Agreement of Peek Acuity with the reference-standard ETDRS

chart did not differ significantly when compared to Snellen with ETDRS ($P = 0.08$, 95% CI: 0.05–0.10). When used at home by a community health care worker, Peek Acuity was 85% sensitive and 98% specific compared to ETDRS charts for detecting eyes with severe vision impairment based on widely used local surgical cutoff point for operable cataracts (VA $\leq$ 6/60). Mean testing time showed that Peek Acuity (77 seconds, 95% CI: 71–84) took no longer than Snellen charts (82 seconds, 95% CI: 73–91, $P = 0.13$).

The acceptability of Peek, including Peek Acuity, was assessed in a qualitative study in Kenya[17] involving key stakeholders and concluded that "Peek was an acceptable solution, as it provides a beneficial service, supports patients' needs, and fulfills health care providers roles, overall contributing to strengthening eye health".

With an increase in the availability of mobile phone–based VA tests in the last decade, 2 systematic reviews compared different mobile acuity applications. In the first review,[18] of the 14 studies were considered to be of sufficient quality for inclusion, the best reproducibility and correlation with in-clinic VA results were found using the Peek Acuity app. In the second review,[19] of the 16 apps surveyed, Peek Acuity was one of 2 that was recognized for its quality as an app that could be integrated within clinical practice and used effectively in resource-constrained settings.

Peek Acuity is embedded in the Peek Capture platform, a data collection app that is configured through Peek Admin. The development of Peek Capture and Peek Admin has been built on 3 randomized controlled trials: school-based trials in Kenya[20] and India,[21] and a community-based trial in Kenya.[22] In 2015, in a cluster–randomized controlled trial, the Peek school eye health system was compared to standard screening in Trans Nzoia County, Kenya, to overcome several barriers: a low number of specialist eye health workers per population, poor screening quality when resources were available, and low adherence to referral for those identified. A total of 25 teachers tested 20,863 children's vision during a 2-week period across 50 schools (25 control, 25 intervention) and referred those with VA <6/12 in either eye for hospital treatment. The primary outcome was attendance at the hospital within 30 days of referral. Children in schools allocated to the control arm of the trial received the standard of care, which included screening using a Tumbling E card and a referral letter sent home with any child who screened positive. Those in the intervention arm were screened using Peek Acuity and given a Peek Acuity–generated vision simulation printout alongside the referral details. Parents and guardians were sent an automated, personalized SMS advising of their child's hospital appointment. Among children identified as having a vision impairment, the proportion attending their referral appointment was significantly higher in the Peek arm (54%) than the control arm (22%, $P < 0.0001$).[20] Results from this trial have led to additional funding to scale up the program countywide. Furthermore, learning from this trial led to an intermediary step between screening and the hospital, consisting of triage at a hub school, increasing referral adherence from 54% to 93%.[23] Peek is working with the Ministry of Health in Kenya to support the delivery of the 2020–2025 Kenyan National Strategic Eye Health Plan, which includes "strengthening referral pathways through validated mHealth tools such as Peek".

Research into the effectiveness of Peek has also provided useful findings that are translatable to other programs. The study in Kenya led to a cluster-randomized trial in 2017, in 50 schools in Hyderabad, India. This trial used Peek technology to track, and in part deliver a complex health intervention and gather evidence on its impact and effectiveness.[21,24] The study used PeekSim images (a simulated image that mimics the visual blur perceived by a child with URE error in one half and normal vision in the other half). These were used for classroom health education sessions. Postcard versions of these were also sent home with the children to show their parents. Voice messages were sent to parents to remind them to take their children to their appointments and to remind their children to adhere to spectacle wear. A total of 701 children were prescribed spectacles (intervention arm: 376, control arm: 325). Unannounced visits after 3 to 4 months were conducted to assess adherence to spectacle wear. A total of 535 out of 701 children (80%) were assessed [intervention arm: 291/352 (82.7%); standard arm: 244/314 (77.7%)]. Spectacle wear was similar in the intervention and control screening groups (53.6% and 52.9%). It was found that only 13.9% of parents had received the PeekSim images, while 70.3% had received voice messages, and 97.2% understood them.

These findings highlighted how behavior change is complex and that a false assumption had been made that children would pass on information to their parents. Using the Peek system, it was possible to review the trial data in real-time, disproving this assumption. When this is applied to a program, it can revolutionize service delivery by allowing evidence-based decisions to be made iteratively and rapidly.

Outside of the school setting, Peek has also been used to task-shift referral decisions to community volunteers, freeing up the time of clinical professionals to focus on appropriate tasks. Peek Community Screening used algorithms based on the World Health Organization (WHO) Africa Primary Eye Care algorithms as a starting point to iterate the algorithms to meet an agreed threshold of specificity and sensitivity.[25] Referral decisions made by community volunteers using the app were compared to those of experienced ophthalmic clinical officers in Trans Nzoia County, Kenya. Subsequent app iterations were developed until the community volunteers reached a sensitivity of 91.0% (95% CI: 87.7%–93.7%) and specificity of 78.1% (95% CI: 71.6%–83.6%).

A cluster–randomized controlled trial with the validated Community Volunteer algorithm compared referral adherence to the first point of care in Trans Nzoia County, Kenya, in 2018 and 2019.[25] Mean attendance rates at primary health clinics of patients with confirmed eye problems in the control group (522 per 10,000 residents, 95% CI: 418–625) was significantly less than that in the Peek intervention group (1429 per 10,000, 95% CI: 1228–1629, $P < 0.0001$). The case-mix coming to the Country Hospital also differed from the 3-year period before the trial,[26] increasing the proportion of people attending the hospital who needed priority specialist ophthalmic and refractive services (cataract, URE, and glaucoma) from 8% to 63% of all those attending the hospital, and reducing the proportion who could have been appropriately managed at the primary eye care level from 61% to 17%.

Future Developments

Population-based Surveys

School-based eye health programs are common globally, and Peek is working with implementing partners in 5 countries where

these programs are ongoing. Due to the lack of data, unsupported assumptions are often made when school eye health programs are initiated about the eye health needs of the specific population, the availability of spectacles and/or medical treatment, human resources and equipment, and context-specific challenges due to existing policies. Considering this, Peek is developing an innovative tool, the School Eye Health Rapid Assessment (SEHRA), to inform the implementation of school eye health programs and monitor and evaluate their impact. SEHRA will address the different areas that need to be explored before planning such programs, such as the magnitude and type of eye health issues requiring treatment, including the proportion with vision impairment; referral pathways to primary eye care, refractive, and specialist services; spectacle and medication supply chains; and barriers and challenges to spectacle access and compliance.

SEHRA builds on the digitization of the Rapid Assessment of Avoidable Blindness (RAAB) tool and Peek's School Eye Health program model and the existing RAAB7 survey, a digital, paperless upgrade to the traditional RAAB, developed by the International Centre for Eye Health[27] and Peek. Results from a RAAB survey can be used to plan and periodically monitor eye health in a population with key outputs in the over 50 years of the age cohort, including the prevalence of blindness and vision impairment, causes of blindness and vision impairment, effective coverage of cataract surgical service, and effective coverage of refractive error services. SEHRA is planned to be a similar comprehensive tool for school eye health programs. An advantage of using such tools before implementing a program is that they allow for standardized methodology and reporting—data are comparable between surveys, and the process can be repeated for monitoring and evaluation.

RAAB7 includes several methodological improvements and enhancements on its predecessor (RAAB6), including the assessment of uncorrected VA, enabling the computation of effective coverage of refractive error services in addition to effective cataract surgical coverage.[28,29]

Near Vision Testing

Most vision screening programs primarily assess distance visual acuity. In most cases, this can be easily corrected by the provision of distance correction spectacles. However, near vision impairment (NVI) is responsible for over half the global burden of vision impairment—uncorrected presbyopia was responsible for 510 million of the world's 1.1 billion visually impaired people in 2020.

Peek has recently developed a test of near visual acuity (NVA). This may be used alongside the Peek Acuity distance vision test or independently to provide a quantitative NVA "score" or as a binary screening tool to identify the presence of NVI according to the WHO definitions—inability to see N6 at a distance of 40 cm. This test is currently being validated in Nepal, which will allow programs to opt into testing for NVI, including presbyopia. Challenges remain in assessing hyperopia in school children due to their accommodation capacity.

The translation of evidence to programs with partners to deliver comprehensive school or community-based vision services remains Peek's focus over the coming years. Peek enables the collection of data that drives continuous quality improvement of programs and accelerates progress toward universal eye health coverage.

VISIONSPRING

VisionSpring is a pioneering social enterprise delivering vision screening and providing high-quality, affordable eyeglasses to low-income communities globally. VisionSpring works at the intersection of community health workers and optometrists, eye hospitals, vision centers and health facilities, government bodies, and the private sector in manufacturing, services delivery, and sales to address uncorrected refractive error, particularly NVI due to presbyopia. Central to these efforts is an unrelenting focus on the working poor—individuals who live on $4 or less per day who are among nearly 1 billion people globally without access to quality vision assessment and a simple pair of eyeglasses needed to work, learn, be safe on the roads and participate in civic life.[30]

Approach and Objectives

According to the WHO (2007), more than 90% of those with vision impairment live in low- and middle-income countries that lack the personnel, equipment, and distribution channels to provide comprehensive eye care services.[31] Hence, VisionSpring developed 2 core initiatives under the banner of its *See to Earn* program, both of which improve productivity, income earning potential, and quality of life for adults. The *Reading Glasses for Improved Livelihoods* (RGIL) in Bangladesh and Uganda delivers vision screening and reading glasses to rural areas through a national network of community health workers, and *Clear Vision Workplaces* (CVW) in India, Bangladesh, and Vietnam corrects factory workers' presbyopia and refractive errors at their place of employment. The large majority of participants in these programs are of working age, across various occupations, from workers on agricultural estates and in garment factories to informal sector weavers, artisans, and smallholder farmers.

In 2006, VisionSpring and BRAC (previously known as Bangladesh Rural Advancement Committee) launched the RGIL program in Bangladesh to deliver basic eye care services to low-income, mostly rural customers to increase individual productivity and household income. RGIL leverages BRAC's network of community health workers and trains them to carry out large-scale vision screening services and reading glasses sales in their communities to resolve uncorrected presbyopia. In 2017, RGIL was replicated in partnership with BRAC in Uganda.

To address the need for correction of near and distance refractive error among workers in factory settings, VisionSpring developed the CVW program. Teams of optometrists and outreach personnel conduct screenings and dispense both reading glasses and prescription glasses for garment, textile, and home goods workers, coupled with activities to encourage eyeglasses wearing. Since its commencement in 2017, CVW has rapidly grown to more than 205 factories in India, Bangladesh, and Vietnam, most producing for international brands. In 2018, VisionSpring extended the program to serve weavers and artisans working in self-help groups and cooperatives in India in collaboration with the Ministry of Textiles, the Ministry of Housing and Urban Affairs (under the national Smart Cities Mission which harnesses technologies for urban renewal), and the Export Promotion Council for Handicrafts.

By bringing vision correction to the locations where customers live and work, RGIL and CVW accelerate the uptake of eyeglasses in populations important to national economies and critical for sustaining household financial stability. The programs'

outcomes propel the achievement of multiple United Nations Sustainable Development Goals (SDGs),[32] specifically, *No Poverty (1), Health and Wellbeing (3),* and *Decent Work and Economic Growth (8)*.

What Is the Reach of the Programs?

The RGIL program is implemented nationally in Bangladesh, with more than 25,000 community health workers (CHWs)—mostly women—across 61 out of 64 districts. It is now implemented in 61 districts in Uganda with 1529 active community health promoters (CHPs). As of 2020, health workers had screened the vision of 7 million people, identifying 5.5 million with presbyopia. Of those needing reading glasses, 1.7 million people chose to purchase eyeglasses from health workers, 75% acquiring their first-ever pair of eyeglasses through the program.

The CVW program has screened close to 275,000 workers, with 42% requiring correction with distance or near eyeglasses. Of those receiving glasses—an equal split of women and men—more than 70% received eyeglasses for the very first time. VisionSpring has screened an additional 200,000 weavers and artisans in informal settings, with 68% requiring distance or near eyeglasses. Of those receiving glasses (68%)—again, an equal split of women and men—the majority (84%) received eyeglasses for the very first time. The distribution of refractive errors and suspected cataracts in the screened population in the 2 programs (from January 2018 to August 2021) is shown in Table 1.

The reason for the higher requirement for glasses among workers in the informal sector and RGIL is related to average customer age—45 years among artisans and weavers as compared to 33 for factory workers. As NVI increases with age, the older the workforce, the greater the need for vision correction.

How Effective Are the Programs?

In the evaluation of the CVW program (2018) in India and Bangladesh, workers self-reported a 16% average increase in productivity and noted improved quality of work as the most important eyeglasses benefit (58%). Factory supervisors subsequently reported a reduction in defects at quality checkpoints that ranged from 20% to 60%. Benefits of clear vision extended to their homes, where respondents reported that eyeglasses helped make their daily tasks easier – for example, removing stones from rice (respondents reporting "no difficulty" with the task increased from 13% before glasses to 72% after wearing glasses), text message and phone use (increased from 17% to 72%), reading newspapers or holy books (increased from 14% to 65%), and helping children with homework (increased from 22% to 54%).

These findings are further confirmed by the PROductivity Study of Presbyopia Elimination in Rural-dwellers (PROSPER)[13] trial, where a significant productivity increase of 22% was achieved in this rural cohort of tea leaf pickers by providing them with eyeglasses to correct presbyopia, with little cost and high intervention uptake. The increase in productivity was particularly evident for those over age 50, who experienced a 32%

Table 1. Distribution of Refractive Errors and Suspected Cataracts in the Screened Population From January 2018 to August 2021

	Reading Glasses for Improved Livelihoods Program§, No. (%)	Clear Vision Workplace Program,¶ Factories, No. (%)	Clear Vision Workplaces, Informal Sector,‖ No. (%)
Countries	Bangladesh, Uganda	Bangladesh, India, Vietnam	India
Target population	Adults engaged in a variety of occupations typical of rural communities	Garment, textile, and homegoods factory workers	Weavers, tailors, and artisans engaged in self-help groups, and cottage industry
Population screened	3,354,307	273,028	202,121
Male	1,286,698 (38.4%)	132,559 (48.6%)	104,093 (51.5%)
Female	2,067,609 (61.6%)	140,366 (51.4%)	98,025 (48.5%)
Mean age (y)	- -	33 (±10.27)	45 (±15.59)
Refractive error	2,068,928 (61.7%)*	114,376 (41.9%)	136,521 (67.5%)
Male RE	779,986 (37.7%)	42,328 (37.1%)	68,510 (50.2%)
Female RE	1,288,942 (62.3%)	72,009 (62.9%)	68,010 (49.8%)
Suspected cataract & other eye disorders (referrals)	559,206 (16.7%)†	13,088 (4.8%)	28,619 (14.2%)
Total glasses	567,727‡	110,826	116,952
-			
Near	567,727 (27.4%)	54,203 (48.9%)	65,702 (56.2%)
Distance	- -	56,633 (51.1%)	51,250 (43.8%)
First-time wearers	74.17%	72.2%	84.1%

RE indicates refractive error; RGIL, Reading Glasses for Improved Livelihoods

*For the RGIL, this is presbyopia only.

†Referrals for RGIL include refractive error (nonpresbyopia).

‡In the care of RGIL, these are the total eyeglasses purchased.

§Data from Bangladesh and Uganda.

¶Data from Bangladesh, India, and Vietnam.

||Data from India.

increase in productivity. In addition, nearly 95% of trial participants indicated that they were willing to pay for glasses if they lost or broke them.

What Challenges Have We Overcome?

The RGIL program has had to overcome numerous implementation challenges over the years. Three stand out in particular: first, helping CHWs learn basic sales skills as they were primarily oriented to providing health services and education; second, overcoming product and supply chain problems, particularly associated with high import duties and limited local manufacturing volume and quality; and third, improving purchase conversion rates among customers who are highly price-sensitive (most living on less than $2.50 per day) and who have limited awareness that reading glasses are an effective and affordable solution for their blurry vision problem.

The CVW program identified 4 key program delivery issues and implemented a number of adaptations. First, VisionSpring added early evening screening times to benefit factory workers on night shifts, and ensure 100% of the workers were covered. Second, female optometrists and counselors were hired to better reflect and serve a majority female customer base, some of whom felt more comfortable interacting with same-gender service providers due to cultural norms. Third, VisionSpring approached factory owners with direct requests for program sponsorship (at subsidized rates matched by the United States Agency for International Development) to strengthen ownership of vision screening and glasses as a workplace benefit and reduce the reliance on international brands who funded the program in their supply chains. Fourth, early CVW pilots revealed that up to 31% of factory workers were inconsistently wearing or not wearing their eyeglasses within 3 months of receiving them for reasons associated with losing or forgetting their glasses, comfort, and self-consciousness. To improve wearing habits and sustain the coverage rates of eyeglasses, VisionSpring built the capacity of 3696 factory floor managers and human resource, administrative, and medical staff as vision champions, receiving basic training in eye care and promotion of adherence to consistent eyeglasses wear. A subsequent program evaluation in 2020 indicated that vision champions required simplified training and ongoing support to reinforce their knowledge, engagement, and dispensing of replacement reading glasses.

Finally, due to the COVID-19 pandemic, starting in 2020, all programs integrated protocols for COVID safety and prevention and, in 2021, added vaccine awareness and hesitancy counseling. Strategies to promote glasses-wearing during a time of mask-wear require further study.

Are the Programs Replicated and Adopted Locally?

The RGIL program is the first program of its kind to promote and scale presbyopia screening and reading glasses dispensing through community health workers and pioneered shifting the task of visual acuity testing from the country's limited number of optometrists to nonspecialized workers at the primary care level. The Bangladesh Ministry of Health and Family Welfare has authorized the RGIL program approach, recognizing a) the competency of community health workers in performing basic vision screening and distributing readers as an over-the-counter product, and b) the benefits of having a large health workforce able to identify and refer more people with possible refractive errors and other eye conditions for higher-level care, including to the government's growing network of vision centers.

VisionSpring and BRAC replicated the RGIL program in Uganda starting in 2017, and other organizations have successfully established large-scale presbyopia screening and reading glasses dispensing programs with lower-level health workers, including Sightsavers with lady health workers in Pakistan and Vision for a Nation with government primary care nurses in Rwanda.

At the time of writing, VisionSpring and other eye care organizations are engaged with the ministries of health of Uganda and Ghana on plans to integrate presbyopia screening and reading glasses into their national primary care services. This includes the ministry of health training guidelines, which were complete for community nurses in Ghana in 2021 with the support of Vision for a Nation, and guidelines that are in process for community health workers in Uganda with the support of VisionSpring and other NGOs.

Additionally, the WHO is developing training to greater access to assistive products, including eyeglasses. This training includes modules for community health workers on basic eye care, presbyopia detection, reading glasses, and referral. The intention is to promote a standardized approach by which CHWs provide basic eye care and support national-level adoption. VisionSpring's founder, Dr Jordan Kassalow, serves on the technical working group, such that learnings from RGIL have helped inform the training content.

Additionally, the Global Partnership for Assistive Technology developed scaling strategies for 5 priority products (collectively known as ATScale 2030), including eyeglasses.[33] The ATScale 2030 plan for eyeglasses highlights the delivery of vision screening and reading glasses through CHWs and conducting workplace vision correction programs as promising models for increasing access to eyeglasses,[34] in part informed by VisionSpring's experience.

Further, the CVW program has broad support from the Bangladesh Garment Manufacturing and Export Association (BGMEA) which has recommended it to member factories for their consideration, and in India from the Ministry of Handloom and Textiles and the Export Promotion Council for Handicrafts which assist with artisan community identification and program introduction.

It has been a long journey from 2006, when VisionSpring first launched the RGIL program, to today when eyeglasses are recognized as a powerful tool for social and economic development, particularly for low-income working-age adults. Over this time, VisionSpring and other eye sector leaders have built the evidence base and developed scalable service delivery models, like RGIL and the CVW program.

Greater financing and adoption by national and state governments, for-profit and mission eye care providers, employers and brands, and international development agencies of such programs will serve to reach the new global target to increase "effective coverage of refractive error with spectacles or contact lenses" by 40% as adopted by member nations at the 74th World Health Assembly in 2021.[35] Further research is needed on the incremental cost to governments of adding vision correction with eyeglasses to their primary care and universal health services and the cost-benefit for businesses of sustaining vision correction as a workplace benefit.

CONCLUSIONS

The service delivery models of both Peek Vision and VisionSpring provide improved pathways of service delivery to populations with the greatest need by eliminating barriers to service uptake. Their success lies in their ability to understand and respond to the needs of the target populations in an evidence-driven fashion. The 2 organizations are constantly evolving and improving their models based on the data they collect, providing an excellent example to governments, communities, and nongovernmental organizations seeking to accelerate progress toward the SDGs through the delivery of eye care.

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