It is estimated that several million refractive procedures are performed each year. Due to cost and availability, most of them are performed in developed countries and refractive surgery is currently considered a luxury, targeting a small but affluent percentage of patients. Developing an effective delivery system for refractive surgery in developing countries could play a significant role in the elimination of avoidable visual disability due to uncorrected refractive errors.

Uncorrected refractive errors are a relevant cause of visual impairment. Unequally distributed among world regions, they are as concerning as cataracts, if not more so in some developing countries where they are recognized as a public health problem. In fact, they affect people without consideration of age, gender, or ethnicity but are strongly influenced by socioeconomic status, being both a cause and a consequence of poverty and limited access to medical eye care. Yet refractive errors can be simply diagnosed, measured, and corrected by spectacles, contact lenses, or surgery. Laser refractive surgery is one of the most notable achievements in medicine and should be affordable for those who need it most—the 90% of people with uncorrected refractive errors living in low-income settings.

The correction of refractive errors has been included as a priority in Vision 2020: The Right to Sight, the Global Initiative for the Elimination of Avoidable Blindness. HOW GREAT IS THE PROBLEM? The magnitude of uncorrected refractive errors was first estimated in 2002 because prior visual impairment estimations were based on corrected distance visual acuity. The presenting acuity concept was introduced as the acuity with whatever refractive correction the person is using. Considering visual impairment from all causes for the first time in 2004, the World Health Organization (WHO) estimated that uncorrected refractive errors were the leading cause of visual impairment and the second leading cause of blindness after cataract (the WHO defines blindness as presenting visual acuity worse than 20/400 in the better eye and visual impairment as presenting visual acuity ranging from 20/120 to 20/400).

At that time, approximately 13 million children aged 5 to 15 years were visually impaired due to uncorrected refractive errors, which leads to negative repercussions on their learning abilities. A significant percentage (29%) of people living with visual impairment due to uncorrected refractive errors were of working age. Because refractive errors manifest at a younger age than the other causes of visual impairment, uncorrected refractive errors are responsible for more years living with blindness than the other causes. In this way, it was estimated in an Indian state that uncorrected refractive errors related to blindness resulted in more than 30 years of blindness for each person compared with 5 years due to untreated cataract. The most recent WHO estimates (2010) indicate that 285 million people are visually impaired and 39 million of these are blind. The principal causes remain uncorrected refractive errors (43% or 120 million people) and cataract (33%). The principal cause of blindness is cataract (51%), with 21% being undetermined and uncorrected refractive errors accounting for only 3%. The decrease from 2004 to 2010 could be explained by methodology biases and the greater use of intraocular lenses in developing countries, reducing the part of aphakia as a cause of uncorrected refractive errors.

Uncorrected presbyopia also causes disability. Several studies have shown reduced quality of life in both the developed and developing world. In an elderly
Nigerian population, impairment of near vision had a significant impact on all domains of quality of life, including physical, psychological, social, and environmental, whereas the effect of distance visual impairment was limited to the environmental domain. More than half of this study population had no formal education, strengthening the fact that presbyopia correction is required not only for reading and writing but for activities of daily living, such as weeding or winnowing in a Tanzanian population and weaving mats or cleaning grains in a Fijian population.

The prevalence of uncorrected presbyopia was reported in 2005 for the first time (although it is not currently included in WHO estimates). As many as 517 million people are without adequate correction for functional presbyopia and 410 million of them experience significant disability in performing near vision tasks and activities. Without intervention, this number is predicted to increase to 563 million people by 2020. With 94% of these people living in developing countries, presbyopia remains the largest and most important source of reversible visual impairment in the world. When considering both uncorrected presbyopia and distance visual impairment, a total of 530 million people worldwide are experiencing a reversible visual disability due to uncorrected refractive errors.

WHAT FACTORS ARE TO BLAME?
The factors responsible for uncorrected refractive errors are lack of screening, lack of available services for testing, insufficient provision of corrective lenses, and cultural disincentives for the use of optical correction in some countries.

There are some issues to consider in the provision of spectacles. A direct dispensing strategy after refraction should be favored because there is a loss in capture if patients must return or go to a secondary site. Ready-made spectacles are convenient for this approach but, because of anisometropia and astigmatism, approximately half of the patients need a prescription rather than a direct dispensing of spectacles.

Spectacle manufacturing equipment requires significant investment and recycling systems are not sustainable, perpetuating dependency on outside resources. As a result, some patients receive spectacles inadequate for their refractive error.

Assuming that the average life span of spectacles is 2 to 5 years, repair and maintenance services should also be available. There may be a loss of capture if indigent patients need to seek out these services.

Contact lenses have limited application for general use in developing countries because there are obvious barriers to their widespread and ongoing use. Practitioner availability, patient education and follow-up, environmental hygiene, recurring material costs, and provision of equipment are some of the barriers.

ROLE OF MODERN REFRACTIVE SURGERY IN REFRACTIVE BLINDNESS
Refractive surgery offers certain advantages over spectacles to solve the problem of uncorrected refractive errors. It removes the necessity for delivery of spectacles and the constraints discussed above. It is also a lifetime solution for the pre-presbyopic individual.

Cultural disincentives are another obstacle resolved by refractive surgery. Even in populations where screening and provision of correction are free or accessible, there is non-compliance in the use of spectacles. Women, who in some cultures are subject to arranged marriages, are considered undesirable if they require spectacles for vision correction.

Many studies have shown marked improvement in quality of life after laser refractive surgery. Benefits are visual and non-visual, and include an increased sense of subjective well-being, adaptability, and self-efficacy. It is important to note that the quality of life reported by patients who had refractive surgery is higher when compared to patients who wear spectacles or contact lenses. In a vision-related quality of life comparison, individuals with myopia who had refractive surgery enjoyed the same quality of life as those with emmetropia. In contrast, those who wore spectacles and contact lenses had more difficulties in coping with life demands and fulfilling their roles, and also had less confidence in everyday activities.

Most patients are eligible for photorefractive keratectomy or LASIK. The procedures are simple, quick, and directly achievable after a careful refraction. If possible, LASIK should be the preferred treatment because it minimizes postoperative discomfort and convalescence. Presbyopia correction needs further discussion, but it should be noted that when targeting emmetropia for all, the patients with presbyopia will need near correction, which can readily be addressed by pre-made spectacles.

Uncorrected refractive errors are associated with measurable reductions in utility (a quality of life measure) regardless of whether near or distance vision is impaired, but worse when both are impaired. They affect not only the quality of life, but have severe consequences on educational and employment opportunities for millions of people worldwide.

Several studies have emphasized that the loss in economic productivity associated with visual impairment due to uncorrected refractive errors is greater than the cost of establishing facilities and operating
services required to deal with it.\textsuperscript{16-18} Because these estimations have been made with correction by spectacles, cost-effectiveness analyses should be considered for refractive surgery.

In a 2002 survey performed by our research group in Alicante, Spain, LASIK was always a cost-saving alternative to contact lenses. In comparison with spectacles, which are less expensive, LASIK matched the cost of lifetime spectacles at the level of 880 Euros.\textsuperscript{19} These data, which are specific to a refractive surgery private market, cannot be compared or extrapolated to the humanitarian refractive surgery effort, and this underlines the need for an economic model adapted to this concept.

The causes of blindness and visual impairment have changed in the past 20 years. Infective causes (particularly trachoma) and glaucoma have declined, whereas cataract has remained at the same level despite an increase in surgical output.\textsuperscript{20} There has been more attention to the burden of vision impairment from eye diseases than from uncorrected refractive errors. Refraction services should be included with eye care missions and cataract surgery campaigns. Collaboration between governmental, non-governmental, and private organizations is needed to solve the problem of uncorrected refractive errors.

**WHAT ARE THE NEXT STEPS?**

We suggest that a working group be established to develop a model integrating refractive surgery as an option complementary to spectacles into the strategy against visual disability due to uncorrected refractive errors. The International Society of Refractive Surgery has formulated a Humanitarian Refractive Surgery Project committee to begin looking into the development of a cost-effective model to address this global concern.

**REFERENCES**