Assessing the Effectiveness of Low Vision Rehabilitation in Children: An Observational Study

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PURPOSE. To evaluate the change in visual functioning (VF) using the L. V. Prasad-Functional Vision Questionnaire II (LVP-FVQ II) following multidisciplinary low vision rehabilitation (LVR) services in children with low vision (LV).

METHODS. Children with LV referred for the first time to the Centre for Sight Enhancement were administered the LVP-FVQ II at baseline and at 3 to 4 months’ follow-up to assess the outcomes of LVR. Participants’ responses to the LVP-FVQ II at baseline and follow-up were transformed into interval-level estimates of VF using Rasch analysis. Cohen’s d values (effect size) were used to estimate the magnitude of change in VF.

RESULTS. A total of 183 participants completed the rehabilitation (mean age, 11.9 years; male, 57%). More than one-half of the participants had retinal disorders (55%) and most were moderately visually impaired (<20/60–20/200, 76.5%). Using the LVP-FVQ II, significant improvement in VF after rehabilitation was recorded (P < 0.0001) and the increase in VF (SD) was 1.20 (1.82) logits. Using Cohen’s d, the magnitude of the improvement in LVR intervention at follow-up was found to be 0.75, indicating nearly large treatment effect.

CONCLUSIONS. Ours is the first study to provide strong evidence that LVR services result in nearly large and significant improvements in the overall VF in children with LV, regardless of the cause of LV. These results should encourage eye care professionals to refer children with LV to LVR services. Further investigation is needed to determine if the improvement in VF can be sustained over a longer duration (>4 months).

Keywords: effectiveness, low vision rehabilitation, children, visual impairment, Rasch analysis, low vision

Estimates suggest that approximately 90% of individuals with low vision (LV) have useful residual vision and could benefit from LV rehabilitation (LVR) services. The aim of LVR is to increase the use of functional vision, facilitating an independent lifestyle. Given this, LVR is a highly valued intervention that has significant impact on individuals’ lives and activities. Service providers are under increasing pressure to demonstrate the effectiveness of their services to ensure the continued funding of their programs. Demonstration of effectiveness of LVR is vital, given the competing demands for the allocation of limited resources in eye care. Recent systematic review of studies of the effectiveness of LVR services in adults concluded that there is a wide variability in the quality of research as well as the magnitude of the effects reported and the outcome measures. Historically (until 2000), LVR outcome studies have involved asking adult patients about their satisfaction with the LVR or the use of LV devices (LVDs). Some studies have used performance-based indicators of functional ability (e.g., reading speed and duration, identifying paper currency, and clock reading). The reported success rates of LVR in adults have typically ranged from 23% to 97%; however, a consistent definition of success is lacking. The past decade has witnessed a shift toward the use of patient-reported outcome measures (PROs) that involve obtaining patients’ perception of ability before and after LVR. Several researchers have used PROs to demonstrate the effectiveness of LVR in adults. Recently, Stelmack et al.19 showed a large improvement in visual function (VF) after a Veterans Affairs interdisciplinary outpatient intervention on the Veterans Affairs Low Vision Visual Function Questionnaire-8. This trial used patients on the waiting list as the control group. The largest effect size (ES) was found for reading at 4 months post LVR. By comparison, the waiting list control group showed a small decline in all aspects of VF over the 4 months. There is very little evidence on LVR outcomes in children. The only evidence that exists relates to reading ability and use of LVDs. There has been no study as yet that has used PROs in children to examine the effectiveness of LVR. Part of the difficulty lies in the availability of a very few well-developed PROs for children with visual impairment (VI), coupled with the relatively uncommon prevalence of VI in children. However, this vulnerable patient group is a priority given that VI in children affects their educational and social development. Several studies have shown a high rate of successful use of LVDs among children compared with adults. Recently two PROs have been developed for use with children with VI: the Cardiff Visual Ability Questionnaire for Children and Impact of Vision Impairment for Children. Additionally, a revised version of the L. V. Prasad-Functional Vision Questionnaire, the LVP-FVQ II, was developed for use in India. It has been estimated that, worldwide, only 5% to 10% of people with VI who could benefit from LVR are...
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accessing the services. To tackle the poor coverage of LVR in India, a new initiative in the form of strengthening the LVR services was approved in the 11th 5-year (2007–2012) plan under the National Program for Control of Blindness in the country. Furthermore, government institutions, such as medical colleges, are being developed as LV units in a phased manner in the country.

The Vision Rehabilitation Centres (VRC) of the L. V. Prasad Eye Institute (LVPEI; a tertiary eye care center), Hyderabad, located in the Southern state of Telangana (35.2 million population in 2011), India, is a recognized provider of comprehensive LVR services in the country since 1997. Although these services have been provided for more than a decade in the region, the effectiveness of these LVR services in India is unknown. The aim of the present observational study was to evaluate the LVR outcomes using the LVP-FVQ II in a sample of children with LV in India.

METHODS

Participants

Participants were referred to the Centre for Sight Enhancement (CSE), VRC, at the LVPEI, Hyderabad, India, for management of LV. All the children were referred from the outpatient services and specialty clinics of the LVPEI. The initial detailed ophthalmologic examinations established the diagnosis and cause for LV. Participants were those who were first-visit patients of CSE, had self-reported difficulty with performing everyday tasks, were enrolled in mainstream schools (grades 3–10), could perform standard clinical vision tests, could speak English, Telugu, or Hindi, and were able to respond to the items (questions) on the LVP-FVQ II. We included children with visual acuity of 20/20 in the better eye (n = 3) because they had accompanying visual field loss in this eye (less than 20 degrees). We excluded children with disabilities, such as sensory, physical, and/or intellectual, those who were prior users of LVDs, and children who were unable to speak English, Hindi, or Telugu. Ethical approval was obtained from the Ethics Committee for Human Research of the LVPEI and the research adhered to the tenets of the Declaration of Helsinki. Informed consent was obtained from the participants and his or her parent(s) or caregiver after a detailed explanation of the study.

Instrument

The LVP-FVQ II. The LVP-FVQ II consists of 23 items (Table 1). Participants are asked to rate the amount of difficulty experienced with 22 tasks using the following three categories: 1, no difficulty; 2, some difficulty; 3, a lot of difficulty. One item was excluded (7) because it had accompanying visual field loss in the eye (less than 20 degrees). We obtained a rating of 1 because they had accompanying visual field loss in this eye (less than 20 degrees). We excluded children with disabilities, such as sensory, physical, and/or intellectual, those who were prior users of LVDs, and children who were unable to speak English, Hindi, or Telugu. Ethical approval was obtained from the Ethics Committee for Human Research of the LVPEI and the research adhered to the tenets of the Declaration of Helsinki. Informed consent was obtained from the participants and his or her parent(s) or caregiver after a detailed explanation of the study.

The LVR Program. Details of the LVR program at VRC, LVPEI have been published earlier. Two VRC centers of the LVPEI provided the LVR service, namely, the Meera and L. B. Deshpande Centre for Sight Enhancement, and the Dr P. R. K. Prasad Centre for Rehabilitation of the Blind and Visually Impaired. The interdisciplinary team included optometrists, special educators, orientation and mobility (O and M) instructors, rehabilitation professionals, information and communication technology instructors, and physiotherapists. The LVR commenced with the optometrist (trained in LV)

reviewing the patient’s history, establishing the goals of the LV clinic visit, recording the clinical measures of vision, refraction and determination of the best-spectacle corrected visual acuity for distance and near, and visual field assessment (where required) using Humphrey Visual Field Analyzer (Carl Zeiss Meditec, Inc., Dublin, CA, USA). Depending on the requirement of the task, and magnification assessment for distance and near, LVDs were demonstrated. The optical LVDs included monocular handheld telescopes, spectacle-mounted telescopes, dome magnifiers, and stand and pocket magnifiers. Electronic devices included portable video magnifiers and closed-circuit television. Nonoptical devices included reading stand, reading lamp, filter for glare control, and needle threader. Following the choice of the LVD(s), children were provided training in use of the prescribed LVD(s). In addition, those who required training in O and M, and in use of computers (special software, screen magnification and screen reading), and in activities of daily living, were provided the same by the rehabilitation professionals at the center. Finally, the LVDs were dispensed at the center and a review appointment was made within 3 to 4 months to assess the use of LVD(s) by the patient, and to evaluate the effectiveness of the intervention. Two to three telephone reminders (separated by a week) were provided for those who failed to keep their follow-up appointment. If the patient failed to return for the follow-up visit, he or she was excluded from the study. Any LVD or glasses prescribed were to be purchased by the patient. Some patients who were economically underprivileged were provided partial waivers through an indigent fund available for this purpose.

Procedure

The LVP-FVQ II was administered in English, Telugu, or Hindi, by trained interviewers in a face-to-face interview on two occasions at the center; once at baseline and subsequently at the follow-up visit scheduled 3 to 4 months from the baseline. This duration was considered to be adequate for children to have gained some experience in the use of the prescribed LVD(s) at home and/or at school, and to have practiced the rehabilitation strategies. The interview was conducted using a written script by a different trained interviewer at each visit. The interviewers were not involved in the LVR process and they were masked to the results of the baseline LVP-FVQ II.

Statistical Analysis

We examined the spread of responses for each item on the LVP-FVQ II to determine if there were tasks rated as “not difficult” by most participants. This helped minimize the impact of intervention on ES by decreasing the ceiling effects, as has been recommended for evaluating LVR outcomes. We excluded six items (numbers 1, 9, 15, 19, 20, and 21), which were either rated at baseline as “not difficult” by at least 80% of the participants, and/or were not applicable for at least 50% of the participants. A total of 17 items remained for further analyses. Higher negative LVP-FVQ II scores (in logits) indicate higher VF (lower visual disability).

We determined that presenting visual acuity (PVA) was significantly associated with the baseline LVP-FVQ II scores; therefore, we used the mixed between-within subjects ANOVA to determine if the impact of LVR differed with varying levels of PVA as well as with age. Based on the PVA in the better eye, we categorized the participants into three groups: mild VI (20/60 or better with a visual field of less than 20 degrees in better eye), moderate VI or LV (20/60–20/200), and legal blindness (<20/200). We categorized the participants in two groups based on median age (<12 years and ≥12 years). The effects of other
Table 1. Item Content of the LVP-FVQ II

<table>
<thead>
<tr>
<th>Item Description</th>
</tr>
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<tbody>
<tr>
<td>Reading the bus numbers</td>
</tr>
<tr>
<td>Finding out the next line while reading</td>
</tr>
<tr>
<td>Locating dropped objects</td>
</tr>
<tr>
<td>Threading a needle</td>
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<tr>
<td>Locating ball while playing in the daytime</td>
</tr>
<tr>
<td>Copying from your friend’s notebook</td>
</tr>
<tr>
<td>Reading the price labels on items (e.g., chips pack, biscuit pack)</td>
</tr>
<tr>
<td>Reading the phone numbers on mobile phone</td>
</tr>
<tr>
<td>Watching TV</td>
</tr>
<tr>
<td>Seeing time in your wrist watch</td>
</tr>
<tr>
<td>Reading from a computer screen</td>
</tr>
<tr>
<td>Copying the small letters from the board</td>
</tr>
<tr>
<td>Walking on uneven ground</td>
</tr>
<tr>
<td>Reading shop names</td>
</tr>
<tr>
<td>Seeing animals in zoo</td>
</tr>
<tr>
<td>Identifying dirt, stains on your own clothes</td>
</tr>
<tr>
<td>Reading your books at near</td>
</tr>
<tr>
<td>Seeing your friend in the playground while playing</td>
</tr>
<tr>
<td>Watching a movie at the theatre</td>
</tr>
<tr>
<td>Selecting a song using iPod</td>
</tr>
<tr>
<td>Playing video games</td>
</tr>
<tr>
<td>Seeing the numbers and markings on the scale</td>
</tr>
<tr>
<td>How well do you think you can perform all your activities in comparison with your normally sighted friends?</td>
</tr>
</tbody>
</table>

characteristics, such as sex (male versus female), cause of LV (retinal versus nonretinal), and level of VI on the likelihood of change in LVP-FVQ-II scores were explored.

We performed Rasch analysis on the stacked data set (baseline and follow-up) of all the patients in a single analysis. Data were anchored to item measures and structured calibrations at baseline. During stacking, however, one would be concerned with local dependencies. Local dependency means that the response to any item is unrelated to any other item when the level of underlying construct is controlled for. To minimize the effect of local dependency, we used anchor values from a random sample in the stacked data.17

Low vision rehabilitation outcome was calculated using ES (i.e., Cohen d),38 and standardized response mean (SRM). Effect size is defined as mean LVP-FVQ-II score change divided by the SD of the LVP-FVQ-II scores at baseline. Standardized response mean is defined as the mean score change divided by the SD of the change score. The ES, as well as SRM, provide direct information on the magnitude of change in the measure, expressed in terms of some measure of variation in the change scores. Both ES and SRM are expressed in SD units and can be interpreted through conventional benchmarks as indicating small (<0.2), moderate (0.5–0.7), and large (≥0.8) effect, respectively.38,40 MedCalc software (version 14.8; MedCalc Software, Ostend, Belgium) was used to estimate the ES and SRM. The success of LVR was defined as a statistically significant ($P < 0.05$) difference in the total LVP-FVQ-II score for each participant between administrations, as determined using SPSS statistical software (version 19.0; SPSS Science, Chicago, IL, USA). A two-sided paired t-test at 5% significance level was used to assess whether the change in VF scores from baseline to follow-up was significantly different from zero.

**RESULTS**

Between February 2012 and March 2013, 1408 children with LV in the age group 8 to 16 years were provided LVR services. Of these, 597 children (28%) were identified and recruited for this study. Some of the most frequent reasons for exclusion were current/prior user of LVDs, having discontinued schooling, and an inability to speak/understand one of the three languages (English, Hindi, or Telugu) of administration of the LVP-FVQ-II. Of the 397 children recruited, 183 (46%) completed follow-up assessments, a rate similar to studies in adults. Children had to visit the clinic for follow-up and were dependent on their parents/caregivers. Common reasons for failure to return for a follow-up assessment were the need to travel long distances that imposed a financial burden on the family, other commitments for parents, parents’ decision for the child to go without LVR, refusal, and inability to be contacted over phone/mail. Participants who completed the LVR did not differ from those who failed to complete the study. Both groups were found to be similar in age, sex, PVA, cause of LV, and location of residence ($P > 0.05$).

The sociodemographic and clinical characteristics of the 183 participants are outlined in Table 2. This sample is representative of the patient population referred for LVR services. A little more than one-half of the participants were from urban areas and had LV caused by retinal disorders. More than three-fourths of the participants had moderate vision impairment (76.5%). The specific components of the LVR service used by our participants are shown in Table 3. A little more than one-third of the participants (39%) acquired the prescribed LVDs. Almost one-quarter of these participants (26%) received a partial waiver for purchase of the LVDs. Telescope for distance tasks (such as for board work) was the most frequently acquired optical LVD. Educational guidance and counseling were the most frequently provided services by the rehabilitation professionals. Educational guidance included provision of a recommendation letter to school about need for child to be seated in the front row and be allowed extra time to
scores between mild VI (n = 140), moderate VI or LV (n = 140), and legally blind (n = 29) groups across the two time points (baseline and follow-up) showed that PVA did not have an interaction effect with the change in visual disability (Wilks λ = 0.98, F2,180 = 1.89, P = 0.15). However, there was a main effect for LVR (Wilks λ = 0.89, F1,180 = 20.3, P < 0.0001) with the LVP-FVQ II scores improving significantly following LVR services across all three groups of participants.

Effectiveness of the LVR at the Subgroup Level
There was no significant interaction effect among the LVR change and sex, cause of VI (retinal versus nonretinal), duration of VI, and location of residence (urban versus rural). We also examined the effects of compliance with LVDs and rehabilitative strategies provided by the LVR practitioner. We divided our participants into two groups: compliant and noncompliant. We found a significant interaction effect with LVR change (Wilks λ = 0.61, F1,181 = 113.6, P < 0.0001) between the overall group, the post-LVR score (−3.44 ± 1.42 logits) was significantly higher than the pre-LVR score (−1.22 ± 1.61 logits, P < 0.0001) for the compliant group; however, Cohen’s d was 1.40 (95% CI 1.09 to −1.71) indicative of a large ES. By comparison, the post-LVR score (−1.41 ± 1.74 logits) was not significantly different from the pre-LVR score (−1.46 ± 1.57 logits; P = 0.71) for the noncompliant group. In addition, we examined the effect of age on change in LVR. When participants were categorized according to their median age (12 years) into two groups (younger [<12 years] and older [≥12 years]), there was a significant interaction effect with LVR change (Wilks λ = 0.91, F1,90 = 9.33, P = 0.003).

**DISCUSSION**
This study used a PRO to investigate the effectiveness of LVR in children with VI. The findings indicate that LVR provided by our center, as measured by the LVP-FVQ II, resulted in nearly large (Cohen’s d = 0.75) and significant improvement in the overall functional visual ability of children with LV. These findings are consistent with the published results of similar studies of improvement of overall functional ability in adults with VI following LVR, using PROs.1,2,19,20,41,42

The instruments used in adults have assessed vision-specific quality of life15 in addition to visual disability and contain several subscales, such as reading, emotional well-being, mobility, visual motor skill, visual information processing, and mobility. By comparison, the LVP-FVQ II measures visual disability and does not contain any subscales by design. Given that our study population consisted of children and that they have limited attention span, it was necessary to use an optimally short instrument. In a recent study, we demonstrated that the LVP-FVQ II possesses superior psychometric properties as compared with the LVP-FVQ, thereby rendering it suitable to assess the effectiveness of LVR interventions in our patient population.31 Among the various benefits of Rasch-based scoring are the lower SEs and increased measurement precision by expanding the instrument at the upper and lower extreme ranges of the scale as compared with summative-based scoring.44,45 Consequently, the Rasch-based scoring is
expected to perform better than the summative-based scoring in detecting changes when pre- and post-LVR scores are involved.

The LVR service provided at our center has several components that include educational guidance and counseling, training in O and M, prescription of LVDs and training in their use, prescription of glasses, and instructions in daily living skills. Given that we provided the usual LVR care to all the participants and did not follow a specific protocol for this study, it is difficult to specifically determine which of the components or a combination of components of our LVR services is primarily responsible for the treatment effect observed. Nonetheless, it is reasonable to hypothesize that the improvement in functional visual ability among our participants was related to a combination of the use of LVDs that render performance of tasks easier, and the different rehabilitation strategies for everyday activities. Our participants had to pay (part or full) for the devices out of pocket. Only a little more than one-third (39%) of our participants acquired the prescribed LVDs. Some of the common reasons cited for lack of acquisition of the LVDs included cost, associated cosmetic blemish with its use, parental concerns regarding loss of the device, and the need for frequent replacement resulting in economic burden. Therefore, it is difficult to comment on the potential for further improvement of the ES if all the participants had acquired the LVDs and made use of the comprehensive services. Similar to the observations of the investigators of the RAND Health Insurance Experiment, the coverage of the cost of the devices may affect the acquisition rate of the devices, which may in turn, improve the treatment outcomes (ES). If the ES truly does change significantly with provision of LVDs at no cost to the participants, then this could have policy implications for provision of LVR services in India. Despite that 90% of the world’s visually impaired live in developing countries such as India, and the many benefits of LVR, in India, these services are available in only a very few urban-based tertiary eye care centers (all privately funded). Consequently, a huge population with VI is still out of reach of the LVR services in the country. Despite a relatively small proportion of participants acquiring the prescribed LVDs, we obtained a nearly large improvement in the functional visual ability following LVR among our participants. The fact that most of the participants (76.5%) had moderate VI could have also contributed to such a result. The observed ES is much larger than that obtained for adults in an Australian population. The favorable results of our study suggest that children with LV and their parents/caregivers should use the LVR services in India. These findings are of most interest to clinicians and researchers (both in primary eye care and in LV), health service managers, government, and policy makers.

The Hawthorne effect should be considered a plausibility, as has been reported in studies of adults with VI. Given that the interviewers at baseline and at follow-up were different, it is unlikely that children were familiar with the interviewer at the follow-up visit, reducing the possibility that the children wanted to please him or her by choosing the lower response categories. Therefore, we believe that the impact of the Hawthorne effect on the LVP-FVQ II scores would be minimal, if any.

In our study, the gain in functional visual ability did not vary significantly by the cause of LV, sex, level of VI, location of residence, or duration of VI. We found significant interaction of LVR change and age of the participants in the mixed-effect models. Participants aged 12 years or older exhibited significantly larger improvements than those younger than 12 years. These differences are difficult to explain, given that the presenting visual acuities in the better eye were not significantly different between the two groups (0.74 ± 0.28 vs. 0.71 ± 0.32, P = 0.99). However, it is possible that children aged 12 years or older were more dependent on their vision to perform everyday activities and had a relatively higher number of visually demanding tasks to perform, which would show greater benefit of LVR. In addition, we believe that the difference in the number of tasks that were applicable to the two groups may have contributed to the difference. Although 32% of the tasks were not applicable to more than half of those younger than 12 years, only 9% of the tasks were not applicable to those 12 years or older. This difference may have caused the scoring to be more variable in the younger age group. The significant interaction between LVR change and compliance is not unexpected, given that the outcomes of LVR or any other treatment are dependent on the compliance with the treatment recommendations.

Our study did not include a control group for comparison. Thus, it is difficult to determine if the overall visual disability would have worsened in the absence of any LVR.

In conclusion, our observational study demonstrates nearly large improvement in overall functional visual ability of children with LV through provision of LVR services. These results should encourage eye care professionals (both ophthalmologists and optometrists) to refer children with LV for LVR services. Further research is required to understand if the ES obtained at 3 to 4 months post LVR can be sustained over a longer period and also determine specifically which of the components of the LVR services are used maximally by children with LV so as to effectively plan increases in these services.

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References


