Are Clinical Measures Good Indicators of Performance of Daily Activities in Vision-Impaired Children

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ABSTRACT

Purpose: The aim of the study was to identify whether clinical measures of visual acuity and contrast sensitivity were good indicators of self-perceived performance of activities of daily living (ADL) tasks in vision-impaired school aged children.

Methods: Clinical measures and performance of visual function were assessed in 22 participants (11 fully sighted and 11 vision-impaired children), aged 5 to 15 years. Distance acuity was assessed by LogMAR chart and contrast sensitivity was measured by Vistech grating contrast sensitivity. Additionally, colour vision was also assessed using Ishihara plates as a control. Performance of visual function was evaluated by completion of one of two modified Visual Acuity Questionnaires (VAQ). This questionnaire measured self-perceived level of difficulty in undertaking specified activities graded on a five-point Likert scale. Results of clinical measures were correlated against VAQ scores.

Results: Vision impaired participants reported greater difficulty performing VAQ visual functions than sighted participants. There was an overall trend of a weak to moderate positive correlation between visual acuity and difficulty in performing daily activities measured on the VAQ and a weak to moderate negative correlation between contrast sensitivity and performing daily activities measured on the VAQ.

Conclusion: Data from this study indicated that visual acuity and contrast sensitivity were weak indicators of general performance of visual function. Whilst this represents pilot data the trends demonstrated were similar to others reported in the literature. Further investigation should be undertaken in this domain of low vision, as many intervention programs are directed by clinical measures.

Key words: vision-impairment, visual acuity, contrast sensitivity, activities of daily living, performance of visual function.

INTRODUCTION

Vision is the primary sense of modality used to integrate and co-ordinate the senses during development. Therefore vision loss early in life adversely impacts on the amalgamation of the sensory system, which is essential in learning and developing skills for daily living. A better understanding of the use of clinical vision measures as an indicator of visual performance would form a sound basis for development of effective intervention strategies.

Traditionally, practitioners use clinical measures of vision, in particular visual acuity and contrast sensitivity, as indicators of visual function. Researchers have sought to ascertain whether or not this is a reliable and valid practice.

Currently, many of the studies surrounding functional performance in the vision impaired are centred on the adult population. For a variety of reasons there is a paucity of research investigating vision and performance of activities of daily living (ADL) in vision-impaired children. Physical tasks and the individual's self-concept and their ability to observe and interact with society in various contexts and environments[1].

Until recently, there had been few low vision studies that have sought to establish a scientific understanding of the relationship between vision measures and performance of visual function[2,3]. However, these investigations primarily involve adult populations and yield conflicting results.

Observation based instruments tend to have strong positive correlation with clinical measures while self-perceived questionnaire based instruments showed weaker correlations[2,4,5,6].

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Findings of several cross-sectional surveys and comparative cohort studies concerned with relationships between clinical measures and performance of ADL in the vision-impaired population were variable. Some studies in this area identified strong positive correlation between visual acuity and contrast sensitivity for general ADL tasks, and with specific activities such as face recognition, reading performance, mobility and spatial perception[2,7]. Others report only weak correlation between vision measures and general performance of ADL[5,8]. Inconsistency in outcomes could be a result of inconsistency of measuring instruments used to measure ADL. Whilst there are a number of instruments to measure ADL in vision impaired populations none have universal acceptance. This lack of agreement may reflect the unspecified psychometric properties of the tests and that some have been developed for specific areas of pathology[1,3,5].

Inconsistency in previous findings might also be due to the variety of clinical instruments being used. The logMAR chart has been widely established as the gold standard for assessment of visual acuity however such uniformity has not been recognized for contrast sensitivity. Many low vision studies used the Pelli-Robson chart to assess contrast sensitivity function whilst others have used the Melbourne Edge test, the low contrast visual acuity test and the Vistech[2,7,9]. The Pelli-Robson chart uses a consistent spatial frequency with decreasing contrast. Hence it is not surprising that researchers report the Pelli-Robson to yield moderate correlation when addressing contrast function in medium to low spatial frequencies, such as mobility[10] and often yield weak correlation when used to assess higher spatial frequency tasks such as face recognition or reading performance in children. Although sine wave grating contrast sensitivity tests are less widely used than the Pelli-Robson, Owsley and Sloane[11] found contrast sensitivity assessed at various spatial frequencies correlated well with real-world targets in the middle to low spatial frequencies. The authors have reported that contrast sensitivity function at 6cpd obtained the strongest correlation with "real world" targets, such as faces, road signs and objects.

The research to date has mostly studied the relationship between observed or perceived measures of vision and performance of ADL. These studies have related to adults and there is no evidence to indicate that these outcomes will be similar for children. In addition previous research has provided inconsistent and conflicting results.

There is insufficient paediatric research available to indicate whether a relationship exists between clinical measures and performance of ADL. This research used a causal-comparative correlational design to identify whether clinical measures of visual acuity and contrast sensitivity were good indicators of performance of daily tasks and which if either was a better predictor.

METHOD

This study included 11 sighted (4 male, 7 female) and 11 vision-impaired participants (8 male, 3 female). Participants were further divided by educational level: Primary school, aged 5-12years (M= 8.5 years) and Secondary School, aged 12-15years (M=13years).

Vision-impaired participants were recruited using quota sampling from Vision Australia clients living in Canberra and Melbourne. Sighted participants were recruited using incidental sampling from children of family, friends and professional colleagues' of the primary investigator (ND) with vision of 6/6 or better and no history of ocular pathology. Informed consent was gained from parents/guardians of all participants and informed consent or accent was given by all participants. Potential participants with physical or cognitive conditions that may impair their ability to perform ADLs and those with vision less than 6/120 were excluded from the study.

Participants were assessed in Canberra (n=18) and Melbourne (n=3). The environmental lighting conditions were similar in both environments and the illumination levels for all clinical tests where measured prior to conducting every test. All participants wore current glasses or contact lenses to correct for refractive errors. All testing procedures were performed with both eyes open as this reflected the normal viewing situation and therefore reflected the daily activity conditions.

Visual acuity was measured using the high contrast Bailey Lovie logMAR chart at 6 metres or 3 metres. The measurement was recorded at threshold in logMAR decimals. Threshold was defined as the line which at least 3 out of 5 optotypes were correctly recognized[12].

Contrast sensitivity was measured using Vistech contrast sensitivity chart at 3 metres. Contrast sensitivity was recorded at threshold. Threshold was defined as the least contrast discrimination of each spatial frequency [12].

Colour vision using the Ishihara and estimation of visual field by confrontation were assessed to control for variables that may affect the results of the performance of ADL.

Performance of ADL was assessed using one of two modified Visual Activity Questionnaires (VAQ)[4]. After an extensive search, only one test, the LV Prasad-Functional Vision Questionnaire (LVP-FVQ)[13] was found to specifically assess vision-impaired children. However, this instrument was not culturally appropriate for use with Australian children. An observed based assessment tool to assess performance of visual function was not chosen as there were no observed based tools identified that met the needs of school age children.

The VAQ is a validated research tool designed for use with adults[8,14]. The VAQ provides a direct comparison between clinical measures and eight different aspects of vision function: colour discrimination, glare sensitivity, light/dark

adaptation, acuity/spatial vision, depth perception, peripheral vision, visual search and visual processing speed.

The original questionnaire comprised 33 closed ended questions with a five-point Likert type scale (Never to Always). The VAQ was modified to 24 and 29 item questionnaires. Inappropriate items were deleted and the wording of some items modified so they were age appropriate, but the intent of each item remained the same. For example "I tend to confuse colours" was substituted with "I sometimes mix up colours". The modified questionnaires were reviewed by six experts (three Primary school teachers and three Secondary school teachers, respectively) in child development and behaviour. This review was conducted to ensure age appropriate language was used and to ensure the tasks asked were relevant to the age group. The selected experts were independent of the research project.

Participants attending Primary school completed 24 questions suited to the activities of 6-11year olds and required some parental assistance. Participants enrolled in Secondary school completed 29 questions suited to the activities of 12-18 year olds. The responses from the two age groups were analysed collectively and the composite score for each VAQ visual subscale was calculated. The composite score for a visual function was defined by Sloan and colleagues[4] as "the mean response for the items listed for that visual function." Modification of the questions may have impacted on results and as such is a limitation of the study.

This research was a causal-comparative correlational design. Clinical measures and VAQ composite scores were analysed using Microsoft SPSS version 10.0.

Descriptive statistics including frequencies, mode, median, minimum, maximum, mean, standard deviation, skewness and kurtosis were initially established. Non-parametric Spearman correlation coefficient was employed to analyse the nature, strength and direction of the correlation between each VAQ visual function and visual acuity and contrast sensitivity.

RESULTS

The 22 subjects recruited for this study were aged between 5 to 15 years and 12 of the participants were female. The mean age was 9.96 (SD 2.75) years. The research sample consisted of two equal cohorts of vision impaired and sighted children (n=11). The pathologies causing vision impairment were distributed as follows: ocular albinism 45% (n=5), retinitis pigmentosa 18% (n=2) and Stargardt disease, congenital nystagmus, cone dystrophy and aniridia 9% (n=1). These demographics are similar to those reported in other paediatric low vision studies[9,13].

The mean visual acuity for sighted participants was -0.30 logMAR ± 0.10 or better than 6/6 Snellen. The mean visual acuity for the vision-impaired participants was 0.63 logMAR ±0.23, approximately 6/24 Snellen.

Comparison of the mean values of contrast sensitivity of each cohort is displayed in Figure 1. The mean values for contrast sensitivity for the sighted cohort were within the normal range of contrast function. The vision-impaired participants' contrast sensitivity function at 1.5cpd was within the lower limits of the normal range, however the remaining frequencies (3, 6, 12 and 18cpd) were below the norm. The results of contrast sensitivity of the vision-impaired participants also demonstrated that a greater percentage of contrast was required when the spatial frequency increased (i.e. level of detail increased).

Sighted cohort — — —
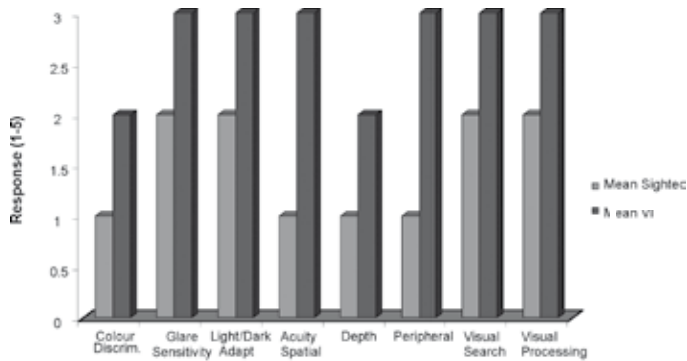Vision Impaired cohort ———
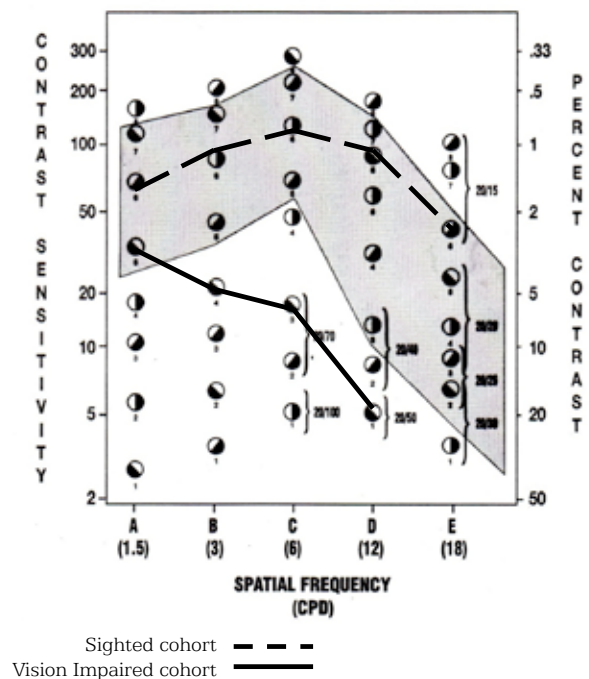
Figure 1. A log plot of mean contrast sensitivity measures as a function of spatial frequency. Results are plotted for sighted (dashed line) and vision-impaired participants (solid line).

Figure 2 compares the sighted and vision-impaired mean response to each VAQ subscale. The graph shows that the majority of the vision-impaired participants reported more difficulty in performing the VAQ visual functions.

Spearman's correlation between visual acuity and contrast sensitivity (at 1.5, 3,6,12 and 18cpd) indicated a significant moderate to strong negative correlation (r^2 = -0.63, -0.87, -0.85, -0.85 and –0.83, p< 0.01 respectively). That is, as acuity decreased, the level of contrast required for differentiation (vision) increased.

Analysis of correlation between each VAQ subscale and visual acuity and contrast sensitivity is displayed in Table 1. The results demonstrated a significant positive weak to moderate correlation between visual acuity and the VAQ visual functions. This suggests that as acuity decreases, the reported level of difficulty also increased when performing the activities of each subscale.

Figure 2. Comparison of the mean values of the VAQ responses between sighted and vision impared cohorts.

Correlation between contrast sensitivity and VAQ subscales indicated a significant weak to moderate negative relationship. This suggests that when contrast was reduced, participants reported a greater difficulty to perform each task. Furthermore, the reported level of difficulty to perform the visual functions increased, as the spatial frequency increased, indicating that as the visual demand of the task increased the task became more difficult to complete.

The contrast sensitivity results indicated that lower spatial frequencies (i.e. 1.5cpd, approximately 3/60 Snellen) demonstrated a weak negative correlation with contrast sensitivity. This suggests contrast sensitivity was a poor indicator of visual function and high contrast was required to ADL when vision was severely reduced. However, contrast sensitivity at moderate to high spatial frequencies (i.e. 3-18cpd or approximately 6/60-6/6) was a good indicators of visual function and performance of ADL.

Both visual acuity and contrast sensitivity had similar strength of correlation with the VAQ subscales. The visual search subscale had the strongest positive correlation with visual acuity ($r^2 = 0.71$, p< 0.01) and the strongest negative correlation with contrast sensitivity at medium to high spatial frequencies (r^2= -0.66, -0.70, -0.68 and -0.68, p< 0.01 respectively). Stronger correlations where also identified between the clinical measures and colour discrimination, acuity/spatial vision and peripheral vision. Glare disability had the weakest correlation with clinical measures.

DISCUSSION

A weak to moderate correlation, existed between clinical measures and visual function indicative of performance of ADL. The strength and direction of correlation between clinical measures and the VAQ visual functions were varied, suggesting that clinical measures were weak indicators of general visual performance with neither visual acuity nor contrast sensitivity being more sensitive. However, correlation between clinical measures and individual VAQ subscales indicated that these clinical measures were applicable indicators for visual search, colour discrimination, acuity/spatial vision and peripheral vision related tasks. The data indicated that as visual acuity and contrast decreased there was greater difficulty in performing ADL. These trends are similar to those reported in the literature [2,5,6,13]

The frequency of reported difficulty to perform the VAQ visual function tasks was greater in the vision-impaired cohort than their sighted peers. This data supports findings of previous studies that vision-impaired participants had increased self-perceived difficulty to perform visual tasks [2,5,13,15].

	visual acuity	contrast 1.5cpd	contrast 3cpd	contrast 6cpd	contrast 12cp	contrast 18cpd
Table 1. Analysis of correlation of each VAQ subscale and visual acuity and contrast sensitivity. Spearman's Correlation Coefficient of the sample population.						
colour discrimination	0.64**	-0.55**	-0.66**	-0.69**	-0.68**	-0.50**
glare disability	0.50	-0.30	-0.37	-0.45**	-0.43**	-0.39
light dark adaption	0.57**	-0.36**	-0.53*	-0.52*	-0.59	-0.52*
acuity/spatial vision	0.69**	-0.52*	-0.62*	-0.61**	-0.67**	-0.62**
depth perception	0.58**	-0.49*	-0.46*	-0.46*	-0.52*	-0.40
peripheral vision	0.64**	-0.39	-0.62**	-0.62**	-0.612**	-0.68**
visual search	0.71**	0.50*	-0.66**	-0.70**	-0.68**	-0.68**
visual processing speed	0.52*	-0.33	-0.38	-0.38	-0.45*	-0.51*

*   Correlation is significant at the).05 level (2-tailed).

**   Correlation is significant at the 0.01 level (2-tailed).

The trends between clinical measures and the VAQ subscales were consistent with previous studies using the VAQ to assess visual function in vision-impaired participantS[4,8]. Although the strength of correlation between clinical measures and performance of ADL varied among previous studies, as did the instruments used to assess clinical measures and performance of ADL, measures of contrast sensitivity and visual acuity remained indicative of visual functions related to performance of ADL[2,5,13].

Furthermore, the results of the present study support previous results that used self-perceived questionnaire assessment of ADL. Conversely, the findings were less consistent with those that used observation-based assessment of ADL. This is plausible pattern as the literature indicates that underlying emotional and psychosocial factors somewhat influence self-perceived assessment where as objective observed tasks reduce this effect.

The data reported in this paper represent a pilot study and can only be considered as indicative trend data. However, the data supports the need for a larger age and sex matched comparative study. A valid instrument specifically designed to assess age appropriate daily living tasks is required to assess Australian vision-impaired children. The instrument should incorporate both observed based and self-perceived questionnaire items to provide a comprehensive understanding of performance of ADL in children. Furthermore, a longitudinal study may provide data on the relative rate of development of ADL between sighted and vision impaired children. It may also provide information on whether intervention, based on clinical measures, can influence that rate. The present study also highlights the need for development of an age appropriate instrument for assessment of performance of ADL.

CONCLUSION

This pilot study is one of the first Australian studies to investigate comparison of clinical measures of visual acuity and contrast sensitivity with perceived performance of ADL in vision-impaired children. This investigation found that vision-impaired children generally have greater difficulty to perform visual tasks than their sighted counterparts. Increased contrast appeared to reduce the impact of sight loss in relation to performance of ADL in the vision-impaired cohort.

Although visual acuity and contrast sensitivity had an overall weak to moderate relationship with perceived performance of ADL, these clinical measures provide some information that can be used by service providers to develop individualised intervention programs. Based on this study there was no difference in relevance of clinical data related to visual acuity or contrast sensitivity as a predictor of perceived ability to perform ADL.

Data from this study indicated trends between clinical measures and self perceived performance of ADL. Nevertheless, it is important that further investigation is undertaken in this domain of low vision, as many intervention programs are directed by clinical measures. The development of a valid instrument based on both psychometric and qualitative data to assess functional performance in vision-impaired children is essential in order to establish clinical norms for this population. Rehabilitation strategies for children with vision impairment should be developed with a full understanding of the value and relevance of clinical measures as indicators of visual function.

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